[OR02-05] FURTHER ANALYSIS OF THE ASSOCIATIONS BETWEEN AIR POLLUTION SOURCE FACTORS AND MORTALITY IN A SMALL AREA NEAR THE MONITORING SITE IN PHOENIX, 1995-1997.

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Tuesday, April 1, 2003, 8:00 AM, Oral Session: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:00 AM-9:30 AM) Kings Garden South

Recent questions concerning the validity of results from the General Additive Model (GAM) using nonparametric smooths, as implemented in current statistical software packages, has led to concerns about the reliability of results from epidemiologic studies using GAM. In addition, new studies using the Phoenix data base have led to an interest in re-investigations in which missing temperature and relative humidity are replaced with imputed values using measurements from the Phoenix Sky Harbor airport (thus increasing the data days from 700 to 765). Also, we were interested in examining the difference between replacing missing source factor data with the average value compared to omitting days with missing source factor data. Results for various models including GAM-D (default convergence criteria), GAM-S (stricter convergence criteria), and GLM (General Linear Model with natural splines) will be reported for both treatments of missing values. Although there are some variations in calculated values of beta and standard error among the models, the major conclusions are unchanged. Factors associated with regional sulfate, vehicular traffic (including resuspended road dust), and vegetative burning are statistically significant. Regional sulfate yields a higher statistical significance and beta than sulfate from XRF measurements of sulfur, presumably because the regional sulfate factor discriminates against coarse particle sulfate from soil or construction/demolition activities. The three source factors are statistically significant on different lag days, regional sulfate on lag day zero, vehicular traffic on lag day one, and vegetative burning on lag day three. These difference in time between exposure and death suggest the possibility of different biological mechanisms for the different types of particles.

% Increase in Risk of Cardiovascular Mortality per Interquartile Increase in Source Factor with 95% Confidence Intervals

	GAM-D (Missing values replaced with average)	GLM +60days (Days with missing values omitted)
Regional Sulfate	5.8 (0.2-11.7)	7.1 (0.9-13.6)
Vehicular Traffic	6.7 (1.7-12.0)	5.0 (0.1-10.1)
Vegetative Burning	5.0 (1.3- 8.8)	4.3 (0.4- 8.3)

[OR02-03] A CASE CROSSOVER ANALYSIS OF PARTICULATE AIR POLLUTION AND CARDIAC ARRHYTHMIA IN PATIENTS WITH IMPLANTABLE CARDIOVERTER DEFIBRILLATORS.

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Tuesday, April 1, 2003, 8:00 AM, Oral Session: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:00 AM-9:30 AM) Kings Garden South

We investigated the relationship between air pollution and cardiac arrhythmia in a study of patients with implantable cardioverter defibrillators (ICDs). Thirty-four patients (ages 15-85, 80% male) with ICDs residing in the Vancouver area were included in the analyses, representing all patients attending the two ICD clinics in the study region who had recorded at least one ICD discharge during the February 14 to December 31, 2001 study period. Air pollutant ($PM_{2.5}$, PM_{10}, SO_4^{2-}, elemental carbon [EC], organic carbon [OC], O_3, SO_2, NO_2 and CO) concentrations on days with ICD discharges ('case days') were compared to control days (7 days before and after each case day) in case crossover analyses. ICD discharges occurring within 72 hours of one another were grouped and considered as one discharge event-day. Temperature, relative humidity, barometric pressure, rainfall and windspeed were included simultaneously as covariates. Sensitivity analyses were conducted to examine the effect of grouping ICD discharges, of including meteorological variables, and including/excluding discharges that were considered inappropriate by a cardiologist. As in previous studies, mean concentrations and interquartile ranges of air pollutants in Vancouver were low. Although in general there were no statistically significant results, there were consistent trends indicating associations between pollutants and ICD discharges. Odds ratios (OR) were consistently higher in summer (7 of 9 were > 1) than in winter (only 1 of 9 > 1) and the highest ORs were observed for lag 0. While an OR of 1.5 (0.51 -4.7) was found in summer at lag 0 for PM_{10}, no indications of associations were observed for $PM_{2.5}$ or SO_4^{2-}. For local combustion-source pollutants, EC, OC, CO and SO_2, ORs were elevated above 1 at all lags (0-3 days) in summer. These findings suggest a weak association between summertime combustion-source primary air pollutants and cardiac arrhythmia.

[OR02-08] THE SUSCEPTIBILITY OF OLDER ADULTS TO AIR POLLUTION.

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Tuesday, April 1, 2003, 8:00 AM, Oral Session: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:00 AM-9:30 AM) Kings Garden South

While older adults clearly have higher overall risks of dying from air pollution due to their higher underlying risks, it is less clear that their relative risk (RR) from air pollution is higher. We consider two data sets, one looking at the risks of long-term exposure to PM, and one at the risk of acute exposures. We compare the RR's of dying from Particulate Matter (PM) air pollution to investigate the age dependence of risk from PM air pollution.

In the analysis of long-term pollution exposures, we consider the national American Cancer Society (ACS) Cancer Prevention II cohort. After controlling for other risk factors, using a Cox-Proportional Hazards Model we found that there is a 1.06 RR of death from Cardiopulmonary disease associated with long-term exposure to 10 ug/m3 of PM2.5 over the period 1982-1998 (Pope et al, JAMA, 2002). We have now reanalyzed these data to consider the pollution RR's for adults <75 yrs. old vs. those 75+ . We find the 10 ug/m3 PM2.5 Cardio-pulmonary RR for 75+ to be greater than for those <75 years of age (RR = 1.049;CI=1.023-1.076 for those < 75, vs. RR = 1.098;CI=1.050-1.148 for those 75+).

In an analysis of short-term PM exposures, we consider daily mortality in New York City for the years 1985-1994. After controlling for other factors such as season and weather using a Generalized Additive Model (GAM), the PM10 RR for Circulatory Deaths without Respiratory disease listed as a cofactor on the death certificate is similar for both adults <75 and adults 75+ years of age (RR per 18 ug/m3 PM10 = 1.027; CI=1.012-1.043 vs. RR=1.022; CI=1.008-1.035, respectively). However, for deaths in which respiratory disease was listed as a co-factor, the PM10 RR for persons <75 is approximately half that for those 75+ years of age (RR per 18 ug/m3 PM10 = 1.033; CI=0.98-1.089 for those <75 vs. RR=1.066; CI=1.027-1.106 for those 75+ years of age). This indicates that higher acute cardiovascular risks from air pollution are found in older adults who have co-existing respiratory disease. Thus, the cardiovascular Relative Risk from long and short term exposure to air pollution are apparently higher per ug/m3 in older adults than younger adults, especially among those who have respiratory disease.

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[OR02-07] A COMPARISON OF HEALTH EFFECTS FROM EXPOSURE TO AMBIENT AND NON-AMBIENT PARTICLES.

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Tuesday, April 1, 2003, 8:00 AM, Oral Session: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:00 AM-9:30 AM) Kings Garden South

The plausibility of epidemiological associations between adverse health effects and outdoor concentrations of airborne particulate matter (PM) is supported by studies demonstrating high correlations between individual exposures to ambient PM and ambient PM concentrations. Since personal exposure to PM is dominated by exposure to non-ambient particles, it is also important to evaluate the potential health impacts of these exposures. In summer 1998, personal exposures to $PM_{2.5}$ and sulfate, and ambient concentrations of PM_{10}, $PM_{2.5}$ and sulfate were measured for a repeated measures (7 repeats) panel study of respiratory and cardiovascular effects in chronic obstructive pulmonary disease (COPD) patients (n=16) in Vancouver. In a further analysis of this dataset, we used an estimation method based on time-activity data and the use of sulfate as a marker for the infiltration of ambient particles with the same size distribution, to develop separate estimates of exposures to ambient $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ and to non-ambient $PM_{2.5}$. The concentrations and health effects of these estimated exposures were compared to the originally measured total personal exposures and to measured ambient concentrations. As in previous studies, personal exposures to $PM_{2.5}$ were dominated by exposures to non-ambient $PM_{2.5}$ (56% on average) which were uncorrelated with exposures to ambient $PM_{2.5}$ and to measured ambient $PM_{2.5}$. For lung function the largest effect estimates were for exposures to ambient $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$. Systolic blood pressure was negatively associated with ambient PM_{10} and $PM_{10-2.5}$ and to a lesser extent with exposures to ambient PM_{10} and $PM_{10-2.5}$. Increased heart rate and increased supraventricular ectopic heartbeats were associated with all ambient PM measures except for sulfate and with exposures to ambient $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$. Heart rate variability measures showed less consistency; decreased r-MSSD was associated with ambient concentrations of $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$, however no associations between SDNN and any PM parameters were observed. Neither exposures to non-ambient PM nor measured personal PM were associated with any of the health outcomes. Results, especially for the lung function, heart rate and heart rate variability outcomes, were sensitive to inclusion of one day of exposure associated with transported Asian dust, with larger effect estimates observed when this day was excluded. Overall, these results indicate the lack of associations between non-ambient PM and any of the measured health outcomes, whereas ambient coarse fraction ($PM_{10-2.5}$) mass, in addition to ambient $PM_{2.5}$, was associated with some adverse effects.

[OR02-01] METANALYSIS OF THE IMPACT OF PM10 ON PREMATURE MORTALITY.

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Tuesday, April 1, 2003, 8:00 AM, Oral Session: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:00 AM-9:30 AM) Kings Garden South

Many analyses have been conducted worldwide to estimate the health benefits from air pollution abatement. A key issue in the estimation of these benefits is the unit risk of the concentration-response function. Among all effects, premature mortality is with no doubt the most important. When local studies (i.e. studies conducted in the same region or city in which the benefits of abatement are being calculated) are available, they are usually used directly in benefit estimation. When no local studies are available, the current practice is to extrapolate results from a similar locality, or to take an average (sometimes weighted) of a given set of studies. However, these methods do no consider the difference in conditions of the target place from the original study place.

In this work we present a meta-analysis of studies of the short term impacts of particulate matter (PM10) impacts on premature mortality, considering explicitly the factors that may influence it. Through a weighted regression model, a meta-analysis of the PM unit risk for a sample of 85 cities around the world was performed, considering as explanatory variables the average concentrations of air pollutants, the monitoring sites density, the mean temperature, the city's surface, the population density, the percentage of population over 65 years old, the average annual mortality rate, and gross income per capita.

Population density, average concentration of PM10, and mean temperature had the greater explanatory power. The effect of PM10 concentrations on unit risk was negative, with the slope decreasing 0.000035 for each 10 μg/m3 of PM10. The effects of temperature and population density were both positive. The proposed model allows to better predicting the effect of particulate matter on mortality for any city on the base of its environmental and demographic attributes.

[OR02-06] ASSOCIATION OF SINGLE AND MULTIPLE COMPONENTS OF PM AND HUMAN MORTALITY IN ATLANTA, GA.

Rebecca J Klemm None, Klemm Analysis Group, Inc., Washington, DC

Tuesday, April 1, 2003, 8:00 AM, Oral Session: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:00 AM-9:30 AM) Kings Garden South

Aerosol Research and Inhalation Epidemiological Study (ARIES) is a program sponsored by the Electric Power Research Institute (EPRI) that involves the collection of air quality and meteorological data at a single site in Fulton County of Atlanta, GA. High-resolution air quality indicators (AQI) are used to examine statistical relationships between air quality and health outcome endpoints. Contemporaneous mortality data are collected for Fulton and DeKalb counties in Georgia. Currently, 24 months of AQI, weather, and mortality data are available for analysis, from August 1998 through July 2000.

We compare the estimated associations of daily mortality and two dozen AQI using Poisson regression in a generalized linear models (GLM) framework. The estimated log-linear association of mortality with various AQI is adjusted for smoothed functions of time and meteorological data using natural splines. Our analysis considers daily deaths due to non-accidental causes by whether the decedent was at least 65 years of age. Associations are also investigated by subgroups of decedents defined by cause of death: deaths due to respiratory conditions, deaths due to circulatory conditions, deaths due to non-circulatory or non-respiratory conditions, and deaths due to cancer.

We also investigate the interaction of various AQI by using comparable models with two AQI, the impact of the placement and number of knots on the estimated associations, and whether the death occurred in Fulton or DeKalb Counties. A chart compares the effect of degrees of freedom for time in the estimated association of fine particles in Atlanta compared to six other cities, and a parallel chart shows the changes in the standard error of the estimated associations. In general, as the number of degrees of freedom for time increases, the estimated associations decrease, and the standard errors eventually begin to increase. The drop is very fast for Atlanta, partly due to a shorter time series and less seasonality.

$PM_{2.5}$, PM_{10} and oxygenated hydrocarbons (OHC) appear strongest in the presence of other AQI in Atlanta. Graphical displays illustrate differences in estimated associations, by AQI alone, and in combination with other AQI. The impact of the number and location of knots are graphically compared by cause of death and AQI. They show, for example, that deaths due to respiratory conditions are more sensitive to whether time is smoothed using monthly knots or quarterly knots. Results are not sensitive to changes in fixed placement of the knots within each month or quarter.

[OR02-02] BEYOND THE HARVESTING EFFECT: MEASURING THE EFFECT OF LONG TERM TSP EXPOSURE ON LIFE EXPECTANCY.

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Tuesday, April 1, 2003, 8:00 AM, Oral Session: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:00 AM-9:30 AM) Kings Garden South

In a recent paper, Murray and Nelson (JAWMA, 2000) attempt to quantify the effect of exposure to tsp on life expectancy. Using daily Philadelphia data from 1974 through 1988, they estimate the unobserved atrisk population, and conclude that short term exposure to tsp has a small effect on life expectancy. The main result that exposure to tsp reduced life expectancy by at most 2 days is consistent with what has been termed the harvesting hypothesis.

One weakness of the Murray and Nelson model is that it does not allow entry into the atrisk pool to be affected by longer term exposure to pollution. In this study, we extend the model of Murray and Nelson to allow for the possibility that longer term exposure to tsp influences entry into the pool of atrisk individuals. We postulate the existence of an unobserved atrisk population, and an unobserved process via which individuals are allowed to enter the atrisk population after being exposed to longer term pollution. We use moving averages of tsp to proxy for long run pollution. The model is cast into state space form, and the Kalman filter is used to estimate atrisk population, entry into the atrisk population, and life expectancy.

Our main result is that while longer term exposure to tsp does indeed increase the pool of atrisk individuals, this effect is quite small. Therefore, while the data appear to be inconsistent with the "harvesting only" hypothesis, the effect of longer term exposure to tsp appears to be much smaller than has been indicated elsewhere in the literature.

[OR03-06] EFFECTS OF ACUTE AND SUBCHRONIC EXPOSURE TO CONCENTRATED AMBIENT PARTICULATES IN HEALTHY AND COMPROMISED RODENTS.

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Tuesday, April 1, 2003, 8:00 AM, Oral Session: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:00 AM-9:30 AM) Kings Garden North

A host of epidemiological studies have reported a slight but consistent association between exposure to higher concentrations of ambient particulate matter (PM) and excess cardiopulmonary-related morbidity and mortality. To further examine this phenomenon, we exposed various rodent models of cardiopulmonary dysfunction to Concentrated Ambient Particulates (CAPs) from Research Triangle Park, NC, and monitored changes in indices of cardiopulmonary function and injury. Animal models used included young (3 mo) Spontaneously Hypertensive (Y-SH), old (11 mo) Spontaneously Hypertensive (O-SH), and healthy (SD) and monocrotaline-treated Sprague-Dawley (MCT-SD) rats. Subsets of animals were implanted with radiotelemeters (Data Sciences International) to monitor (5-min intervalsX24h/d) electrocardiogram (ECG), heart rate (HR), systemic blood pressure (BP), and core temperature (T_{co}). Exposure protocols for Y-SH rats were either Continuous (4h/dX2-3d/wkX11wk) or Intermittent (4h/dX1d/wkX11wk) while SD, MCT-SD, and O-SH were exposed 4h/dX2-3d/wkX1wk. All exposures were conducted in nose-only exposure chambers. Pulmonary function tests (Buxco Electronics) were performed on all animals before, during, and after exposures. At the termination of the study, animals underwent bronchoalveolar lavage (BAL) and the BAL fluid was examined for biochemical indices of pulmonary injury and inflammation. Heart and lung tissues were harvested for histological and morphological analyses. PM exposure concentrations ranged from 135-1600$\mu g/m^3$. In general, despite the variety of exposure protocols and compromised animal models used, these studies demonstrated minimal adverse effects on cardiopulmonary and thermoregulatory function in cardiopulmonary-compromised rats after exposure to RTP CAPs. As such, these studies underscore the inherent complexities of conducting discrete, limited toxicology studies using environmentally-relevant exposure protocols in order to verify large scale epidemiological studies. Furthermore, these studies emphasize the importance of companion source characterization/apportionment studies to the overall PM research effort. (Abstract does not represent USEPA policy. This research was supported in part by EPA CT826513.)

[OR03-02] EFFECTS OF CONCENTRATED AMBIENT PARTICLES ON HEMODYNAMIC PARAMETERS IN SPONTANEOUS HYPERTENSIVE RATS.

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Tuesday, April 1, 2003, 8:00 AM, Oral Session: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:00 AM-9:30 AM) Kings Garden North

Epidemiological studies have shown that increased concentration of ambient particles is associated with cardiovascular morbidity and mortality. However, the exact mechanisms remain unclear. Recent studies have revealed that particulate air pollution exposure is associated with indicators of autonomic function including heart rate (HR), blood pressure (BP), and heart rate variability (HRV). However, this association has not been clearly demonstrated in animal studies. To overcome the problems of wide variations in diseased animals and circadian cycles, we have developed a novel approach using mixed-effects model to investigate whether ambient particle exposure was associated with the changes of HR, BP, QA interval (QAI), and HRV in diseased animals. QAI reflects the ventricular contractility, anwas calculated to represent HRV. In this study, spontaneously hypertensive rats were implanted with radiotelemetry and exposed to concentrated ambient particles generated by an air particle concentrator developed by Sioutas et al. Four rats were held in nose-only exposure chambers for 6 hours per day exposing to concentrated particles for 2-6 times and filtered air for 2-5 times in the periods of February-March and June-July, 2002. The particle number concentrations for tested animals ranged between 7-46x104/m3 in February-March and 13-40x104/m3 in June-July. Statistical analysis using mixed-effects models revealed that particle exposure was associated with changes in HR, BP, and QAI after particle exposure, the hourly-averaged heart rate increased for a maximal of 53 beats per minute in the period of February-March ($p < 0.01$) and 38 beats per minute in the period of June-July ($p < 0.01$). The hourly-mean blood pressure also increased after the particle exposure for a maximal of 11 mmHg ($p < 0.01$) in February-March but not in June-July. QAI was found to decrease after PM exposure in the periods of February-March and June-July. These changes of HR, BP and QAI were observed during the particle exposure, then returned to the baseline within 2-3 hours after the end of exposure. The results of the particle effects on SDNN will be presented in the meeting. Our findings suggest that ambient particles may induce alterations in the autonomic nervous function.

[OR03-01] META ANALYSIS OF DUTCH INHALATION TOXICITY STUDIES WITH CONCENTRATED PARTICULATE MATTER IN COMPROMISED RATS.

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Tuesday, April 1, 2003, 8:00 AM, Oral Session: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:00 AM-9:30 AM) Kings Garden North

Ambient particulate matter (PM) can be seen as a complex mixture of fractions with greater and with lesser health relevance. The most efficient and cost-effective reduction of health effects will be achieved by reducing the most toxic part of PM. Although significant progress has been made over the past few years, there are currently only suggestions for the causal fractions, as they have not yet been identified. Studies with concentrated ambient PM0.15-2.5 (CAPs) have been performed in experimental animals since 1998. This paper will present an overview on the only CAPs studies performed in Europe.

Experiments were focussed on 1-day inhalation exposures in healthy and compromised rats thereby mimicking possible human risk groups primarily focussing on pulmonary inflammation and blood hypertension. Studies have been performed in an industrialized area in the city of Utrecht as well as a location that is strongly dominated by freeway emissions. It was hypothesized that exposure to CAPs resulted in an oxidative stress, which subsequently induces (pro) inflammatory mediators, endothelium damage and blood viscosity, supporting the plausibility of PM induced cardiovascular effects. The effects of CAPs exposures were studied two days post exposure focussing on pathology and cell proliferation, bronchiolar lavage analysis (including cytokines, cell viability and proliferation, Clara cell protein CC16), and blood analyses (endothelines, fibrinogen, cell differentials). There is no PM mass concentration-effect relationship for the investigated parameters. Inhalation up to 2000 ug CAPs/m3 did not induce severe toxic or pathological effects in the lung. Cell proliferation (BrdU-labeling of predominantly Clara cells in the terminal bronchioles) is frequently increased after exposure to CAPs, as well as indicators for oxidative stress in the lungs. Signs of PM being able to cause adverse effects in both healthy and compromised animals and humans are emerging. The available evidence from CAPs exposures studies in healthy and compromised animals advocates that PM mass concentrations are not evidently correlated with the adverse health effects. This suggests that other metrics might be more appropriate, like chemical composition or physical properties.

[OR03-07] EXPERIMENTAL EXPOSURES OF ASTHMATIC AND HEALTHY VOLUNTEERS TO CONCENTRATED AMBIENT COARSE PARTICLES IN LOS ANGELES.

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Tuesday, April 1, 2003, 8:00 AM, Oral Session: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:00 AM-9:30 AM) Kings Garden North

Twelve asthmatic and 4 healthy adults were exposed to filtered air (FA) and to concentrated ambient coarse particles (CCP) using 15 parallel virtual impactors interfaced to a whole-body exposure chamber. Exposures lasted 2 hr with intermittent exercise. Mean CCP concentration was 157 (range 56-218) $\mu g/m^3$ by continuous monitoring with a tapered-element oscillating microbalance (TEOM); on average, 85% was coarse (2.5-10 μm aerodynamic diameter) and the rest <2.5 μm. No clinically important symptoms were observed during/after CCP, relative to FA, and CCP did not significantly alter spirometry, arterial O_2 saturation, or airway inflammation as judged from total cell counts of induced sputum. After CCP, small increases in heart rate and decreases in several measures of heart rate variabililty were statistically significant ($P < .05$) or suggestive ($P < .1$). Conclusion: Exposures to ambient coarse particles had no obvious pulmonary effects but appeared to alter autonomic nervous system influence on the heart.

[OR03-04] EXPOSURE TO CONCENTRATED FINE AND ULTRAFINE AMBIENT PARTICLES NEAR HEAVILY TRAFFICKED ROADS INDUCES ALLERGIC REACTIONS IN MICE.

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Tuesday, April 1, 2003, 8:00 AM, Oral Session: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:00 AM-9:30 AM) Kings Garden North

The goal of this study was to test the hypotheses that: (1) mobile emissions will exacerbate airway inflammation and allergic airway disease; (2) the magnitude of allergic airway disease responses will be greater at sites with higher concentrations of ultrafine particles; and (3) organic and inorganic PM constituents that can generate ROS will be associated with responses. Ovalbumin (OVA)-sensitized Balb/c mice were exposed to concentrated fine and ultrafine ambient particles (CAPs), to purified air, at three sites at increasing distances downwind from a heavily trafficked roadway. The three sites were 50m (BH1), 100m (BH2) and 500m (BH3) downwind. The average mass concentration for the CAPs exposures at each of the 3 sites was maintained at 400 micrograms per cubic meter. The exposures were conducted for 4 hours per day, 5 days per week for 2 weeks. Prior to each day's exposure, OVA was administered to each mouse by nasal instillation. Two weeks after the final exposure the mice were challenged with OVA aerosol. Their lungs were lavaged and blood samples were obtained. The numbers of inflammatory cells (PMN) and eosinophils (EOS) in BAL were determined. The lavage fluid was analyzed for interleukin-5 (IL-5) and interleukin-13 (IL-13). The serum was analyzed to quantitate the amounts of OVA-specific antibodies (IgE and IgG1). These endpoints represent important hallmarks of allergic and asthmatic responses.

Exposure to CAPs elicited significant increases in numbers of eosinophils, increased concentrations of IL-5 in lavage fluid and increased concentration of OVA-specific IgG1 in blood serum in mice exposed at BH1, but not BH2 or BH3, compared to measurements in mice exposed to purified air. A 2-factor analysis of variance showed that for each of these endpoints mice exposed at BH1 showed changes consistent with allergic responses to the OVA-challenge following CAPs exposure but not after purified air exposure (EOS, $p = 0.04$; IL-5, $p < 0.001$; IgG1, $p = 0.002$). Particle numbers at BH1 were 5 to 8 times those measured at BH2 or BH3 during the exposures.

The results of this study suggest that exposure to fine and ultrafine particles at sites near a heavily trafficked roadway can elicit allergic responses. The importance of this finding is that it is consistent with the role of an environmental contaminant (ambient fine and ultrafine particles) in the exacerbation and/or development of allergic airway diseases, such as asthma.

This project was funded by the California Air Resources Board and the U.S.E.P.A. Southern California Particle Center and Supersite.

[OR03-05] CONCENTRATED AMBIENT PARTICLES ATTENUATE ALLERGEN-INDUCED AIRWAY RESPONSES IN THE LUNGS OF BROWN NORWAY RATS.

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Tuesday, April 1, 2003, 8:00 AM, Oral Session: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:00 AM-9:30 AM) Kings Garden North

Health effects of inhalation co-exposures of air pollutants and airborne allergens have not been thoroughly investigated. The purpose of the present study was to determine the effects of inhalation exposure of concentrated ambient particles (CAPs) on the lungs of rats that were concurrently exposed to a pulmonary allergen (ovalbumin; OVA). A mobile air research laboratory, equipped with inhalation chambers and ambient particle concentrators, was used to conduct the study. The mobile lab was parked in a residential site in Claremont, CA. OVA-sensitized, male, Brown Norway rats were exposed to filtered air (controls), concentrated ambient coarse (2.5-10μ m; CCAPs), fine (0.15-2.5μm; FCAPs) or ultrafine (0.01-0.15μ m; UFCAPs) particles for 5 h/day (11am -4pm) for three consecutive days. Immediately prior to each daily inhalation exposure, the rats were intranasally challenged with saline alone or a 0.5% solution of ovalbumin in saline. Rats were exposed to average mass concentrations of 554, 515 and 45 μg/m3 for CCAPs, FCAPs, and UFCAPs, respectively. 24 hours after the end of the exposures, rats were sacrificed, their airways lavaged with saline, and their lungs processed for microscopic and mRNA analyses. OVA-instilled rats had allergic bronchiolitis with mucous cell hyperplasia and allergic alveolitis with marked increases in eosinophils in the bronchoalveolar lavage fluid (BALF). OVA-instilled and air-exposed rats had 538% more eosinophils in the BALF, 104% more stored mucosubstances in the bronchiolar epithelium, and a 6-fold increase in mucin-specific gene expression in bronchiolar airways than saline/air controls. Exposures to FCAPs or UFCAPs, but not CCAPs, caused a marked attenuation (50-100%) of the OVA-induced allergic alveolitis, mucous cell metaplasia and mucin-specific gene expression. These results indicate that fine and ultrafine particulate matter may significantly interfere with allergen-induced airway responses during co-exposure of these airborne agents. (Research funded in part by USEPA Grant #R-82921601)

[OR03-03] RELATIVE CONTRIBUTIONS OF $PM_{2.5}$CHEMICAL CONSTITUENTS TO ACUTE ARTERIAL VASOCONSTRICTION.

Bruce Urch, Jeffrey Brook, David Wasserstein, James Scott, Robert Brook, Sanjay Rajagopalan, Alina Rivilis, Paul Corey, Frances Silverman Gage Occupational & Environmental Health Unit, University of Toronto/St. Michael's Hospital, Toronto, ON, Canada; Public Health Sciences, University of Toronto, Toronto, ON, Canada; Air Quality Research Branch, Environment Canada, Toronto, ON, Canada; Internal Medicine, University of Michigan, Ann Arbor, MI; Department of Medicine, University of Toronto, Toronto, ON, Canada

Tuesday, April 1, 2003, 8:00 AM, Oral Session: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:00 AM-9:30 AM) Kings Garden North

Introduction: We have recently reported a significant ($p=0.007$) decrease of 0.09 ± 0.15 mm (mean ± SD) in the mean brachial artery diameter (BAD) of humans immediately following exposure to 153 ± 36 $\mu g/m^3$ concentrated ambient $PM_{2.5}$ (CAP) and 120 ± 3 ppb O_3. Subsequent analyses of the major $PM_{2.5}$ chemical constituents now allow us to compare the strength of the associations between each constituent and individual BAD responses. Such knowledge is critical for public health risk management and abatement strategies. **Methods:** Twenty-four healthy adults underwent a randomized, controlled, double-blind, cross-over study in which we measured the change (post - pre) in BAD (ΔBAD) over a 2-hr exposure at rest, to CAP+O_3 and particle-filtered air (FA). Filter samples were collected from the CAP+O_3 airstream for gravimetric measures of $PM_{2.5}$ mass concentration (MC) followed by IC analyses for inorganic ions. In addition, co-located 24-hr ambient $PM_{2.5}$ measures were used to estimate exposures to trace elements and elemental & organic carbon EC/OC. Linear regression analyses using two response variables were performed with each single PM constituent as a predictor. One response variable was the individual's ΔBAD on the CAP+O_3 exposure day (model #1), and the other was the difference in an individual's ΔBAD with CAP+O_3 minus their Δ BAD with FA (model #2). A standardized regression coefficient (SRC) was then calculated by dividing the regression coefficient by the ratio of the SD of the response variable to the SD of the predictor. **Results:** Total MC poorly predicted ΔBAD in both model #1 (SRC=-0.07, r=0.07, p=0.74) and model #2 (SRC=0.18, r=0.18, p=0.40). There were no significant ($p \leq 0.05$) associations between ΔBAD and any PM constituents with model #1. In model #2 we observed significant SRCs for both OC (-0.45: r=0.45, p=0.036) and EC (-0.42: r=0.42, p=0.05). OC accounted for 89 ± 3% of total carbon MC (EC+OC). **Conclusions:** We have shown that carbon in $PM_{2.5}$accounted for a significant amount of the variability of ΔBAD. Studies of PM with high organic carbon (CAP and diesel exhaust) have demonstrated cytokine production/release *in vitro* and cytokine and cellular inflammation in the lungs and circulation of animals and humans. It follows that organic carbon may initiate a pulmonary response capable of systemic effects, such as altering vascular tone.

Funded by: Health Canada TSRI and Air Quality Health Effects Research Section, Government of Canada.

[OR02-04] ASSOCIATIONS BETWEEN PARTICULATE MATTER COMPONENTS AND DAILY MORTALITY AND MORBIDITY IN PHILADELPHIA, PA.

Kazuhiko Ito, Gary Norris, Matt Landis, William Wilson, George Thurston NYU School of Medicine, Nelson Institute of Environmental Medicine, Tuxedo, NY; U.S. EPA, RTP, NC

Tuesday, April 1, 2003, 8:00 AM, Oral Session: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:00 AM-9:30 AM) Kings Garden South

In evaluating the health risks from particulate matter (PM), the question remains as to which component(s) of PM are most harmful. We investigated this issue using PM mass, PM constituents, mortality, and the elderly hospital admission data in Philadelphia, PA. Daily paired $PM_{2.5}$ and PM_{10} samples were collected at one site in downtown Philadelphia between May 1992 and September 1995. Trace elements as analyzed by energy dispersive X-ray fluorescence from $PM_{2.5}$ filters (including Br, Ca, Fe, K, Mn, Ni, S, Se, Si, V, and Zn), gaseous pollutants (CO, NO_2, SO_2, and O_3), and coefficient of haze (CoH) were also analyzed. Daily cardiovascular mortality, total (non-accidental) mortality, cardiovascular elderly (age over 65) hospital admissions, and respiratory elderly hospital admissions were aggregated for the Philadelphia Metropolitan Statistical Area. Generalized Linear Poisson regression Model (GLM) was used to estimate the excess health outcomes associated with PM components and gaseous pollutants adjusting for temporal trends, weather, day-of-week, and major holidays. Several alternative weather models as well as varying extent of seasonal smoothing were applied to examine the sensitivity of results to model specifications. Among the PM components examined, the most consistent associations with health outcomes were observed for S, $PM_{2.5}$, and PM_{10} (70% of whose mass, on the average, was $PM_{2.5}$). Of these, S often showed the most significant associations. For example, the estimated relative risks for cardiovascular mortality at lag one day in a GLM model were 1.055 ($t = 2.50$), 1.044 ($t = 2.04$), and 1.039 ($t = 1.68$) for S, $PM_{2.5}$, and PM_{10}, respectively per corresponding 5th-to-95th percentile distribution increment. $PM_{10-2.5}$ was not significantly associated with any of the health outcomes. These results suggest the strongest PM associations are between regionally uniformly distributed secondary aerosol and health outcomes in Philadelphia during this time period.

This work has been wholly funded by the United States Environmental Protection Agency under cooperative agreement number CR827358 to New York University School of Medicine. It has been subjected to Agency Review and approved for publication

[OR05-01] STATUS OF THE NATIONAL EMISSIONS INVENTORY (NEI) FOR PM2.5 AND ITS PRECURSORS.

Thompson G. Pace Emissions, Monitoring & Analysis Div, D205-01, US EPA, RTP, NC

Tuesday, April 1, 2003, 10:00 AM, Oral Session: Workshop 5: Emissions: Measurement, Characterization, and Modeling (10:00 AM-11:30 AM) Kings Garden South

The National Emission Inventory (NEI) is a comprehensive annual inventory covering criteria pollutants and hazardous air pollutants (HAPs). The NEI was created by the EPA Emission Factor and Inventory Group (EFIG) in Research Triangle Park, North Carolina. This presentation discusses primary (directly emitted) PM2.5 and PM10 and the following precursors: SO2, NOx, Ammonia, VOC.

The NEI for criteria pollutants contains annual emission estimates for point sources, area sources, onroad mobile sources, and nonroad mobile sources. Point sources in the NEI are sources for which the specific location is known. Examples of point sources are electric utilities and large industrial facilities. Area sources are small, often ubiquitous sources that are generally not feasible to treat as point sources. Examples of area sources are residential wood stoves, open biomass burning, dry cleaners, and gas stations.

The NEI is a compilation of State, local and Tribal agency inventory submissions, aggregated to the county level. It includes emission estimates for onroad (highway) mobile sources such as cars and trucks. Nonroad mobile sources include a wide variety of nonroad vehicles and equipment such as tractors, construction equipment, off road recreational vehicles, aircraft, locomotives, and commercial marine vessels. All sources are classified and organized by assignment of source classification codes (SCC). Several levels of summary statistics are available and the detailed data are also available for download at the EPA ftp site: ftp://ftp.epa.gov/EmisInventory/finalnei99ver2/.

The NEI is published as an annual compilation and it is left to the user to develop a time- and space-resolved emissions inventory suitable for air quality modeling. This temporal and spatial allocation is usually accomplished using emissions preprocessor software such as SMOKE or EPS and their outputs are often fed directly into the regional transport models. However, other options do exist for getting better time resolution of at least some source categories. For example, a database of SO2 emissions from continuous emission monitors (CEM) can be used in modeling applications. Also, some of the emissions models (MOBILE, NONROAD and BEIS) have the capability to estimate emissions associated with certain meteorology or day-of-week.

The quality of the NEI varies among source categories and generally decreases as the spatial and temporal resolution becomes finer. Generally, estimates of uncertainty are difficult to ascertain. However, much can be inferred about confidence in the overall inventory-modeling system by comparing model results to ambient measurements and receptor model analyses.

[OR06-04] DEVELOPMENT OF URINARY METABOLITE BIOMARKERS TO ASSESS POPULATION EXPOSURE TO PM2.5 FROM VARIOUS COMBUSTION SOURCES.

Joellen Lewtas, Steven Myers, Christopher Simpson, Russell Dills, David Kalman NERL, US EPA, Port Orchard, WA; Univ. of Louisville School of Medicine, Louisville, KY; Dept.of Environmental Health, Univ. of Washington, WA

Tuesday, April 1, 2003, 10:00 AM, Oral Session: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (10:00 AM-11:30 AM) Kings Garden North

A primary goal of our research is to validate the use of urinary biomarkers to apportion the sources of human exposure to PM2.5. Organic source tracers have been used in source apportionment studies of ambient PM2.5 to distinguish a range of combustion sources. Both gas and particle-phase organic tracer species have been used as biomarkers of exposure to combustion sources. The nicotine urinary metabolite, cotinine, is an example of a well-validated biomarker of exposure to tobacco smoke that has been successfully used in large population studies. Polycyclic aromatic hydrocarbons (PAH) and their urinary metabolites have been used as exposure markers for combustion sources including traffic and coal sources. Levoglucosan (1,6 -anhydro-β-D-glucose) found in particles and methoxyphenols (lignin combustion products found in both gas and particle phase) are source tracers for woodsmoke. Levoglucosan is a conserved and stable organic tracer for ambient exposure measurements. Methoxyphenols, although less stable when collected on filters, are metabolized and excreted as urinary metabolites. In ongoing ambient and personal exposure studies in Seattle, where woodsmoke and mobile sources (diesel and gasoline) are the major sources of PM2.5, both organic and inorganic source tracers are measured in personal, indoor and outdoor filter samples. Urinary samples are collected and metabolites of these source tracers are measured using GC/MS and HPLC. Validation studies include 1) correlating the exposure to methoxyphenols, levoglucosan and PAH in home-indoor and home-outdoor samples, and 2) examining the relationship between exposure to levoglucosan and PAH in personal air samples and excretion of methoxyphenols and PAH metabolites in urine. Initial studies are examining the time course of exposure and excretion over 10 day sampling periods in susceptible and normal populations. These studies have been conducted in subjects (n=6) that experienced a range of PM2.5 exposure variations over the 10 day period. Mean home-outdoor PM2.5 concentrations for these subjects were 18.8 $\mu g/m^3$; (range 5.0-41.5 $\mu g/m^3$), and mean home-outdoor levoglucosan concentrations were 501 ng/m^3; (range 88-1214 ng/m^3). Studies to determine the half-life of these urinary metabolites are also in progress. *This work has been funded by the U S EPA (Cooperative Agreement #R827177 & EPA Northwest Research Center). It has been subjected to Agency review and approved for publication.*

[OR06-03] RISK FACTORS ASSOCIATED WITH INCREASED FINE PARTICLE DEPOSITION IN HEALTHY CHILDREN.

William D Bennett, Kirby L Zeman Center for Environmental Medicine, Asthma, and Lung Biology, University of North Carolina at Chapel Hill, Chapel Hill, NC

Tuesday, April 1, 2003, 10:00 AM, Oral Session: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (10:00 AM-11:30 AM) Kings Garden North

Inter-child variability in particle deposition may contribute to variability in observed morbidity associated with inhaled particulate air pollution. We have measured fractional deposition (DF) of fine particles (2um monodisperse, carnauba wax particles) in healthy children, age 6-13 (n=36) while they followed a breathing pattern previously determined by respiratory inductance plethysmography (i.e. that child's spontaneous pattern at rest). Breath-by-breath DF (ratio of particles not exhaled/total particles inhaled) was determined by photometry at the mouth. The variation in DF among the children was most strongly predicted by their tidal volume (Vt) ($r = 0.79$, $p < .001$). Multiple regression analysis further showed that Vt was predicted by age, height and body mass index (BMI), i.e. at any given age and height, Vt increased with increasing BMI ($p = 0.001$). The most obese children (>90th percentile BMI) (n=10) had twice the DF of those in the lowest BMI quartile (<25th percentile) (n=9), 0.28+/- 0.11 vs. 0.15+/-0.06 respectively, $p < 0.01$. In the same groups, resting minute ventilation (Ve) was also significantly higher in the obese children, Ve = 8.1+/- 2.1 vs. 5.9+/-1.1 L/min, $p = 0.01$. Consequently, the rate of deposition, Drate (i.e. particles depositing/time), in the obese children (proportional to the product of DF and Ve) was 2.8 times that of the leanest children ($p = 0.01$). Among all children Drate was significantly correlated with BMI ($r = 0.46$, $p = 0.004$). These results suggest obese children may be at increased risk associated with the inhalation of pollutant particles in ambient air. This is an abstract of a proposed presentation and does not necessarily reflect EPA policy.

Supported by USEPA Cooperative Agreement CR829522.

[OR06-02] FACTORS INFLUENCING AEROSOL DEPOSITION IN HUMANS AND RATS USING A MULTIPLE PATH PARTICLE DOSIMETRY MODEL (MPPD V1.0).

Renata De Winter-Sorkina, Flemming R. Cassee Center for Substances and Integrated Risk Assessment, RIVM (National Institute of Public Health and the Environment), Bilthoven, Netherlands; Center for Environment and Health Research, RIVM

Tuesday, April 1, 2003, 10:00 AM, Oral Session: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (10:00 AM-11:30 AM) Kings Garden North

Knowledge of the tissue-specific dose of PM is a critical link between individual exposure and health outcomes. Computer models are suited to analyse PM dosimetry. A Multiple Path Particle Dosimetry model (MPPD) has been developed by CIIT (Chemical Industry Institute of Toxicology, USA) in close collaboration with RIVM (National Institute of Public Health and the Environment, the Netherlands). The MPPD model allows calculation of PM deposition fractions and exposure doses for humans and rats, and includes age-specific human lung models.

The results of monodisperse aerosol deposition calculations with the MPPD model and its sensitivity to various parameters are described. Regional, lobar and alveolar depositions are calculated with a stochastic lung model for human adult.

Age dependency of PM deposition for children and young adults is studied. Coarse mode particles (5-10 μm) thoracic deposited mass is found to be significantly larger for children and adolescents of a specific age group compared to adults (age 18 and older), mainly due to the larger deposition in the head for adults. Increasing coarse particle size from 5 μm to 10 μm reduces the lower boundary of this age group from 8 years to 2 years and increases the difference in thoracic depositions between children and adults. Pulmonary deposition per alveolus is higher for 8-14 years old children compared to adults for particles of about 5 μm.

Dependency of regional deposition on the level of physical exertion is studied for human adults. Increasing physical exertion results in a higher thoracic deposition. The thoracic deposition of ultrafine particles is higher than the thoracic deposition of fine and coarse mode particles for light to modest exercise. When breathing is changed from nasal to oronasal the thoracic deposition behaviour of fine and coarse particles changes - for modest to heavy exercise the thoracic deposition of larger particles is higher.

Thoracic deposition depending on particle size is 45-200 times larger for humans than for rats at rest. Coefficients for the rat-human deposition extrapolation have been determined for three levels of human physical exertion (sleep, rest and light exercise).

In conclusion, age of the subject, physical activity, the functional capacity of the lungs and breathing parameters as well as the individual lung morphometry are factors that significantly affect the particle deposition and can explain differences in responses among people.

[OR06-01] DEMONSTRATION OF A TECHNIQUE TO ESTIMATE INDIVIDUAL, DAILY VALUES FOR THE AMBIENT AND NONAMBIENT COMPONENTS OF TOTAL PERSONAL EXPOSURE TO PARTICULATE MATTER.

William E Wilson, Stefanie Ebelt, Michael Brauer National Center for Environmental Assessment, U.S. Environmental Protection Agency, Research Triangle Park, NC; Environmental Science and Engineering Program, Harvard School of Public Health, Boston, MA; Department of Medicine, University of British Columbia, Vancouver, BC, Canada

Tuesday, April 1, 2003, 10:00 AM, Oral Session: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (10:00 AM-11:30 AM) Kings Garden North

Total human exposure (*T*) to particulate matter (PM) may be divided into two major components: (1) exposure to ambient PM while outdoors plus exposure while indoors to ambient PM that has infiltrated indoors (ambient exposure, *A*) and (2) exposure to nonambient PM due to indoor sources and personal activity or personal cloud sources (nonambient exposure, *N*). For epidemiology using panel studies with measurements of individual health outcomes, it is desirable to know total, ambient, and nonambient exposures as well as ambient concentrations. A data set from a panel study in Vancouver, BC, Canada, that contains measurements of total personal exposure and ambient concentrations of both $PM_{2.5}$ and sulfate, provides sufficient information to estimate daily, individual values of ambient and nonambient exposure to $PM_{2.5}$, and ambient exposure to $PM_{10-2.5}$ and PM_{10}. The technique requires the assumption that either there are no indoor sources of sulfate, or if such sources exist a correction may be made, and the assumption that some information is available on the values of the penetration factor (*P*) and the deposition or removal rate (*k*) for the PM mass or composition fractions of interest. This technique is based on the equilibrium mass balance model which relates ambient exposure (*A*) to ambient concentration (*C*), i.e., A = yC + (1-y)(Pa/[a+k])C, where *y* is the fraction of time spent outdoors, and *a* is the air exchange rate. Also A/C = \{y + (1-y)(Pa/[a+k])\}= the attenuation factor. In the Vancouver panel study, subjects kept activity diaries so it was possible to estimate individual, daily measured values of the fraction of time spent outdoors (*y*). Since *T* = *A* for sulfate, *T/C* = *A/C* for sulfate = the attenuation factor for sulfate. If estimates of *P* and *k* for sulfate are available, then daily, individual values of *a*, which does not depend on the particle size, may be estimated. The *A* for $PM_{10-2.5}$ is estimated using the measured values of *y*, the estimated value of *a*, and estimated values of *P* and *k* for $PM_{2.5}$. Plots of *T* vs. *C* for sulfate, for individual subjects, and for the entire panel, are used to check for the presence or absence of indoor sulfate sources and to check for outliers. If a subject is found to have an indoor source of sulfate, the attenuation coefficient is taken from the regression of personal sulfate on ambient sulfate. The time series of individual, daily exposures have been used to investigate the association of various health effects with the different indicators of exposure.

[OR04-01] PROBLEMS AND SOLUTIONS FOR MEASURING BLACK CARBON IN SUSPENDED PARTICLES.

Judith C Chow, John G Watson, Antony Chen, Hans Moosmuller, Peter W Barber, W Pat Arnott, William R Stockwell, Barbara Zielinska, Kochy K Fung Division of Atmospheric Sciences, Desert Research Institute, Reno, NV; Executive Office, AATMA, Calabasas, CA

Tuesday, April 1, 2003, 10:00 AM, Oral Session: Workshop 4: Time-Integrated Sampling and Analysis of PM for Composition (Including Semi-Volatile Species) (10:00 AM-11:30 AM) LeBateau

Knowledge of the black carbon (BC) fraction of total carbon (TC) in suspended particulate matter (PM) from source emissions and ambient air is important ambient air and source emissions is important for: 1) material balances of PM2.5 and PM10 (PM less than 2.5 and 10 μm, respectively) into its major chemical components (sulfate, nitrate, ammonium, sea salt, geological material, organic carbon (OC) and BC); 2) apportioning ambient concentrations to source emissions; 3) creating chemical light extinction budgets for tracking improvements in urban and regional haze; 4) quantifying effects of PM levels on the earth's radiation balance; 5) determining how gases and particles interact in the atmosphere; and 6) associating PM chemical properties with adverse health effects.

Systematic research is not being executed to resolve these discrepancies. Such research should include: 1) documentation of the method applied, especially for thermal evolution methods with different combustion temperatures, residence times, ramp rates, and optical pyrolysis corrections; 2) review and evaluation of the published carbon literature, much of which is not in the common air quality journals; 3) optical modeling of changes in absorption properties of particles on and within a filter relative to those suspended in air; 4) preparation of standards representing different black carbon sources (e.g., diesel, wood burning, tar, gasoline engine) on different filter media (e.g., Teflon membrane, quartz fiber) at different deposit levels (light, medium, and dark appearances) while measuring absolute absorption with a photoacoustic spectrometer; 5) experimental examination of the distribution of particles and pyrolysis artifacts within a filter; 6) experimental evaluation of the effects of non-absorbing particles, transmittance wavelengths, initial darkness, carbonate deposits, and oxygen-supplying minerals on optical pyrolysis adjustments; and 7) optimization of carbon e fractions to identify source contributions.

[OR04-02] INVITED SPEAKER: AN OVERVIEW OF PM2.5 CHEMICAL SPECIATION NATIONWIDE NETWORK PROGRAM.

RKM Jayanty Industrial and Environmental Chemistry, RTI, Research Triangle Park, NC

Tuesday, April 1, 2003, 10:00 AM, Oral Session: Workshop 4: Time-Integrated Sampling and Analysis of PM for Composition (Including Semi-Volatile Species) (10:00 AM-11:30 AM) LeBateau

On July 18, 1997, the U. S. Environmental Protection Agency (EPA) promulgated the new National Ambient Air Quality Standards (NAAQS) for PM. The NAAQS apply to the mass concentration of particles with aerodynamic diameters lower than 2.5 um (PM2.5) and 10 um (PM10). The deployment of a new PM2.5 monitoring network by EPA is a critical component in the national implementation of the PM2.5 NAAQS. The compliance (mass) monitoring portion of the network was established first. Data from the compliance network is used to determine attainment with the NAAQS. EPA soon supplemented the network with a chemical speciation monitoring program to provide complementary data on the chemical composition of PM2.5 for the purposes of identifying sources, developing implementation plans, and supporting ongoing health effects research. RTI has been given the responsibility of assisting State and local agencies in the operation of PM2.5 chemical speciation monitoring network by providing filter media and analytical support for the analysis of air filters for gravimetric mass, elemental concentrations (sodium through lead), organic and elemental carbon, anions (ammonium, sodium, and potassium) and cations (sulfate and nitrate), and analysis of semivolatile organics and microscopic analysis of selected filters. The program has grown significantly over the last three years and currently RTI is providing chemical speciation support to over 225 PM2.5 monitoring sites established throughout the United States and Puerto Rico.

Several challenges encountered in the operation of this program include sample handling, high blank levels for gravimetric mass on Teflon filters, high background levels for quartz and nylon filters, data validation, and reporting. For example, RTI has shown that the outgassing from the white Delrin® rings originally used in the MetOne sampler are a cause of high blank levels for the gravimetric mass on Teflon® filters. Subsequent, research performed at EPA/Montgomery confirmed RTI's findings. Other challenges and their solutions implemented in the nationwide network, as well as a general overview of the PM2.5 Chemical Speciation Program, will be presented.

[OR09-06] WITHDRAWN

Tuesday, April 1, 2003, 1:00 PM, Oral Session: Workshop 9: Regional, Seasonal and Temporal Factors in Health Effects (1:00 PM-2:30 PM) Kings Garden North
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[OR09-04] QUALITATIVE DIFFERENCES IN PARTICULATE AIR POLLUTION AT DIFFERENT LOCATIONS THROUGHOUT EUROPE.

Henk JT Bloemen, John F Boere, Paul HB Fokens, Daan LAC Leseman, Gergio Catani, Bjørn V Johansen, Tadeusz Halatek, Flemming R Cassee Center of Environment and Health Research and Laboratory of Field Measurements, National Institute for Public Health and Environment, Bilthoven, Netherlands; Division of Environmental Medicine, Norwegian Public Health Institute, Oslo, Norway; Department of Toxicology and Carcinogenesis, Nofer Institute of Occupational Medicine, Lodz, Poland; Laboratorio di Ultrastrutture, Instituto Superiore di Sanita, Rome, Italy

Tuesday, April 1, 2003, 1:00 PM, Oral Session: Workshop 9: Regional, Seasonal and Temporal Factors in Health Effects (1:00 PM-2:30 PM) Kings Garden North

Given the widely different prevalence rates of respiratory allergies and asthma between the countries of Europe and the substantial exposure to ambient particles in urban environments, the EU project Respiratory Allergy and Inflammation Due to Ambient Particles (RAIAP) project aimed to relate the chemical composition of collected ambient particulate matter (PM) to different health end-points. PM samples were collected in urban areas in Amsterdam (NL), Rome (I), Lodz (PL) and Oslo (N), as well at a Dutch sea-side background site over a 4-6 week period during spring, summer and winter. High-volume (900 litres/min) cascade impactor technology for simultaneous sampling of ambient air coarse (PM10-2.5) and fine (PM2.5-0.1) particles on large-capacity polyurethane foam (PUF) substrate was used. A multiple chemical analyses was performed on these two size fractions focused on inorganic ions, metals, polycyclic aromatic hydrocarbons and traffic markers (hopanes and steranes, constituents of diesel oil and lubricants).

Levels of PAHs were high in samples collected in Lodz in the cold seasons, and which was less evident in samples collected in Oslo. Steranes and hopanes, indicators of traffic emissions, were generally higher in the fine than the coarse mode, but were still substantial in the latter. The contribution to the total mass varied for the different locations though was in general higher in the winter. Sulfates in the fine fraction were markedly higher in Amsterdam compared to the other locations. This contrast was not observed for the coarse mode. Relatively high levels of potassium, iron and aluminum (indicators for crustal material) were measured in the Rome samples, whereas zinc levels were markedly higher in the fine mode samples collected in Lodz. Although the collection and pretreatment method might alter the samples slightly the results show that distinct differences are present among PM fractions collected at various locations and seasons. The samples will further be screened for the adjuvant allergic activity and capacity to induce respiratory inflammation.

[OR09-01] HOW CAN SOURCE APPORTIONMENT AND RECEPTOR MODELLING DATA BE USED IN EPIDEMIOLOGY?

Thomas Lumley, Hao Liu Biostatistics, University of Washington, Seattle, WA

Tuesday, April 1, 2003, 1:00 PM, Oral Session: Workshop 9: Regional, Seasonal and Temporal Factors in Health Effects (1:00 PM-2:30 PM) Kings Garden North

Human health effects models based on pollution sources have been proposed as easier to fit and interpret, and more relevant for public health and regulation. We will show that the first of the claims is not entirely correct.

Measurement error in the concentrations of chemical species or size fractions will often be well approximately by a classical additive independent error model. The estimates from a source apportionment model, however, have very complicated non-independent errors due to both the original measurement error and uncertainty in the model.

We will describe possible approaches to this estimation problem. One approach is to regress health outcomes on the concentrations of chemical species, where standard measurement error correction methods are applicable, and then apply an estimated source apportionment model to convert these health effects to the scale of interest. Another approach, when replicate measurements of chemical species are available, is to use instrumental variable methods from econometrics.

[OR09-03] SEASONAL AND SPATIAL VARIABILITY OF THE SIZE-RESOLVED CHEMICAL COMPOSITION OF PM2.5 IN THE LOS ANGELES BASIN.

Philip M Fine, Satya B Sardar, Peter A Jaques, Constantinos Sioutas Civil and Environmental Engineering, University of Southern California, Los Angeles, CA, USA; School of Public Health, University of California, Los Angeles, Los Angeles, CA, USA

Tuesday, April 1, 2003, 1:00 PM, Oral Session: Workshop 9: Regional, Seasonal and Temporal Factors in Health Effects (1:00 PM-2:30 PM) Kings Garden North

Previous studies of PM2.5 size-resolved chemistry in the Los Angeles Basin (LAB) have included only a few days or weeks of sampling. In order to provide a more complete picture of LAB aerosol characteristics, more extensive sampling is needed. As part of the routine sampling activities of the Southern California Supersite, one 24-hour size-fractionated PM2.5 impactor sample is collected and analyzed each week. The mobile sampling trailer was moved to different locations in the Los Angeles Basin over the approximately two years of continual sampling. The sites (and corresponding dates) are Downey (10/00 - 2/01), Riverside (2/01 - 6/01), Rubidoux (6/01 - 9/01), Claremont (9/01 - 7/02), and Downtown Los Angeles/University of Southern California (9/02 - present). Micro-orifice uniform-deposit impactors (MOUDIs) collect particles in the following size bins: 1.0 - 2.5 μm; 0.56 - 1.0 μm; 0.32 - 0.56 μm; 0.1 - 0.32; and <0.1 μm. Samples are collected on aluminum and Teflon substrates and analyzed for gravimetric mass, sulfate and nitrate by ion chromatography, and elemental and organic carbon by thermal evolution/optical transmission analysis. High organic and elemental carbon levels in the smaller particles were observed in the upwind sites which are strongly influenced by vehicular emissions. The highest concentrations of nitrate were found in the larger particles at the inland, downwind sites during the warmer months when photochemical secondary particle formation occurs. Correlations within size bins for the different chemical components are also presented.

[OR09-05] RESPIRATORY ALLERGY AND INFLAMMATION DUE TO AMBIENT PARTICLES - A EUROPEAN-WIDE ASSESSMENT (RAIAP).

Erik Dybing, Flemming R Cassee, Konrad Rydzynski, Marco Martuzzi, Martinus Lövik, Per E Schwarze, Peter A Steerenberg
Norwegian Institute of Public Health, Oslo, Norway; National Institute of Public Health and the Environment, Bilthoven, Netherlands; Nofer Institute of Occupational Medicine, Lodz, Poland; WHO European Centre for Environment and Health, Rome, Italy

Tuesday, April 1, 2003, 1:00 PM, Oral Session: Workshop 9: Regional, Seasonal and Temporal Factors in Health Effects (1:00 PM-2:30 PM) Kings Garden North

The overall objective of this multinational project in 2001-2004 is to assess the role of ambient suspended particles (PM) in causing local inflammation in the respiratory tract and in induction and elicitation of respiratory allergies, in order to understand the underlying mechanisms for involvement of particles in the development of these diseases.

Coarse (PM10-2.5) and fine (PM2.5-0.1) particles were collected during 4-6 week periods during spring, summer and winter in Amsterdam (NL), Rome (I), Lodz (PL) and Oslo (N), as well as from a Dutch sea-side background site. Samples were collected using a high-volume (900 litres/min) cascade impactor. During the same time periods samples were collected by low-volume sampling for electron microscopic characterisation. Chemical analyses from the high- and low-volume PM samples included inorganic ions, metals, PAHs and traffic markers (hopanes, steranes).

The collected samples are being screened for allergenic potential using the popliteal lymph node assay and measurement of total IgE-production in mice. Human lung cell cultures and primary rat macrophages and type 2 cells are being screened for respiratory inflammation potential by studying cytokine release from the cells.

Verification of allergenic potential of samples is carried out using a mouse ovalbumin model after intranasal application. Studied parameters include antibody response (IgE), eosinophils and cytokines in bronchoalveolar lavage as well as phagocytic activity in macrophages. Inflammation verification is studied in a rat model after intratracheal instillation of samples. Inflammatory parameters include determination of Clara cell protein, albumin and neutrophils in lavage fluid, as well inflammatory reactions studied by histopathological methods.

Later mechanistic studies will focus on modulation of molecular and cellular functions of the immune system, of signalling pathways in lung cell cultures and of immune responses in the respiratory system.

The project will end with a workshop summarising the scientific knowledge on the role of ambient particles for respiratory allergies and the implications of this knowledge for regulators, the general public and industry.

Contract number: QLRT-2000-00792. http://www.raiap.org

[OR09-09] INFLUENZA AND AIR QUALITY: A TIME-SERIES ANALYSIS OF WEEKLY MORTALITY IN LONDON RELATIVE TO THE MAJOR AIR POLLUTION EPISODES OF THE 1950s.

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Tuesday, April 1, 2003, 1:00 PM, Oral Session: Workshop 9: Regional, Seasonal and Temporal Factors in Health Effects (1:00 PM-2:30 PM) Kings Garden North

The London air pollution disaster of December 1952 has recently received renewed attention, in part because of a recent paper that claims a death toll much higher than that reported by the original publications of the time. At issue is whether the excess mortality seen in the three months following the episode should be attributed to delayed air pollution effects or to sequellae of influenza, since a flu epidemic was experienced in the south of England in early 1953 (although influenza was not then an officially reportable infectious disease) and such epidemics may trigger excess mortality from other causes.

This question is addressed through time-series analysis, based on published weekly data from late 1949 to 1958, a period during which 5 additional major air pollution episodes were reported. The analysis uses air quality data from these episodes, reports of influenza deaths, and seasonal adjustments based on weekly sequence numbers, as a means of separating air pollution from influenza effects. The influenza effects are based on data from England and Wales, which show that total deaths associated with flu are about 3.5 times those actually coded as flu. These national flu deaths are then used as a surrogate for London flu deaths, a paradigm that was highly statistically significant.

Major findings from this analysis include:

Flu epidemics occurred regularly during this period, often biennially, but varying in severity and the hardest-hit locations. This periodicity makes it problematic to assess pollution effects solely by contrast with the previous year.1

The apparent delayed (lag) effects of air pollution depend on how well seasonality is controlled in the regression model. Evidence for a 1-week lag effect is strong, but any additional lag effects up to 9 weeks are small or negative. Such negative effects suggest mortality "harvesting."

The absence of persistent excess mortality after the 1952 "Great Fog" is consistent with the relatively constant annual mortality rates reported for the 1950s in London.

The pollution regression coefficients are consistent with others based on daily time-series methods (0.2% excess deaths per 10 mg/m3 smoke; 0.16% excess deaths per ppb SO2). Using the coefficient for a 2-week period and the average SO2 level over (assumed) background yields an excess mortality of about 3900 deaths for the London Administrative County, from 1949-58, or about 1.1%. The same model predicts total influenza deaths of 9500 (2.6%) for the period.

[OR09-08] THE EPRI-WASHINGTON UNIVERSITY VETERANS COHORT STUDY: MODEL SENSITIVITY STUDIES AND RESULTS FOR ADDITIONAL AIR POLLUTANTS.

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The Veterans Cohort comprises about 50,000 male veterans who had been diagnosed as hypertensive; 35% were African-American and 81% had smoked. We considered all-cause mortality with county-level air quality.

Sensitivity studies showed that successive deletion of individual subjects' height, interactions between age and body-mass index (BMI), and interactions between age and systolic blood pressure (SBP) had no effect on model fit (AIC) or on the effect estimates for PM10 or peak O3. Further, deletion of all blood pressure variables increased AIC, decreased the PM10 effect by 12% and increased the peak O3 effect by about 5%.

The additional variables tested included peak and mean SO2; average (as opposed to peak) O3, 1999 PM10, PM2.5, and PM10 - PM2.5; and vehicle-miles traveled (VMT/area, an index of vehicular pollution). The results for SO2, PM2.5, and PM10 were sensitive to the inclusion of ecological variables (EVs) in the model, as shown in the first paper. With EVs included, mean and peak SO2 showed similar effect estimates that were largely negative, significantly so for the more recent exposure and follow-up periods. These findings are similar to those for SO42-.

Without EVs in the model, 1999 PM2.5 was associated with an excess 1989-96 mortality risk of about 12%, which lost significance and dropped markedly to about 3% excess risk when EVs were included. The corresponding PM10 values were similar but slightly lower; the risks associated with PM10 - PM2.5 were nil.

In contrast, the risks associated with O3 and vehicles were not sensitive to the inclusion of EVs. Effects of mean O3 were negative for all exposure and follow-up periods, largely significantly so. This is consistent with findings from other cohort studies and in sharp contrast with the previous positive findings for peak O3. For the vehicular pollutant variable (ln[VMT/county land area]), attributable mortality risks were significant at about 2-3% when all U.S. counties were considered, but increased to 5-8% when the analysis was limited to counties having the 1979-84 PM2.5 data used in previous studies.

[OR09-02] ISSUES IN THE USE OF SOURCE-ORIENTED PARTICULATE MATTER INDICES FOR AIR POLLUTION EPIDEMIOLOGY.

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Tuesday, April 1, 2003, 1:00 PM, Oral Session: Workshop 9: Regional, Seasonal and Temporal Factors in Health Effects (1:00 PM-2:30 PM) Kings Garden North

Particulate matter (PM) is a chemically non-specific pollutant, and may originate or be derived from different emission source types. Thus, its toxicity may well vary depending on its chemical composition. If the PM toxicity could be determined based on source types, the regulation of PM may be done more meaningfully. A large number of monitors started collecting chemical speciation data from $PM_{2.5}$ filters starting 2000-2001 in the U.S. The data from this chemical speciation network may be useful for source-oriented evaluations of PM health effects. Current approaches in such investigations compute factor-analysis (or its variants) derived PM or air pollution indices, and include them in time-series health effects regression models. While such approaches have merit, there are several issues that need to be considered in the analysis and interpretation of these data. One major issue is a monitor's representation of regional, sub-regional, and local air pollution exposures to the population in a city or metropolitan area. Because health outcomes in time-series air pollution epidemiological studies are aggregated over a wide geographical boundary, the regional pollution may have smaller \\"error\\" in exposure estimates than does local pollution. Under such a condition, the relative significance of associations between health outcomes and various \\"source-oriented\\" pollution indices may not necessarily reflect the source's relative toxicity, due to their differing relative error (spatial variation and analytical uncertainty) in representing population exposure estimates. We examined this issue using newly available speciation data from multiple cities. For example, the speciation data from three monitors (a few miles apart) in New York City during 2001-2002 period showed that the correlations among the three monitors for sulfate (regional secondary aerosol) were higher (0.92 to 0.99) than those for sub-regional soil related element, Si, (0.77 to 0.49), or elemental carbon (0.22 to 0.52), which can be strongly influenced by local traffic patterns. Factor analyses of these data from three monitors also suggest that regional or sub-regional factors are more stable than factors that appear to reflect more local impacts. The implication of these monitor-to-monitor differences in source-specific exposure spatial representativeness on health effects analyses results are illustrated using 2001 elderly hospital admission data.

This work has been funded by the United States Environmental Protection Agency STAR grant R82799701 and PM Center grant R827351, but may not reflect EPA policy.

[OR09-07] A SYNTHESIS OF LONG-TERM MORTALITY STUDIES, 1990-2002.

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Tuesday, April 1, 2003, 1:00 PM, Oral Session: Workshop 9: Regional, Seasonal and Temporal Factors in Health Effects (1:00 PM-2:30 PM) Kings Garden North

Since long-term human clinical exposure studies are either unethical or impractical, annual air quality standards are based on epidemiology studies and are relatively rare. They are also controversial, because of differences in the subjects and time periods involved, selection of exposure measures, control of confounders, and statistical methods. This paper compares and contrasts 1990-2002 long-term mortality studies and provides combined estimates of effects on mortality for various pollutants. In so doing, the relevant measure of uncertainty is the standard error of the mean across the group of studies, as opposed to the standard errors of the estimates in each study, which depend on sample size. I consider the cohort studies of the Harvard Six Cities and American Cancer Society (CPS-II), as originally published and as reanalyzed by Krewski et al., the Veterans Cohort Study (Lipfert et al.), the Adventist Health Study (Abbey et al.), and the Netherlands Cohort Study (Hoek et al., 2002). In addition, I consider selected ecological studies, including a recent longitudinal study in Dublin.

Preliminary results show that the PM estimates for females tend to exceed those for males, for which none of the means across studies is statistically significant. There is a trend towards decreasing effect estimates by period of mortality follow-up. The effect estimates for O3 and NO2 are larger and more consistent by gender. Although the O3 and NO2 estimates are somewhat larger than typical estimates for acute effects based on time-series studies, the PM estimates are not.

The paper also considers heterogeneity among the studies, including time periods studied (temporal trends), precision of exposure estimates (degree of spatial aggregation), control of potential confounders, cohort vs. ecological designs, population attributes (age, race, socioeconomic status, level of education). The need for new cohort studies to address these study design issues is also discussed.

[OR10-04] CHEMICAL CHARACTERIZATION OF FINE AND ULTRAFINE AEROSOLS DURING THE ROCHESTER, NY SUMMER INTENSIVE, 2002.

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Tuesday, April 1, 2003, 3:00 PM, Oral Session: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (3:00 PM-4:30 PM) LeBateau

Some toxicological studies in animals have shown more significant adverse effects due to inhalation of ultrafine aerosol (diameter less than 0.10 μm) than fine aerosol (diameter less than 2.5 μm). Chemical characterization of fine and ultrafine aerosol concentrations were obtained in Rochester, NY, June 3 to 19, 2002 as part of ongoing work by the University of Rochester EPA Ultrafine PM Center to characterize ultrafine aerosols in U.S. urban areas.

Two modified MOUDI/Nano-MOUDI (MSP Model 110 and 115) samplers were used in parallel to obtain inorganic ion, elemental and organic carbon and trace metal concentrations of particles from 10 to 180 nm. The MOUDI/Nano-MOUDI samplers collected aerosol for eight consecutive days in order to obtain sufficient sample for analysis. Two precautions were taken to minimize the possibility of particle bounce from the upper stages to the ultafine particle stages. The MOUDIs were modified to reduce the flow to 10 lpm while maintaining the particle size cut-points by carefully masking two-thirds of the jets on each stage in the MOUDI. The reduced flowrate decreases the velocity that the particles move through the system, decreasing the likelihood of particle bounce. In addition, greased substrates (dioctyl phathalate) were used on MOUDI stages above 180 nm to capture the larger particles. The greased substrates were changed every 48 hours to maintain good capture efficiency. Results of a preliminary study done to determine a grease with minimal transfer to lower stages will be presented.

In addition to the ultrafine particle collection, four 48-hour samples were collected with three MOUDIs and a PM1.8 sampler to obtain chemical speciated, size segregated fine aerosol concentrations. The MOUDIs were operated with a cyclone at the inlet to restrict collected particles to the range 0.056 - 1.8 μm. Speciated concentrations of fine and ultrafine aerosol will be compared and MOUDI/Nano-MOUDI size distributions will be presented.

A Nano-SMPS (scanning mobility particle sizer TSI Model 3936N25), a Long-SMPS (TSI Model 3936L22) and an APS (Aerosol Particle Sizer, TSI Model 3320) were run continuously during the eight days of filter sampling to obtain size distributions of particles ranging from 0.004 um to 10 um. This data will be used to further characterize the fine and ultrafine ambient aerosol. Particular attention will be paid to size distributions obtained while a diesel truck idled near the sampling site.

Supported by EPA PM Center grant R827354

[OR11-11] MODELING PHOTOCHEMISTRY AND AEROSOLS IN POLLUTANT PLUMES WITH THE CMAQ PLUME-IN-GRID APPROACH.

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Tuesday, April 1, 2003, 3:00 PM, Oral Session: Workshop 11: Air Quality Modeling (3:00 PM-4:30 PM) Kings Garden South

Significant emissions of NOx and SOx are released into plumes emanating from the tall stacks of point sources, such as isolated power plants. These primary species are important precursors of a variety of secondary pollutants, including ozone and aerosol species. However, important characteristics of point sources plumes are their initially small dimensions and their finite growth rates downwind due to meterological processes. Since the traditional Eulerian grid model method is to instantly mix point source emissions into a large grid cell volume, considerable artificial dilution can occur which adversely impacts chemical and aerosol processes. The plume-in-grid (PinG) approach integrated into the EPA Community Multiscale Air Quality (CMAQ) grid modeling system was specifically designed to provide a realistic treatment of the physical and chemical processes affecting pollutant concentrations in major point source plumes. The PinG method simulates the gradual horizontal and vertical expansion of subgrid scale plumes and more properly treats the chemical evolution in individual plume cells during the subgrid scale phase within a CMAQ Chemical Transport Model (CCTM) simulation.

The PinG treatment has been extended with the incorporation of the same aerosol module being applied in the CCTM grid model, which allows gas-phase chemistry and aerosol processes to be performed concurrently in the PinG submodel. The aerosol module employs a modal approach with the size distribution defined by Aitken, accumulation, and coarse modes. The fine aerosol mass for secondary species, including sulfate, nitrate, ammonium, and organics from anthropogenic and biogenic sources are determined. Simulations have been performed for a group of major point sources exhibiting a range of NOx, SOx, and particulate emission rates located in the region surrounding Nashville, TN during summer periods from the Southern Oxidant Study (SOS) experimental studies in 1995 and 1999. Model runs were conducted with two different chemical mechanisms (Carbon Bond IV and RADM2) and two different chemical solvers (QSSA and SMVGEAR) to explore the impact on aerosol species concentrations. Comparisons of model results for selected gas species and aerosol concentrations will be examined against plume data obtained by research aircraft traverses across plumes. Initial results are encouraging as the evolution of ozone and aerosol sulfate appears to agree with emerging plume data. More fine sulfate was generated in the SO2-rich plumes which exhibited lower NOx emission rates than in plumes containing greater NOx levels.

[OR11-06] SIMULATION OF THE ATMOSPHERIC AEROSOL SIZE/COMPOSITION DISTRIBUTION IN A THREE-DIMENSIONAL CHEMICAL TRANSPORT MODEL.

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Tuesday, April 1, 2003, 3:00 PM, Oral Session: Workshop 11: Air Quality Modeling (3:00 PM-4:30 PM) Kings Garden South

Atmospheric pollutants have been implicated in the development of adverse effects on human health, the formation of acid rain and acid fogs, visibility reduction, and influence on the energy balance of the planet. Models that accurately describe the physical and chemical atmospheric transformations of these pollutants are necessary to determine how changing emissions will affect downwind airborne concentrations and how to best go about controlling air pollution.

Improvements and additions have been made to the chemical transport model CAMx to create a new transport model PMCAMx. These improvements focus on aerosol and aqueous-phase treatment. The first addition was a hybrid mass transfer approach to determine partitioning between the gas and aerosol phase for volatile inorganic species. Here bulk equilibrium is assumed for fine particles and mass transfer equations are solved for larger particles. To simulate the behavior of secondary organic aerosol (SOA) components and their interactions with inorganics, an SOA model was also integrated into PMCAMx. Finally, in an effort to describe cloud and fog processing of pollutants, a variable size resolution aqueous-phase chemistry module also was incorporated into the model.

We will present an overview of our additions to PMCAMx and explore the accuracy and efficiency of these additions.

[OR11-05] USE OF HIGH-TEMPORAL-RESOLUTION PM DATA FOR MODEL PERFORMANCE EVALUATION.

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Tuesday, April 1, 2003, 3:00 PM, Oral Session: Workshop 11: Air Quality Modeling (3:00 PM-4:30 PM) Kings Garden South

Speciated, high-temporal-resolution particulate data available from the SouthEastern Aerosols Research and CHaracterization Study (SEARCH) and concurrent monitoring programs were used to evaluate the performance of two particulate matter (PM) air quality models, as applied to two multi-week modeling episode periods. The SEARCH measurements include speciated particulate matter with diameters of less than 2.5 microns (PM2.5) and between 2.5 and 10 microns (PMCOARSE), and trace gas measurements of ozone, oxides of nitrogen (NO, NOx), NOy, carbon monoxide (CO), and sulfur dioxide (SO2). The SEARCH data provide a basis for beginning to evaluate in detail the ability of PM models to simulate hourly variations in PM species for a variety of geographical locations (including urban, suburban, rural sites and both coastal and inland locations).

Several air quality models are being developed and tested for the purposes of evaluating strategies for reducing PM concentrations and exposure. The reliable application of such models requires that the models be rigorously evaluated and tested - not only relative to whether longer-term averages of PM constituents can be reproduced, but also with regard to whether the detailed daily and hourly concentrations that comprise the longer-term averages are consistent with available speciated, high-temporal-resolution data.

This poster presents the methods and results of the evaluation of the REgional Modeling System for Aerosols and Deposition (REMSAD) and the particulate version of the variable-grid Urban Airshed Model (UAM-VPM), with emphasis on the ability of the models to represent hourly variations in particulate and gaseous concentrations of several species. Ratios of various species are also used to compare the modeling results with observed data and obtain information about whether the processes represented by the chemical mechanisms are in line with those indicated by the relative species concentrations in the observed data. Conclusions regarding model performance for longer-term averages versus daily and hourly variations are also compared. The high-temporal-resolution SEARCH data provide a basis for a detailed evaluation of the modeling results.

Results for REMSAD for the two episode periods suggest good representation of PM2.5 but somewhat mixed representation of the various component species. Organic aerosols tend to be underestimated. For one simulation period, ozone is well simulated while, for the other, ozone is generally overestimated. As of the writing of this abstract, the evaluation of UAM-VPM is not complete.

[OR11-10] RELATIVE CONTRIBUTIONS OF PRIMARY AND SECONDARY (BIOGENIC AND ANTHROPOGENIC) ORGANIC AEROSOLS AT NASHVILLE: COMPARISONS OF OBSERVATIONS AND MODELING RESULTS.

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Tuesday, April 1, 2003, 3:00 PM, Oral Session: Workshop 11: Air Quality Modeling (3:00 PM-4:30 PM) Kings Garden South

The performance of EPA's Models-3/CMAQ (2002 release) on relative contribution of primary and secondary (biogenic and anthropogenic) organic aerosols was examined and evaluated, paired in time, against observational data from the SOS/Nashville'99 Experiment (June 15 to July 15, 1999). The 12-hour mean ratios of $^{14}C/^{13}C$ measured by radiocarbon analysis were used to determine the fractions of biogenic total carbon (BTC). Organic carbon (OC), elemental carbon (EC) and total carbon (TC) concentrations were measured by a thermo-optical transmission analyzer. The results show that the model captured the temporal variations of observed TC (correlation coefficient (r) =0.90) with slightly higher mean modeled TC concentration (5.4 $\mu g\ C\ m^{-3}$) than the observed TC (4.8 $\mu g\ C\ m^{-3}$). The model slightly overpredicted nighttime observed TC but underpredicted daytime observed TC. The modeled mean fraction of BTC (0.36) was ~44% lower than the observation (0.64). This is due to the fact that the modeled mean BTC concentration (2.0 $\mu g\ C\ m^{-3}$) was 39% lower than the observation (3.2 $\mu g\ C\ m^{-3}$). One of the reasons for the underprediction of BTC by the model is that the model did not include the contribution from the primary BTC. A close inspection of daytime and nighttime cases indicates that the model overpredicted the nighttime OC but underpredicted daytime OC.

[OR11-03] INORGANIC AEROSOL THERMODYNAMIC MODEL WITH N(III).

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Tuesday, April 1, 2003, 3:00 PM, Oral Session: Workshop 11: Air Quality Modeling (3:00 PM-4:30 PM) Kings Garden South

Heterogeneous reactions are generally taken as the major formation mechanisms of atmospheric nitrous acid. The concentrations of nitrous acid in the South Taiwan are 0.16~ 18.3 $\mu g/m^3$ and those of nitric acid are 0.14~13.6 $\mu g/m^3$. Thus, the concentrations of nitrous acid are greater than those of nitric acid in Taiwan. Although the concentrations of nitrite have been measured in many studies, there are few studies including nitrite and nitrous acid in aerosol model development and application. Because of the importance of nitrous acid and particulate nitrite, the purpose of this study is to establish an aerosol thermodynamic model with nitrous acid and nitrite.

In this aerosol thermodynamic aerosol, Pitzer method and Bromley method are used to estimate binary activity coefficients and multi-component activity coefficients, respectively. ZSR relationship is used to calculate the aerosol water content. The species in this model include aqueous phase species (K^+, Na^+, Ca^{2+}, Mg^{2+}, NH_4^+, Cl^-, NO_2^-, NO_3^-, SO_4^{2-}, CO_3^{2-}, H^+) and gaseous phase species (HCl, HNO_3, HNO_2, NH_3). Atmospheric gaseous species and $PM_{2.5}$ samples were collected at Annan in southern Taiwan. Gaseous species (HCl, HNO_3, HNO_2, NH_3) were collected using annular denuder system and filter pack was used to collect particles. The samples were then analyzed by ion chromatography to determine the concentrations of Cl^-, NO_2^-, NO_3^-, SO_4^{2-}, K^+, Na^+, Ca^{2+}, Mg^{2+}, NH_4^+, .

The average concentrations and standard deviations of gaseous HNO_2, HNO_3, NH_3, particulate (<2.5 μm) NO_3^- and NH_4^+, NO_2^-, SO_4^{2-}, Na^+ were 4.5(±2.6), 1.6(±2.3), 22.1(±9.62), 0.7(±0.4), 3.0(±2.0), 0.64(±0.76), 7.3(±3.8), 0.29(±0.16) μg/m3, individually. Meteorological conditions were humid with relative humidity from 74%~84% and temperatures were between 297.2 K~302.2 K during sampling. Note that the concentrations of nitrous acid were greater than those of nitric acid. Nitrous acid may be important than nitric acid at this site.

The measurements of nitrous acid and nitrite($PM_{2.5}$) were used to evaluate this thermodynamic model. The measured and simulated results of nitrous acid are in good agreement. The average relative error, defined as [simulated-measured]/measured, was 0.185 and the correlation coefficient was 0.937. The acidity of HNO_3 is much greater than that of HNO_2. Therefore, more HNO_2 volatilizes into gaseous phase while most of HNO_3 remains within aerosol.

Aerosol thermodynamic model that include nitrite/nitrous acid has been established in this study. The measured and simulated results are in good agreement. Due to the weaker acidity of nitrous acid, the concentrations of nitrite are lower than those of nitrous acid.

[OR11-08] AIR QUALITY MODELING OF AN EXTREME PM10 EPISODE AT SANTIAGO, CHILE.

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Tuesday, April 1, 2003, 3:00 PM, Oral Session: Workshop 11: Air Quality Modeling (3:00 PM-4:30 PM) Kings Garden South

The city of Santiago, Chile is subject to strong anticyclonic, subsidence-based thermal inversions reinforced by low coastal troughs on the Pacific Ocean (110 km to the west). In such episodes, ambient concentrations of pollutants start to rise as the episode worsens.

We are using the Comprehensive Air Quality Model with Extetensions (CAMx) to study one episode that happened from May 14 through May 19, 1998. The atmospheric conditions were such that the PM10 hourly levels reached dangerously high levels (see Table), and 24h moving average values rose as high as 350 (μg/m^3).

In addition, the air temperature difference between 2 and 8 m above ground was near 4 K at all those hours, signaling a strongly stable surface boundary layer, with Richardson numbers exceeding the critical value of 0.25 at those hours. The episode enden on Monday, May 18th, when authorities shut down 50% of the stationary sources and banned near 60% of the older vehicles in the city, curbing down pollution levels.

The modeling exercise was carried out applying CAMx to a region extending 120 km E-W and 80 km N-S, completely covering the greater metro area of Santiago (30 by 35 km in size) with a 2 by 2 km grid resolution.

The meteorological information was obtained by applying the CALMET preprocessing scheme to the following configuration of data:

a) A dense surface network, consisting of 30 surface meterological stations b) The output of the HIRLAM regional scale meteorological model, at 0.1 degrees of resolution, covering central Chile.

The model outcome was assessed using the ambient air quality monitoring performed routinely by the local authorities at 8 monitoring sites apread across the city, covering most of the urban zone.

The results of the model performance are assessed in graphical and statistical ways, showing the capabilities of the CAMx modeling system to simulate the transport and chemistry over such a complex terrain flow.

Summary of PM10 episode, May 1998

Day	LST at peak PM10	PM10 (μ/m^3)	Ri (5m)
Friday, 15th	22-23	600	0.20
Saturday, 16th	21-22	818	0.37
Sunday, 17th	21-22	495	1.86
Monday, 18th	22-23	198	2.45

[OR11-07] DEVELOPMENT AND APPLICATION OF THE PMCAMx MODEL TO TREAT FINE PARTICULATE AND VISIBILITY ISSUES.

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Tuesday, April 1, 2003, 3:00 PM, Oral Session: Workshop 11: Air Quality Modeling (3:00 PM-4:30 PM) Kings Garden South

The Comprehensive Air-quality Model with extensions (CAMx) is a photochemical grid model that was developed in the late 1990s to treat urban and regional ozone issues under a one atmosphere concept. CAMx was first applied to address ozone issues as part of the Ozone Transport Assessment Group (OTAG), but has undergone continuous development and refinement. Because CAMx consists of all new computer coding in a modular framework, it is ideally suited for extension to other air quality issues beyond ozone and the platform has become a host fotr several "probing tools" including Ozone Source Apportionment Technology (OSAT), Decoupled Direct Method (DDM), and Process Analysis. This paper discussed the extension of the CAMx to treat particulate matter (PM) and visibility issues through the inclusion of state-of-science aerosol modules. A sectional approach has been adopted in PMCAMx to treat size resolved PM. Aerosol thermodynamics are treated using either a full dynamic module or the ISORROPIA equilibrium module. A multi-sectional aqueous-phase chemistry algorithm has also been implemented. Secondary organic aerosol is being treated using a reversible semi-volatile scheme. New dry and wet deposition schemes have been developed. A PM Source Apportionment Technology (PSAT) is also being developed and implemented into PMCAMx that allows source attribution of primary and secondary PM to user selected geographic source regions and source categories.. This paper presents the technical formulation of the PMCAMx treatment of aerosols, the application and evaluation of the model to western and eastern US cities, and the formulation and performance of the PSAT PM source apportionment scheme.

[OR11-09] AN EVALUATION OF THE MODELS-3 CMAQ AEROSOL MODULE.

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Tuesday, April 1, 2003, 3:00 PM, Oral Session: Workshop 11: Air Quality Modeling (3:00 PM-4:30 PM) Kings Garden South

Ambient air concentrations of particulate matter (PM) continue to be a major concern for the U.S. Environmental Protection Agency. High concentrations of fine particles have been linked to detrimental health effects and visibility degradation. Accordingly, the Clean Air Act and its Amendments require EPA to establish National Ambient Air Quality Standards (NAAQS) for PM and to assess current and future air quality regulations designed to protect human health and welfare. One of the most reliable tools for performing these assessments are air quality models, such as the Models-3 Community Multiscale Air Quality (CMAQ) model, which simulates air concentrations and deposition of various pollutants, including PM. These simulations, which can be conducted on numerous spatial and temporal scales, support both regulatory assessment by EPA Program Offices, as well as scientific studies by research institutions.

The aerosol module within CMAQ is designed to simulate the complex processes involving both PM2.5 and PM10, which are not single entities, but consist of varying mixtures of chemical species, each having its own emission, transport and deposition characteristics. Aerosol species considered within CMAQ are sulfate, nitrate, ammonium, water, secondary organic aerosols from both anthropogenic and biogenic sources, primary organic aerosols, elemental carbon, and unspecified primary aerosol material. These species are contained in the fine particle size range (PM2.5, which are represented by two interacting lognormal distributions, the Aitken and accumulation modes. Particles with diameters larger than 2.5μm are represented by a third lognormal distribution that does not interact with those representing PM2.5. The coarse mode chemical species are represented by two categories, soil-derived particles and chemically unspecified particles.

In order to determine its value to the regulatory communities, CMAQ, like all models, must be evaluated using observational data. Accordingly, this research compares PM simulated by CMAQ during a three month simulation (June through August, 2001) with PM data collected by two networks: 1) the Interagency Monitoring of PROtected Visual Environments (IMPROVE) network; and 2) the Clean Air Status and Trends Network (CASTNet). A suite of metrics will be used in the evaluation, including summary statistics, numerous measures of bias (mean, mean normalized, mean fractional, normalized mean) and error (root mean square, normaized mean, mean absolute gross and mean normalized gross).

[OR10-01] RECENT ADVANCES IN OUR UNDERSTANDING OF PHYSICAL AND CHEMICAL PROPERTIES OF PARTICULATE MATTER.

Peter H. McMurry Department of Mechanical Engineering, University of Minnesota, Minneapolis, MN

Tuesday, April 1, 2003, 3:00 PM, Oral Session: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (3:00 PM-4:30 PM) LeBateau

Atmospheric particles range from molecular clusters of ~1 nanometer diameter to coarse particles with characteristic sizes of tens to hundreds of microns. Individual particles typically contain complex mixtures of species, which may be uniformly mixed throughout the particle, or which may be separated into multiple distinct phases. Furthermore, a fraction of the particle mass is often semivolatile (i.e., consists of compounds that are simultaneously present at significant levels in both the condensed and gas phases.) Because of these complexities, the effects of particles on health or radiation transfer might not be simply dependent on species concentrations, as is more likely the case for gases.

Our understanding of aerosol physical and chemical properties has advanced rapidly over the past five years. Especially important have been advances made in measuring the concentrations of the major particulate species with high time resolution (minutes rather than hours or a day), in measuring the composition of individual particles by mass spectroscopy, and in measuring particle size distributions down to 3 nm with a temporal resolution of minutes. This presentation will summarize observations about aerosol physical and chemical properties that are now possible as a result of newly-developed measurement capabilities. Evidence will be shown that a large fraction of the submicron particles consist of mixtures of sulfates, organics, and other compounds, and that particles of a given size typically include several (or many) chemically distinct types. Therefore, aerosol particles are both internally and externally mixed. These differences in composition lead to differences in hygroscopic properties, which influence particles tendency to form cloud droplets. Furthermore, insights on the diurnal and seasonal dependencies of aerosol composition obtained with high-time resolution measurements of particulate ammonium, nitrate, sulfate and other ionic species will be discussed. Evidence will also be shown that sub-50 nm particle concentrations can be increased by a factor of 10 or more when nucleation occurs, which appears to happen on about one quarter of the days per year in many locations. Nucleation events can occur uniformly over wide regions, or can occur locally, presumably due to the impact of plumes from nearby sources. Regional nucleation events can occur in all seasons, but are more common in spring and summer, and lead to particle growth rates ranging from 1 to 10 nm/hour.

[OR10-02] SPATIAL AND TEMPORAL VARIATIONS IN PM2.5 MORPHOLOGY.

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Tuesday, April 1, 2003, 3:00 PM, Oral Session: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (3:00 PM-4:30 PM) LeBateau

Extensive studies are currently underway at characterizing the ambient aerosol by measuring its size distribution and chemical composition. Relatively few studies have examined the morphology of these particles (1,2). Though there are only a few studies, there is a general observation that the finer sized particles are more aggregated or have lower fractal dimensions. In this study, an electrostatic sampling system in conjunction with the TEOM was used to collect PM 2.5 particles onto electron microscope grids. The method allows for the collection of particles without potentially altering the aggregate structures. A Scanning Electron Microscope was then used to examine the morphology of ambient aerosols in the Greater Cincinnati air shed and at the St. Louis Supersite. A computer algorithm was developed and used to calculate the mass-fractal dimension based on the cumulative-intersection method. Spatial and temporal variations of the variations of the morphology of the ambient particles will be reported.

Preliminary results show that the percentage of agglomerate particles varied over a day of sampling. The percentages started high (14%) during the morning rush hour and steadily decreased to 1% in the evening. The total number of agglomerates followed the same pattern. The total number of particles (agglomerate and non-agglomerate) started high in the morning, decreased during the day, but increased in the evening. Fractal Dimensions for agglomerates varied from 1.4 to 2, with an average of 1.80 (SD=0.12, n=18). The same analysis is being done for other days, from locations in St. Louis and in Cincinnati, and the results will be presented.

1. Xiong, C., and Friedlander, S.K. (2001) Morphological Properties of Atmospheric Aerosol Aggregates. Proceedings of the National Academy of Sciences, 98, 11851-11856.

2. Katrinak, K.A., Rez, P., Perkes, P.R. and Buseck, P.R. (1993) Fractal geometry of carbonaceous aggregates from an urban aerosol. Environmental Science and Technology 27, 239-547. (Click to see figure 1)

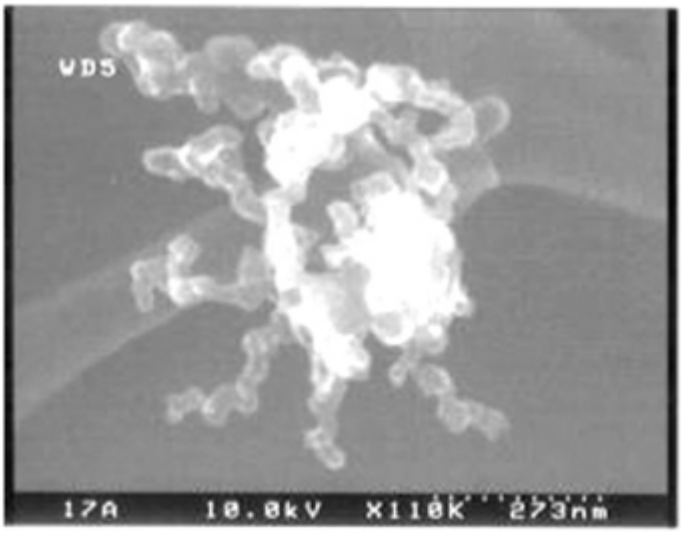

Figure 1. Sample agglomerate captured during sampling D1=1.76

Figure

[OR11-13] SIMULATION OF PARTICULATE MATTER IN SOUTHERN TAIWAN BY MODELS-3/CMAQ.

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Tuesday, April 1, 2003, 3:00 PM, Oral Session: Workshop 11: Air Quality Modeling (3:00 PM-4:30 PM) Kings Garden South

Particulate matter is one of major pollutants causing the ambient air quality standard to be exceeded in southern Taiwan, especially during November to February in the following year. The results from field measurements showed that the abundant species in PM2.5 were sulfate, nitrate, ammonia, organic carbon and elemental carbon. In this study, Models-3/CMAQ was used to simulate the particulate matter in southern Taiwan from the 21st to 27th, November 1996 and the simulated results were then compared with field measured data. The meteorological data were provided by MM5 with FDDA and the emission data were from Taiwan Emission Data System version 4.2 (TEDS 4.2) by using SMOKE for stationary, mobile and area sources. The VOCs emitted from biogenic sources were estimated by BEIS2. Four layers of nested grids with the finest grid of 4 km by 4 km, 15 vertical sigma layers, RADM2 and RPM mechanisms were used in the simulation. In southern Taiwan, measured data showed that sulfate concentrations were about 1.5 times greater than those of nitrate. However, the simulated results revealed that nitrate concentrations were about 2 times greater than those of sulfate. But the simulated nitrate concentrations were similar to the observed data and sulfate concentrations were significantly underestimated. Note that the average ratios of measured to simulated NOx and SO2 were 1.4 and 1.1, respectively. That is, both were in good agreement for SO2 and the simulated NOx were slightly underestimated. Therefore, the formation of sulfate was underestimated by RPM in Models-3/CMAQ. The underestimation of ammonia may due to the underestimation of sulfate, because ammonia sulfate was the major compound in secondary aerosol. Based on measured results, carbonaceous species accounted for about 20% of PM2.5 in Kaohsiung City. Thus, the simulated concentrations of organic carbon (OC) and elemental carbon (EC) were underestimated, too. However, the differences between simulated and measured NMHC concentrations were even greater. Therefore, the underestimation of VOCs emission may cause the lower simulated concentrations of OC/EC. Diurnal variation patterns of NO3--N and HNO3-N were similar between simulation and observation data: greater HNO3 concentrations occurred in daytime and the opposite pattern was observed for nitrate. However, the peak concentrations of HNO3 and NO3- were not in the same ranges between simulated and observed data. Additionally, ammonia was highly correlated with sulfate in measured data, but in simulated results, ammonia was strongly correlated with nitrate.

[OR11-04] PERFORMANCE EVALUATION OF MULTI-PHASE INORGANIC AEROSOL THERMODYNAMIC MODULE: UHAERO.

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Tuesday, April 1, 2003, 3:00 PM, Oral Session: Workshop 11: Air Quality Modeling (3:00 PM-4:30 PM) Kings Garden South

Over the past decade, several atmospheric aerosol thermodynamic modules predicting the equilibrium partition of inorganic compounds have been developed. The most popular modules are SCAPE2 and ISORROPIA. These models have been used in a number of studies for the analysis of ambient measurements. However these models rely on a priori knowledge of the presence of components in certain relative humidity, and often fail to accurately predict delequescence point depression in the multi-phase aerosol growth. The present approach, relying on the Extended UNIQUAC activity coefficient model, incoperates the TABLEAU analysis and Newton-type active-set method to determine the right set of governing equations automatically given temperature, relative humidity and the total ammonia, nitric acid, sulfate, sodium and hydrochloric acid. The comparison is conducted between our approach and available experimental results. The current model agrees with experimental results for single salt systems. For multi-component systems, our model reproduces observed multi-stage growth patterns and deliquescence point depression.

[OR10-03] PARTICLE FORMATION AND GROWTH IN SO_2- AND VOC-RICH PLUMES NEAR HOUSTON, TEXAS.

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Tuesday, April 1, 2003, 3:00 PM, Oral Session: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (3:00 PM-4:30 PM) LeBateau

Gas-phase particle precursors and tracer species and particle size distributions were measured aboard an aircraft downwind from industrial and urban sources in the vicinity of Houston, Texas during the daytime in late August and early September, 2000. The plumes originating from several sources, including a gas- and coal-fired power plant, the petrochemical industries along the Houston ship channel, and the urban center of Houston, were studied. On the days selected for analysis, the nearly constant southerly wind allowed the plumes to advect in parallel to the north of Houston with minimal mixing between the plumes. These meteorological conditions allowed comparison of the evolution in particle properties within the plumes from the discrete sources as a function of plume age and oxidation.

The industries and electrical utilities at the periphery of the city were the primary sources of particulate mass flux from the Houston metropolitan area. Particle volume was observed to increase with increasing plume oxidation (age) in those plumes that were rich in SO_2, but which did not contain elevated concentrations of volatile organic compounds (VOCs), at a rate consistent with condensation and neutralization of the gas-phase oxidation products of SO_2. In contrast, in plumes from petrochemical industries that were rich in both SO_2 and VOCs, observed particle growth greatly exceeded that expected from SO_2 oxidation alone, indicating the formation of organic particulate mass. In those plumes which had enhanced concentrations of VOCs but which did not contain much SO_2, and in the plume of the Houston urban center, no particle volume growth with increasing plume oxidation was detected. Since substantial particle volume growth was associated only with SO_2-rich plumes, and not with those with enhanced concentrations of VOCs alone, these results suggest that photochemical oxidation of SO_2 is the key process regulating particle mass growth in all the studied plumes in this region over time scales of several hours. However, the uptake of organic matter--perhaps enhanced by acid-catalyzed reactions on the surfaces of the particles--probably contributes substantially to particle mass in petrochemical plumes rich in both SO_2 and VOCs. We recommend further quantitative studies of particle formation and growth in photochemical systems containing nitrogen oxides (NO_x=NO+NO_2), VOCs and SO_2 to extend those previously made in NO_x-VOC systems.

[OR11-14] A PARTICULATE MATTER AIR QUALITY FORECAST MODELING SYSTEM FOR THE NORTHEAST U.S. - COMPARISONS WITH SUMMER 2001 EPA SUPERSITE FIELD INTENSIVE DATA.

Chenxia Cai, Christian Hogrefe, George Kallos, Petros Katsafados, Julius S. Chang, Kenneth L. Demerjian Atmospheric Sciences Research Center, Univeristy at Albany - SUNY, Albany, NY; University of Athens, Athens, Greece

Tuesday, April 1, 2003, 3:00 PM, Oral Session: Workshop 11: Air Quality Modeling (3:00 PM-4:30 PM) Kings Garden South

An air quality forecast modeling system (AQFMS), which has run reliable18-hr oxidant air quality forecasts for the Northeast United States for over a year, has been further developed to consider the prediction of PM air quality in the region. The AQFMS was designed to operate with forecasted meteorological fields from either of two mesoscale meteorological models, the Penn State/NCAR Mesoscale Model MM5 or the University of Athens' ETA-SKIRON meteorological model. The meteorological fields are used to drive the Comprehensive Air Quality Model with Extensions (CAMx), a photochemical air quality simulation model.

This prototype system has recently been upgraded to incorporate emissions of SO2, NH3, and primary particulate matter and a rudimentary secondary formation mechanism for sulfate, nitrate and organic particulate matter. Archived meteorological forecasts, generated as part of the PMTACS-NY Supersite Summer 2001 Field Intensive, have been used to re-run the forecasts with updated emissions generated by the SMOKE emission model and the modified chemical mechanism within the CAMx model.

Preliminary assessment of the PM air quality forecast modeling system is presented and forecasted PM model results for the northeast and New York metropolitan areas are compared with measurements performed during the EPA Summer 2001 Supersite intensive field campaign.

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[OR11-02] POLICY IMPLICATIONS OF THE CURRENT STATE OF PM CHEMICAL TRANSPORT MODELS: THE USE OF CHEMICAL TRANSPORT MODELS TO ESTIMATE PARTICLE CONCENTRATIONS AND EXPOSURE.

Christian Seigneur, Michael Moran Air Quality Division, Atmospheric & Environmental Research, Inc., San Ramon, CA; Meteorological Service of Canada, Environment Canada, Downsview, ON, Canada

Tuesday, April 1, 2003, 3:00 PM, Oral Session: Workshop 11: Air Quality Modeling (3:00 PM-4:30 PM) Kings Garden South

As part of the 2003 NARSTO North American PM Assessment, we have reviewed the current status of chemical transport models (CTMs) in the context of PM2.5 ambient air quality standards and regional haze regulations. We summarize that review here, beginning with the current representations of physico-chemical processes in CTMs and recent applications of CTMs to both episodic and long-term simulations. We address various policy-related questions that will typically be addressed in most PM applications of CTMs. For each question, we provide our best assessment of how well it can be addressed by current CTMs. We also discuss the main aspects of the CTM performance evaluation process, the use of CTMs to complement monitoring networks, and the use of CTMs to estimate exposure. Some examples of policy-relevant results from CTM applications to date are presented. Finally, a list of critical uncertainties in PM modeling is presented and recommendations are provided to reduce those uncertainties.

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[OR11-12] MODELING PARTICULATE MATTER WITH THE COMMUNITY MULTISCALE AIR QUALITY (CMAQ) MODELING SYSTEM DURING THE PACIFIC NORTHWEST 2001 (PNW2001) FIELD CAMPAIGN.

Robert A Elleman, David S Covert, Clifford F Mass, Brian K Lamb, Jack Chen, Leonard A Barrie, Richard Barchet Department of Atmospheric Sciences, University of Washington, Seattle, WA; Department of Civil and Environmental Engineering, Washington State University, Pullman, WA; Atmospheric Sciences Technical Group, Pacific Northwest National Laboratory, Richland, WA

Tuesday, April 1, 2003, 3:00 PM, Oral Session: Workshop 11: Air Quality Modeling (3:00 PM-4:30 PM) Kings Garden South

The Community Multiscale Air Quality (CMAQ) modeling system is examined for its ability to predict particulate material (PM) concentrations in the Pacific Northwest. Particulate matter pollution in the Pacific Northwest is unique due to few large pollution point sources and to the large contribution of biomass burning. The worst particulate pollution occurs on cold, stable, stagnant days when wood stoves are heavily used. Strong inversions trap PM close to the surface and often concentrate it in narrow valleys around the Puget Sound. Summertime PM production impacts visibility in the numerous Class I areas in the region. Transport is important from other urban areas such as Portland, OR and Vancouver, BC as well as from forest fires east of the Cascade mountain crest.

To understand PM and gaseous pollution in this region, Pacific Northwest National Laboratories (PNNL) and others conducted the Pacific Northwest 2001 (PNW2001) campaign in August, 2001. This was done in concert with Pacific 2001, a Canadian study of pollution in the Lower Fraser Valley of British Columbia and northwest Washington. Air pollutants, gaseous precursors, and meteorological variables were measured from the ground and by aircraft within the boundary layer. CMAQ simulations were performed using 12 km and 4 km gridded domains for August 20th, 26th, and 27th, the days when the most intensive observations were conducted. The states of Washington, Oregon, and Idaho as well as Environment Canada provided a ground-up emissions database for this study. MM5 produced meteorological fields using a combination of analysis nudging at the coarse resolution and observation nudging to winds at the fine scale. Sensitivity to analysis and observational nudging and to boundary layer parameterizations is investigated by comparison to observations from surface profilers, PNNL aircraft, and more than one hundred surface sites. The results indicate nudging to a gridded analysis improves meteorological fields throughout the simulation. In addition, the MRF boundary layer parameterization produced more realistic profiles and PBL heights than the Asymmetric Convection Model PBL scheme. The CMAQ modeling results are compared to aircraft and ground measurements of PM size, mass, species, and optical properties.

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[OR14-01] QUANTITATIVE TRAIT ANALYSIS OF THE DEVELOPMENT OF PULMONARY TOLERANCE TO ZINC OXIDE IN MICE.

Scott Wesselkamper, Lung Chi Chen, Terry Gordon Environmental Medicine, NYU School of Medicine, Tuxedo, NY; Environmental Health, U. of Cincinnati, Cincinnati, OH

Tuesday, April 1, 2003, 5:00 PM, Oral Session: Workshop 14: Susceptibility, Genetics and Biological Indicators (5:00 PM-6:30 PM) Kings Garden South

Following repeated exposures to inhaled toxicants, many individuals may develop tolerance to the induction of adverse pulmonary effects. In inbred mouse strains, we previously demonstrated that genetic background plays an important role in the development of pulmonary tolerance to inhaled ZnO, as assessed by polymorphonuclear leukocytes (PMNs), macrophages, and total protein in bronchoalveolar lavage phenotypes. BALB/cByJ (CBy) and DBA/2J (D2) strains were identified as the most tolerant and non-tolerant, respectively. The present study was designed to identify candidate genes that control the development of pulmonary tolerance to inhaled ZnO. Genome-wide linkage analyses of a CByD2F2 mouse cohort identified the following quantitative trait loci (QTLs): a significant QTL on chromosome 1 and suggestive QTLs on chromosomes 4 and 5 for the protein phenotype, as well as suggestive QTLs on chromosomes 1 and 5 for the PMN and macrophage phenotypes, respectively. Within the significant protein QTL on chromosome 1, the toll-like receptor 5 (Tlr5) gene was identified as a putative gene candidate. Pulmonary tolerance was observed in Tlr5-mutant MOLF/Ei mice repeatedly exposed to ZnO. Our findings suggest that, as in the case with other inhaled toxicants, a toll-like receptor pathway may play a role in the genetic regulation of the pulmonary response to inhaled ZnO.

[OR13-02] NEW OPPORTUNITIES FOR ORGANIC TRACER ANALYSES OF ATMOSPHERIC PARTICULATES, APPLICATION TO SOURCES, RECEPTORS, TRANSPORT AND SECONDARY PRODUCTS.

Bernd R Simoneit College of Ocean and Atmopsheric Science, Oregon State Unviversity, Corvallis, OR

Tuesday, April 1, 2003, 5:00 PM, Oral Session: Workshop 13: Receptor Modeling and Source Apportionment (5:00 PM-6:30 PM) LeBateau

The characterization of source specific organic tracers in aerosol particles is a well established method. Most tracers of utility are derived from biological and geological organic matter and are analyzed in solvent extracts of bitumen/lipids from filtered particles using gas chromatography-mass spectrometry. Organic matter in aerosols is derived from two major sources and is admixed depending on the geographic relief of the air shed. These sources are the natural background from biologically derived detritus (e.g., plant wax, microbes, etc.), and from soils (resuspension) and anthropogenic particle emissions (e.g., fossil fuel use, soot, synthetics, etc.). Both biogenic detritus and some of the anthropogenic particle emissions contain organic compounds which have unique and distinguishable distribution patterns. Vascular plant and microbial lipids are the dominant biogenic residues and are recognizable by their aliphatic homolog distributions with strong carbon number preferences. Fossil fuel hydrocarbons (petroleum and coal), with lesser amounts of the pyrogenic polynuclear aromatic hydrocarbons (PAH), and synthetic compounds (e.g., halogenated compounds, plasticizers), are the major anthropogenic residues found in atmospheric particles. The organic constituents in coal smoke are distinguishable from petroleum tracers and are more diverse due to combustion temperature, ventilation, burn time, and coal rank (geologic maturity).

Biomass burning is another important primary source of biologically derived particles injected into the global atmosphere. Molecular tracers in smoke are generally source specific. Dehydroabietic acid is typical for conifer smoke in the atmosphere and degradation products from biopolymers (e.g., levoglucosan from cellulose) confirm the smoke contribution. Numerous additional tracers of thermally-altered and directly-emitted natural products identified in smoke aid the assessment of fuel type and input from biomass combustion to aerosols. Soils contain primary biomarkers from the surficial vegetation and mono- and disaccharides (sugars) are the unique source tracers in the case of such an input. The precursor to product approach of compound characterization by organic geochemistry can be applied successfully to provide source specific tracers for studying the chemistry and dispersion of ambient aerosols and the intermingling of natural with anthropogenic emissions and smoke plumes, as well as resuspension of soil and desert dust. The fate of source emissions can thus be traced during aerosol transport and secondary alteration.

[OR13-04] HOW CAN SOURCE APPORTIONMENT AND RECEPTOR MODELLING DATA BE USED IN EPIDEMIOLOGY?

Thomas Lumley, Hao Liu Biostatistics, University of Washington, Seattle, WA

Tuesday, April 1, 2003, 5:00 PM, Oral Session: Workshop 13: Receptor Modeling and Source Apportionment (5:00 PM-6:30 PM) LeBateau

Human health effects models based on pollution sources have been proposed as easier to fit and interpret, and more relevant for public health and regulation. We will show that the first of the claims is not entirely correct.

Measurement error in the concentrations of chemical species or size fractions will often be well approximately by a classical additive independent error model. The estimates from a source apportionment model, however, have very complicated non-independent errors due to both the original measurement error and uncertainty in the model.

We will describe possible approaches to this estimation problem. One approach is to regress health outcomes on the concentrations of chemical species, where standard measurement error correction methods are applicable, and then apply an estimated source apportionment model to convert these health effects to the scale of interest. Another approach, when replicate measurements of chemical species are available, is to use instrumental variable methods from econometrics.

[OR13-03] ADDRESSING SOME THREATS TO VALIDITY IN MULTIVARIATE RECEPTOR MODELING.

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Tuesday, April 1, 2003, 5:00 PM, Oral Session: Workshop 13: Receptor Modeling and Source Apportionment (5:00 PM-6:30 PM) LeBateau

Traditional chemical mass balance studies have estimated pollution source contributions using estimated source profiles and a single observation of a collection of species concentrations. As species measurements have become less expensive and more abundant, many studies now involve multiple (e.g., hourly, daily, or weekly) measurements over a period of time. Additionally, the scope of receptor modeling studies has extended in both location and purpose so that the number of pollution sources and the composition of pollution source profiles are often unknown or only partially known. In such scenarios, multivariate factor analytic approaches are becoming increasingly attractive.

We consider some threats to the validity of solutions obtained from multivariate receptor models. Specifically, we discuss the need for solutions that are: (1) unique and physically meaningful, (2) based on only partial source profile information, and (3) valid for temporally-correlated data. We propose the use of a flexible multivariate receptor model. The use of latent variable modeling allows the direct incorporation of subject matter knowledge into the model, including known physical constraints and partial pollution source information obtained from laboratory measurements or past studies. Because air quality data often exhibit temporal dependence, we consider the importance of accounting for such correlation in estimating model parameters and making valid statistical inferences. We propose an approach for incorporating dependence structure directly into estimation and inference procedures via a nested block bootstrap method which adjusts for bias in estimating moment matrices. The proposed approaches are evaluated by simulation and illustrated with an analysis of hourly measurements of volatile organic compounds in the El Paso, Texas/Ciudad Juarez, Mexico area.

[OR14-04] GENE EXPRESSION PATTERN IN SPONTANEOUS HYPERTENSIVE RATS EXPOSED TO URBAN PARTICULATE MATTER (EHC-93).

Ingeborg M. Kooter, John A.J.F. Boere, Daan L.A.C. Leseman, Miriam E. Gerlofs-Nijland, Jan Bos, Renaud Vincent, Flemming R. Cassee MGO, National Institute for Public Health and the Environmental (RIVM), Bilthoven, Netherlands; Growth and Development Section, Environmental Health Centre, Ottawa, ON, Canada

Tuesday, April 1, 2003, 5:00 PM, Oral Session: Workshop 14: Susceptibility, Genetics and Biological Indicators (5:00 PM-6:30 PM) Kings Garden South

Based on the fast number of epidemiological studies associating ambient particulate matter with both morbidity and mortality, toxicologists are faced with the task to identify the biological mechanisms behind these observations. Micro-array technologies are a promising tool to monitor a large number of genes, possibly involved of the changes in human or animal physiology resulting in pulmonary and cardiovascular health effects.

Previous studies in our group have shown that instillation of with urban particulate matter collected in Ottawa (EHC-93) alter protein and mRNA levels. Clear-elevated levels of TNF- α and MIP-2 were detected in the lung lavage fluid. Whereas endothelial damage was suggested by decreased ACE and increased ET-1 mRNA levels of lung tissue.

Normal spontaneous hypertensive rats (SHR, 12 weeks old) were exposed by intratracheal instillation to 2.5 mg EHC-93 and were sacrificed after 2, 4, 6, 15, 18, 21, 24, 32 and 40 hours. Groups were aggregated into an early (2-6 hours), middle (15-21 hours) and late (24-40 hours) response group. Each time point consisted of 3 rats. Total RNA was isolated from lung tissue and gene expression patterns were explored using Affymetrix RG U34A arrays (containing probes representing >7000 genes). Analyses of the data shows that the most abundant changes in gene expression, compared to the sham exposure, were found 2 to 6 hours after instillation. Among them are about 100 genes which exclusively have changed a factor >3 in this early response.

A large group of genes are highly (up to 8x) upregulated at the early response (2-6 hours), after which a decrease to a factor of 2-3x in upregulation occurs at the middle and late response. This group contains several chemokines, a transcription factor related to the NF-κB family, and proteins involved in oxidative stress response (metallothionein, glutathion metabolism related, inducible nitric oxide synthase).

This study shows that the patterns of differential gene expressions in rat exposed to a single intratracheal exposure to urban PM were noticeable, and clearly dependent on the time after the exposure. The most abundant changes are found in the early (2-6 hours) response.

[OR14-03] PARTICLE EFFECTS ON HEART RATE REGULATION IN SENESCENT MICE.

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Tuesday, April 1, 2003, 5:00 PM, Oral Session: Workshop 14: Susceptibility, Genetics and Biological Indicators (5:00 PM-6:30 PM) Kings Garden South

Because epidemiology studies consistently identify the elderly at risk for air pollution-related morbidity and mortality, we developed a model of senescent-dependent susceptibility based on indices of physiological aging. In the current study, we hypothesized that heart rate regulation during particulate matter (PM) exposure differs with senescent-dependent susceptibility owing to variation in autonomic nervous control. Heart rate (HR) and heart rate variability (HRV) parameters were measured from162 samples of 2-min ECG recordings in age-matched healthy (n = 5) and terminally-senescent (n = 3) AKR mice during 3-h exposures to filtered-air (FA, day 1) and carbon black (CB, day 4; <200&μg/m3). On day 1, HR was significantly ($P < 0.05$) depressed during FA in terminally senescent mice. By day 4, HR was further slowed significantly ($P<0.05$) due to the effects of CB exposure for 3 days. The combined effects of terminal senescence and CB exposure acted to depress HR to an average (±SEM) 445±40 bpm, or ~80 bpm lower compared to healthy HR responses. The change in rMSSD, a HRV parameter corresponding to relative influences of parasympathetic tone on HR, was greater on day 1 and day 4 in terminally senescent mice compared to healthy mice. In contrast, the LF/HF ratio, a HRV parameter derived from spectral analysis indicating relative changes in cardiac sympathetic tone was significantly ($P < 0.05$) depressed in terminally senescent mice on day 1. By day 4, increases in LF/HF were significant ($P < 0.05$) in healthy mice during CB exposure suggesting that HR regulation was associated with an increase in sympathetic tone. However, terminally senescent mice appeared to modulate a lower HR in the absence of increased sympathetic tone during CB exposure. In conclusion, older healthy mice increase cardiac sympathetic tone during PM exposure while terminally senescent mice demonstrate a greater PM-induced parasympathetic tone in HR regulation.

[OR14-05] ALVEOLAR MACROPHAGE PRODUCTION OF INFLAMMATORY CYTOKINES INDUCED BY ULTRAFINE PARTICLES IS INCREASED IN AGED ANIMALS.

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Tuesday, April 1, 2003, 5:00 PM, Oral Session: Workshop 14: Susceptibility, Genetics and Biological Indicators (5:00 PM-6:30 PM) Kings Garden South

Altered immune responses and increase susceptibility to infection occur with age. Similarly, inflammatory cell function has been noted to altered in aged humans and in various animal models. In particular altered cytokine expression has been observed . Epidemiologic data suggests individuals of advanced age as a susceptible population following exposure to environmental particles however, little is known regarding the cellular effects of age as it relates to particle effects. Alveolar macrophages were isolated from the lungs of young (7-12 weeks) and old (20-22 month) but otherwise healthy, mice and placed in short term culture under non adherent conditions. These cells were stimulated with varying concentrations of laboratory generated ultrafine particles of varying composition for a period up to 24 hours and cell death and inflammatory cytokine production measured. In addition, cells were stimulated with various concentrations of LPS to evaluate the effect of "priming" on particle induced gene expression. Compared to cells from "young" mice, cells from "old" mice exhibited a significantly higher level of baseline production of MIP-2 (>2fold) and an enhanced response to the addition of low concentrations of LPS (2-5 fold). In contrast TNF production was greater in young animals. Incubation with ultrafine particles containing iron, elicited a 3-7 fold greater release of MIP-2 from "old" cells. Combined particle LPS treatments enhanced this effect. This suggests that the greater susceptibility among the "aged" population is due to an exaggerated inflammatory response to particle exposure that could lead to systemic effects

Supported by EPA STAR PM Center Grant R-827354

[OR14-02] HYPERTENSIVE RATS ARE SUSCEPTIBLE TO TLR4-MEDIATED SIGNALING FOLLOWING EXPOSURE TO COMBUSION PARTICULATE MATTER (PM).

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Tuesday, April 1, 2003, 5:00 PM, Oral Session: Workshop 14: Susceptibility, Genetics and Biological Indicators (5:00 PM-6:30 PM) Kings Garden South

Toll like receptor 4 (TLR4) has been shown to play a role in cell signaling that results in neutrophilic inflammation in response to LPS and RSV virus infection. TLR4 also interacts with CD14, which when activated, triggers TLR4-associated signaling pathways to produce a pro-inflammatory response. This mechanism involves the adapter protein MyD88 which eventually results in the activation of NF-kB and subsequent inflammatory gene induction. In order to determine the effect of residual oil fly ash (ROFA), rich in zinc and nickel but not vanadium, on a possible activation of TLR4 mediated cell signaling and subsequent inflammation, we intratracheally (IT) instilled 3.3 mg/kg ROFA PM into male Wistar-Kyoto (WKY) and Spontaneously Hypertensive (SH) rats. Pulmonary inflammation, changes in BAL protein, and levels of TLR4 and CD14 protein in the lung were determined 24 h post IT. BALF neutrophils and total cells were significantly increased in the ROFA exposed WKY and SH rats, however, in both parameters the SH rats showed greater increases than WKY rats. Similarly, BALF protein and LDH levels were increased in all ROFA exposures but to a significantly greater extent in SH rats. The increased inflammation seen in ROFA-exposed SH rats was accompanied by a significant increase in TLR4 protein in the lung tissue. There was also a TLR4 increase in WKY rats which was, however, not significant. The TLR4 mRNA levels were not increased concomitantly at the 24 h time point. The CD14 and MyD88 were also increased in both SH and WKY exposed rats. These data suggest that the increased inflammation in the lungs of ROFA exposed SH rats compared to WKY rats is accompanied by an increase in TLR4-mediated cell signaling. Therefore, in SH rats, ROFA exposure may incur a hypersusceptibility through activation of TLR4 cell signaling. This abstract does not reflect US EPA policy. Supported in part by #CR829522 between EPA and UNC.

[OR15-04] TIME-RESOLVED DETERMINATION OF INDOOR, OUTDOOR AND REGIONAL CONCENTRATION RELATIONSHIPS FOR PM2.5 NITRATE, SULFATE AND CARBON.

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Tuesday, April 1, 2003, 5:00 PM, Oral Session: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (5:00 PM-6:30 PM) Kings Garden North

Human health effects form the basis for the regulation of outdoor particulate matter, yet time activity studies show that most people, including children, spend the majority of their time indoors. Knowledge of indoor concentrations of particles of outdoor origin is needed to evaluate human exposure, especially for particles with diameters below 2.5 μm, called PM2.5, that are readily transported indoors. This paper examines the indoor concentrations for PM2.5 aerosols of outdoor origin through chemically- and time-resolved measurements in an unoccupied house, and examines the appropriateness of using regional data to model indoor concentrations from outdoor sources.

Sub-hourly concentration profiles of nitrate, sulfate, and black carbon were measured simultaneously at three locations: an unoccupied residence in Clovis, California, the backyard of the same residence, and a regional monitoring site in Fresno, California, located 6 km southwest of the residence. PM2.5 nitrate and sulfate concentrations were determined using an automated collection and vaporization system, and black carbon was assayed by light attenuation through a filter deposit. Indoor concentrations are compared to those measured immediately outside the house, and to those measured at the regional monitoring site.

Outdoors, the time-resolved data showed consistent daily, or twice-daily species concentration peaks of several hours duration. Indoors, these concentration peaks exhibited considerable attenuation and broadening as well as time-lag by comparison to the outdoor data. The indoor concentration reduction was the largest for PM2.5 nitrate, which appears to undergo phase changes in addition to indoor deposition and penetration losses. In general, much greater differences were seen across the building shell than between measurements immediately outside the house and the regional monitoring site. For this data set the regional results provide a good representation of the concentrations seen at the building exterior.

This research was supported by the Assistant Secretary for Fossil Energy, Office of Natural Gas and Petroleum Technology through the National Petroleum Technology Office under U.S. Department of Energy Contract No. DE-AC03-76SF00098, and by the Western States Petroleum Association.

[OR15-03] INFILTRATION BEHAVIOR OF $PM_{2.5}$ CHEMICAL COMPONENTS: IMPLICATIONS FOR PM EXPOSURE ASSESSMENT AND EPIDEMIOLOGICAL ASSOCIATIONS.

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Tuesday, April 1, 2003, 5:00 PM, Oral Session: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (5:00 PM-6:30 PM) Kings Garden North

Numerous epidemiological studies have reported significant associations between ambient PM concentrations and adverse health effects. Although current toxicological evidence indicates that some PM components may be more toxic than others, epidemiological associations have been predominantly for total fine particle mass rather than the mass of specific PM components. Current efforts are ongoing to develop databases of ambient PM component measures that can be used in epidemiological investigations. Because so much of people's exposures to PM occurs indoors, it is also important to better understand the relationships between ambient, indoor, and personal exposures to PM components for the proper interpretation of epidemiological findings.

As part of this process, we analyzed indoor and outdoor $PM_{2.5}$ components data from a comprehensive indoor particle characterization study conducted in nine residential homes in Boston, Massachusetts to investigate the infiltration behavior of various $PM_{2.5}$ components. Previous analyses of these study data quantified indoor infiltration of $PM_{2.5}$ and specific size fractions (Long *et al.*, 2001), and demonstrated the utility of sulfur as a tracer for $PM_{2.5}$ (Sarnat *et al.*, in press). Focusing on periods with little or no active indoor sources, new analyses were conducted for $PM_{2.5}$ components that have been linked to specific ambient PM sources: polycyclic aromatic hydrocarbons (wood smoke, vehicular exhaust), elemental carbon (diesel exhaust), nickel (oil-burning), and zinc, iron, potassium, silica and calcium (crustal materials).

Current results show that outdoor levels of PAHs, elemental carbon, Ni, Zn, Fe, K, Si, and Ca were significantly correlated with their corresponding indoor levels, with a strong effect of particle size. Data also show that home characteristics such as air exchange rate have differential effects on the infiltration of the various PM components, with larger effects being observed for indicators of crustal particles (e.g., Ca, Si). For example, similar indoor-outdoor Spearman correlation coefficients (r_s) were observed for Ni for summer and winter sampling (0.82 and 0.80), while lower and seasonally-affected r_s were observed for Si (0.65 and 0.42), a larger particle component. Additional analyses are planned to quantify component-specific penetration efficiencies and to tie in particle sizing data for the evaluation of the utility of these different $PM_{2.5}$ components as tracers for various PM fractions.

[OR15-01] THE ROLE OF SUBPOPULATION, DISEASE STATE, HOUSING, SEASON AND OTHER FACTORS UPON PERSONAL EXPOSURES TO PM OF AMBIENT ORIGIN.

Ron Williams, Jack Suggs, Gary Evans, Anne Rea, Linda Sheldon, Alan Vette, Burke Janet, Carry Croghan, Kelly Leovic, John Creason, Debra Walsh, Charles Rodes, Jonathan Thornburg, Phil Lawless, Ademola Ejire, Margaret Herbst, William Sanders, Jr. National Exposure Research Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC, USA; National Health and Environmental Effects Research Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC, USA; Research Triangle Institute International, Research Triangle Park, NC, USA; Shaw University, Raleigh, NC, USA; Department of Cardiology, University of North Carolina-Chapel Hill, Chapel Hill, NC, USA

Tuesday, April 1, 2003, 5:00 PM, Oral Session: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (5:00 PM-6:30 PM) Kings Garden North

A series of longitudinal particulate matter (PM) and related co-pollutant human exposure panel field studies were conducted in Baltimore, Maryland (1997,1998) Fresno, California (1999) and Research Triangle Park, North Carolina (2002-2001). They were designed to evaluate the effects of personal exposures to PM of ambient origin under differing sub-populations, regions of the country, seasons, and housing conditions. Participants were monitored over time (28 days) to investigate both longitudinal and cross-sectional correlations between personal, residential indoor, residential outdoor, and ambient measurements. Measurements of $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ were routinely performed. Copollutant monitoring included CO, O_3, NO_2, SO_2, elemental-organic carbon and metals. Daily time activity diaries and questionnaires documented potential source exposures. The studies involved a variety of potentially susceptible subpopulations made up of non-smoking, ambulatory volunteers being at least 55 years old. Some of the subjects lived in communal (apartment or cottage-style) housing while others lived in single family residences. Results revealed a wide range in the magnitude and variability of daily personal $PM_{2.5}$ exposures (3 to 200 $\mu g/m^3$). Time activity patterns and estimated exposures to indoor generated sources appeared to be some of the primary factors influencing personal to ambient PM mass concentration associations (r ranging from 0.0 to 0.95). Mean personal $PM_{2.5}$ clouds ranged from 3 to 10 μ g/m^3 relative to the various study populations and were clearly influenced by individual time activity patterns among the participants. Results from the RTP-based study showed that ambient $PM_{2.5}$ sources contributed to approximately 50% of the total personal exposure mass concentration regardless of season, residence, occupational status or disease state. This work has been funded wholly by the United States Environmental Protection Agency under contract #68-D5-0040 and 68-D-99-012 to the Research Triangle Institute and assistance agreement #CR-828186-01-0 to Shaw University. It has been subjected to Agency review and approved for publication.

[OR13-01] NEW OPPORTUNITIES FOR TRACE ELEMENT ANALYSIS TO SUPPORT RECEPTOR MODELING.

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Tuesday, April 1, 2003, 5:00 PM, Oral Session: Workshop 13: Receptor Modeling and Source Apportionment (5:00 PM-6:30 PM) LeBateau

Receptor modeling and trace element data have gone hand-in-hand since the first application of this approach decades ago. Multi-elemental analytical techniques such as X-ray fluorescence (XRF), proton Induced X-ray emission (PIXE), and Instrumental Neutron Activation (INAA) have been the methods of choice for decades in source apportionment studies for particulate matter (PM). More recently, methods such as ICP-AES and ICP-MS have been applied for characterization of atmospheric PM. These advanced analytical techniques offer significantly better sensitivity and can provide data for trace elements that may offer new tracers for significant sources of PM in all size classes.

ICP-MS is now one of the most powerful techniques for the analysis and quantification of trace elements. Past limitations of ICP-MS such as polyatomic interferences in the elemental signals originating from argon or the sample matrix can be avoided with high resolution machines. High mass resolution is thought to be the gold standard for the identification and elimination of interferences. Elimination of these interferences enables accurate and reliable quantitative multi-element analyses at trace levels often with minimal sample preparation. High precision isotope ratio determinations for many elements are also possible and provide another layer of sophistication in receptor modeling studies. The application of high-resolution ICP-MS to receptor modeling studies focused on understanding the sources of PM exposure to children in health studies will be presented.

[OR15-02] ESTIMATING OUTDOOR CONTRIBUTIONS TO INDOOR AND PERSONAL PARTICULATE AIR EXPOSURES.

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Tuesday, April 1, 2003, 5:00 PM, Oral Session: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (5:00 PM-6:30 PM) Kings Garden North

Many epidemiologic studies have shown an association between adverse health effects and particulate concentrations measured at centrally located sites. Few studies quantify the contribution of ambient and indoor sources to personal exposures. This study quantifies the outdoor and indoor contributions to personal PM exposures, using $PM_{2.5}$ and PM_{10} measurements collected from 108 subjects and their residences in a large exposure assessment study conducted between 1999 and 2001. The PM data measurements consist of integrated measurements, using the Harvard impactors for fixed sites and Harvard personal environmental monitors for subjects, and continuous measurements using the Radiance nephelometers for fixed sites and personal DataRAM for a subset of subjects. The Teflon filters collected from the integrated monitors were analyzed for sulfur with XRF. We use several techniques to estimate the outdoor contribution to indoor concentrations (i.e., infiltration efficiency, F_{inf}) and to personal PM exposure (i.e., attenuation factor). These techniques include the random component superposition (RCS) model, fixed effect models with random intercepts or random slopes, recursive model, and the sulfur tracer technique. The RCS model, using 24-h integrated measurements, estimates the outdoor contribution to indoor and personal $PM_{2.5}$ concentrations to be 47% and 51%, respectively. The recursive model, using continuous measurements, estimate an average F_{inf} of 0.66 and an average attenuation of 0.68. Results from the fixed effect models using 24-h integrated measurements are similar to those from the RCS model. Based on the sulfur tracer method, the F_{inf} from home outdoor to home indoor site is 61±3% and the attenuation from central site to subjects is 0.45±0.03, and from home outdoor to subjects is 0.49±0.03, indicating that home outdoor $PM_{2.5}$ reflects more of subject exposure than the central site measurements. We examine the variability of F_{inf} and attenuation by subject, type of residence, season, and ambient particulate concentration. For indoor concentration models, the best fitting models have the infiltration efficiency varying by residence and cooking activities. For personal exposure models, the best fitting models assume a constant attenuation factor, with indoor and personal contributions varying by the age of subjects.

This work has been funded wholly by the United States Environmental Protection Agency under EPA Cooperative Agreement number (#R827177) and the EPA Northwest Research Center for Particulate Air Pollution and Health (#R827355).

[P08-05] ASSESSING THE OXIDATIVE CAPACITY OF ENVIRONMENTAL AND MODEL PARTICULATE MATTER (PM) IN SYNTHETIC RESPIRATORY TRACT LINING FLUID (RTLF).

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Introduction: Transition metals released from the surface of inhaled PM have been proposed to contribute to their pulmonary toxicity by catalyzing the formation of free radicals at the air-lung interface.

Methods: We investigated the capacity of a range of environmental (8-10 daily collections of PM2.5 and PM10) and model (10 residual oil fly ash samples of differing composition) particulates to oxidatively consume antioxidants in a synthetic RTLF model (200μM ascorbate, urate, and reduced glutathione, pH 7.4) as an index of their oxidative capacity. Particles were incubated in RTLF at a dose of 50μg/mL for 4h after which reactions were stopped by acidification and the particles removed by centrifugation. Antioxidant concentrations were determined using HPLC and spectrophotometric methods. Concentrations of water leachable Fe, V, Ni, Cu, Pb and As were determined by ICP-MS.

Results: Incubation with environmental PM resulted in a significant loss of ascorbate from the synthetic RTLF. Fine and coarse PM appeared comparatively reactive, with losses observed in the daily samples ranging from: -47.5±1.6 to -90.1±0.4% (fine) and -68.4±7.3 to -95.2±0.6% (coarse). The magnitude of these losses were comparable to those observed with the 10 ROFA samples: -36.0±2.8 to -97.5±0.3%. Significant losses of glutathione were also observed with all fine and coarse samples. These responses were strongly correlated in both fractions with the extent of ascorbate depletion: $r=0.7$, $p<0.01$ (fine&coarse), though quantitatively smaller: maximal depletion, -25.5±6.6 (fine) and -29.0±0.5% (coarse). In the environmental PM samples the extent of ascorbate depletion was significantly associated with the soluble Fe and Cu concentrations ($r=0.45$, $p<0.05$ and $r=0.41$, $p<0.05$, respectively), whilst GSH depletion only showed a significant correlation with Cu ($r=0.54$, $p<0.01$). In contrast no such associations were noted in the ROFA samples where significant losses of both ascorbate and reduced glutathione were observed in particles with low or unmeasurable Fe and Cu concentrations. Notably, these samples had high concentrations of soluble vanadium.

Conclusions:These data demonstrate that environmental PM are highly reactive toward RTLF antioxidants and that this oxidant activity is related to their soluble Fe and Cu composition. However, the ROFA data illustrated that other metals, specifically vanadium can also drive the oxidation of RTLF antioxidants and contribute to the overall avtivity of PM.

[P04-11] PARTICLE SIZE DISTRIBUTIONS OF UNRESOLVED COMPLEX MIXTURE FROM RESIDENTIAL WOOD COMBUSTION AS DETERMINED BY DIRECT THERMAL DESORPTION-GC/MS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (11:00 AM-12:00 PM) Grand Ballroom 2-4

Unresolved complex mixture (UCM) is a facet of organic chemical analysis of combustion source related fine particulate matter ([PM2.5]; particles with aerodynamic diameters [da]≤2.5 microns). It is observed in GC/MS total ion chromatogram (TIC) traces as a prominent hump, positioned beneath resolved components, over a broad retention time range and partly comprises aliphatic and aromatic hydrocarbons. For aerosols of carbon-based emission sources, the chromatographic area ascribed to UCM typically exceeds that which is resolved, establishing it as abundant on a mass basis. Also, UCM mass is conserved to some degree in ambient PM2.5. With considerable epidemiological support, ambient PM2.5 mass is linked to human morbidity and mortality. Further, particle deposition efficiency in the lung and biological toxicity are size dependent; thus, improved comprehension of the chemical composition of potentially toxic UCM in emissions by particle size is critical. This work generates and examines particle size distributions of UCM chemical fractions from residential wood combustion appliances (wood stove and fireplace, which seasonally emit substantial quantities of PM2.5 mass). Chemical analysis was achieved with direct thermal desorption (TD)-GC/MS of collection substrates from a Dakati electrical low-pressure impactor (ELPI). Tested fuels were oak and Douglas fir. Single ions of aliphatic, mono-, di-, and tri-aromatic steroid, alkylbenzene, alkylnaphthalene, and alkylphenathrene constituents of UCM from size segregated fine particles of wood combustion aerosols were mathematically extracted from the TIC matrix. It is estimated that the alkylbenzene constituent of UCM is most abundant, followed by aliphatic, monoaromatic steroid, and alkylphenathrene components. Generally, higher estimated total UCM concentrations are associated with smaller particle diameters. Improved classification of UCM from additional sources of carbonaceous aerosol emissions is now possible. With these data widely available, the health effects mechanisms, and regulatory and air quality modeling issues of PM2.5 can be advanced.

[P04-10] CHEMICAL SPECIATION OF PM-2.5 COLLECTED DURING PRESCRIBED FIRES OF THE COCONINO NATIONAL FOREST IN FLAGSTAFF AZ.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (11:00 AM-12:00 PM) Grand Ballroom 2-4

The fire-suppression policy of the past century has left forests overgrown with heavy duff and litter layers, increasing the likelihood of catastrophic fire. Prescribed fire, in combination with mechanical thinning, is a preferred method to reduce this fuel load; hence, the use of prescribed fire is expected to increase in the next decade. Fine particulate (PM-2.5) is produced in forest fires, both natural and prescribed. In this work, we examine the chemical composition of PM-2.5 generated during prescribed fires of the Coconino National Forest during October 2001 and October 2002. All fires studied are broadcast burns (as opposed to pile or slash burns) in areas with a 9-12 year accumulation of duff and litter.

Particulate is collected using a battery-operated chemical speciation PM-2.5 monitor (MetOne SuperSASS). Smoke is sampled during the ignition, combustion, or smoldering phase of the prescribed fire, as well as during laboratory burns of litter, duff, and soil taken from the prescribed fire site. PM-2.5 in the wood smoke is collected simultaneously on four filters. Three of the filters (PTFE, nylon + MgO denuder, and quartz) are analyzed at Research Triangle International for total mass and 48 elements (sodium through lead); ions (anions and cations); and total, organic, and elemental carbon, respectively. Preliminary efforts are underway to analyze the fourth filter (quartz) at Northern Arizona University for mutagenic activity and selected polyaromatic hydrocarbon concentrations (benz(a)anthracene, benzo(b)fluoranthene, chrysene, fluoranthene, and pyrene). A description of the sampling method, analysis procedures, and results will be presented.

[P04-09] AMBIENT PM2.5 DURING A HEAVY POLLUTED EPISODE IN HEATING SEASON IN BEIJING, CHINA.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (11:00 AM-12:00 PM) Grand Ballroom 2-4

Coal is primary energy in Beijing and about 23% burned for residential heating in heating season starting on each November 15 and ending on March 15 the next year, leading to more frequent days with heavy air pollution than in non-heating season. One-week integrated PM2.5 samples were collected continuously with a low-flow rate sampler at a downtown site (Chegongzhuang, CGZ) and a residential site (Tsinghua University, THU) in Beijing between since July 1999. Average concentration of TSP was 833 μg.m-3 at CGZ in the week of 11/18-11/25/99, just after the beginning of heating season. PM2.5 mass in this week rocketed to 330 μg.m-3 from 195 μg.m-3 in the last week, then decreased to 93.4 μg.m-3 in the next week, exhibiting large weekly fluctuation. In this stagnation week (SW), daily average wind velocity was less than 1.5 m/s except on November 25, and relative humidity (RH) ranged between 65-91% during four continuous days between 11/20-11/23, leading to much increased air pollutants due to space heating to accumulate near ground surface. For example, daily PM10 concentrations were between 413-632 μg.m-3 for these four days. PM2.5 constituted 87% of PM10 and 40% of TSP in SW, much higher than the values of 55% and 29% on an annual average basis.

All the species except crustal elements in PM2.5 had their maximum weekly concentrations in SW. Average concentrations of SO42-, NO3-, NH4+, OC, and elemental carbon (EC) alone were 61.6, 54.0, 22.1, 58.9, and 25.4 μg.m-3, which were 2.9, 3.1, 1.7, 1.0, and 1.4 times higher than their seasonal mean, respectively. Much more abundant ions in SW suggests that meteorology (for example, RH, stagnation) has very important impact on gas to particle transformation in Beijing. Meanwhile, crustal species (consisting of oxides of aluminum, silicon, calcium, magnesium, and iron, and 25% of that of potassium) only accounted for 6.4% of the PM2.5 mass, much less than the annual value of 11.1%. The enrichments of most trace elements in SW were much higher than their annual mean, and an order of magnitude higher than that of a typical week with serious dust storm in the spring of 2000, suggesting that anthropogenic contribution was substantially enhanced then. The mass ratio of bromine to lead (Br/Pb, 0.048) in this week was much less than that in fall (0.078) and spring (0.086), which could not explained by emission from motor vehicle alone. High correlation of lead with selenium and EC suggested coal burning was probably another major source of lead.

[P04-08] SOURCE RESOLUTION OF SULFATE AND TRACE ELEMENTS IN PM2.5 IN NEW YORK, NEW YORK.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (11:00 AM-12:00 PM) Grand Ballroom 2-4

As a part of the New York Supersite Program 24 hour PM2.5 aerosols were collected on 47mm Zefluorú filters at three sites in New York State. The sampling sites were located at Queens, Whiteface Mountain and Pinnacle State Park. The sampling site located in Queens Public School 219 (PS219) was our urban site and the other two were rural sites. The filters were extracted in 7 ml of double deionized distilled water at 70° C for 1.5 hours. A 1 ml portion of the extract was analyzed by ion chromatography for SO_4^{2-} and another 1 ml aliquot for water-soluble trace elements by inductively coupled plasma mass spectroscopy (ICPMS). The remaining 5 ml plus the filter was microwave digested in a mixture of 2 ml nitric acid, 4 ml hydrogen peroxide and 0.5 ml hydrofluoric acid and analyzed for total trace metals by ICPMS. The data is being used to: (1) characterize the chemical composition of PM2.5 aerosols; (2) estimate contributions form regional emissions to the observed concentrations in New York City; and (3) determine the sources of chemical species using chemical mass balance method, and potential source contribution function.

In this paper, we present the efficiency of water extraction for selected trace metals. Our results indicate that the measured trace metals fall under three groups, those which are highly soluble Mg, V, Mn, Zn, As, Se Sb and Pb with water extraction efficiencies between 75 - 95 %; those which are moderately soluble Ca, Fe, Co, Ni, with water extraction efficiencies between 58 and 44 % and the elements Al, Cr and Cd, which have the lowest solubility, with efficiencies in the range 10 - 12%. Generally the observed quarterly and annual mean concentration of SO_4^{2-}, and the measured trace metals are highest at PS219 followed by Pinnacle State Park (PSP) and Whiteface Mountain (WFM). At all three sites the SO_4^{2-} concentration is highest in the third quarter (July to Sept). At PS219 the mean trace metals concentrations are highest in the fourth quarter (Oct - Dec). The annual SO_4^{2-}/Se ratio at all three sites are around 4000 indicating a regional component. These ratios are indicative of "aged" aerosols transported from distances of several hundreds of km. In fresh aerosols the typical SO_4^{2-}/Se ratios are ~1500. High concentration of Zn, Cd, Sb and Pb were observed at Queens on September 13,2001. Comparison of pre and post September 11, 2001 data and air trajectories indicate that these peaks are a result of air mass passing over the World Trade Center sites before reaching our receptor.

[P04-07] MEASUREMENTS OF PM2.5 CARBONACEOUS SPECIES IN RURAL AND URBAN AREAS OF SOUTHERN CALIFORNIA.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (11:00 AM-12:00 PM) Grand Ballroom 2-4

Elemental carbon (EC) and organic carbon (OC) particles represent an important fraction of the atmospheric PM2.5 mass and play a major role in aerosol toxicity and climate radiation forcing. While both EC, OC, and toxic components such as polycyclic aromatic hydrocarbons (PAHs) are emitted by combustion processes, there are additional non-combustion OC sources (e.g. biogenic and secondary organic aerosol, SOA) that contribute to the atmospheric carbonaceous particle burden.

EC, OC and PAH concentrations were measured in six sites of Southern California from May 2001 to July 2002. Two are located in rural areas (Atascadero and Lompoc) and four in receptor areas downwind of central Los Angeles (San Dimas, Riverside, Upland and Mira Loma). PM2.5 samples were collected every eighth day for 24 hrs. at ~113 lpm. EC and OC were measured using a thermo-optical transmission analyzer, and PAHs by HPLC-Fluorescence.

OC to EC ratios have been used by several researchers to estimate, separately, the contributions of primary (anthropogenic and biogenic) and secondary OC to the total OC burden. The measured OC/EC ratios were higher in the rural areas (4.6-9.8) with a maximum seen in Lompoc during the spring. In urban areas, the OC/EC ratios were always higher during the hot season (2.8-4.1), decreasing to ~2.0 as the temperatures decreased. For all areas during the warmer months, the OC/EC ratios were larger than 2.0, indicating additional contributions of biogenic and SOA. The observed PAH concentrations followed the general EC and OC trends. PAH concentrations increased as the air temperature decreased, an indication of absorption from the vapor-phase, lower inversion layers and reactivity. Significant concentrations of benzo[ghi]perylene and indeno[1,2,3-cd]pyrene were found in both the urban and rural areas, suggesting important contributions from vehicular exhaust emissions.

[P04-06] SECONDARY ORGANIC AEROSOL CONTRIBUTION TO CARBONACEOUS PM2.5 CONCENTRATIONS IN PITTSBURGH.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (11:00 AM-12:00 PM) Grand Ballroom 2-4

A major component of PM2.5 in the Eastern US is carbonaceous material. This organic particulate matter results from both direct emissions from sources such as automobiles, trucks and industries (primary), and from the oxidation of organic gases (secondary). Data from the Pittsburgh Air Quality Study are used to examine the contribution of secondary organic aerosol to the total organic aerosol loading measured in the city during 2001 and 2002.

The contribution of secondary organic aerosol is estimated by using elemental carbon as a tracer for primary emissions of organic particulate matter (OC to EC ratio approach). A systematic method for the determination of the primary ratio has been developed based on the correlation of measurements of OC and EC to gaseous tracers of photochemical activity (O3) and primary emissions (CO, NOx). Sampling methods of carbonaceous aerosols have been a big area of discussion because of the different issues associated with the different samplers characteristics and analysis methods. In this work, the proposed algorithm to determine the primary and secondary contribution of OC is applied to different sets of organic aerosols measurements (using an undenuded sampler, a denuded sampler and an in-situ carbon analyzer) for carbonaceous concentrations. Consistent results for the SOA fraction are obtained when the method is applied to the different sets of measurements for OC and EC. This approach indicates that between 20 and 40% of the organic particulate matter in Pittsburgh during the summer months is secondary in origin, negligible contributions of SOA are estimated for the winter of 2001-02, and from 5 to 25% secondary material contributions are estimated for the fall of 2001.

[P04-05] ESTIMATION OF SECONDARY ORGANIC AEROSOL.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (11:00 AM-12:00 PM) Grand Ballroom 2-4

The secondary organic aerosol (SOA) is generally estimated as SOA = OC - EC*(OC/EC)pri, where OC and EC are organic and elemental carbon, respectively and (OC/EC)pri is the ratio for primary sources. Generally the minimum measured (OC/EC) is used as the (OC/EC)pri. However, the contributions from various primary sources may changes from time to time and the (OC/EC)pri should also vary. In this study, three different methods are used to estimate the (OC/EC)pri. In addition to the minimum measured (OC/EC), the (OC/EC)pri were estimated using the results from receptor model analysis (chemical mass balance) and emission inventory. First, the ratios of (OC/EC) were measured for each individual sources. The (OC/EC)pri was then computed as the ratio of [summation]OCi*Fi to [summation]ECi*Fi, where OCi and ECi are the fractions of organic and elemental carbon in particles from primary sources and Fi is the contribution of each types of primary sources to the ambient particles. Two different methods were used to estimate the value of Fi: chemical mass balance receptor model and emission inventory. The results showed that the (OC/EC)pri is 1.27, 2.37, and 2.52 for the minimum measured method, chemical mass balance method, and emission inventory method, respectively. Therefore, the estimated concentrations of secondary organic aerosol from three methods are different by a factor of about 2. That is, due to the variation of contribution from primary sources, the minimum measured method may overestimate the SOA by a factor of two.

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[P04-04] THE PRESENCE AND POTENTIAL SOURCES OF ALKYLNITRONAPHTHALENES IN AMBIENT AIR AT LOCATIONS IN SOUTHERN CALIFORNIA.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (11:00 AM-12:00 PM) Grand Ballroom 2-4

Alkylnaphthalenes are semi-volatile polycyclic aromatic hydrocarbons (PAHs) emitted into the atmosphere from a variety of sources including diesel exhaust. The methylnaphthalenes (MNs), ethylnaphthalenes (ENs) and 9 of the 10 isomers of dimethylnaphthalenes (DMNs) have been measured in ambient air (1,8-DMN is not observed in ambient air nor in diesel fuel). At ambient temperatures, these alkylnaphthalenes exist primarily in the gas-phase and their major atmospheric loss process is by daytime gas-phase reaction with the hydroxyl (OH) radical.

Simulated atmospheric reactions of volatilized diesel fuel with OH radicals or with NO_3 radicals were carried out in a 7000 L all-Teflon environmental chamber. Additionally, ambient measurements were conducted in August 2002 to analyze for alkylnitronaphthalenes which had been identified as atmospheric transformation products in our environmental chamber reactions. Four time intervals per day (07:00-10:30, 11:00-14:30, 15:00-18:30 and 19:00-06:30) were sampled for one week in urban Los Angeles (12-16 August 2002) and at Riverside (26-30 August 2002), a downwind receptor site.

Our ambient measurements showed the presence of methylnitronaphthalenes (MNNs), dimethylnitronaphthalenes (DMNNs) and ethylnitronaphthalenes (ENNs). The profiles of the alkylnitronaphthalenes from the OH radical chamber reactions of volatilized diesel fuel are very similar to the profiles of the alkylnitronaphthalenes observed in ambient air, suggesting that alkylnaphthalenes from unburned diesel fuel undergo atmospheric reactions to form mutagenic nitro-derivatives. Consistent with laboratory studies of the photolysis of the MNNs, certain alkylnitronaphthalenes were observed to decrease in the midday samples, suggesting that photolysis is an important loss process for the alkylnitronaphthalenes.

To our knowledge, this is the first report of DMNNs in ambient air. To date, we have only identified the nitro-derivatives of 2,6-DMNN. Although the DMNs were observed at 5-10% of the naphthalene concentration, their nitro-derivatives appeared relatively more abundant and may have toxicological significance.

[P04-03] SEASONAL, SPATIAL, AND DIURNAL VARIATIONS OF INDIVIDUAL ORGANIC COMPOUND CONSTITUENTS OF ULTRAFINE PM AND PM2.5 IN THE LOS ANGELES BASIN.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (11:00 AM-12:00 PM) Grand Ballroom 2-4

Recent studies have used individual organic compounds as tracers for primary sources of ambient particulate matter in chemical mass balance or other source apportionment techniques. Most of these studies have focused on total PM2.5 and on sampling periods encompassing entire days or longer. A newly developed high-flow rate, low pressure-drop ultrafine particle separator enables collection of sufficient mass for organic speciation in two particle size fractions over relatively short periods of time. At a nominal flow rate of 500 liters per minute, particles between 0.18 and 2.5 μm in diameter are collected on an impaction substrate and ultrafine particles below 0.18 μm are collected on a downstream high-volume filter. Four daily time period samples (morning, midday, evening, and overnight) were collected over five weekdays to form a weekly average composite for each diurnal period. Sampling was conducted at two sites over two seasons; summer (August) and winter (January) samples were collected at both an urban site near downtown Los Angeles and a downwind inland site in Riverside, California. Examples of individual organic compounds that are tracers for primary emissions are hopanes and steranes from motor vehicles and levoglucosan from wood combustion. The results show how these and other organic PM species vary from season to season, between upwind and downwind sites, and over the course of the day. The collection and analysis of two distinct size fractions (accumulation and ultrafine modes) provide information on how these compounds are distributed with respect to particle size. Finally, observations of seasonal, diurnal, and geographical patterns allow for the identification of potential organic markers for photochemical secondary organic aerosol formation.

[P04-02] CHARACTERISATION AND DETERMINATION OF POLLUTANT EMISSIONS (HYDROCARBONS AND HEAVY METALS) FROM ROAD TRAFFIC IN AN URBAN AREA.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (11:00 AM-12:00 PM) Grand Ballroom 2-4

In urban areas, road traffic is recognised as an important source of particles and both organic and inorganic pollutants. Road traffic involves numerous potential sources of hydrocarbons and metals, e.g., combustion products from fuel and oil, wear products from tires, brake linings, bearings, coach and road construction materials, and resuspension of soil and road dust. Therefore, emission measurements in conventional dynamometric tests alone are not sufficient to fully address this problem. In order to do so, studies need to be performed under realistic driving conditions in environments where the contribution from other emission sources is eliminated. Measurements in two heavily trafficked tunnels in Paris conurbation have been used successfully to quantify emissions of a large number of particulate pollutants. At least, five runs were made in each tunnel, generally extending over several hours, during which air concentrations of pollutants in the middle of the tunnel were determined. In this research program, hydrocarbon (aliphatic hydrocarbons and 16 PAHs selected from the priority list of the US Environmental Protection Agency) and heavy metal pollutants were measured from road traffic. The results showed the characteristic distribution of road traffic for both organic and inorganic pollutants. With respect to organic pollutants, the PAH profiles of air samples from the tunnel were determined with the predominance of phenantrene, fluoranthene and pyrene. About inorganic pollutants, antimony, cadmium, copper, lead and zinc were highlighted as mainly representative of road traffic. Moreover, study of the pollutants fingerprints, using specific ratios, suggested the significance of combustion sources (predominance of heavy weight PAHs (4 to 6 rings)) and the presence of brake-lining derived particles (Cu/Sb ratio).

[P04-28] A MULTI-SITE INTERCOMPARISON OF SEMI-CONTINUOUS CARBON, NITRATE AND SULFATE MONITORS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

A 12-month study (July 2002-2003) is being conducted to evaluate the operational performance and intercomparison of the R&P 5400C, 8400N, and 8400S carbon, nitrate and sulfate monitors at five National Air Monitoring Sites located across the country. The monitors are sampling $PM_{2.5}$ aerosols and the monitoring results are being compared to corresponding results obtained from filter-based 24-hour samples collected by the EPA Chemical Speciation Network samplers. This experimental study included the development of standardized operating procedures and the design and implementation of an independent field auditing scheme for the sulfate and nitrate monitors. In addition to the inter- and intra-site comparisons of measured values, data and information are being collected to assess the operational stability, level of maintenance, and overall costs associated with long term routine use of such semi-continuous technologies by state and local agencies. The results from this work will help guide the EPA and state/local agencies on the appropriate addition of semi-continuous monitors into the existing 54-site Chemical Speciation Trends Network for the primary purposes of providing higher temporal resolution of speciation data for health studies and near real-time public information.

An approach to achieve the latter data application is being assessed in the current pilot study by evaluating the installation and use of point data collection systems at each of the five sites. These systems, developed by Information Processing Systems of California, Inc., provide automated collection and processing of air quality data and also perform automated calibration of sensors, provide significant QC of received data, offer complete GUI for user data validation, save data in EPA AIRS format, and apply the entire set of MeteoStar® LEADS visualization tools to real-time or averaged data. In such manner, monitor operational control and data output can be accessed through direct satellite uplink and made readily-available for state agency/EPA review and quickly communicated to the general public in appropriate formats.

[P08-04] MOLECULAR ADSORPTION AT PARTICLE SURFACES: A PM TOXICITY MEDIATION MECHANISM.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Fine atmospheric particles depositing in the lung present a large adsorbent surface for the adsorption of broncho-alveolar lining fluid (BALF) components, including lung surfactant and its associated proteins. Such adsorption at invading particle surfaces is known to be important in biological particle clearance, and the immunological and toxicological fate of these particles. In experiments reported here, it was hypothesized that this is also true for particles of non-biological origin, and that fine particles with large surface areas could adsorb opsonising components of BALF. It may be further hypothesized that physiological alterations in the levels of these defensive surfactant components - through absence or depletion - may lead to reduced host defense performance on PM inhalation.

Elemental carbon (EC) is a ubiquitous component of fine particulate matter (PM2.5). EC originates largely from fossil fuel combustion, and vehicles in particular contribute a significant proportion of PM2.5 EC mass. Since the size distribution of EC is sub-micron, industrially produced carbon blacks in the 25-100 nm size range were used as a surrogate for urban EC, in terms of surface area and chemistry. Sub-micron and micron polystyrene particles with different surface functionalities were used as surrogates for other atmospheric particle types.

Particles were first washed and re-suspended in physiological saline three times to remove surfactant coatings added during manufacture. Colloidal suspensions of particles with estimated surface areas and specific chemistries were generated. Isolated components of BALF (albumin, fibrinogen, DPPC and surfactant proteins) were added at concentrations spanning physiological concentrations, as measured in human lung lavage.

Particles visibly accumulated within hours when placed in increasing concentrations of two BALF components. Marked changes in the size distribution of the immersed particles were observed, compared to a saline control. Differences in particle agglomeration were also observed in the particles with different surface chemistries, including carbon blacks. Marked reductions in the zeta potential of some particle types were detected when specific BALF components were added, indicating surface adsorption was responsible for the observed agglomeration. These coated particles introduced to cell lines also provoked different responses to uncoated particles. These differences may be attributed to changes in the surface chemistry and the reduced surface areas of the introduced particles. Molecular adsorption at PM surfaces in BALF may therefore mediate the toxicity of PM via one or both of these mechanisms.

[P04-14] AGGLOMERATION AND ADSORPTION OF FINE CARBONACEOUS PARTICLES ONTO ASIAN DUST PARTICLES.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (11:00 AM-12:00 PM) Grand Ballroom 2-4

Asian Dust particles are composed mainly of mineral dust that originated from the major desert-sources in the northern and northwestern China. Severe visibility impairment during the Asian Dust storm periods is resulted from the enormous amount of coarse particles. Extensive aerosol optical and chemical monitoring were seasonally carried out in order to investigate the physico-chemical properties of Asian Dust particles from 1999 to 2001 in the urban area of Kwangju (35°10′N, 126°54′E, 70.5 m A.S.L.), Korea. Mass fractions of chemical components of fine and coarse particles were analyzed to identify the seasonal variation of visibility characteristics in the urban atmosphere of Kwangju from the result of 1999 to 2000. Fine mass fraction of carbonaceous particles (EC/OC) during Asian Dust storm periods of 2000 was observed less than those during other seasons. Therefore the extensive monitoring was partially modified to investigate the chemical components of coarse particles during ACE-Asia (Aerosol Characterization Experiments) international cooperative observation, 26th March to 6th May, 2001. There were three Asian Dust storms in Korean peninsula, on 22nd March, 11th April, 25th April. Black carbon for the coarse regime was analyzed using the switching method of aethalometer with PM2.5 and PM10 inlet additionally. Single particle analysis was carried out on the fine and coarse particles using SEM/EDX (scanning electron microscope/energy dispersive x-ray analysis). The differences of their chemical compositions and physical characteristics between the fine and coarse regime were investigated among three Asian Dust storm events. In particular, it was revealed that the great loading of Asian Dust particles resulted in the agglomeration and adsorption of fine carbonaceous particles. Agglomeration rate ($[BC_{coarse}]/[BC_{PM10}]$) of mass concentration of black carbon was calculated to be 0.41, 0.50, and 0.24 during the three Asian dust events, respectively. Mass concentration of black carbon was observed to be highest value of 3.96 $\mu g/m^3$ for the coarse regime due to the agglomeration of them by Asian dust particles.

[P08-06] RESPONSE OF HUMAN ALVEOLAR MACROPHAGES TO ULTRAFINE, FINE AND COARSE URBAN AIR POLLUTION PARTICLES.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

In the lower airways, macrophages are important regulators of inflammation and indispensable in their antimicrobial activities. Thus, air pollution particles, which modulate airway macrophage host defenses may, in susceptible individuals increase severity of inflammatory and infectious disease. In the present study, size fractionated, ultrafine (UF), fine (PM0.1-2.5) and coarse (PM2.5-10) particles were collected from two urban sites in the Netherlands, and were compared for effects on human alveolar macrophages (AM). Inflammatory cytokine production, phagocytosis, and expression of phagocyte receptor CD11b were assessed in particle-exposed AM. IL-6 levels induced by PM2.5-10 (20411 pg/ml) were >10- fold higher than induced by PM0.1-2.5 (1781 pg/ml). Levels induced by PM0.1-2.5 were 2-3 fold higher than induced by UF (770 pg/ml) when cells were exposed to the same particle mass. Cytokine induction by the PM was inhibited by antibody to CD14 and required the presence of serum for optimal stimulation, implying that bacterial products or endotoxin were a stimulatory moieties in both coarse and fine particulate matter. Phagocytosis of opsonized yeast was inhibited by coarse PM> fine, as was yeast-induced oxidative burst. Coarse particles decreased CD11b expression > fine PM. The UF did not affect these functions.Taken together these results suggest that PM recognition by human alveolar macrophages involves receptors evolved to recognize microbial cell structures, and that microbial products preferentially found in the coarse particle fraction of PM may be involved in inflammatory events and decreased pulmonary defenses associated with exposure to pollution particles.

[P08-07] EXPRESSION OF C-REACTIVE PROTEIN AND HEAT SHOCK PROTEIN 70 IN THE LUNG EPITHELIAL CELL LINE A549, IN RESPONSE TO PM10 TREATMENT.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Increased levels of C-reactive protein (CRP) and heat shock protein 70 (HSP70) in plasma are known to be associated with an increased risk of cardiovascular disease. In this study the effect of environmental air pollution particles (PM10) on the expression of CRP and HSP70 in the lung epithelial cell line A549 cells was investigated. After PM10 treatment the expression of both CRP and HSP70 in A549 cells was significantly increased. Using ELISA and Western blot techniques it was also found that both CRP and HSP70 were secreted from the cells after PM10 treatment. Proteins produced in the lung can rapidly enter the systemic circulation. These results show that these two proteins can be induced by PM10 treatment of A549 lung epithelial cells and this may be important to an understanding of how air pollution episodes contribute to an increased risk of cardiovascular disease.

[P08-08] DEFINING THE RELATIONSHIP BETWEEN PARTICLE SIZE, NUMBER, METAL COMPOSITION AND OXIDANT ACTIVITY IN AMBIENT PARTICULATE MATTER.

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There is a need to identify the properties of particulate matter (PM) responsible for its adverse health effects. Studies with ambient and model PM have revealed that a range of metals (Fe, Cu, V) can participate in Fenton chemistry and other biologically relevant oxidation reactions. We compared the oxidative activity of PM using a range of complementary methodologies: (1) ESR, using the spintrap 5,5-dimethyl-1-pyrroline-N-oxide (DMPO) to quantify H2O2-dependent formation of hydroxyl-radicals by PM; (2) DNA oxidation in cell-free (calf thymus) and cultured A549 cells using oxidative DNA damage (8-OHdG) and single strand breaks; as well as, (3) the capacity of PM to deplete antioxidants (ascorbate, urate and reduced glutathione) in a synthetic respiratory tract lining fluid model. These endpoints were related to water leachable transition metals, determined by ICP-MS. Using parallel daily ambient samples of PM10, PM2.5 and PM1 collected in Duisburg, Germany we have demonstrated that all PM fractions have the ability to induce OH-radical formation in the presence of H2O2, as well as to consume both ascorbate and reduced glutathione in the absence of exogenous oxidants. In each of these endpoints the greatest activity was observed in the PM1 fraction. The DMPO-OH generation by PM fractions correlated well with their capacity to degrade both ascorbate and GSH (r2=0.73). In both PM10 and PM2.5, a significant correlation was also observed between ESR-activity and formation of 8-OHdG in nude DNA, confirming that OH-radical generation was driving oxidative DNA damage. In A549 cells, both PM10 and PM2.5 induced 8-OHdG and DNA single strand breaks. In all fractions, the DMPO-OH formation correlated well with metal content and with parallel total particle counts, although the latter was strongest in the PM2.5 fraction. Daily variation in particle oxidant activity was examined by analysis of coarse and fine PM collected from 3 sites over half a year time frame. In summary, oxidant activity of PM, assessed by cellular and acellular methods, can be quantified and related to both metal content and particle number. We propose to supplement such an integrative measure of activity to the current mass metric in interpreting the potential health impacts of ambient PM.

[P08-09] EXPOSURE OF SPONTANEOUS HYPERTENSIVE RATS TO AMBIENT PARTICULATE MATTER AFFECTS CARDIOVASCULAR PERFORMANCE IN A LANGENDORFF MODEL.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Exposure to ambient particulate matter (PM) is associated with increased mortality and morbidity among those subjects with cardiovascular impairment. Since the spontaneous hypertensive rat (SHR) resembles genetically the disease state of mature cardiovascular diseases, we hypothesized that treatment of SHR with PM, would affect its cardiovascular performance after coronary occlusion and reperfusion.

Four different groups of SHR were exposed by intratracheal instillation with I) Saline control, II) 10 mg road tunnel dust (RTD)/kg body weight, III) 10 mg EHC-93/kg body weight and IV) LPS 350 endotoxin units/animal. At 4 or 24 hrs post-exposure, hearts were isolated and retrograde perfused in the Langendorff mode. The experimental protocol included 30 minutes stabilization, a 35 minutes coronary occlusion (LAD) followed by 120 minutes reperfusion. Coronary flow (CF), pressure in left ventricle (LVDP), systolic pressure, diastolic pressure and heart rate (HR) were measured and hearts were either fixed for histology or frozen for protein analyses. Effluent was also collected for determination of lactate dehydrogenase (LDH). Results: No significant differences in baseline CF, HR and LDH were found at 4 or 24 hours after exposure to either RTD, EHC-93 or LPS. However, baseline LVDP was significantly decreased ($P<0.035$) compared to group I at 4 but not 24 hours after instillation. A decrease in LDVP was noted in all hearts after occlusion followed by a rapid recovery upon reperfusion. In RTD-exposed animals the recovery of LDVP was much slower. This delayed recovery led to a significantly decreased LDVP at two hours of reperfusion ($P<0.01$). An increase in coronary flow (CF) was noted in all hearts after occlusion, but the recovery of CF to baseline differed amoung the exposure groups. In PM-exposed animals (group II and III), CF was significantly increased upon reperfusion compared to saline-exposed rats (ANOVA, Post-hoc testing) The level of statistical significance varied between 0.04 and 0.09 dependent on specific time-point (60 or 120 min) after reperfusion and PM sample (RTD vs EHC-93). Both effects on LDVP and CF were acute since they were only seen at 4 hrs post-exposure, and not at 24 hrs. Conclusion: This study demonstrates that exposure to ambient PM has an acute effect on several cardiovascular parameters measured in the Langendorff model. The effect is transient and since LPS did show effects we suggest that apart from inflammation driven systemic effects ambient PM can exert direct changes on cardiac function.

[P08-10] VASCULAR EFFECT OF PARTICLE INSTILLATION IN SPONTANEOUS HYPERTENSIVE RATS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Exposure to particulate matter (PM) is associated with increased mortality and morbidity among those with cardiovascular impairment. We studied whether ambient particle or LPS pretreatment could impair vascular function in aorta of spontaneous hypertensive rats (SHR) 4 and 24 hours post-instillation. Receptor-dependent and -independent relaxation was induced by acetylcholine (Ach) and sodium nitroprusside (SNP) respectively. We used phenylephrine (Phe) and KCl to study receptor-dependent and -independent contraction. The role of the endothelium was investigated using aorta rings stripped of endothelium. Results. Pretreatment with PM (EHC-93, 10 mg/kg) or LPS (350 EU) caused a significant increase in receptor dependent vasorelaxation of aorta when compared to saline instilled rats. The largest effect was seen with PM at 4hrs after instillation (EC50 Ach = 1,37 vs 1,70 nM control), while at 24 hrs the effect was much smaller (EC50 Ach = 1,75 nM). SNP induced vasorelaxation was increased only in rats treated with EHC-93 (EC50 = 10,79 vs 10,96 nM) at 4 hours. As with Ach, the effect at 4 hours groups was more significant than at 24 hours groups. Phe induced vasoconstriction was dose dependent in rat aorta rings but no difference was seen between treatments in the presence or absence of endothelium at 4 hours. However, at 24 hours after instillation, the LPS group shows diminished contraction in comparison to control (EC50 = 0,071 μM vs. 0,05 μM). Animal pretreatment did not cause a change in receptor independent vasoconstriction induced by KCl, since there was no difference between the groups for both time points, except in the LPS group which contracted less at 24 hours but only in the absence of endothelium. Conclusion. Our data suggests that particle pre-treatment causes a short-term, acute disturbance in normal vasorelaxation but not vasoconstriction of aorta rings. The common mechanism between the receptor-dependent and receptor-independent relaxation which is the NO-cGMP pathway, seems to be involved here. It remains to be established whether such an effect also occurs in smaller blood vessels in the lung that receive a larger effective dose.

[P08-11] TIME COURSE STUDY OF PULMONARY AND CARDIOVASCULAR EFFECTS OF AMBIENT PARTICULATE MATTER IN SPONTANEOUS HYPERTENSIVE RATS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Particulate air pollution may be responsible for serious respiratory and cardiovascular health effects or even premature mortality especially among susceptible subpopulations. To get insight in the time course of ambient particulate matter (PM)-induced toxicity we have examined the response in 12 week old spontaneous hypertensive rats (SHR) at different time points (4, 24 and 48 hours) after PM exposure. SHR received a single dose by intratracheal instillation (0.3, 1, 3 or 10 mg PM/kg body weight) of a mixture of coarse and fine PM sampled at a Dutch freeway tunnel. In addition, EHC-93 (Ottawa dust, 10 mg/kg body weight) was used as a reference and LPS (350 EU/rat) as a positive control for inflammation. Exposure-related effects were investigated using histopathology (pathological changes, cell proliferation), bronchoalveolar lavage fluid (BAL) and blood analysis (cytokines, lactate dehydrogenase (LDH), alkaline phosphatase (ALP), protein, cell differentials, endothelins, fibrinogen, Clara cell protein). Both tunnel PM and EHC-93 induced significantly increased LDH levels in BAL at 24 and 48 hours but only at the highest dose and the LDH levels increased with time. Instillation of EHC-93 resulted in elevated ALP levels at all post-exposure times whereas the tunnel sample induced increased ALP levels only at 48 hours at the two highest levels. No changes in LDH or ALP levels were observed after LPS exposure and also the instillation procedure itself did not influence the LDH or ALP levels in BAL. A dose-effect relationship was observed for the viability in BAL at 24 hours after exposure to high ambient PM levels and the increased viability seems to diminish at 48 hours. These preliminary results indicate that a relatively high dose of ambient PM is needed to cause pronounced pulmonary toxicity and that these effects occur at least 24 hours after the exposure, via instillation. This study was performed within the scope of two EU projects: Health effects of particles from motor engine exhaust and ambient air pollution (HEPMEAP; http://www.hepmeap.org) and Chemical and biological characterisation of ambient air coarse, fine, and ultrafine particles for human health risk assessment in Europe (PAMCHAR; http://www.pamchar.org)

[P08-13] ADJUVANT ACTIVITY DIFFERENCES IN PARTICULATE AIR POLLUTION (COURSE VS. FINE) AT DIFFERENT LOCATIONS THROUGHOUT EUROPE.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Given that there are widely different prevalence rates of respiratory allergies and asthma between the countries of Europe and that exposure to ambient particles is substantial in urban environments throughout Europe, the EU project Respiratory Allergy and Inflammation Due to Ambient Particles (RAIAP) was designed to collect representative ambient particulate matter samples in Amsterdam (NL), Rome (I), Lodz (P) and Oslo (N), as well from a Dutch sea-side background site. The RAIAP project utilized a high-volume (900 litres/min) cascade impactor technology for simultaneous sampling of ambient air coarse (PM10-2.5) and fine (PM2.5-0.1) particles. PM fractions were tested for their adjuvant activity in an (ovalbumin-induced) allergy model in mice. The results were compared with an urban reference sample collected in Ottawa, Canada (EHC-93). It was found that 3 out of 6 samples collected in spring and only 2 out of 8 summer samples induced increased IgE levels. It was found that 4 out of 7 samples of the course fraction and 2 out of 7 of the fine fraction were active. In this model, intranasal application of ovalbumin neither induces IgE specific for ovalbumin, nor inflammation in the lung. However, combined with particulate matter it was found that the increase of IgE coincidence with significant increase of inflammatory responses in the lung in which the eosinophilic granulocyte was the predominant cell type. This was substantiated by the increase of eosinophils in the BAL. No increase of cytokines skewing the classic Th2 response was observed. PM only affected the adjuvant activity in the sensitization phase and did not induce changes in the challenge phase. The results indicate that at the same PM dose, PM from different fraction (coarse and fine) and collected at various locations were able to induce different effects on ovalbumin induced allergic responses.

[P10-10] CONTINUOUS MEASUREMENT OF THE ATMOSPHERIC AEROSOL PARTICLE SIZE DISTRIBUTION AT THE ST. LOUIS-MIDWEST SUPERSITE.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

In this paper, we present the design and performance of the instrument system which has been used to measure continuously the particle size distribution of atmospheric aerosols at the St. Louis-Midwest Supersite. We then provide a brief summary of observations during Year 1 of the program (April 2001-April 2002).

We used two scanning mobility particle sizers (SMPSs) and two optical particle counters (OPCs) to cover the 3 nm to 10 μm diameter range. The four instruments operated synchronously and completed 10 measurements every hour. At the beginning of every hour, 10 minutes were spent to measure the responses of the OPCs to 450-nm atmospheric particles selected by a DMA. We found that OPC responses varied with time, due to variabilities in particle composition (and therefore refractive index). We also found that 450 nm mobility diameter particles included an external mixture of "dark" and "bright" particles. The relative humidity of sampled aerosols was controlled and set at 40% before introduction into the instruments. Measurements with the four instruments overlapped in several size ranges, and data in those overlapping ranges were used for measurement quality assurance as well as to identify problems with instrument operation.

In Year 1, the average total number concentration was 4.0×10^4 particles cm^{-3}. Particles from 3 nm to 10 nm made up about a half of this concentration. The concentration below 10 nm was impacted significantly by particle bursts during which the concentrations were as high as ~10^5-10^6 cm^{-3} and which were observed quite often, about 10 days per month throughout the year. The season-averaged total number concentration was lower in summer than in winter, i.e. 3.2×10^4 cm^{-3} in June-August and 4.3×10^4 cm^{-3} in December-February. The daily-averaged number concentration was almost the same on weekdays and weekends. Averaged number concentrations varied diurnally, however; the minimum value of ~2.5×10^4 cm^{-3} was observed at 2-3 a.m., and concentrations increased almost linearly to the daily maximum of ~7.0×10^4 cm^{-3} at 10 a.m., and gradually decreased toward the minimum at 2-3 a.m. This diurnal pattern for the entire size range was dominated by that of particles of ~30 nm and smaller, which reflected the observation that the aforementioned burst events occurred most frequently at around 10 a.m. In contrast, above ~30 nm, the number concentration was almost constant throughout the day, although the period between 9:00 and 18:00 had slightly reduced concentrations in the particle size range between ~30 and ~200 nm compared to the rest of the day.

[P08-15] FATE AND TOXIC EFFECTS OF INHALED ULTRAFINE CADMIUM OXIDE PARTICLES IN THE RAT LUNG.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Fate and toxic effects of inhaled ultrafine cadmium oxide particles in the rat lung were examined.
Methods: Female Fischer 344 rats were exposed for 6 h to ultrafine cadmium oxide particles, generated by spark discharging, either at a low concentration of 70 μg Cd/m^3 (40 nm modal diameter) or at a high concentration of 550 μg Cd/m^3 (50 nm modal diameter). Lung morphology and quantification of Cd content/concentration by ICP-mass spectrometry were performed up to 7 days after exposure. Lung lavage was carried out immediately after the end of exposure.
Results: Exposure to a low concentration of CdO particles caused neither exposure related morphological changes of lungs nor inflammatory responses in lavaged cells. Cd content in the lung on day 0 was 0.53 ± 0.12 μg/lung corresponding to 19 % of the estimated total inhaled cumulative dose, and the amount remained constant throughout the study. In the liver no significant increase of Cd content was found up to 4 days. A slight increase was observed in the liver on day 7 (0.09 μg/liver, $p< 0.05$). The lungs of rats exposed to a high Cd-concentration were swollen and showed multifocal alveolar inflammation accompanied by an increased number of neutrophils in the lavage fluid. Although the Cd content in the lung was comparable between day 0 and day 1 (3.9 μg/lung), significant elevation of Cd levels in the liver and kidneys (0.05-0.6 μg/organ) was observed on both days. Two of 4 rats examined on day 0 showed elevation of blood cadmium, indicating rapid systemic translocation of a fraction of deposited Cd from the lung in this group.
Conclusions: These results and comparison with reported data using fine CdO particles indicate that inhalation of ultrafine CdO particles results in efficient deposition in the rat lung. With regard to the deposited dose, adverse health effects of fine and ultrafine particles appear to be comparable. Apparent systemic translocation of Cd took place only in animals exposed to a high concentration of ultrafine Cd particles which induced lung injury.

[P04-01] ELEMENTAL CONCENTRATIONS AND PARTICLE SIZE DISTRIBUTIONS OF AMBIENT AEROSOL IN METROPOLITAN AREA WITH INTENSE HIGHWAY TRAFFIC: GREATER CINCINNATI STUDY.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (11:00 AM-12:00 PM) Grand Ballroom 2-4

Respiratory problems and other health effects have been associated with the finer fractions of the PM2.5 aerosol. This motivated an extensive study on factors affecting the PM2.5 concentration levels and elemental composition of ambient aerosols in the Greater Cincinnati metropolitan area, which is characterized by intense highway traffic and thus considerable emissions of diesel exhaust particulate matter. The study was conducted during four seasons (winter, spring, summer and fall) and included 8 monitoring cycles. The measurements were conducted at 11 locations around the city at different distances from highways (ranging from 200 m to 4.2 km). In each monitoring cycle, 24-hour ambient aerosol sampling was performed simultaneously at four sites for about two weeks. The samples were collected with Harvard impactors during working days in order to obtain consistent concentration levels with respect to the traffic. Teflon filters were utilized for subsequent elemental analysis, and quartz filters were used for the elemental and organic carbon analysis. The particle size distributions were measured by a MOUDI impactor. The spatial and temporal variation of the PM2.5 total mass and elemental concentrations were determined. Meteorological conditions, traffic density, configuration of interstate highways and industrial air pollution were incorporated in the analysis. The average PM2.5 concentration ranged from 10 to 29 $\mu g/m^3$ and was evenly distributed through the city area, independent of the distance from the highway. The weekly variation of PM2.5 was not significant, while there was a noticeable seasonal variation. The PM2.5 concentration increased from winter to summer. Three inner city stations, located in downtown, close to the major highway, clearly showed elevated levels of metal concentrations, e.g., Fe (73-585 ng/m^3), Pb (2-71ng/m^3), Zn (10-80ng/m^3) and elemental carbon concentration, C_{El} (0.21-0.44 $\mu g/m^3$) possibly suggesting a greater diesel engine exhaust contribution in comparison to other sites. All other stations showed significantly lower levels of these elements and lower elemental-to-total carbon ratios. Further analysis to establish this on a more precise, quantitative manner is being performed. The particle size distributions revealed that significant mass fraction of the PM2.5 is represented by the submicrometer particle size range.

[P04-30] PRELIMINARY RESULTS OF EPA\\'S PERFORMANCE EVALUATION OF FEDERAL REFERENCE METHODS AND FEDERAL EQUIVALENT METHODS FOR COARSE PARTICULATE MATTER.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

The main objective of this study is to evaluate the performance of sampling methods for potential use as a Federal Reference Method (FRM) capable of providing an estimate of coarse particle (PMc: particulate matter with an aerodynamic diameter between 2.5 μm and 10 μm) mass concentrations in ambient air. Three sampling approaches are being evaluated. These approaches include a discrete method for measuring coarse particles directly using a sequential sampler; a discrete difference method, which uses two samplers, one to measure PM2.5 the other PM10 with the difference, PM10-PM2.5, representing an estimate of PMc; and two continuous coarse particle samplers that measure PMc directly with a time resolution of less than 1 hour. The direct sequential and continuous methods use the dichotomous virtual impactor for separating fine and coarse particles. The samplers will be evaluated in three locations that provide diverse challenges to the samplers, including high PMc to PM10, high PM2.5 to PM10, and an intermittent site (impacted by a source to see high and low values) under cold conditions. This presentation will provide preliminary results from the first location with a high PM2.5 to PM10 ratio.

[P04-27] NUMBER CONCENTRATIONS OF PARTICLES CONTAINING SPECIFIC CHEMICAL COMPONENTS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

Single particle mass spectrometers are ideally suited to count ambient particles as a function of size and chemical composition. In the past, single particle data has been used to determine the fraction of particles for a given particle size that contain a specific chemical composition and to estimate the time-dependent mass concentration of these components. Number concentrations of particles containing specific chemical components have not been reported, despite growing evidence that both number concentration and chemical composition correlate strongly with adverse health effects.

The lack of composition-dependent number concentration measurements can be traced to the performance of most single particle mass spectrometers - they do not efficiently analyze particles in the fine/ultrafine size range where number concentrations are greatest. We have deployed single particle mass spectrometers at the Baltimore and Pittsburgh supersites that efficiently analyze particles between about 50 nm and 1000 nm in diameter. With these instruments, the absolute number concentrations of particles containing specific chemical components can be determined from the rate at which particles are detected and analyzed.

In this poster, the methodology for composition, size and time dependent number concentration measurements will be presented, and results will be shown for the specific example of transition and heavy metals in particles. At the Baltimore supersite, over 10% of the particles analyzed contain one or more of these metals. Number concentrations of particles containing specific metals enable emission source characterization, receptor modeling and exposure studies that are based on number rather than mass concentration.

[P04-26] SEMI-VOLATILE PM2.5 MATERIAL ALONG THE WASATCH FRONT.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

Ammonium nitrate and semi-volatile organic compounds (SVOC) are significant components of fine particles in urban atmospheres. These components, however, are not properly determined with current U.S. EPA accepted methods such as the PM2.5 FRM or other single filter samplers due to significant losses of semi-volatile material (SVM) from particles collected on the filter during sampling. Continuous PM2.5, mass measurements are attempted using methods such as the R&P TEOM monitor. This method, however, heats the sample to remove particle-bound water resulting in evaporation and loss of semi-volatile material. Research at Brigham Young University has resulted in samplers for both the integrated and continuous measurement of total PM2.5 including the semi-volatile material. The PC-BOSS (Particle Concentrator-Brigham Young University Organic Sampling System) is a charcoal diffusion denuder based sampler for the determination of fine particulate chemical composition including the semi-volatile organic material. The RAMS (Real-time Ambient Mass Sampler) is a modified TEOM monitor which includes diffusion denuders and Nafion dryers to remove gas-phase material which can be absorbed by a charcoal sorbent filter. The RAMS uses a "sandwich filter" consisting of a conventional particle collecting Teflon coated TX40 filter, followed by an activated charcoal sorbent filter which retains any semi-volatile ammonium nitrate or organic material lost from the particles collected on the Teflon coated filter, thus allowing for determination of total PM2.5 mass including the semi-volatile material. The semi-volatile component of PM2.5 has been measured over a two-year period from winter 1999 through winter 2001 at three locations along the Wasatch front in Utah using RAMS and PC-BOSS. Data were collected at the Hawthorne EMPACT sampling site in Salt Lake City, Utah and at STAR sampling sites in Bountiful, and Lindon, Utah. Data will be presented for three short intensive periods during that sampling program; two winter periods with high PM2.5 concentrations due to winter inversions, and a summer period when the Salt Lake City site was impacted by smoke from wildfires in the Wasatch Mountains. PM2.5 was dominated by organic material and ammonium nitrate in the winter and by organic material in the summer. In all cases, substantial amounts of semi-volatile material, SVM, was present which was not measured by a TEOM monitor or by EPA PM2.5 FRM sampler but was detected by the RAMS and PC-BOSS. The EPA PM2.5 FRM sampler could be modified using the techniques presented here to allow for the correct determination of semi-volatile particulate matter.

[P04-25] POLICY IMPLICATIONS OF $PM_{2.5}$ FEDERAL REFERENCE METHOD PERFORMANCE RELATIVE TO MASS BALANCE CLOSURE.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

The National Ambient Air Quality Standards (NAAQS) for ambient air concentrations of $PM_{2.5}$include regulatory standards defining $PM_{2.5}$ as the mass measured by the Federal Reference Method (FRM). Many urban and metropolitan areas in the US are projected to exceed the annual average $PM_{2.5}$ NAAQS of 15 $\mu g/m^3$.

Comparing FRM mass measurements to the mass of the sum of the aerosol chemical components provides a means of evaluating FRM performance against atmospheric conditions. Daily ambient aerosol samples were taken in Pittsburgh, Pennsylvania from the summer 2001 through winter 2002 as part of the Pittsburgh Air Quality Study (PAQS) to measure $PM_{2.5}$ mass by the FRM and the aerosol chemical composition. Monthly average $PM_{2.5}$ concentrations for July and August were 20 and 28 $\mu g/m^3$. During this time, the FRM measurement periodically exceeded the mass of the sum of the aerosol chemical components by almost 30%, with monthly average discrepancies of 13 and 20%. In the winter months, monthly average $PM_{2.5}$ concentrations were approximately 12 $\mu g/m^3$, with the FRM-measured mass at or slightly below the sum of the mass of the aerosol chemical components.

The observed mass balance discrepancy may be explained by a combination of factors, including retention of aerosol water, loss of organic material and nitrates, and uncertainty regarding the conversion of organic carbon data to total organic material. Days with significant positive mass discrepancy can be explained by estimates of aerosol water content. The negative discrepancy observed on days dominated by organic aerosol or winter days with relatively high nitrate concentration appears to correlate with estimated volatilization losses.

The finding that the mass discrepancy observed appears to be a function of aerosol chemical composition has implications for national air quality policy for several reasons. First, aerosol composition varies considerably across the US, suggesting that the mass discrepancy may vary on a regional basis. Second, if indeed the FRM discrepancy is attributable to aerosol composition, basing $PM_{2.5}$ compliance on FRM data may lead to control strategies that target species disproportionately in comparison to their relative health effects. Comparing FRM and aerosol composition data across the country allows further delineation and quantification of the policy impacts of the FRM discrepancy effect.

[P04-39] AEROSOL ANALYSIS BY ICP-MS: PROBLEMS, SOLUTIONS, AND APPLICATIONS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

Inductively-coupled plasma mass spectrometry (ICPMS) approaches can provide distinct advantages over traditional methods of aerosol chemical characterization. These advancements include; significantly enhanced detection limits, improved accuracy, and the capability for isotopic resolution. Also, importantly, the ICPMS approach can readily be integrated with techniques which supply phase and chemical speciation information. For example, selective chemical extractions can provide critical data on the association of metals with major phase-components and oxidation state of certain metals. Extractions with physiological relevant fluids can address the bioavailable species. Valuable information on metal-ligand stability can be obtained when electrochemical techniques, such as cathodic stripping voltammetry, are applied to these same extracts.

However, realization of these unique advantages for the broad spectrum of aerosol components depends upon careful implementation of a comprehensive set of chemical and instrumental protocols which address contamination, solubilization, and interferences. This paper will outline, with the use of specific examples, various strategies to address these problems, recognizing that laboratory facilities may vary and multiple solutions are possible. Efficient, validated, solubilization methods are crucial and a range of options adapted for specific groups of elements, as well as generational capabilities of ICPMS instrumentation, will be presented. Matrix and plasma-sourced polyatomic interferences can severely compromise detection levels for many key elements. However, several strategies for minimization of these interferences are practical and these will be discussed in context with specific digestion methods and ICPMS tools.

We will also present data from our recent research that clearly illustrate the advanced capabilities and broad applications of these new methods. Examples will include: (1) detailed size-resolved trace element analysis of aerosols, (2) comprehensive elemental characterization of extremely small samples from personal samplers, (3) assessment of the potentially bioavailable fraction of metals in aerosols through extractions with physiological relevant fluids, and (4) the use of metal stable isotopes in source reconciliation.

[P04-38] NICKEL SPECIATION OF URBAN PARTICULATE MATTER.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

A mixture of $NiSO_4$, Ni_3S_2, Ni°, and NiO and NIST urban PM standard reference material (SRM 1648) were analyzed in duplicate using a Ni sequential extraction method designed to quantify soluble, sulfidic, elemental, and oxidic forms of Ni that may occur in PM. Leachates from these extractions were analyzed for their Ni contents. Extraction residues are being analyzed using two definitive speciation techniques, x-ray absorption spectroscopy (XAS) and x-ray diffraction.

In cooperation with the Broward County Department of Planning and Environmental Protection, ambient PM, PM_{10}, and $PM_{2.5}$ were sampled continuously during August 26-31, 2002, from an urban SLAMS site in Fort Lauderdale, FL. Relatively large amounts (0.2 gram) of bulk PM and much smaller amounts ([Ite]2 mg) of PM_{10} and $PM_{2.5}$ were collected. These samples are being analyzed using scanning electron microscopy, sequential Ni extraction, and XAS. Forthcoming analysis results will be used to evaluate the Ni species selectivity of the extraction method and identify the chemical forms of Ni present in urban PM, PM_{10}, and $PM_{2.5}$.

[P04-37] THE EXPERIMENTAL INVESTIGATION OF AEROSOL PARTICLES IN THE DYNAMIC THERMAL DIFFUSION CHAMBER.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

A full filtration of gases from aerosol particles, which in the definite fields of industry - semi-conductor technique, medicine, different biotechnologies is even practically impossible for the most existing aerosol filters. Since the requirements to the degree of filtration are steadily increasing, the search of methods and creation of filtration systems are conducted, which would meet the following requirements: the sedimentation of aerosol particles shouldn't depend on their sizes, should provide continuity of filtration process and mustn't require the regeneration of a filter.

One of the possible variants of filters of this sort is examined. Well-known physical processes such as: the condensational growth of aerosol particles in the diffusive field of super-saturated water vapor and their movement in laminar flow under gravity force are put into the basis of the suggested elaboration.

The experimental investigation of movement of the diluting aerosol NaCl in the mixture "air-aqueous vapor" was carried out. The sizes of aerosol particles were (0.2-0.7) micron, and their concentration wasn't more then 1000 in cubic centimeter. The investigation was carried out on the basis of the dynamic slit horizontal thermal diffusion chamber. The method of measuring consisted in the fixation of zero sudden change of aerosol particles when thermal conduction is given and the measuring of volumetric gas consumption, which are called "critical", is simultaneous.

The investigations showed the possibility of full sedimentation of aerosol particles. So when the temperature is changing in the range (10-25) °C between heating and condenser of the thermal diffusion chamber expenditures are in the range (0.02-0.8) liter per minute and then the full sedimentation of aerosol particles occurred.

[P04-36] MEASUREMENT UNCERTAINTY IN THE DETERMINATION OF FINE PARTICLE MASS AND MASS CONCENTRATIONS OF SULFATE AND TRANSITION METALS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

Measurements of fine particle mass concentrations and speciated mass concentrations carry significant consequences from both regulatory and health effects perspectives. Data of known precision and accuracy needs to be the starting point for pollution mapping, air quality models, regulatory decisions, and scientific and health effects research. For a number of reasons, measurements of airborne particulate matter, and specifically fine particulate matter (or $PM_{2.5}$) place extraordinary demands on measurement technologies.

Indicators of data uncertainty and reliability will be explored in this paper. In the absence of NIST standards (or the equivalent) for particulate matter and its component species, comparisons of co-located measurements provide useful estimates of measurement uncertainties. Two case studies will be examined; 1) measurements of bulk mass concentration using FRM filter samplers and two versions of the continuously measuring TEOM® mass monitor; and 2) measurements of sulfate, lead, and transition metals from three co-located filter samplers. For the second case the three samplers consist of an IMPROVE sampler, a R&P 2300 sampler as part of the EPA Speciation Trends Network (STN), and an ACCU® sampler attached to a TEOM monitor. Sulfate is measured via Ion Chromatography for all samples, but samples are collected and handled differently and the analysis occurs at two different laboratories. Elements are measured by X-Ray Fluorescence (XRF) at two independent laboratories and by Inductively Coupled Plasma - Mass Spectrometry (ICP-MS) at the third laboratory. These multiplicities of methodologies and laboratories will allow a better estimation of measurement uncertainties.

[P04-35] INFORMATION FROM IONS IN EXTRACTS FROM ACIDIC GAS DENUDERS USED IN THE PM2.5 CHEMICAL SPECIATION SAMPLING NETWORK.

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Each of the four designs of PM2.5 chemical speciation collectors employs magnesium oxide (MgO) or sodium carbonate (Na2CO3) coated denuders prior to the nylon filters that collect PM for ion analysis. The denuders remove acidic gases, such as nitric acid vapor, from the air stream and prevent them from reaching the filter surface. MgO denuders remain in use for up to 30 sampling days; Na2CO3 denuders are in use for one sampling day. Exploratory work to determine the "catch" of the MgO denuders has been undertaken. Topics to be covered include:

Extraction methods and recovery estimates - A method for aqueous and buffered extraction of ions (representative of acidic species) from the denuder surfaces is described. Ions at concentrations representative of ambient air acidic gas concentrations are spiked into the MgO slurry that is subsequently applied to denuder surfaces. Recoveries are reasonable and range from 107 to 116 percent. The capacity of the denuder for absorption of acidic gases is reviewed.

Comparison of acidic gas concentrations across PM2.5 sites - Concentrations of acidic gases such as nitric acid vapor (expressed as micrograms of species per cubic meter of air sampled) are determined via ion chromatographic analysis of denuder extracts for nitrate and other anions. Average values (for three months’sampling at a frequency of every third day) of acidic gas concentrations are compared for several sites in the U.S. that differ in PM2.5 composition. Relationships between acidic gas concentrations and the ionic components of the PM2.5 collected during the same time period are sought and discussed. Acid gas concentrations are also compared to values reported in the literature.

[P04-34] DEVELOPMENT AND EVALUATION OF AN ELECTROSTATIC COLLECTOR FOR SEMI-VOLATILE PM2.5.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

The objective of this research is to evaluate the potential of electrostatic precipitation to minimize sampling artifacts associated with semi-volatile components of PM-2.5. A device is being developed which is intended to collect a sample of atmospheric particulate matter without shifting its gas/particle phase partitioning. This work builds upon previous research at UNC which demonstrated the usefulness of a personal ESP sampler for collecting oil mist samples. The personal ESP reduced both positive and negative artifacts when tested using a laboratory-generated semi-volatile aerosol. The new sample collector will be tested using PM-2.5 Federal Reference Method samplers, with the electrostatic collector used in place of the Teflon filter.

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[P04-33] SPECIATION OF AEROSOL PARTICULATE MATTER BY SEPARATING AND QUANTIFYING THE VOLATILE AND INVOLATILE AS WELL AS THE SOLUBLE AND WATER-INSOLUBLE FRACTIONS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

We report results obtained in course of an ongoing study that aims at understanding sampling artifacts on filters and in impactors as well as providing detailed information about the composition of PM under different meteorological conditions. Mass closure is one of the ultimate goals. Ambient aerosol matter is sampled in the form of PM2.5, PM10 and TSP on membrane, quartz fiber and glass fiber filters (teflon filter to be added soon) as well as in low-pressure impactors (Berner, Moudi). To identify the contribution of adsorbed NOx, SO2 and other gases, sampling is also carried out with and without denuders and by implementing impregnated filter packs. Six essentially identical aerosol deposits on 37-mm diameter filter can be produced using two PM2.5 (or PM10) samplers in parallel, each containing three monitors. Great effort was devoted to producing high-purity filters by extracting soluble impurities in ultra-pure water, followed by backing up to high or the maximum tolerable temperatures. The aerosol covered filters as well as the back-up filters are initially characterized in terms of the total mass, the ion mass, the acidity and the elemental composition, the latter being measured by proton induced X-ray emission spectrometry, PIXE. Thereafter samples of the same composition are passed through various treatments like controlled removal of volatile components at temperatures up to 400°C and/or separation of the water soluble and insoluble fractions. Owing to the reproducible filter pretreatment it is possible to quantify both the dissolved and the insoluble mass. The soluble mass can be separated into the ionic and the non-ionic fraction. Quite generally we find that the aerosol matter collected on different types of filters or in impactors, but under otherwise the same conditions, exhibits distinct differences in composition. Whereas, for example, the SO4 concentration derived from membrane and fiber filter measurements is the same, the (apparent) NH4 and NO3 concentrations are lower for fiber filters by up to factors of 2 and 9 (!), respectively. Moreover, the (apparent) mass concentration calculated from samples collected on fiber filters may be up to a factor of 2 lower than for membrane filters. This could be due, at least in part, to a higher water content of samples collected on membrane filters. The water soluble component amounts to between 50 and 70% of the total PM and the ionic fraction comprises about 80% of the soluble matter.

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[P04-12] INFLUENCE OF CANADIAN FOREST FIRE ON MEASUREMENTS OF CARBONACEOUS COMPOUNDS IN FINE PARTICULATE MATTER DURING THE 2002 PHILADELPHIA SUMMER INTENSIVE PARTICULATE MATTER PROGRAM.

Cheol-Heon Jeong, Doh-Won Lee, Eugene Kim, Philip K Hopke Civil and Environmental Engineering, Clarkson University, Potsdam, NY; Chemical Engineering, Clarkson University, Potsdam, NY

Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (11:00 AM-12:00 PM) Grand Ballroom 2-4

During July 2002, the North East Oxidant and Particle Study intensive program was conducted in northeastern Philadelphia, PA. On July 2, 2002, a Canadian forest fire started and severe smoke was transported to the monitoring site from July 6 to 9, 2002. The smoke plume radically altered the local air quality conditions around Philadelphia for a few days. In this study, $PM_{2.5}$ mass, organic carbon (OC), elemental carbon (EC), black carbon (BC), ultraviolet absorbing particulate matter (UVPM), and sulfate aerosol were continuous measured using a 30°C TEOM with a SES (Sample Equilibration System) dryer, a semi-continuous OC/EC analyzer (Sunset Lab), a two-wavelength Aethalometer (AE-2, Magee Scientific Company), and a continuous sulfate analyzer (Harvard School of Public Health design). In addition, daily integrated filter samples were collected and analyzed using a Sunset Lab. thermal / optical OC/EC analyzer and an Ion chromatography (Dionex-500). During the measurement period, an abrupt increase of $PM_{2.5}$ was observed on the afternoon of July 6. The highest $PM_{2.5}$ mass concentration was greater than 160 $\mu g\ m^{-3}$ late in the evening of July 7. Peaks in the measured semi-continuous thermal and optical EC were observed on same day. The thermal EC was three time higher than the optical EC. In addition, UVPM was much higher than BC during the Canadian forest fire. It strongly suggests that there was substantial amounts of aromatic organic compounds in $PM_{2.5}$ during the forest fire. Also, the difference between optical EC, thermal EC, BC, and UVPM indicate that these measurement methods are strongly dependent on the chemical composition of $PM_{2.5}$. During July 7 to 8, sulfate aerosol concentration increased from 4 to 7 $\mu g\ m^{-3}$ while thermal OC and EC dramatically increased from 0.3 and 5.0 to 3.1 $\mu g\ m^{-3}$ and 43.0 $\mu g\ m^{-3}$, respectively.

[P04-31] WITHDRAWN

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WITHDRAWN

[P04-13] POST HARVEST BIOMASS BURNING AEROSOLS AND THEIR IMPACT ON AIR QUALITY IN GWANGJU, KOREA.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (11:00 AM-12:00 PM) Grand Ballroom 2-4

Open field burning after harvest greatly impact the regional air quality in Gwangju, Korea. In order to investigate the chemical characteristics of those biomass burning aerosols, intensive 12-hr particulate matter sampling had been conducted 4~15 June 2001 in Gwangju. A rotating shadowband radiometer (RSR) was used to monitor atmospheric optical depth during the same period. The biomass burning aerosols were collected using PM10 and PM2.5 URG cyclone samplers to analyze mass, ionic and carbonaceous species. The ionic species were analyzed using ion chromatography and the carbonaceous species were analyzed using a selective thermal manganese dioxide oxidation (TMO) method. The mean PM10 and PM2.5 concentrations for the entire intensive sampling period were 153.8 and 129.6μg/m3, respectively. Exceptionally high level of PM2.5 concentration exceeding in the National Ambient Air Quality Standards (NAAQS) was observed, which was compared to 35.8μg/m3 observed during normal days. The average organic carbon and elemental carbon concentrations were 19.61μg/m3, 2.68μg/m3, respectively with OC/EC ratios 5.9~9.1 during the intensive period. The mean aerosol optical depth (AOD) derived from RSR measurement was 0.74 during the biomass burning events and 0.32 during normal days. Enrichment in the fine particles was remarkable and these increased aerosols which were originated from biomass burning after harvest brought about visibility reduction and increase of AOD also may affect the human health.

Mean value of criteria particulate matter released from biomass burning during intensive period in Gwangju, Korea.

	PM10(μg/m3)	PM2.5(μg/m3)	NO3-(μg/m3)	SO42-(μg/m3)	OC(μg/m3)	EC(μg/m3)	AOD
Mean±std.	153.8± 27.2	129.6± 24.6	17.46± 10.42	23.31± 12.91	19.61± 9.36	2.68± 0.91	0.64± 0.23

[P04-24] THE DEVELOPMENT AND TESTING OF A SEQUENTIAL PMc (COARSE) AMBIENT PARTICULATE SAMPLER.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

A new sequential gravimetric sampler by which ambient air particulate is segregated into PM Coarse (PM_c); that being the collection of ambient particulate between 10 and 2.5 micrometers AED, utilizes the $1m_3$/hr classical Virtual Impactor. The U.S. EPA is considering future changes in the National Air Quality Standards (NAAQS) to include a national network for PM Coarse. The classical Dichotomous Sampler utilizing the Virtual Impactor operates with the flow rate at 16.67alpm collecting the ambient particulate onto two filters, one being PM_c Coarse and other $PM_{2.5}$ Fine. A project was undertaken to develop a candidate PM_c Reference Method sampler utilizing a set of sequential filters for one week of daily sampling onto two 47mm PTFE membrane filters. The platform sampler is essentially a modified EPA Reference Method sampler for $PM_{2.5}$ utilizing the Virtual Impactor beneath the PM_{10} FRM Inlet. The sequential sampler uses two sets of filters, mechanically and pneumatically moved through the sampler each 24 hour sample event. A review of the historical literature from the 1970's to present, and field testing of the Virtual Impactor are revisited. Recent field and laboratory tests of the new Sequential PM_c sampler demonstrate the sample gave a cut point of $PM_{2.5}$ to 0, and $PM_{2.5}$ to 10. Field tests concluded a precision and accuracy within the EPA requirements.

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[P04-23] USING ULTRAFINE CONCENTRATORS TO INCREASE THE HIT RATE OF SINGLE PARTICLE MASS SPECTROMETERS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

A rapid single particle mass spectrometer, RSMS-3, developed at the University of California, Davis and the University of Delaware was installed at the EPA Supersite in Pittsburgh to measure ultra-fine single particles in the atmosphere. This instrument is used to analyze both sizes and chemical components of ultra-fine particles simultaneously, but is limited by its hit rate to more polluted conditions. To extend its application to cleaner areas, several methods are under consideration to increase its hit rate. One of them is to introduce an ultra-fine particle concentrator to the sampling inlet of the mass spectrometer.

An ultra-fine particle concentrator, VACES, developed at the University of Southern California has been deployed in many field experiments. In its optimum configuration, VACES concentrates ultra-fine particles by factors of 15-25, depending on the minor-to-total flow ratio of the virtual impactor. Previous experimental results showed that the concentrator does not distort the size distribution of the original ultra-fine aerosols.

A test of VACES coupled to the RSMS-3 mass spectrometer was conducted at the Pittsburgh EPA Supersite in April 2002 to determine the hit rate increase and elucidate particle composition changes induced by the concentrator. The hit rate increased by 5-20 times. Statistical analysis shows that there was no change in particle composition due to concentration. At the same time, a number of lessons were learned pertaining to details of the use of these systems together. Problems and their possible solutions are discussed.

[P04-22] DATA VALIDATION AND QUALITY ASSURANCE FOR THE CHEMICAL SPECIATION TRENDS NETWORK.

James B. Flanagan, Jessie A. Deal, James A. O'Rourke, Edward E. Rickman EICD, RTI, RTP, NC

Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

The PM2.5 Chemical Speciation program has very tight data turnaround requirements -- fully-validated data are currently being uploaded to AIRS in an average of <120 days after sampling for all 59 analytical values that are reported for each sampling event. Data for 225 field monitoring sites (approximately 1800 separate monitoring events per month) are validated and reported at monthly intervals to the state and local air monitoring agencies which operate the samplers. An efficient system for data validation has contributed to RTI's ability to meet EPA's stringent requirements. This presentation will provide an overview of the steps used to validate the data and the different kinds of data comparisons used to identify questionable data. Some of the routine validation steps include checks of exposure dates and range checks on various parameters; and verification of mass balance, anion/cation charge balance, and sulfur/sulfate balance.

The high degree of integration with the laboratory database has enabled many data entry, validation, and reporting functions to be automated, and also allows human data reviewers to assess overall trends easily. The monthly validation procedures sometimes help to identify problems with individual samplers in the field (such as a leaking flow channel), which can then be brought to the attention of the agency that operates the field site.

Data quality assessment reports are prepared by RTI on a semi-annual basis. Much of the information in these reports is based on results of validation screening, as well as from laboratory QC procedures, and from data processing. Data quality results from the most recent semiannual QA report will be presented.

[P04-21] ESTIMATING ANALYTICAL MEASUREMENT UNCERTAINTY FOR THE PM2.5 CHEMICAL SPECIATION PROGRAM.

James B. Flanagan, Max R. Peterson, William F. Gutknecht, Andrea C. McWilliams EG, RTI, RTP, NC

Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

The PM2.5 Chemical Speciation program uses four separate analytical methods -- anions and cations by ion chromatography (IC), trace elements by X-ray fluorescence (XRF), gravimetric mass, and organic/elemental carbon (OC/EC). A total of 59 separate analytical values are reported. Each method differs in the factors that affect the total analytical uncertainty.

Many of the factors that contribute to total uncertainty are difficult to assess using conventional laboratory quality control (QC) samples such as calibration standards, laboratory blanks, spikes, and replicates. Some examples that will be presented include the following:

Assessment of filter lot contamination - Each new filter lot from the manufacturer must be checked before it is used for environmental sampling. Filter lots that do not pass the acceptance levels must either be sent back to the manufacturer, or the laboratory must clean each filter from that lot. Residual levels of contamination can be estimated based on laboratory blank results.

Estimation of Artifact Carbon - The OC/EC method uses quartz filters, which have been fired at 900°C, to collect particulate matter for carbon analysis. There is a clear time dependency in the organic fraction that may be due to uptake of volatile and semi-volatile organic compounds (VOCs and SVOCs) from the atmosphere. This phenomenon affects the bias and precision of the OC measurements, but usually has little effect on EC results.

XRF "Uncertainty" Values - The XRF instruments that are used to measure 48 elements provide "uncertainty" figures paired with each analytical result as part of the software's output. These uncertainties are based, in part, on raw counting statistics. A current challenge is to reconcile these reported uncertainty values with other determinations of precision such as statistical evaluation of replicate analysis results.

[P04-20] ASSURING COMPARABILITY BETWEEN MULTIPLE X-RAY FLUORESCENCE INSTRUMENTS USED IN THE PM2.5 CHEMICAL SPECIATION PROGRAM.

Andrea C. McWilliams, James B. Flanagan, William F. Gutknecht, RKM Jayanty EICD, RTI, RTP, NC

Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

X-ray fluorescence (XRF) is used for the measurement of 48 elements collected on Teflonâ filters in the U.S. Environmental Protection Agency’s PM2.5 Chemical Speciation Program. This technique provides a high level of sensitivity for many of the elements of interest, provides linear response to concentration over several orders of magnitude, and is relatively fast and interference free. The Chemical Speciation Program began with one XRF operated by Chester LabNet and now includes three instruments at Chester LabNet, one at Cooper Environmental Services, and two at RTI.

To ensure comparability of the results obtained from these different instruments, the equivalency of each XRF was initially tested as it was brought on-line. Each instrument was first shown to meet basic QC requirements for precision and accuracy based on measurements with commercial and NIST SRM standards. Then, real-world filters selected from the Chemical Speciation Program's filter archive were analyzed in order to show that results, which were statistically equivalent to the results obtained by the original Chester LabNet instrument, could be obtained. The filters for the instrument equivalency tests were specifically chosen to provide a wide range of concentrations for the major, commonly found elements. An ongoing round-robin intercomparison program coordinated by RTI helps to ensure that the instruments continue to agree on the real-world filter results. Correlations of the round-robin results between instruments are generally good, but average ratios for individual elements outside the desirable 90% to 110% range are not unusual, particularly for elements that have poor measurement precision. The ongoing comparisons have resulted in identification of several minor problems including a calibration drift on one instrument, and high background values for three elements on another instrument that turned out to be an instrument artifact.

[P04-19] MEASURE OF IONS IN PM2.5 FILTERS.

Eva D. Hardison, David L. Hardison, Christine C. Van Hise EG, RTI, RTP, NC

Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

Ion chromatography (IC) is used for the measurement of two anions, sulfate and nitrate, and three cations, sodium, potassium, and ammonium, collected on nylon and Teflonâ filters in the U.S. Environmental Protection Agency's PM2.5 Speciation Program. The measurement method is selective and sensitive, allowing measurement to below 0.05 ppm in the filters extracts. Duplicate injections show a relative percent difference of better than 5% above about 0.05 μg/mL. Analysis of quality control check samples show a recovery of better than 95%. In this work, four different Dionex, dual-column IC instruments are being used. Several different issues have been addressed in the process of generating the best possible analytical data. First, the nylon filters used for the collection of particulate material analyzed for ion content must be cleaned prior to use. Several approaches were taken in response to variability with level of contamination; the final method involves five sequential extractions in deionized water. Another issue is the method of ion extraction. Since one filter must be analyzed for both the cations and anions, deionized water was the only solvent of choice. Research has shown that water only extracts about 90% of the nitrate on the nylon.
Sodium carbonate buffer, normally used for anion extraction, could not be used because of the need to measure sodium in the particulate; another approach cutting the filter in half and extracting one-half for cations using water and the other half for anions using carbonate buffer, is thus far, considered impractical.

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[P04-18] COMPLEXITY IN FILTER HANDLING AND SHIPPING IN PM2.5 CHEMICAL SPECIATION NETWORK OPERATIONS.

Jessie A. Deal, James A. O'Rourke EG, RTI, RTP, NC

Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

The Sample Handling and Archiving Laboratory (SHAL) at RTI provides technical support to the U.S. Environmental Protection Agency's PM2.5 Speciation Trends Network (STN). The STN is a component of the National PM2.5 Monitoring Network. Two-hundred and twenty five samplers participate in the STN are located across the U. S., including one sampler in Puerto Rico. The objectives of the STN are to determine annual and seasonal spatial characterization of aerosols, air quality trends analysis, and development of emission control strategies. The SHAL supplies clean filters to the network field sampling sites and receives the filters back from the sites following sampling of ambient air. Sampled filters are removed from their housings and distributed to analytical laboratories. The fine particulates collected on the filters are analyzed for 59 chemical species.

Field sites in the STN network operate on one of three different schedules. The fine particulates are collected by the field samplers on three different types of filters. There are currently five different types of samplers deployed in the STN network.

A detailed description of the SHAL operations and a discussion of the problems involved when using multiple types of samplers and sampling on different schedules will be presented. The growth in the STN since its inception in February 2000 and some of the quality assurance issues of SHAL operations will also be described.

[P04-17] DETECTION AND QUANTIFICATION CAPABILITIES OF MEASUREMENT SYSTEMS.

Lloyd A. Currie, Jeffrey L. West ARL/AMD, NOAA, Research Triangle Park, NC

Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

To address the growing need for meaningful and common communication of measurement capabilities and measurement results in the international metrological community, the International Union of Pure and Applied Chemistry [IUPAC; Ref. 1] and the International Organization for Standardization [ISO; Ref. 2, 3] have prepared guidelines for the reporting of experimental data and specification of detection and quantification capabilities of measurement processes. In this presentation we (1) summarize the recommendations of IUPAC and ISO regarding basic concepts, terminology, and numerical evaluation; and (2) present some rudimentary illustrations for measurement problems relevant to the NARSTO program. A central element of the guidelines is the distinction between the MEASUREMENT PROCESS [MP], with its underlying capabilities (LD, Detection Limit; and LQ, Quantification Limit), and MEASUREMENT RESULTS [MR], with their estimated values, uncertainties, and detection decisions (LC, Critical Value). Note that LC is defined in terms of the probability of a false positive (α); LD, in terms of the probability of a false negative (β), given LC; and LQ, in terms of the relative standard deviation (rsdQ) at the Quantification Limit. Default values for α and β are 0.05 each; for rsdQ, 0.10. Under simplifying assumptions (normal random error with constant sd): LC = 1.645 σo, LD = 3.29 σo, and LQ = 10 σo, where σo is the standard deviation of the estimated net result.

For the MP, the key issues are the use of LD and LQ for planning, or to assess the adequacy of the MP for the measurement problem. For the MR, key issues are the application of LC for deciding whether results are significantly greater than the blank, and to avoid information loss and non-detect substitution bias ["virtual reality"], by always reporting the numerical value obtained (even if it is negative) and its total uncertainty [uc: combined standard uncertainty; 3].

1.IUPAC Recommendations, 1995: Nomenclature in Evaluation of Analytical Methods, including Detection and Quantification Capabilities, Pure & Appl Chem, 67 (1995) 1699-1723.

2ISO Standard 11843-1,2 Capability of Detection, Part 1 (1997), Part-2 (1998).

3.Guide to the expression of uncertainty in measurement [ISO-GUM], issued by BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, and OIML (ISO, Geneva) 1993.

[P04-16] AIRBORNE AND DEPOSITIED BACTERIA NEAR A WASTE WATER TREATMENT PLANT.

Ashish K Sahu, Thomas Holsen, Stefan Grimberg Civil and Environmental Engineering, Clarkson University, Potsdam, NY

Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (11:00 AM-12:00 PM) Grand Ballroom 2-4

Bacteria samples from air upwind and downind of a wastewater treatment plant and from the roof of the Science Center at Clarkson University were collected. Airborne samplers were collected by drawing air through a filter and depositions samples were collected with water on a surrogate surface. Bacterial counts were determined using the BAC_Light test to calculate concentration and flux at the sites. Onsite wind information was collected during sampling to evaluate the upwind and the downwind readings. Results obtained indicated higher concentrations and fluxes of bacteria downwind of the treatment plant. DNA of the bacteria was extracted to determine what type of bacteria were collected. The results obtained is helpful for bioaerosol risk evaluation.

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[P04-15] CHARACTERIZATION OF PARTICULATE EMISSIONS FROM A COMBUSTION BOILER WITH DUAL FUEL CAPACITY.

Oliver M.C. Chang, Glenn England, Stephanie Wien Energy and Environmental Research Corp., GE, Irvine, CA

Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (11:00 AM-12:00 PM) Grand Ballroom 2-4

ABSTRACT

In 1997, the United States Environmental Protection Agency (EPA) promulgated new ambient air standards for particulate matter with aerodynamic diameter smaller than 2.5 micrometers (PM2.5). There are few existing data regarding emissions and characteristics of fine aerosols from petroleum industry combustion sources, and the information that is available is old. A dilution sampler was deployed to characterize PM2.5 emission from an industrial boiler unit with duel fuel capacity of burning natural gas and heating oil. The diluted exhausted was diluted at 20 air ratio and aged for 80 seconds prior than sample collection, including PM mass, metal (XRF), EC/OC (TOR), sulfate, nitrate, and gaseous PM2.5 precursors such as VOC, SVOC, and carbonyls. It is found that organic carbon the most abundant species and accounts for more than 80% of PM2.5. In addition, a modified Micro-Orifice Uniform Deposit Impactor is used to characterize distribution of metal species in the range of <0.1, 0.1-0.32, 0.32-1.0 and 1.0-2.5mm. The results indicate particles less than 0.32mm are 60-80% of the mass in PM2.5. Number concentrations of particle less than 0.32mm measured by Measurement of SMPS number concentrations indicated that the particle size mode of 20-40nm for natural gas combustion and 80-100 nm for heating oil combustion and the transformation due to particle condensation/coagulation process occurs in the order of a few seconds. Further more, the results of the chemical composition profile from this study can provide an insight of PM2.5 emission from stationary sources for source apportionment and receptor modelings.

[P08-18] DIESEL SOOT BINDS AND CONCENTRATES A PROINFLAMMATORY CYTOKINE THAT CAUSES NEUTROPHIL MIGRATION.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Combustion emissions induce adverse health effects, including inflammatory responses in the lungs, but the properties of the emissions that induce these effects are not understood. To examine the direct effects of diesel soot (DS) on alveolar epithelial cells, monolayers of the human alveolar epithelial cell line, A549 cells, were exposed to a wide range of concentrations of DS (National Institute of Standards and Technology Standard Research Material 2975). Release of the neutrophil-attracting chemokine Interleukin-8 (IL-8) from these cells was analyzed by enzyme-linked immunosorbant assay (ELISA). Low doses of DS increased the concentration of IL-8 detected in the conditioned medium after 24 hours. Higher doses appeared to suppress the response, although this suppression was not related to acute DS toxicity as determined by release of the cytoplasmic enzyme lactate dehydrogenase. In a cell-free system, incubation of IL-8 with DS resulted in removal of immunoreactive IL-8 in the supernatant of the reaction. In contrast, carbon black did not reduce the concentration of IL-8 in the mixture. The DS-induced loss was only weakly blocked by a large excess of bovine serum albumin (BSA), indicating some specificity of the effect. Neither high concentrations of salts nor extraction of the soot with organic solvents to remove the organic carbon constituents of the soot prevented the interaction. We next examined whether the loss was due to binding of the IL-8 to the DS (rather than destruction of the epitope required for ELISA assay), and whether bound IL-8 was biologically active. Human blood neutrophils were exposed to DS that had been pre-incubated with IL-8, then washed to remove free IL-8. The neutrophils changed shape in a manner suggesting directed movement toward the particles. The transformation of morphology was not observed with either carbon black that had been incubated with IL-8 or with DS alone. These results suggest that DS not only induces the production of IL-8 by epithelial cells, but also binds biologically active chemokine in a particle- and protein-selective manner. DS-induced inflammatory responses may therefore be more focused or sustained as a result of this binding of inflammatory mediators by DS.

Supported by the Office of Heavy Vehicle Technology, US. Department of Energy.

[P04-32] EFFECT OF NITRATE VOLATILIZATION ON MEASURED GRAVIMETRIC MASS IN CALIFORNIA AND IN THE IMPROVE NETWORK.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

Volatilization of particle nitrate from Teflon sampling filters during sampling can represent a significant loss of $PM_{2.5}$ or PM_{10} mass (Table 1). The highest $PM_{2.5}$ mass loss found in the California Acid Deposition Monitoring Program (CADMP) occurred during summer daytime in southern California, amounting to 30-40% of the gravimetric $PM_{2.5}$ mass. Mass losses of 5-15% were observed in national parks in the Sierra Nevada, with higher losses in the winter than in summer. Although the measurements necessary to calculate the actual nitrate mass loss are not available for remote sites in the IMPROVE network (Interagency Monitoring or Protected Visual Environments), the potential mass loss was consistent with the measured loss observed in the CADMP network.

The extent of mass loss is geographically and seasonally dependent. Not only is the mass measurement affected, but also the results of speciation analysis and source apportionment modeling could be misleading if the nitrate is not measured accurately. There is no straightforward method to correct for the mass loss using routine monitoring data.

Although there is loss of volatile nitrate from Teflon filters during sampling, the nitrate remaining after collection appears to be quite stable. There was little, if any, loss of nitrate from Teflon filters collected in the IMPROVE program after as much as two hours under vacuum and one minute of heating by a cyclotron proton beam.

Fraction of $PM_{2.5}$ mass volatilized as ammonium nitrate by site, season, and time of day for CADMP measurements.

Site	Summer Daytime	Summer Nighttime	Winter Daytime	Winter Nighttime
Azusa	0.33	0.12	0..21	0.12
Bakersfield	0.15	0.06	0.09	0.02
Fremont	0.16	0.09	0.16	0.07
Gasquet	0.09	0.08	0.07	0.04
Los Angeles	0.40	0.12	0.16	0.07
Long Beach	0.17	0.10	0.15	0.06
Sacramento	0.10	0.08	0.10	0.06
Santa Barbara	0.12	0.11	0.14	0.08
Sequoia National Park	0.08	0.05	0.15	0.11
Yosemite National Park	0.05	0.05	0.10	0.08

Summer - June through September, Winter - October through February

[P10-22] THE DEVELOPMENT AND DESIGNATION TESTING OF A NEW EPA APPROVED FINE PARTICLE INLET A STUDY OF THE U.S. EPA DESIGNATION PROCESS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

The process by which ambient air sampling instruments are designated for use under the U.S. EPA Reference and Equivalency Program is a rigorous and demanding routine involving design, laboratory and field testing. The process for Equivalency PM-2.5 Class II and III designation has been coined as nearly impossible to achieve. A project was undertaken to develop an Equivalent Method to the EPA WINS PM-2.5 Impactor as a Class II Equivalent Method for the FRM sampler. The project built upon the authors' previous development of design models for cyclones, together with practical experience suggesting that cyclones are capable of superior field performance under loading when compared with impactor systems. Empirical cyclone models were used to develop a new generation of very sharp cut cyclones (VSCC). In laboratory tests, the VSCC demonstrated a precise 2.5 μm D_{50} cut point and sharpness superior to the WINS. A formal application was then undertaken to achieve EPA Class II Equivalency designation. The process included aerosol laboratory loading trials with results showing no change in cut point after up to 90 days between cleaning cycles. Several FRM field trials to compare the WINS FRM to the VSCC were performed in western and eastern airsheds to demonstrate the precision and accuracy of the candidate VSCC FRM. Results showed the VSCC used in the FRM gave a cut point of 2.5 micrometers and the field tests concluded a precision and accuracy within EPA requirements.

[P10-03] INTERCOMPARISON OF APS, ELPI AND LPI FOR COARSE, FINE AND BIMODAL PARTICLE MASS SIZE-DISTRIBUTIONS.

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The aim of this work was to compare the Electrical Low-Pressure Impactor (ELPI), the Aerodynamic Particle Sizer (APS) 3320, the APS 3321 and a coventional Low-Pressure Impactor (LPI) for mass size-distribution measurements of aerosols consisting of 1) only coarse mode, 2) only fine mode and 3) both coarse and fine mode particles.

The APS and the ELPI are two aerosol size spectrometers with which particle size distributions in the size-range 0.5-10 μm can be measured with high time-resolution. The main advantage of these instruments compared to conventional optical techniques is the ability to classify the particles according to their aerodynamic equivalent diameter. While the lowest size-bin of the APS is around 0.5 μm, the ELPI covers the size-range from 0.03 to 10 μm.

Coarse particles (MMAD~4 μm) were generated with a medical nebuliser (Pari Boy). The fine particles (MMAD~0.25 μm) were produced with a TOPAS monodisperse particle generator. The aerosol material was in both cases di-octyl sebacate (DOS). The aerosol was passed through a bipolar charger before entering a 0.5 m^3 experimental box. The particles were sampled to the 4 instruments simultaneously using copper tubes. The particle concentration was 1-2 mg/m^3 for each mode. Triplicate experiments were performed each for coarse mode only, fine mode only and bimodal size-distributions.

In the experiments with the coarse mode only it was found that the ELPI overestimated the particle mass in stages 10-12 (particles > 2.5 μm) compared to the LPI. There was good agreement between both APS-models and the LPI mass in the range 1-6 μm. For larger particles the APS 3321 underestimated the concentration, this was assumed to be caused by a combination of impaction losses in the inner inlet of the instrument and droplet deformation. Severe overestimation of particles > 8 μm in the APS 3320 was likely caused by particles recirculating in the sensor.

In the experiments with the fine mode only, it was found that all three spectrometers showed significant contribution to the total mass in the coarse mode range. The overestimation in the ELPI may be caused by fine particle losses in the upper stages of the impactor. It has to be noted that in the experiments with the fine mode the concentration in the APS-channel <0.523 μm was as high as 4000 cm^{-3}, the concentration >0.523 μm was below 800 cm^{-3}. The artefact in this case may be avoided by further dilution.

In the experiments with both the fine and coarse mode present, there was overestimation in the ELPI stage 10-12 and in both APS models. These are caused by a combination of the mechanisms for the coarse and the fine mode respectively.

[P10-04] REAL-TIME PM MEASUREMENTS WITH OUTDOOR AIR ELPI.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

Electrical Low Pressure Impactor (ELPI, Dekati Ltd.) measures particle size distribution and number concentration in real-time. The operation is based on charging, inertial classification, and electrical detection of the aerosol particles. The particles are first led through a unipolar diode charger where the particles are charged by the ions produced in a corona discharge. After the charger the particles are size classified in a low pressure impactor into 12 size fractions in the size range of 0.03-10 mm. The impactor stages are electrically insulated and the current signal from each stage is measured using sensitive electrometers (Keskinen et al., 1992). Using particle size dependent relations describing the properties of the charger (Marjamäki et al., 2000) and the impactor (Hillamo et al., 2002) the current values are converted into a particle number size distribution.

Outdoor Air ELPI is a stand-alone version of the standard ELPI developed to meet the needs of continuous ambient air measurements. High sample flow rate, 30 lpm, is used to increase the sensitivity of the instrument. The suitability of the instrument to measure PM2.5 mass size distribution of airborne particles was studied. Special focus was on the effect of humidity and particle density on the results.

Humidity affects the particle mass results in ELPI because the instrument operates on real-time basis and most of the airborne particles are hygroscopic. A sample conditioning unit consisting of a temperature controlled sampling line, instrument casing and sample dryer was used to dry the aerosol sample. Field tests were made to compare the results with other methods. With the sample conditioning unit a good correlation with other instruments was found. Outdoor Air ELPI is capable of measuring typical atmospheric aerosols. Instrument has wide size range and good time resolution. Sample humidity has effect on the particle size distributions and it must be considered when comparing results with other instruments.

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[P10-05] MEASUREMENTS OF AEROSOL MASS AND SIZE DISTRIBUTION IN A RESIDENTIAL AREA IMPACTED BY WOOD SMOKE.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

Increased use of small-scale biofuel combustion is considered part of a future sustainable energy system in Sweden. The research programme "Emission and air pollution from combustion of biofuel", financed by the Swedish Energy Agency, includes a study of the air pollution impact of an extended use of wood stoves. FromJanuary to March, 2002, an air quality monitoring campaign was performed in Lycksele, northern Sweden. The small city of 8 000 inhabitants is situated in a river valley. During cold winter nights the ventilation is reduced due to thermal inversion and low wind speeds. Although the district heating system is rapidly expanding, there are still between 600 and 700 individual wood stoves operating in the city.

Particle mass (TEOM), size distribution (DMPS) and hygroscopicity (TDMA) were measured in a residential area with many wood stoves. During the same period, size distribution was measured in a central area, where most of the houses are connected to the district heating system.

The PM10 and PM2.5 levels registered in Lycksele are in general low and close to background levels. However, during cold wintertime episodes, when temperature falls below -10 °C, there is a marked increase in PM levels. While the residential area aerosol has number/volume peaks at ~ 60/350 nm, the central aerosol peaks at ~ 25/150 nm, respectively. Particle number is about the double at the central site, but the volume only about a fourth, if compared with the residential area. During periods with temperature above -10°C both number and mass is strongly reduced in the residential area, while the levels at the central site are about the same as during cold events.

A comparison with PM2.5 data confirms the dominant impact of local emissions in the residential area under those cold periods. The locally generated aerosol shows a low growth rate, indicating fresh combustion particles. Although hygroscopic properties do not allow the separation of wood stove and vehicle emitted particles, it is possible to quantify the fresh, locally generated combustion aerosol from the long distance contribution. Dispersion model results show that wood stove emissions can explain the enhanced levels in both number and volume/mass during cold periods. Except for cold periods, the residential aerosol is determined by background levels (mass) plus traffic (number). Clearly the use of small scale wood stove heating may contribute to local exceedances of the European air quality directive and Swedish Environmental Legislation for daily averages of PM10 (not to exceed 50 μgm-3 more than 35 days during a year), while the yearly average is only marginally influenced.

[P10-06] EFFECTS OF GASEOUS POLLUTANTS AND METEOROLOGICAL PARAMETERS ON NUCLEATION AND GROWTH OF ULTRAFINE PARTICLES IN URBAN AMBIENT AIR.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

Number concentrations and size distributions of fine particles in the size range of 10 to 500 nm were measured the NYS DEC monitoring site (Latitude 43° 09' 40", Longitude 77° 36' 12") in downtown Rochester, NY during the measurement period of December, 2001 to January, 2003. The particle size distributions and number concentrations were measured using a Scanning Mobility Particle Sizer (SMPS) comprising of a differential mobility analyzer (DMA, TSI 3071) and a condensation particle counter (CPC, TSI 3010). The number concentrations were classified and analyzed as a function of size ranges, 11 to 50 nm, 50 to 100 nm, and 100 to 470 nm to characterize the variation of size ranges. Continuous particle mass measurements were made with a 50°C Tapered Element Oscillating Microbalance (TEOM) operated by NYS DEC. In addition, hourly CO, SO_2, O_3, relative humidity, ambient temperature, wind speed and wind direction were measured. Nucleations of fine particles occurred more frequently during summer than during winter months. During the summer months, two types of fine particle nucleation typically occurred between noon and 3 p.m. One type involves only nucleation in the size range 10 nm to 30 nm occurs while the other type begins with nucleation followed by particle growth up to approximately 80 nm during the following 12 hours. At the time of the nucleation event, the highest concentration was in excess of 170,000 cm^{-3}, whereas the average concentration was 11,000 cm^{-3}. The nucleation events also occurred occasionally between 3 p.m. and 6 p.m. with nucleation mostly associated with particles in the 20 to 50 nm diameter range. In addition, SO_2 concentrations dramatically increased at the same time the number concentration of particles rose during the nucleation events, whereas $PM_{2.5}$ somewhat decreased during the nucleation events. The main wind direction was west-north for both nucleation event days or non event days, but the nucleation events tended to occur while wind was blowing from east-north east.

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[P10-07] NUMBER CONCENTRATION AND SIZE DISTRIBUTION OF URBAN AEROSOLS NEAR DOWNTOWN DETROIT.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

This paper presents the results from a study conducted in SW Detroit to examine the effect of nearby sources and meteorological conditions on the concentration and size distribution of ambient particles. The number concentrations of ambient particles in 0.01 to 19.8 μm size range were obtained from a scanning mobility particle sizer (SMPS) and an aerodynamic particle sizer (APS). Meteorological parameters including ambient temperature, relative humidity, wind speed, wind direction, rainfall, and solar radiation flux were also monitored concurrently atop a 10-m tower. On average, ultrafine particles ($d_p < 0.1$ μm) accounted for approximately 90 % of the total number concentration (N_T), where mean N_T ranged from $1.5 \cdot 10^4$ to $2.9 \cdot 10^4$ cm^{-3} . Time series plots of the 5-min number concentrations revealed that on several days peaks occurred around solar noon, or within a few hours, when photochemical activity is at a maximum. The number concentrations showed significant variation during the study with standard deviations ranging from $4.6 \cdot 10^3$ to $1.1 \cdot 10^4$ cm^{-3} . The number size distribution exhibited one to three distinctive modes with the most typical mode diameters around 0.01, 0.05, and 0.1 μm. The smaller two modes are mostly seen in the immediate vicinity of motor vehicles emissions, thus known to be indicative of traffic-related particles. On few occasions, the ultrafine particle concentration dropped to levels five times lower than its original concentration immediately after the onset of heavy rain events. The resulting size distribution then showed only one mode in the accumulation range peaking near 0.2 μm. In addition, ultra fine particle-growth was observed before a rain event with winds out of the south and a relative humidity 55 %. Overall, data indicated motor vehicle emission and, to some extent, photochemical reactions are the major sources of ultrafine particles in Detroit area. Meteorological factors are shown to have a substantial effect on the number concentration and size distribution.

[P10-08] DIURNAL AND SEASONAL TRENDS IN OUTDOOR PARTICLE SIZE DISTRIBUTIONS MEASURED AT URBAN AND RURAL LOCATIONS DURING THE PITTSBURGH AIR QUALITY STUDY.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

Numerous epidemiological studies have shown adverse health effects of PM including respiratory irritation and changes in pulmonary function as well as associations between PM mass concentrations and mortality. Some controlled exposure studies have also shown that for a given mass concentration, health effects are larger for smaller particle sizes. This work presents the results of one year of continuous monitoring of size distributions at the Pittsburgh Supersite. Diurnal and seasonal trends will be presented for measurements at an urban site located in a park 5 km downwind of downtown Pittsburgh. These data will be compared to the size distributions measured continuously for 6 weeks at a rural site upwind of Pittsburgh to assess the spatial variability and impact of the urban plume on number distribution.

Two SMPS systems and an APS system (TSI Inc) were used at the main site to measure aerosol size distribution from 3 nm to 20 μm. In addition to the size distribution measurements, other aerosol and gas phase parameters were monitored at the central site. The rural site was located in Florence, PA 38 km west (upwind) of the city. At the rural site an SMPS system was operated for a period of 6 weeks.

It was found that particle number and PM2.5 mass are not correlated in Pittsburgh. This is mostly due to the occurrence of frequent (50% of the study days) particle nucleation events that increase particle number with negligible increase in particle mass (Stanier, 2002). Strong diurnal patterns were evident in particle number concentrations. During weekdays without particle nucleation particle number showed peaks at 8 AM with a weaker secondary peak at 3 PM. During weekdays without particle nucleation particle number had a single peak at noon. This diurnal pattern was most evident in particle size ranges associated with vehicular traffic from 10 nm - 100 nm. Additional analyses, including seasonal differences in aerosol size distributions and a comparison of size distributions at the urban and upwind rural site will be presented.

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[P10-09] AEROSOL SIZE DISTRIBUTIONS: A COMPARISON OF MEASUREMENTS FROM URBAN AND RURAL SITES.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

Aerosol size distributions were measured during the summer of 2001 at Queens, NY and during the summer of 2002 at Whiteface Mountain in the northern Adirondack region mountains of upstate New York as part of the PMTACS-NY Supersite program. Several instruments (Nano SMPS, Long Smps, and APS) were used to characterize the aerosol size distributions over a range from 10 nanometers to 10 micrometers. These measurements illustrate the differences in aerosol processes active at rural and urban sites

Size distributions from both sites exhibit a persistent mode at about 85 nanometers to 100 nanometers. This feature is more dominant in the Queens data than at Whiteface. The distributions also show small aerosol events characterized by the appearance of a second mode in the neighborhood of 25 nanometers, independent of location. This mode may appear as distinct from the main mode or may cause the distribution to broaden and have a flat peak. The amplitude of these modes in the Queens data is close to the size of the persistent mode but at White face, the amplitudes may be twice the size of the persistent mode. These characteristics are probably related to the differences in aerosol sources and secondary production as well as the rate of coagulation of small aerosols.

Distributions at Queens frequently have substantial concentrations at sizes larger than 1 micron. The mass concentration during these large particle episodes account for the majority of the aerosol mass. Large particle events at Whiteface Mountain are rare and make a minor contribution to the total aerosol mass.

In both locations, departures of the size distribution from the average tend to occur during events which may be related to advection or local sources. In some cases these changes are clearly related to air mass changes. Diurnal changes are not clearly recognizable because they are masked by a ubiquitous background with a much longer time scale.

Future analysis will concentrate on the incorporation of other data which may provide information on aerosol formation processes. A more detailed analysis of the meteorological data, particularly on a local scale, may provide information on other influences on the size distributions at these sites.

[P10-12] STATISTICAL SUMMARY AND OBSERVATIONS OF SEMICONTINUOUS PARTICLE SIZE DISTRIBUTIONS MEASURED AT THE BALTIMORE SUPERSITE.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

Size distributions of aerosol particles wre measured in the range 9.3 to 20,535 nm from February through November, 2002 using an SMPS (9.3 nm to 437 nm, Model 3080) and an APS (0.486 to 20.535 mm, Model 3321) installed in a specially equipped trailer at Ponca Street, Baltimore, MD, as a part of the Baltimore Supersite program. A statistical summary of these data, showing the frequencies of occurance of nucleation, aerosol accumulation, and course particle peaks are presented, as well as their seasonal trends. Further analysis of the combined SMPS and APS spectra coupled with meteorological, traffic, NO/NO2, EC/OC, and nitrate data are used to classify these spectral features in terms of nucleation (10 to 30 nm range) events, primary and secondary sources, including transient particle producing events. Interesting features associated with a Canadian smoke influence and dust events are described. Complete SMPS/APS data sets will be available on the Eastern Supersites Program Relational Database.

[P10-26] CALIBRATION OF THE NANO-MOUDI II CASCADE IMPACTOR.

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Cascade impactors normally have lower cut sizes of about 0.5 um. To go to smaller sizes of about 0.5 um, two techniques have been used: low pressure or small nozzles. To go to even lower cut sizes, a combination of low pressure and small nozzles must be used. This is the technique that has been used in Nano-MOUDI cascade impactor by MSP Corporation, where three nano stages have been added to the basic MOUDI. The success of this unit has led to a new impactor, the Nano-MOUDI II. Unlike the original Nano-MOUDI, which was three stages added to the standard MOUDI, the Nano-MOUDI II is an entirely new design. The Nano-MOUDI and the newly developed Nano-MOUDI II cascade impactors (MSP Corporation, Minneapolis, Minnesota) have been calibrated to define the particle collection efficiency curves. The design of the Nano-MOUDI started with a standard MOUDI, operating at 30 L/min, and then three nano-cut stages operated at 10 L/min was added at the exit, to provide for cut sizes of 18, 10, 5.6, 3.2, 1.8, 1.0, 0.56, 0.32 0.18, 0.10, 0.056, 0.032, 0.018, and 0.01 um. The newly designed Nano-MOUDI II starts with three nano-cut stages, and adds seven stages at the inlet to provide for cut sizes of 2.5, 1.0, 0.56, 0.32, 0.18, 0.10, 0.056, 0.032, 0.018 and 0.01 um, all at 10 L/min. In addition to the calibrations, the number and size of the nozzles in the upper stages of the Nano-MOUDI II were modified so as to reduce the pressure drop through all stages to as low a value as possible. The advantage of low pressure drops through the upper stages is to keep the absolute pressure at the nano-cut stages to as large a value as possible, reducing affects of mass loss due to volatile particles.

[P10-25] THE NATURE OF SIZE-RESOLVED INDIVIDUAL ASIAN DUST STORM PARTICLES COLLECTED AT GROUND-BASED SITE ON WEST COAST OF JAPAN.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

It is widely recognized that Asian dust storm is a serious and growing environmental problem in East Asia as well as the Pacific Basin. To determine the nature of Asian dust storm particles as single particles, the intensive field measurement was carried out on west coast of Japan (Yasaka, Tango Peninsula, 35.62°N; 135.07°E) during dense Asian dust storm event on March 2002. Due to the size dependence of the chemical composition of aerosol particles, the size-segregated aerosol particles were collected using low pressure Andersen impactor sampler. Also, in order to understand the many distinct types of single particles observed in the receptor area, soil samples collected at four desert areas in China were analyzed. For the quantification analysis of the ultra trace elements in the individual coarse particles (>1.17 μm), X-ray microprobe system equipped at Super Photon ring-8 GeV (SPring-8) BL-39XU was applied. By using this SPring-8 system, we could successfully carry out the reconstruction of elemental map and quantification analysis for multiple elements in individual particles with ~ pico gram level sensitivity. As one of the representative soil components, aluminum masses of individual particles at stage-2 (Dp: 5.07 μm) and stage-5 (Dp: 1.17 μm) are in the range of $6.40X10^{-2}$ pg to $5.78X10^{-1}$ pg with average $2.09X10^{-1}$ pg and in the range of $1.19X10^{-1}$pg to $1.44X10^{-1}$pg with average $1.30X10^{-1}$ pg, respectively. The mass ratios of [Σsoil components] to [Σ total element] are 0.82 at stage-2 and 0.75 at stage-5, respectively. This implies that the effect of soil components on total elements mass is significant. While on the other hand, the several anthropogenic elements like vanadium, chromium, manganese, cobalt, nickel, copper, and zinc are poor at both stages. To estimate the chemical mixing state of individual Asian dust storm particles with sea salt and other artificial components, elemental maps were drawn. Particles were categorized into two groups, namely internally mixed particles and externally mixed particles. The fine structure in the immediate vicinity of the X-ray absorption edge is sensitive to the valence of the absorber atom and the site geometry. From this near-edge feature referred to as X-ray absorption near edge structure (XANES), the chemical forms of iron (Fe^{2+}, Fe^{3+}) in individual particles could be clearly characterized.

[P08-16] RESPIRATORY ALLERGY AND INFLAMMATION DUE TO AMBIENT PARTICLES (RAIAP) - A EUROPEAN-WIDE ASSESSMENT - INFLAMMATION SCREENING.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

The overall objective of the RAIAP project is to assess the role of ambient suspended particles in causing local inflammation in the respiratory tract and induction and elicitation of respiratory allergies. In order to understand the underlying mechanisms for involvement of particles in the development of respiratory diseases, knowledge about whether qualitative differences in particulate matter may explain differences in particle-induced inflammatory and/or allergic responses is essential. In the RAIAP project, coarse ($PM_{2.5 - 10}$) and fine ($PM_{2.5}$) fractions of ambient particulate matter have been collected in Amsterdam, Rome, Lodz and Oslo, as well as at a Dutch seaside background site. Particles were sampled during the spring, summer and winter 2001/2002, and all samples are being characterised by physical-chemical parameters as well as analysed for binding of allergens, endotoxins and β-glucans to the particles.

The objective of the study presented here was to investigate if the various particle samples have different capabilities to induce markers of inflammatory processes in different types of epithelial lung cells. Cytokine release after exposure to the coarse and fine fractions collected during the spring season is presented. A human alveolar epithelial cell line (A549) and primary rat type 2 cells were used, and release of the proinflammatory cytokines IL-8, MIP 2 and IL-6 was analysed by ELISA. The results demonstrated that the coarse fractions had higher potencies to induce IL-8 than the fine fractions in A549 cells. Among the coarse fractions, there were significant differences between particles from different sampling sites. With respect to the type 2 cells, MIP-2 release was induced in a relatively similar pattern as compared to the IL-8 release in A549 cells. With respect to IL-6 release, however, type 2 cells seemed more responsive than A549 cells. Also in this case, the coarse fractions were more potent than the fine fractions. Furthermore, the coarse fractions appeared to be more toxic than the fine fractions in both cell types. At higher concentrations, however, all fractions resulted in reduced viability. In summary, the coarse fractions of ambient particulate matter sampled during spring demonstrated a higher potency to induce both cytokine release and toxicity compared to the fine fractions.

The study is supported by a grant from EU (A European Commission Shared-Cost Research Project, QLK-CT-2000-00792).

[P10-23] CORRECTION OF DROPLET DISTORTION EFFECTS IN AERODYNAMIC PARTICLE SIZING INSTRUMENTS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

Aerodynamic particle sizers (models APS and Aerosizer; TSI, Inc.) are widely used to measure diameter distributions of aerosols. Droplets have been observed to distort into oblate spheroids in the acceleration field of the APS, resulting in underestimation of particle aerodynamic diameter. The Aerosizer accelerates particles at a higher rate than the APS and produces a larger degree of diameter underestimation.

Droplet aerodynamic diameter underestimation was measured for several liquids (several polymethylsiloxanes, triethanolamine, and oleic acid) with a range of viscosities (η = 0.052 to 0.59 N·s/m^2) and surface tensions (σ = 0.020 to 0.032 N/m). Droplets were generated over a range of sizes between about 4 to 15 μm using a vibrating orifice generator and their aerodynamic diameters were calculated from the observed droplet settling velocities. The droplets were measured using an APS 3310, an APS 3320, an Aerosizer LD, and an Aerosizer DSP, though not all instruments were used at the same time. The measurements were grouped by instrument type (APS, n = 56 and Aerosizer, n = 50) and a relatively simple function was found to fit all the data within experimental error, after excluding three outliers. The function consisted of the size shift $\Delta = - a \times d^b / (\sigma^c \times \eta^e)$, with d in μm. Fits to the data using a range of values for a, b, c and e were investigated. The mean square error (MSE), upon which the regression depended, did not increase more than 20% for a relatively broad range of the four fitting parameters. It was decided that the simplest equation consistent with theoretical information available would be used. The value of b was taken to be 2, since this appeared to be approximately correct from published APS calculations. The resulting constants were different for the APS ($a = 8.84 \times 10^{-5}$; c = e = 0.688) and the Aerosizer ($a = 4.45 \times 10^{-4}$; c = 0.934; e = 0.253). The MSE for the APS was 0.0371 (1 outlier removed) and for the Aerosizer was 0.122 (2 outliers removed). The outliers occurred for the largest droplets, perhaps from residual solvent affecting the viscosity and surface tension. There appeared to be no significant difference between the response of different models of the APS or of the Aerosizer. The equations fitted the experimental data reasonably well and may be useful to estimate the acceleration effect for similar liquids. However, caution in their use is advised in that these are only empirical fits to the data and there is little theoretical justification for the chosen equation, especially when extrapolating outside the range of parameters used in these experiments. For example, water droplet distortion appears to be overestimated.

[P08-01] ON-ROAD EXPOSURE TO HIGHWAY AEROSOLS: 1. PARTICLE CHEMISTRY AND RAT EXPOSURE SYSTEM.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

There has been growing interest in the heath effects of ultrafine particles over the past decade based on laboratory experiments with generated aerosols. Because ultrafine particles have a relatively short residence time in the atmosphere, it is difficult to provide high concentration exposures to experimental animals. Recently there have been efforts to concentrate the ultrafine particle fraction of the ambient aerosol in order to mimic high ambient exposure scenarios for controlled clinical or animal inhalation studies. However, it is unclear how representative such particles may be after the processing that is necessary in the concentrator systems. Recent studies have shown particle number concentrations over urban roadways are higher than roadside and much higher than downwind. In fact, on-road number concentrations are often higher than provided by concentrator systems. People in passenger cars and trucks are directly exposed to these particles that are present on highways at high concentrations. Thus, an on-road exposure system was developed in which laboratory animals were transported on active roadways in order to provide exposures to fresh ultrafine aerosols. The University of Minnesota\\'s Mobile Emissions Laboratory has been used extensively to make on-road emission measurements. It was adapted for use as both an emission laboratory and exposure system. An inlet brings the on-road aerosol from in front of the truck into the laboratory in the cargo container in the truck bed where measurements and animal exposures are performed. In these experiments, some of the equipment was removed to make room for the animal exposure system. An air delivery system was built to provide exposures for 3 groups: whole highway aerosol; filtered air with the gaseous pollutants present; and clean air without particles, CO, VOCs, or NOx. The cages held 10 animals each so thirty animals could be used for a given experiment. Rats of old age were used, with and without pre-exposure to endotoxin or human influenza virus, as well as spontaneously hypertensive rats, with telemetric EKG and blood pressure implants. The truck was then driven on highways around Rochester under varying conditions to provide a range of exposures to the animals. The physical nature of the observed aerosol and the experimental design and the responses of the animals to the various challenges are presented in two companion posters.

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[P10-21] ASPIRATION AND TRANSFER EFFICIENCIES OF THE TSP AND DICHOTOMOUS PM SAMPLING INLETS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

An experimental system has been developed for the rapid measurement of the aspiration/transfer efficiency of aerosol samplers in a wind tunnel. The system was used in an EU-funded project to study the application of scaling principles to sampler aspiration efficiency. As part of this work, we measured the aspiration and transfer characteristics of two inlets commonly used for sampling airborne PM: the 'Total Suspended Particulate' or TSP inlet, and the low-volume dichotomous sampler inlet typically used in sampling PM10 or PM2.5.

Each test inlet type was constructed on three scales: full-scale, half-scale and double-scale in the case of the TSP inlets, and full-scale, half-scale and third-scale in the case of the dichot inlet. Tests were carried out using an aerosol of polydisperse solid glass spheres, with the APS used to compare aerosol concentrations sampled alternately through the inlets and through isokinetic reference probes. Confirmatory tests were carried out using monodisperse aerosols of sodium fluorescein, and narrow-fraction aerosls of fused alumina.

The main results of interest concern the fraction of the external aerosol that enters the inlet and is transferred through it, hence is available for collection by a filter, or further size fractionation into PM10 or PM2.5. This is referred to here as the sampling efficiency, being the product of the inlet aspiration efficiency and the inlet transfer efficiency. Our results show that the sampling efficiency of the low-volume dichot inlet has D50 $\approx$15 μm in calm air; the D50 increases with increasing external wind speed. The TSP sampling efficiency is similar to the dichot in calm air, but it decreases with increasing external wind. At external winds higher than ~8 km/h the D50 of the TSP sampler falls below ~10μm.

An interesting question is whether one can scale the inlets to operate at either higher or lower flow rates, while preserving the same sampling characteristics as the current full-scale, 16.67 l/min versions. In the case of the dichot inlet our results indicate that scaling to lower flow rates presents no problem. In scaling the inlet to operate at higher flow rates, the fall-off in efficiency at low external winds might present practical limitations. For the TSP sampler, scale-invariance was not observed and the double-scale inlet displayed lower sampling efficiency than expected on the basis of scaling principles.

The conclusions drawn from this work are:

The low-volume dichot inlet has satisfactory sampling efficiency that increases as the external wind increases. Under all conditions expected in practical use the inlet aspirates sufficient PM to allow either PM10 or PM2.5 to be selected downstream. The inlet can be scaled to operate at different flow rates.

The TSP inlet does not select a constant fraction of the external PM at all wind speeds. It is likely to undersample the coarse end of the PM10 fraction at moderate and high external winds. The inlet cannot be scaled to operate at higher flow rates as this further degrades its aspiration efficiency

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[P10-20] MASS AND CHEMICALLY RESOLVED SIZE COMPOSITIONS OF FINE PARTICULATE MATTER AT THE PITTSBURGH SUPERSITE.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

Multi orifice impactor samplers (MOUDI) were used to collect aerosol samples in eight size bins from 0.056 to 2.5 micrometers in particle diameter. Samples were collected in aluminum foils for analysis of carbonaceous material and Teflon filters for analysis of particle mass and inorganic ions. 24-hour samples were collected during the summer intensive (July 2001) and winter intensive (January 2002). Aerosol mass distributions were measured daily during the whole Pittsburgh Air Quality Study (PAQS), form July 2001 to July 2002.

MOUDI performance was compared against other integrated mass samplers (TEOM, FRM, Dichot). The inter-comparison results show that the MOUDI tends to overestimate the PM2.5 mass by 15%. Size distributions obtained from the MOUDI are compared to an SMPS system to validate measurements from both instruments.

Stage mass concentrations are inverted and lognormal distributions are obtained for total mass collected on the impactors. Separate inversions are performed for the organic and inorganic speciation MOUDI data and lognormal distributions are obtained.

The number of modes and their peak diameters are used to provide insights about the age of the aerosol and the processes that affected it (e.g. cloud processing). The ratio of organic to inorganic concentrations is used to estimate the hygroscopic properties of these particles as a function of their size.

[P10-19] SIZE AND CHEMICAL CHARACTERIZATION OF URBAN ULTRAFINE AND FINE PARTICULATE MATTER IN THE EASTERN UNITED STATES.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

Recently, ultrafine particles, particles with aerodynamic diameters less than 100 nm, have gained increasing attention because of their hypothesized adverse health effects and potential to act as cloud condensation nuclei. Size, chemical composition, and temporal variations of ultrafine particles at the single particle level are essential for assessing their impact on air pollution, global climate change, and human health. A dual polarity aerosol time-of-flight mass spectrometer (ATOFMS) with an aerodynamic lens inlet system[1,2], was developed for on-line characterization of individual fine and ultrafine particles. In the summer of 2002, this ATOFMS was deployed for atmospheric measurements in two urban areas in the Eastern United States (Rochester, NY and Atlanta, GA) to characterize fine and ultrafine urban particulate matter. The observed particles consisted of organic carbon (OC), elemental carbon (EC), and EC/OC. EC and EC/OC were found to be the major ultrafine particle types, whereas OC and OC/EC were dominant for particles between 100 nm and 300 nm. The mass spectral signatures will be compared to ion markers identified in ATOFMS source characterization studies to determine the emission sources. These major particle types and their associations with inorganic species (i.e. ammonium, sulfate, nitrate, and heavy metals) as well as the temporal variations during the two studies will be presented.

Acknowledgements

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[2] Liu, P.; Ziemann, P.J.; Kittelson, D.B.; McMurry, P.H.; "Generating Particle Beams of Controlled Dimensions and Divergence: II. Experimental Evaluation of Particle Motion in Aerodynamic Lenses and Nozzle Expansions," *Aerosol Sci. Technol.* **1995**, 22, 314-324.

[P10-18] SEASONAL EFFECTS ON THE SIZE DISTRIBUTION OF PAH, EC AND OC IN CLAREMONT, LOCATED DOWNWIND OF CENTRAL LOS ANGELES.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

The size distribution of air particles determine their dry and wet deposition, atmospheric residence time and efficiency of deposition in the human respiratory system. Changes in size distributions may result from chemical and physical processes, and from changes in meteorological conditions. To better understand these effects, we measured the size distributions of 12 priority polycyclic aromatic hydrocarbons (PAH), elemental (EC) and organic carbon (OC), from October 2001 to July 2002 in Claremont, located ~ 40 km downwind of central Los Angeles. Samples were collected once a week for 24-hr with MOUDI impactors, and composited into monthly periods in 3 aerodynamic dia. intervals: 0-0.18 um (ultrafine UF), 0.18-2.5 um (accumulation AC), and 2.5-10 um (coarse CR). Temp., RH, WD and WS were also measured. The distributions of the PAH group that includes the more volatile species (PHE-FLT) are similar to the group containing the less volatile PAH (BAA-IND). However, the distribution shapes varied markedly over the year. From Oct. to Jan., the distributions contained no CR modes. Beginning in Feb., most of the distributions showed a prominent CR mode, especially for the less volatile group. PAH concentration in the less volatile group closely tracked ambient temp., but not so well for the more volatile group. For both groups, the Oct.-Jan. mass conc. did not vary much in all 3 modes, with the largest mass found in the AC mode. After a spike observed in Feb., the total concentrations significantly increased in the more volatile group, and decreased in the less volatile group, and, for both groups, the largest fraction of the mass moved towards the CR mode. High positive correlations of temp. with PHE and ANT suggest increased contribution from diesels, and partitioning from the vapor-phase during transport. Negative correlations of temp. with the less volatile PAH in UF and AC modes suggest desorption from the particle-phase (as temp. increases) and partitioning from the vapor to the particle-phase (as temp. decreases). During the year, EC distributions showed prominent UF and AC modes, but no CR modes. Significant AC modes were seen for OC in all samples, and a smaller UF mode for most samples. A strong effect of temp. on the conc. of EC and OC was seen.

[P10-17] CHARACTERIZATION OF CONCENTRATED ULTRAFINE AEROSOLS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

Ultrafine aerosols (diameters less than 100 nm) are suspected of causing adverse health effects in humans. Ultrafine particles composed of trace metals and acidic apecies have been suggested as causes of the observed health effects. The Prototype Harvard Ultrafine Particle Concentrator, located at the University of Rochester Medical Center, is targeted for use in toxicological studies in animals and for controlled clinical studies in humans related to ultrafine aerosols. These studies are part of the research objectives of the EPA Ultrafine PM Center at the University of Rochester. The study presented in this poster, along with a companion poster by researchers at University of California, San Diego, was undertaken to characterize the ultrafine aerosols obtained from the Concentrator.

Two modified MOUDI/Nano-MOUDI samplers (MSP Model 110 and Model 115) were used in parallel to obtain trace metal, inorganic ion and elemental and organic carbon composition of particles with diameters ranging from 10 to 180 nm. Eight-hour samples were collected on each day from June 3 - 8, 2002, at the University of Rochester. Sample collection typically began between 8 and 9 am and concluded by mid-afternoon. Weather conditions over the six days ranged from rainy and cool to sunny and warm.

The MOUDI/Nano-MOUDI sampler consists of a standard MOUDI operating at 30 lpm and a Nano-MOUDI operating at 10 lpm. The MOUDIs were modified to reduce the flow to 10 lpm while maintaining the particle size cut-points by carefully masking two-thirds of the jets on each stage in the MOUDI. The decreased flow rate through the two samplers allowed simultaneous sampling from the Concentrator which has a nominal flowrate of 20 lpm. Greased substrates (dioctylpthlate) were used on MOUDI stages larger than 180 nm to minimize particle bounce but were not analyzed for chemical composition.

In order to further characterize the aerosol from the concentrator, ambient and concentrated size distributions were measured simultaneously. A Nano-SMPS (scanning mobility particle sizer TSI Model 3936N25) and a Long-SMPS (TSI Model 3936L22) were used to obtain size distributions of concentrated aerosol and a Long-SMPS (TSI Model 3936L22) was used to obtain size distributions of ambient ultrafine aerosol. Size resolved chemical composition of the concentrated aerosol will be presented along with ambient and concentrated size distributions.

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[P10-16] CHEMICAL CHARACTERIZATION OF FINE AND ULTRAFINE AEROSOLS DURING THE ROCHESTER, NY SUMMER INTENSIVE, 2002.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

Some toxicological studies in animals have shown more significant adverse effects due to inhalation of ultrafine aerosol (diameter less than 0.10 μm) than fine aerosol (diameter less than 2.5 μm). Chemical characterization of fine and ultrafine aerosol concentrations were obtained in Rochester, NY, June 3 to 19, 2002 as part of ongoing work by the University of Rochester EPA Ultrafine PM Center to characterize ultrafine aerosols in U.S. urban areas.

Two modified MOUDI/Nano-MOUDI (MSP Model 110 and 115) samplers were used in parallel to obtain inorganic ion, elemental and organic carbon and trace metal concentrations of particles from 10 to 180 nm. The MOUDI/Nano-MOUDI samplers collected aerosol for eight consecutive days in order to obtain sufficient sample for analysis. Two precautions were taken to minimize the possibility of particle bounce from the upper stages to the ultafine particle stages. The MOUDIs were modified to reduce the flow to 10 lpm while maintaining the particle size cut-points by carefully masking two-thirds of the jets on each stage in the MOUDI. The reduced flowrate decreases the velocity that the particles move through the system, decreasing the likelihood of particle bounce. In addition, greased substrates (dioctyl phathalate) were used on MOUDI stages above 180 nm to capture the larger particles. The greased substrates were changed every 48 hours to maintain good capture efficiency. Results of a preliminary study done to determine a grease with minimal transfer to lower stages will be presented.

In addition to the ultrafine particle collection, four 48-hour samples were collected with three MOUDIs and a PM1.8 sampler to obtain chemical speciated, size segregated fine aerosol concentrations. The MOUDIs were operated with a cyclone at the inlet to restrict collected particles to the range 0.056 - 1.8 μm. Speciated concentrations of fine and ultrafine aerosol will be compared and MOUDI/Nano-MOUDI size distributions will be presented.

A Nano-SMPS (scanning mobility particle sizer TSI Model 3936N25), a Long-SMPS (TSI Model 3936L22) and an APS (Aerosol Particle Sizer, TSI Model 3320) were run continuously during the eight days of filter sampling to obtain size distributions of particles ranging from 0.004 um to 10 um. This data will be used to further characterize the fine and ultrafine ambient aerosol. Particular attention will be paid to size distributions obtained while a diesel truck idled near the sampling site.

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[P10-15] SIZE-RESOLVED AEROSOL CHEMICAL COMPOSITION MEASUREMENTS DURING THE NEW ENGLAND AIR QUALITY STUDY WITH AN AEROSOL MASS SPECTROMETER ABOARD THE *RONALD H. BROWN*.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

The New England Air Quality Study is a multi-institutional research project to improve understanding of the atmospheric processes that control the production and distribution of air pollutants in the New England region. During July-August, 2002 a large, collaborative, intensive period of atmospheric measurement and model comparisons took place. As part of this study, an Aerosol Mass Spectrometer (AMS) was deployed aboard the NOAA ship *Ronald H. Brown* in the Gulf of Maine and collected 2-minute averaged particle mass spectra as well as organic, sulfate, and nitrate mass distributions. The AMS measures non-refractory components of aerosol particles with aerodynamic diameters between roughly 40 and 1500 nm. Because sodium chloride, sodium sulfate, and sodium nitrate are relatively non-volatile at the AMS heater temperature used during this study, these species were not detected with the AMS.

A wide variety of air masses were sampled during the intensive period, including clean marine, clean continental, and polluted continental air masses. In general, the non-refractory particle composition was mostly organic and sulfate with significantly lesser amounts of nitrate and particle mass loadings typically peaked around 400-600 nm in aerodynamic diameter. Several events with high aerosol organic, sulfate, and/or nitrate mass loadings were observed and the atmospheric processes that caused them will be discussed.

[P10-14] PARTICLE FORMATION AND GROWTH IN SO_2- AND VOC-RICH PLUMES NEAR HOUSTON, TEXAS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

Gas-phase particle precursors and tracer species and particle size distributions were measured aboard an aircraft downwind from industrial and urban sources in the vicinity of Houston, Texas during the daytime in late August and early September, 2000. The plumes originating from several sources, including a gas- and coal-fired power plant, the petrochemical industries along the Houston ship channel, and the urban center of Houston, were studied. On the days selected for analysis, the nearly constant southerly wind allowed the plumes to advect in parallel to the north of Houston with minimal mixing between the plumes. These meteorological conditions allowed comparison of the evolution in particle properties within the plumes from the discrete sources as a function of plume age and oxidation.

The industries and electrical utilities at the periphery of the city were the primary sources of particulate mass flux from the Houston metropolitan area. Particle volume was observed to increase with increasing plume oxidation (age) in those plumes that were rich in SO_2, but which did not contain elevated concentrations of volatile organic compounds (VOCs), at a rate consistent with condensation and neutralization of the gas-phase oxidation products of SO_2. In contrast, in plumes from petrochemical industries that were rich in both SO_2 and VOCs, observed particle growth greatly exceeded that expected from SO_2 oxidation alone, indicating the formation of organic particulate mass. In those plumes which had enhanced concentrations of VOCs but which did not contain much SO_2, and in the plume of the Houston urban center, no particle volume growth with increasing plume oxidation was detected. Since substantial particle volume growth was associated only with SO_2-rich plumes, and not with those with enhanced concentrations of VOCs alone, these results suggest that photochemical oxidation of SO_2 is the key process regulating particle mass growth in all the studied plumes in this region over time scales of several hours. However, the uptake of organic matter--perhaps enhanced by acid-catalyzed reactions on the surfaces of the particles--probably contributes substantially to particle mass in petrochemical plumes rich in both SO_2 and VOCs. We recommend further quantitative studies of particle formation and growth in photochemical systems containing nitrogen oxides (NO_x=NO+NO_2), VOCs and SO_2 to extend those previously made in NO_x-VOC systems.

[P10-13] SIZE RESOLVED MASS BALANCE OF AEROSOL PARTICLES OVER THE METROPOLITAN REGION OF SAO PAULO, BRAZIL.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

The mass size distribution of atmospheric aerosol particles in the heavily polluted metropolitan region of Sao Paulo, Brazil, was determined by means of a micro-orifice uniform deposit impactor (MOUDI) during the period of 3-11 of August, 1999. The particles collected on the 5 lower stages of the impactor (stages 9A, 7A, 6A, 5A and 4A with d_{50} of: 0.09, 0.38, 0.59, 1.0 and 1.8 μm, respectively) were analyzed by particle induce X-ray emission technique (PIXE) for up to 20 trace elements. These 5 stages plus the After Filter were analyzed also for mass, black carbon (BC) and by ion chromatography (inorganic ions: Na^+, NH_4^+, K^+, Mg^{2+}, Ca^+, Cl^-, NO_3^- and SO_4^{2-}). Real time carbon monitor provided organic and elemental carbon concentration for PM10.

Considering that there is enough ammonia in the urban atmosphere, it was assumed that all sulfate was in the form of ammonium sulfate. For the 5 stages, the ammonium sulfate concentration was estimated by the sulfur concentration obtained by PIXE analysis assuming a conversion factor of 4.125; and the crustal material was estimated by the sum of the main oxides and carbonates: Al_2O_3, SiO, $CaCO_3$, K_2CO_3, Fe_2O_3 and ZnO.

The liquid water adsorbed by the inorganic aerosol was also taken into account by using the ISORROPIA model (Nenes et al., 1998), using as input the concentrations obtained by ion chromatography.

The averaged mass balance analysis for each stage showed that BC is concentrated in the After Filter, being present as particles with very low diameters. The ammonium sulfate and the liquid water content have simple unimodal size distributions, with a maximum value at stage 6A (d=0.59μm). The crustal material contribution is greater at stages with greater cut-off diameters. More than half of the fine particulate matter is not resolved. Part of this difference should be explained by the organic carbon (OC) and water absorbed by these small organic particles, which were not considered. Assuming that all the OC measured by the carbon monitor is in the fine mode, it would explain almost 60% of the missing mass.

On the basis of these results and assumptions it can be concluded that carbon (OC+BC) may have higher contributions than ammonium sulfate, and that the three of them are responsible for the major composition of the fine particulate in the metropolitan region of Sao Paulo.

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[P10-11] AEROSOL NUMBER-SIZE DISTRIBUTIONS AT AN URBAN LOCATION: LONG TERM DATA FROM SEATTLE, WA. PARTICULATE MATERIAL CENTER, CENTRAL MONITORING SITE.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

The aerosol number-size distribution from 20nm to 5μm diameter has been measured nearly continuously for two years to produce a representative time series of urban data for incorporation into health effect studies and chemical transport models. The site is located near the confluence of major interstate freeways and local traffic arteries, within a few kilometers of an industrial zone, a major shipping port and the central downtown area of Seattle. Meteorological and aerosol chemistry and optics data are collected at the site including 24-hr filter samples, air toxics samples and 15 minute time resolution, mass, sulfate, nitrate and organic material concentrations.

The data have been processed to determine the mean concentrations, diameters, and standard deviations of the number- surface- and mass-size distributions for up to four log-normally fitted modes within the measured size range. The fitting routine minimizes the residual between the measured concentration as a function of size and the fit values simultaneously for the three moments of the distribution rather than for each moment individually. Fitting individual moments often leads to inconsistencies in the output size distributions which in the atmosphere were single valued. The modes are generally associated with the ultrafine, accumulation and coarse size intervals, 20 to 100nm, 100 to 1000nm and 1μm to 5μm respectively. Time series and time correlation analyses show the cyclic nature of some of the modes and features of the distribution on a diurnal and weekly basis. An initial analysis of 2 months of size, gas phase and meteorological data from the site during the winter season showed that subsets of the size distribution could be attributed to four specific source types through Positive Matrix Factor and UNMIX analysis. The identified source types were diesel and gasoline combustion, wood smoke, and secondary aerosol. Results from other seasons which include photochemically active air masses in the Summer months and periods of air stagnation in the Autumn, show different size distributions and different time variation.

[P10-24] SPATIAL AND TEMPORAL VARIATIONS IN PM2.5 MORPHOLOGY.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

Extensive studies are currently underway at characterizing the ambient aerosol by measuring its size distribution and chemical composition. Relatively few studies have examined the morphology of these particles (1,2). Though there are only a few studies, there is a general observation that the finer sized particles are more aggregated or have lower fractal dimensions. In this study, an electrostatic sampling system in conjunction with the TEOM was used to collect PM 2.5 particles onto electron microscope grids. The method allows for the collection of particles without potentially altering the aggregate structures. A Scanning Electron Microscope was then used to examine the morphology of ambient aerosols in the Greater Cincinnati air shed and at the St. Louis Supersite. A computer algorithm was developed and used to calculate the mass-fractal dimension based on the cumulative-intersection method. Spatial and temporal variations of the variations of the morphology of the ambient particles will be reported.

Preliminary results show that the percentage of agglomerate particles varied over a day of sampling. The percentages started high (14%) during the morning rush hour and steadily decreased to 1% in the evening. The total number of agglomerates followed the same pattern. The total number of particles (agglomerate and non-agglomerate) started high in the morning, decreased during the day, but increased in the evening. Fractal Dimensions for agglomerates varied from 1.4 to 2, with an average of 1.80 (SD=0.12, n=18). The same analysis is being done for other days, from locations in St. Louis and in Cincinnati, and the results will be presented.

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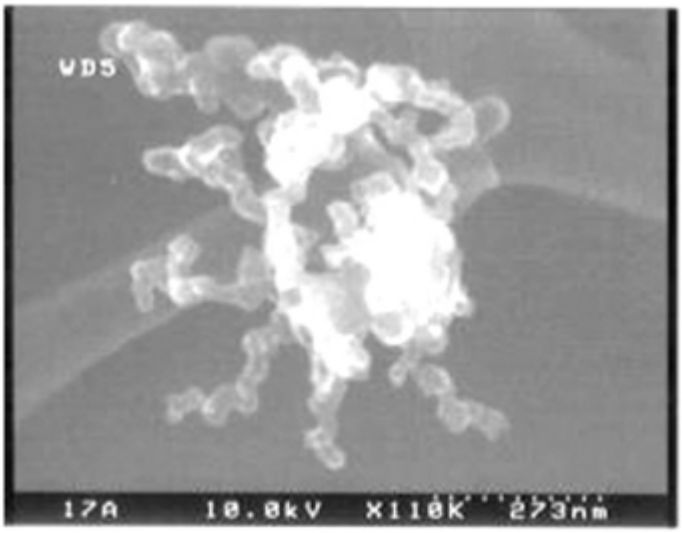

Figure 1. Sample agglomerate captured during sampling D1=1.76

Figure

[P08-29] GENE EXPRESSION PROFILES IN HUMAN AND RAT VASCULAR ENDOTHELIAL CELLS EXPOSED TO RESIDUAL OIL FLY ASH (ROFA) OR VANADIUM (V).

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Epidemiological studies have reported increased mortality and morbidity in cardiopulmonary patients with increased levels of particulate matter (PM) in the environment. The mechanisms of action for PM and the constituents responsible for the observed health effects are not known. Recent studies implicating cardiovascular and clotting systems in PM response suggest that the vascular endothelium may be targeted. To test this hypothesis and understand the possible role of endothelial dysfunction in PM cardiovascular toxicity, we initiated studies with primary vascular endothelial cell cultures using a model PM, ROFA, and one of its toxic metal constituents, V. Assessing the temporal differential expression of genes on acute exposure to ROFA or V could reveal the transcriptional regulation involved in the initiation and progression of acute injury. Primary cultures of human umbilical vein endothelial cells (HUVEC) and rat pulmonary micro-vessel endothelial cells (RLMVEC) (VEC Technologies, Inc., New York, NY) were exposed to saline, ROFA (1μg/ml) or V (1μM) for 25 minutes to investigate the immediate injury and or stress response. Global gene expression profiles were generated using human (8k) and rat (4k) plastic microarray (Clontech, Palo Alto, CA). Analysis of the gene expression data (GeneSpring, Silicon Genetics, Redwood City, CA) indicated exposure and species-specific differential gene expression and altered genes can be grouped into genes common to both the treatments as well as unique to ROFA and V exposure. Classification of altered genes based on biological processes, cellular components and molecular function indicated species-specific differences in ROFA and V toxicity. Despite species differences, the differential gene expression profiles observed here suggest direct toxic effects of ROFA and V on endothelial cells and their possible involvement in cardiovascular effects of PM. (This abstract does not reflect US EPA policy).

[P08-12] ADJUVANT ACTIVITY OF VARIOUS DIESEL EXHAUST AND AMBIENT PARTICLES IN TWO ALLERGIC MODELS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

In the framework of an EU study entitled "Respiratory Allergy and Inflammation due to Ambient Particles (RAIAP)" various particulate matter samples have been tested for their adjuvant potency in two animal models for allergy. A pollen allergy model in the Brown Norway (BN) rat and an ovalbumin model in the Balb/c mouse were used in this study to compare the discriminatory value of these two models. Two different sources of diesel exhaust particles (DEPI supplied by Dr Mauderly; DEPII is purchased from National Institute of Standards and Technology: SRM2975), a residual oil fly ash source (ROFA) and two sources of ambient borne particles (Ottawa dust: EHC-93 and road tunnel dust (RTD)). Rats were sensitised intratracheally with Timothy grass pollen (Phleum pratense, 200 μl, 10 mg/ml) on day 0, challenged on day 21 and examined on day 25. Mice were sensitised intranasally at day 0 and 14, challenged intranasally at day 35, 38, 41, (0.5μl, 0.4 mg Ovalbumin/ml) and examined at day 42. Particulate matter (PM) was administered either during the sensitisation phase or during the sensitisation and challenge phases (for mice only) or during the challenge phase only.

In the pollen model, only DEPI stimulated the effect on the IgE and IgG1 response to pollen allergens. In the BAL of BN rats exposed to a combination of pollen and PM the percentage eosinophilic granulocytes had decreased compared to the BAL of BN rats immunised with pollen only. No other biomarkers in lung or BAL revealed adjuvant activity in the pollen model.

The IgE levels were increased in mice after co-exposure to ovalbumin and PM in the sensitisation phase but not after co-exposure during the challenge phase only. The inflammatory response was stronger in the lung, predominantly by the influx of eosinophilic granulocytes, as was observed by both histopathological examinations and bronchoalveolar lavage (BAL) analysis. In addition, BAL levels of inflammatory interleukines IL-4 and IL-5 were increased. Based on the IgE antibody response to ovalbumin, the ovalbumin model ranked the adjuvant capacity of the particles in the following order: RTD> ROFA>EHC-93> DEPI> DEPII.

In conclusion, adjuvant activity of air borne particles was shown in an ovalbumin allergy model in mice, whereas this could not be reproduced in a pollen induced allergy model in rats.

[P08-19] INFLAMMATORY EFFECTS INDUCED BY PM_{10} SAMPLES OF DIFFERING COMPOSITION.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Numerous studies have demonstrated toxicological effects of ambient particulate (PM_{10}), but have been unable to identify the physical or compositional elements responsible. In this study PM_{10} was collected from six locations in the UK which vary in predominant source and composition of particulate. PM_{10} samples were collected for 24 hour periods onto Teflon filters for one year. The concentrations of primary, secondary and course particulate comprising each PM_{10} sample were analysed by mathematical modelling (Stedman *et al*., 1998). The inflammation induced by each sample was determined using a rat lung instillation model. Particulate was recovered into 1ml saline of which 500μl was intra-tracheally instilled into female Wistar rat lungs. Within each experiment, the PM_{10} samples instilled were all sampled on the same date. Control animals were instilled with saline alone. Eighteen hours after instillation broncho-alveolar lavage (BAL) was conducted to assess the inflammatory cell population and biochemical markers of inflammation. There was a significant increase in neutrophils ($p<0.001$) and MIP-2 ($p<0.05$) in BAL from lungs exposed to roadside PM_{10} collected from Marylebone Road, London compared to the control but inflammation induced by urban, rural and industrial PM_{10} was not significant.

Preliminary statistical analysis indicates that mass dose of PM_{10} instilled is the greatest factor influencing neutrophil influx into the lung. However, the primary particulate content of PM_{10} is also a strong factor in inducing inflammation. In contrast, the secondary and coarse fractions of the PM_{10} were relatively weak in this respect. This preliminary data would suggest that the primary component of PM_{10} is more important than the secondary or coarse component in driving the inflammatory effects induced by PM_{10} in the rat lung.

[P08-20] SMOG CHAMBER EXPERIMENTS OF URBAN MIXTURES ENHANCE INFLAMMATORY RESPONSES IN LUNG CELLS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Complex urban air mixtures that realistically mimic urban smog can be generated for investigating adverse health effects. UNC Smog chambers that have been used for over 30 years to conduct experiments for developing and testing photochemical models used to predict ambient ozone (O_3) concentrations and secondary organic aerosol (SOA) formation, were used to generate photochemical and non-irradiated systems which were interfaced with an in vitro exposure system to compare the inflammatory effects of complex air pollutant mixtures with and without sunlight driven chemistry. These are preliminary experiments in a new project to study the health effects of particulate matter and associated gaseous co-pollutants. Briefly, two matched outdoor chambers capable of using natural sunlight were utilized to generate two test atmospheres for simultaneous exposures to cultured lung cells. One chamber was used to produce a photochemical active system, which ran from sunrise to sunset, producing O_3 and the associated secondary products. A few hours after sunset, NO was added to titrate and remove completely the O_3, forming NO_2. In the second chamber, an equal amount of NO_2 was injected and the same amount of the 55-component hydrocarbon mixture used to setup the photochemical system in the first side. A549 cells, an alveolar type II-like cell line grown on membranous support were exposed to the photochemical mixture or the original NO_2/hydrocarbon mixture for 5 hours and analyzed for inflammatory response (IL-8 mRNA production) 4 h post-exposure. In addition, a variation of this experiment was conducted to compare the photochemical system producing O_3 and NO_2, with a simple mixture of only the O_3 and NO_2. Our data suggest that the photochemically altered mixtures which produced secondary products induced an about 2-3 fold greater IL-8 mRNA production than the mixture of NO_2 and hydrocarbons or O_3. These results indicate that secondary products generated through the photochemical reactions of NOx and hydrocarbons significantly contribute to the inflammatory responses induced by exposure to urban smog.

[P08-21] FINE DUST PARTICULATE MATTER INDUCES CYTOKINE RELEASE THROUGH TRPV1 ACTIVATION IN LUNG CELLS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Inflammation is an important initial event in PM lung toxicity that may mediate the subsequent development of whole body responses including cardiovascular and respiratory symptoms. Recent in vitro cell culture studies involving treatment of cultured cells with well characterized combustion and soil derived fine particles are summarized in the poster.

Fine particulate samples d<2.5 mm (PM 2.5) were examined for production of interleukin-6 (IL-6) in the human epithelial lung cell line BEAS-2B. A Utah desert dust sample induced significantly greater IL-6 production than a coal fly ash particulate sample even though previous work * showed that coal ash has higher bioavailable iron than soil dusts. Particulate matter may mediate lung cell toxicity through interactions with the vanilloid receptor TRPV1. To further test this supposition, cytokine production by PM 2.5 in a BEAS-2B cell line engineered to over-express TRPV1 was measured. This engineered cell line exhibited a significantly greater PM 2.5-induced IL-6 response, corroborating the importance of TRPV1 in particulate matter-lung cell interactions. In addition, PM 2.5-exposed BEAS-2B cells treated with capsazepine (CPZ), an antagonist of TRPV1, exhibited a marked decrease in IL-6 production. These data suggest that soil dust particles expected to be benign are in fact surprisingly pro-inflammatory, and that particulate matter likely elicits lung cell toxicity through interactions with TRPV1.

* Ball, B. Ryan, Kevin R. Smith, John M. Veranth, Ann E. Aust, Inhalation Toxicology 12:209-225 (2000)

[P08-22] CHEMICAL AND *IN-VITRO* TOXICOLOGICAL CHARACTERIZATION OF WINTER AND SPRING $PM_{2.5}$ IN HELSINKI.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Urban air fine particulate ($PM_{2.5}$) concentrations are consistently associated with changes in cardiorespiratory functions among susceptible population groups. In Finland, there are large contrasts in sources of PM pollution between winter (high regional + long-distance transport + local automotive engine emissions) and spring (high resuspension of road dust). The objective of our present study was to compare the chemical and *in-vitro* toxicological characteristics of $PM_{2.5}$ from these seasons.

A field study was conducted at a traffic site in Helsinki between 13 January and 20 April 2000. A total of 28 samplings of ambient air $PM_{2.5}$ were made in 3 and 4-day periods using a High-Volume Low cutoff Impactor (HVLI) at 68 m3/h. The extracted PM masses from the winter and spring periods were pooled separately on the basis of the $PM_{2.5}$:PM_{10} concentration ratio (continuous beta attenuation data) to form larger samples representing contrasting urban air PM pollution situations:

1) Winter-$PM_{2.5}$ during high $PM_{2.5}$:PM_{10} ratio (0.58; low resuspension)

2) Spring-$PM_{2.5}$ during low $PM_{2.5}$:PM_{10} ratio (0.28; high resuspension)

Spring-$PM_{2.5}$ had clearly higher watersoluble soil metal contents (Al, Fe, Ca) and lower anionic contents (SO_4^{2-}, NO_3^-) than Winter-$PM_{2.5}$. The PM samples from both periods induced dose-dependent NO production in murine RAW 264.7 macrophages without a major seasonal difference in potency. In contrast, Winter-$PM_{2.5}$ was a significantly less potent inducer of TNF-α production than Spring-$PM_{2.5}$. Moreover, Winter-$PM_{2.5}$ caused practically no IL-6 production, whereas Spring-$PM_{2.5}$ produced a partially dose-dependent response. The PM samples from both periods induced dose-dependent reductions in cell viability without major seasonal difference. With regard to cell viability, and especially cytokine productions, the insoluble fractions of Winter-$PM_{2.5}$ and Spring-$PM_{2.5}$ seemed to be responsible for nearly the whole responses. Polymyxin B (antagonist of endotoxin) abolished the IL-6 production induced by Spring-$PM_{2.5}$ and significantly reduced the TNF-α productions induced by both Winter-$PM_{2.5}$ and Spring-$PM_{2.5}$. Deferoxamine (somewhat cytotoxic iron chelator) did not modify these responses. Neither polymyxin B nor deferoxamine modified the PM-induced reductions in cell viability.

In conclusion, Winter-$PM_{2.5}$ and Spring-$PM_{2.5}$ had different proinflammatory profiles in a standard murine macrophage cell line. This activity was strongly associated with the insoluble PM fraction involving partly endotoxin.

[P08-23] CHEMOTAXIN RELEASE BY TYPE II EPITHELIAL CELLS FOLLOWING TREATMENT WITH FINE AND ULTRAFINE PARTICLES.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

In rat inhalation studies it is well documented that ultrafine particles induce more pulmonary inflammation than fine particles at the same lung mass burden. We hypothesise that this acute inflammatory response following deposition of ultrafines is a result of chemotaxin production by epithelial cells following exposure to ultrafine particles. More specifically we hypothesise that, in vivo, ultrafine particles can induce type II epithelial cells to secrete chemotactic agents which can alter the normal pattern of particle clearance from the lungs. Retention of macrophages and their particle loads in the lung periphery could cause build-up of particle dose resulting in increased toxicity via mechanisms such as oxidative stress.

We have therefore used a modified 96-well chemotaxis assay chamber to assess the macrophage chemotactic potential of the type II cell secretions. Utilizing Zymosan Activated Serum (ZAS), a well documented source of the chemotactic complement protein C5a, we have examined both time and dose- related macrophage migration and measured the chemotactic activity in conditioned medium obtained from epithelial cells dosed with fine & ultrafine particles. We found that sub-toxic doses (125 μg/ml) of carbon black in its ultrafine form, induced chemotaxis to a greater extent than equivalent mass doses of either fine carbon black or both forms of titanium dioxide. (0.587 ± 0.076 compared to 0.427 ± 0.045 for fine TiO_2; 0.412 ± 0.045 for ultrafine TiO_2 and 0.484 ± 0.068 for fine carbon black. All data given is the mean of 3 experiments plus or minus SEM).

Preliminary experiments to determine the degree of the chemotactic activity using molecular weight cut-off filters have shown the chemotactic agents to be located above 5 kDa molecular weight (0.467 ± 0.031 for the 5 kDa - 10 kDa fraction and 0.470 ± 0.027 for the >10 kDa fraction compared to 0.403 ± 0.002 for the <5 kDa fraction).

Future investigations will concentrate on further identifying the chemotactic agent secreted by the type II pneumocytes with the objective of obtaining a clearer picture of the events surrounding the enhanced pathogenicity of ultrafine particles in the lung.

[P08-24] ADVERSE HEALTH EFFECTS DUE TO INHALED CARBON NANOPARTICLES?

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Many epidemiological studies, but not all, have identified associations between the frequency of adverse health outcomes in man and the mass concentration of particulate matter (PM) in ambient air. However, plausible mechanistic models capable of interpreting the epidemiological findings are not available at present. This unsatisfactory situation is clearly related to the fact that the mass concentration of aerosol particles is a very gross parameter that does not describe the concentration of inflammatory or toxic components of PM reasonably well. Most of the previous studies have not even made a distinction between the soluble and the insoluble fraction of PM. In this contribution possible adverse health effect due to incorporation of carbon nanoparticles (NPs) in the human lung are assessed. Recent work in this laboratory (K. Wittmaack, Atmospheric Environment 36 (2000) 3963; K. Wittmaack et al., Atmospheric Environment, in press) has provided evidence that carbon NPs constitute the core of a significant fraction of larger fine particles which have grown in the atmosphere by condensation of sulfates, nitrates and organic carbonaceous compounds. All particle-type carbon matter identified by scanning electron microscopy (SEM) had sizes between 20 and 40 nm, irrespective of the final size of the air borne particles. The results are in very good agreement with other recently reported investigations using other techniques. With information on the size distribution at hand, the mass concentrations of carbon NPs in ambient air can be calculated from measured number concentrations. It turns out that, averaged over 24 h, the contribution of carbon NPs to PM2.5 is well below 1%, i.e. only on the order of 100 ng/m^3. Animal studies, on the other hand, are usually performed at carbon NP mass concentrations that are more than three orders of magnitude higher. In spite of these very high doses, the observed effects were small.Considering these results it is not very likely that carbon NPs, a major component of the insoluble fraction of fine (and ultrafine) PM in urban aerosols, constitute an important risk factor for human health. Hence attention should focus on the much larger soluble fraction of aerosol matter.

[P08-25] CYTOKINE RESPONSES ELICITED BY $PM_{2.5}$ SEAS SAMPLES COLLECTED AT THE BALTIMORE SUPERSITE DURING A 2002 INTENSIVE STUDY.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Exposure to fine particulate matter, $PM_{2.5}$, has been associated with adverse health effects, including increased human morbidity and mortality. These particles contain a complex mixture of organic and inorganic compounds, elemental carbon, trace elements and biological components including endotoxin. A major goal of the Baltimore PM Supersite is to relate chemical and biological endpoints of $PM_{2.5}$ with local and/or geographically distinct sources. We hypothesized that continuously collected ambient air samples have biological activity that reflect specific components of the particles. Particles collected at 30-minute intervals using a semi-continuous aerosol sampler (SEAS) during a summer "intensive" sampling period at the Baltimore Supersite (Ponca St.) were analyzed for their ability to elicit the release of pro-inflammatory cytokines from RAW 264.7 cells, and chemokines from A549 cells. Alveolar type II epithelial cells (A549) released IL-8 and MCP-1 at levels that varied with collection time. Similarly, different levels of TNF-α and IL-6 were released by macrophage-like cells (RAW 264.7) depending on the time of day the samples were collected. Endotoxin was also present in many of the samples; but cytokine and chemokine release did not correlate directly with these levels. Our data suggest a role for other components of $PM_{2.5}$, such as metals, in the cellular response to the particles and that adverse health effects may be attributable to these component-specific effects.

Supported by the Baltimore Supersite Program grant R82806301

[P08-26] COMPARISON OF THE BIOLOGICAL ACTIVITY OF NIST INTERIM REFERENCE MATERIAL FOR $PM_{2.5}$ WITH NIST STANDARD REFERENCE MATERIAL® 1648 FOR URBAN PARTICULATE MATTER.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

For the past 25 years, the only sources of industrialized urban air particulate matter (PM) legitimated by the National Institute of Standards and Technology (NIST) have been standard reference material® (SRM) 1648 and SRM® 1649a ("urban dust" certified for organic compounds only). While well characterized with respect to its inorganic speciation, SRM® 1648 is poorly characterized with regard to the size of its constituent particles. Because epidemiological evidence suggests that human morbidity and mortality are associated with exposure to particulate matter of size 2.5μm or less ($PM_{2.5}$; fine fraction), the NIST and the USEPA have jointly developed an interim reference material for urban particulate matter specifically of this size. In order to test the hypothesis that the interim reference material for $PM_{2.5}$ is biologically active, we exposed the human alveolar type II (ATII) cell line, A549, to NIST fine particulate matter (0.62 mg/ml-1.0 mg/ml) for 24 hrs. A549 cells elicited the chemokines IL-8 and MCP-1 at levels above medium control and in a $PM_{2.5}$ dose-dependent manner. IL-8 release was similar in separate experiments for ATII cells exposed either to 500 μg/ml interim NIST $PM_{2.5}$ or to 100 μg/ml $ZnCl_2$, suggesting that metals may play a role in the biological activity of NIST $PM_{2.5}$. We then compared the interim NIST sample against SRM® 1648 in the same *in vitro* system and at identical concentrations (0.62 mg/ml-1.0 mg/ml). The IL-8 response after treatment with the interim reference material was similar to that of SRM® 1648 at all concentrations except 250 μg/ml, at which the interim SRM was six times more active than SRM® 1648. Similarly, interim reference material was 1.2-1.5 times more active in the production of MCP-1 by A549 cells at concentrations of 125-500 μg/ml than were the same concentrations of SRM® 1648. Interestingly, increasing concentrations of ZnCl2 (25-400 μM) led to decreasing MCP-1 release by A549 cells without a significant decrease in cell viability. In conclusion, our data support the hypothesis that the biological activity of PM is due not only to speciation, but also to particle size, and that during exposure to $PM_{2.5}$, ATII cells may signal two completely different cell types into the alveolar space, depending on the content of the particulate matter inhaled into the distal lung.

[P08-27] CHARACTERIZATION OF ORGANIC AEROSOL (WOOD SMOKE AND DIESEL EXHAUST PARTICULATE) USING SUBCRITICAL WATER FRACTIONATION AND IN VITRO TOXICITY TESTS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

In contrast to inorganic aerosols, which are often well characterized, only ca. 15%-50% of the organic carbonaceous (OC) particulate mass has been characterized. The limited knowledge of OC fractions is due to the use of organic solvents, which are able to extract only nonpolar or slightly polar organics. In addition, polar compounds cannot usually be analyzed via gas chromatography with a mass spectrometer (GC/MS). Recently, subcritical water (defined as hot water under sufficient pressure to maintain the liquid state) has been used to extract organics with a wide range of polarities. The advantage of water extraction is in the ability of water to change polarity when the temperature is changed. At lower temperatures (e.g., 25°-100°C), water can extract polar compounds; with increasing temperature (e.g., to 250°C), the polarity of water decreases and becomes comparable to the polarity of organic solvents, allowing nonpolar compounds to be extracted.

In this study, subcritical water was used for the extraction and fractionation of organic atmospheric particulate. Two common carbonaceous aerosols, diesel exhaust particulate (relatively nonpolar matrix) and wood smoke particulate (polar matrix), were sequentially extracted using a range of subcritical water temperatures from 25° to 300°C. The toxicological importance of individual fractions was studied on four separate systems, bacterial and mammalian cell respiration, mammalian cell cytotoxicity, and bacterial genotoxicity. The data obtained were related to the composition of extracts, which was determined on the basis of carbon, hydrogen, nitrogen, and sulfur analysis; total organic carbon; GC/MS analysis; and for diesel exhaust particulate, the analysis of metals.

In general, cytotoxicity was highest for the polar fractions from wood smoke particulate and the non-polar fractions from diesel exhaust particulate. In addition, the most polar fraction of diesel exhaust showed significant cytotoxicity. This might be attributed to the increased concentration of sulfur, Fe, Zn, Mg, and Mn (possibly present in the form of soluble sulfates). The detailed toxicity and analytical results will be presented. In summary, the results indicate that standard methods employing organic solvents neglect characterizing the polar fractions of aerosol particulate, which are important from a toxicological point of view.

Acknowledgment

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[P10-02] REGIONAL ULTRAFINE PARTICLE NUCLEATION OBSERVED IN ST. LOUIS, MO.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

Size distributions of ambient particles (0.003 μm~10 μm) were measured as a part of the EPA St. Louis Midwest supersite program. This paper focuses on implications of those measurements for nucleation, and pertains to measurements from the 13-month period beginning in April 2001. Measurements were made continuously with an automated system, which completed 10 size distribution measurements per hour. The sampling system included a nano-scanning mobility particle sizer (3 nm < DP < 40 nm), a long-column scanning mobility particle sizer (30 nm < DP < 400 nm), a PMS Lasair optical particle counter (OPC) (0.1 μ m < DP < 2 μm) and a Climet CI-500 OPC (0.3 μm < DP < 10 μm). The first 10 minutes of each hour were dedicated to calibration of the OPCs with atmospheric particles of 450 nm mobility diameter.

We observed clear evidence for nucleation and subsequent growth on 83 days. Nucleation typically occurred after sunrise and lasted for about 6~8 hours. These nucleation events did not show any clear association with measured gases, and the constant growth rates irrespective of wind direction suggested that they were regional in extent. Nucleation occurred more frequently in spring, summer and autumn than winter, although nucleation was observed during each month of the year. The average diameter growth rate during nucleation episodes on the 83 days was 3.33 nm/hour, but growth rates in the summer were 5-7 times rages in the winter. Estimated particle formation rates during nucleation episodes were typically on the order of several tens cm-3s-1.

In this paper salient features of the nucleation events including conditions that favored nucleation will be discussed.

[P08-28] IN VITRO TOXICITY OF AMBIENT PM10 AND PM 2.5 COLLECTED FOR HEPMEAP PROJECT.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Despite the many epidemiological studies correlating exposure to ambient PM10 levels with respiratory diseases and cardiopulmonary mortality, there is a need to establish biologic plausibility of these health effects. Here we present the preliminary comparison of eight coarse (PM10) and fine (PM2.5) samples collected at two different locations across Europe for the HEPMEAP project (QLRT-1999-01582). The identity of the locations (A; B) and time of collection is still unknown. We used the cell line RAW 264.7 (mouse monocytes/macrophages) and the same concentrations for all particles of 20μg/cm2 and 60μg/cm2. RAW 264.7 cells when stimulated with lipopolysaccharide (LPS) release large amounts of inflammatory mediators including the cytokine interleukin-6 (IL6) and the precursor of prostaglandins arachidonic acid (AA); in order to control the activation of our cells we have included LPS (1 μg/ml) in our experiments. Cytotoxicity was measured by the release of LDH. LPS induced a moderate release of 1.26±0.29% while all tested samples had no effect on cell viability apart one coarse fraction. The inflammatory mediators released by macrophages or epithelial cells in vitro play major roles in pulmonary inflammation related to particle exposure. Both fine and coarse particles collected in location A, dose dependently increased AA release as compared to control cells. However, AA release was only slightly induced in two samples, with no difference between the two fractions, while in the other two samples coarse particles were more effective than fine particles. In fact coarse particles of the latter samples induced at 60 μg/cm2 a highly significant ($p<0.001$) AA release of 226 ± 21.95% and 236± 24.74% similar to the LPS-induced which was 237± 22.62%. The coarse fraction with the lowest AA release was the only one of location A which induced ($p<0.0005$) at both concentrations the production of IL6. In two samples of location B the coarse fractions were more effective than fine fractions in releasing AA, and at 60 μg/cm2 the release was similar to the LPS-induced level. In the other two samples fine fractions were more effective than coarse fractions, but without attaining the level of LPS. It seems that there is no correlation between the increase of AA release and the increase in IL6 production. Among all tested samples only one of location B increased both AA release and IL6 production. As the two end points are linked to two different cell signalling pathways these results can be expected. Our results suggest that there is the possibility with our model system to show contrasts and discriminate between samples with different composition.

[P10-01] INTENSIVE ANALYSIS OF AMBIENT AEROSOLS IN THE GREATER CINCINNATI AIRSHED.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (11:00 AM-12:00 PM) Grand Ballroom 2-4

Respiratory complications and other detrimental health effects have been associated with increased PM2.5 in ambient air. This led to a study examining the "factors affecting the PM2.5 concentration levels" in the Greater Cincinnati metropolitan area. This area is characterized by high interstate highway traffic and therefore increased exposure to Diesel Exhaust Particulate (DEP) matter. To supplement long-term Impactor measurements, more intense measurements were made during the summer of 2002. They included simultaneous measurements of instantaneous mass concentration (TEOM), integrated mass concentration (Harvard Impactor, Teflon and Quartz filters), total particle counts (CPC and OPC), size distributions (SMPS), morphological analysis (Electrostatic Aerosol Sampler) and meteorological parameters.

Samples were collected at five different sites. The Findlay site is downtown, 200m from the interstate. The Mernic site is a suburban backyard, 4500 m from any major highway. The Blue Ash and Spa Store sites were directly across the interstate from each other. Measurements were made between 30 and 200m from the highway at these sites. The Truck Test Track site was on the interior of a banked curve racetrack and provided a signature of diesel truck emissions.

The TEOM was able to detect significant peaks in PM2.5 concentration that were not observed by the Harvard Impactor. At Findlay, the most prominent peaks were observed during certain periods of the day (10-11AM, 12-1PM, and 4-6PM). There were no pronounced peaks after 9PM. Fewer peaks were observed at the Mernic site. There was no discernable difference in mass concentration as a function of distance from the highway (50-200m) in the Blue Ash/Spa Store site. Impactor samples collected on Quartz filters were lower in mass concentration than collocated measurements sampled on Teflon filters for all samples. TEOM data averaged over a 24-hour period was found to be significantly different than Harvard Impactor data collected over the same period for both the Truck Test Track and Findlay. These sites, which had the highest organic carbon concentration, also had a higher DEP contribution. The difference between TEOM and Impactor data was most prominent at the Truck Test Track site, where ambient aerosols were predominantly DEP.

Detailed measurement data obtained from the instruments listed above will be presented.

[P08-30] INFLUENCE OF EXTRACTION TECHNIQUE AND COLLECTION SUBSTRATE ON THE OXIDATIVE ACTIVITY OF ENVIRONMENTAL PARTICULATE MATTER (PM).

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Toxicological assessment of PM is dependent on the samples being representative of those within the environment. Whilst this is often assumed there are many potential pitfalls related to sampling and extraction procedures that may result in artifactual distortions of particle activity. In this study we examined three potential sources of error in obtaining representative environmental PM: the impact of particle sonication, the nature of the collection matrix; and the type of extraction fluid. Study 1: Diesel exhaust particles (100μg/ml) underwent various periods of sonication (1-20 min.), prior to separation into whole, supernatant and washed particle fractions. The activity of these fractions was then assessed by measuring their capacity to deplete ascorbate (AA-200μM, pH7.4). Extended periods of sonication resulted in increased particle activity. One minute of sonication (S1) resulted in a 76% loss of AA, compared with a fall of 49% in the un-sonicated sample (V0). This loss increased to 82% after 20 min of sonication (S20). A similar pattern was observed in the particle supernatants: V0, 25%; S1, 40%; S20, 66%. In contrast, although 1 min sonication greatly increased washed particle activity: 4% (V0) vs. 66% (S1), further sonication resulted in a loss of activity up to S20 (34%) as the activity was displaced from the particle surface. Study 2: The activity of particles collected directly into ultra-pure water (BioSampler ®) was compared against samples extracted from Teflon filters (Partisol) and polyurethane foam (High Volume Cascade Impactor) matrices. Particles extracted from the Teflon filter and polyurethane foam had significantly greater activity than particles collected directly into water resulting in AA losses of 40±6% (BioSampler ®) vs. 100 ± 0% (filter) vs. 73±3% (foam). Study 3: The activity of coarse and fine PM was compared following extraction from foams into water or methanol. We observed little difference in the capacity of coarse or fine PM to deplete AA when they were extracted into water or methanol: 55±6 % vs. 45±11% (coarse) and 67±6% vs. 63±3% (fine) respectively. Conclusion: These data illustrate that both the sampling matrix and extraction procedure can have profound effects on PM activity. As the BioSampler ® collection results in the lowest level of particle interference we believe this probably gives the most accurate representation of environmental PM. These results highlight the need for caution when relating the activity of PM measured in in vivo and in vitro models to that breathed environmentally.

[P08-31] METAL COMPONENTS OF AIR POLLUTION PARTICLES AFFECT THE FUNCTION OF CULTURED CARDIAC MYOCYTES.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Epidemiological studies have reported increases in cardiovascular morbidity and mortality following peak episodes of acute air pollution exposure. In addition, toxicological studies have shown that dysrhythmias, changes in repolarization, and increases in internal defibrillator discharges correlate with air pollution particulate matter (PM) exposure. Previous studies have shown that PM and its components (e.g. transition metals) are capable of leaving the lung and entering the vascular system. This study addresses the hypothesis that zinc (Zn) directly interacts with myocardial cells to cause electrophysiological changes that may underlie the cardiac dysfunction reported in epidemiology and toxicology studies. Ventricular myocytes isolated from 1-day old rats were cultured as confluent monolayers for 11-13 days. Myocytes were then exposed to different concentrations of Zn for various times and spontaneous myocyte beat rate, a surrogate measure of heart rate, was measured. Compared to baseline, exposure to Zn significantly decreased beat rate at 4 hours by 17%. Since beat rate is affected by impulse propagation and cell-to-cell communication, the effect of Zn on cellular coupling was assessed using fluorescent recovery after photobleaching (FRAP, a physiologic measure of cell-to-cell communication and gap junction permeability). Zn decreased the FRAP rate at 4 hours by 76% suggesting that Zn may decrease heart rate by disrupting cell-to-cell communication. Changes in gene expression of gap junction proteins that facilitate cell-to-cell communication and impulse propagation were measured next. Zn increased gene expression of connexin 43, the major gap junction protein expressed in the heart, by 76% but had no effect on a second gap junction protein, connexin 40. Potassium and calcium channels can also influence spontaneous beat rate by affecting repolarization of the myocytes. Compared to control, exposure to Zn increased mRNA accumulation of voltage-gated potassium channel proteins Kv4.2 and KvLQT1 and the alpha 1 subunit of the L-type calcium channel. No evidence of cytotoxicity was observed at the concentrations of Zn used in this study. These data suggest that soluble metals found in air pollution particles can affect the spontaneous beating of cardiac myocytes, possibly by disruption of cell-to-cell communication or by affecting the complex repolarization system, thereby potentially contributing to PM-associated cardiac morbidity and mortality. This abstract does not necessarily reflect EPA policy.

[P08-32] DNA DAMAGE ASSAY AS A QUANTITATIVE MEASURE OF FREE RADICAL FORMATION BY SIZE-FRACTIONATED COAL COMBUSTION-DERIVED ASH PARTICLES.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Respirable particulate materials in the air have been of interest in recent years because of a number of research studies correlating particulate exposure with health risks. However, the nature, origin, and mechanism of the pathology associated with these risks require further study. Respiratory and cardiovascular consequences of exposure to airborne particulates may arise as the result of formation of reactive oxygen species (ROS) at the particle interface or from water-soluble transition metal ions arising from the particulates. Rapid quantitative assessment of ROS formation by particulates from various sources and of different sizes and compositions would provide insights regarding the relative toxicological importance of these aspects of particulate materials. Performing this assessment in the context of a natural biomolecule such as DNA is more meaningful biologically. Therefore, we employed a ROS-dependent DNA damage assay using supercoiled circular DNA from the bacteriophage ΦX174 as the test substrate. Free radical damage creates nicks in the superhelical coiled structure, resulting in relaxed DNA forms that migrate differently under electrophoresis. The technique was tested on ash particulate samples of different sizes collected using differential filtration of materials originating from combustion of a lignite coal. Time- and dose-dependent assays were conducted, and comparisons of the DNA damage originating from exposure to particulates from different sources and of various sizes were performed in fully crossed analysis panels with and without ascorbate, desferoxamine, citrate, and mannitol. Free radical-dependent DNA damage was measured by comparing relative quantities of supercoiled vs. nicked DNA visualized with ethidium bromide following separation by electrophoretic migration through a 0.6% agarose gel. Particulates catalyzed formation of ROS products, but distinct differences were noted between ROS formation mediated by particulates of differing sizes. DNA damage in samples exposed to particulate materials was apparently through iron-dependent formation of hydroxide radicals. The DNA breakage assay for measuring ROS production by particulate materials is sensitive, rapid, and quantitative. Results of this in vitro assay appear likely to reflect expected in vivo toxicity. Meaningful comparisons of particulate toxicities are rapidly attainable with this technique. Application of this technique to compare particulate materials may be informative regarding the health hazards likely to be associated with human exposure.

[P08-33] EXPOSURE TO PARTICULATE MATTER IN AIR POLLUTION LEADS TO INFLAMMATORY RESPONSES IN THE MOUSE BRAIN.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

The etiology of neurodegenerative disorders is at present unknown. Although a small percentage of these disorders are familial cases linked to specific genetic defects, most are idiopathic. Thus environmental factors are thought to play an important role in the onset and progression of neurodegeneration. In the present study, we determined the effect of an exposure (4 hours, 5 days per week for 2 weeks) to concentrated airborne particulate matter on brain inflammatory indices in cortical tissue of ovalbumin-sensitized BALB/C mice. Animals were divided into three exposure groups; filtered air (control) ultrafine particles (UF) or fine plus ultrafine particles (F + UF). The levels of proinflammatory cytokines interleukin-1 alpha (IL-1α) and tumor necrosis factor alpha (TNFα) in the cytoplasmic fraction of brain homogenates were significantly increased in mice exposed to F + UF. While IL-1α was also increased in the brain of mice exposed to UF alone, TNFα levels were not substantially different in this group compared to the control. These data indicate that components of inhaled fine particulate matter may enter the brain and trigger a proinflammatory response. Levels of the immune-related transcription factor NF-κB were also found to be substantially elevated in the nuclear fraction of brain homogenates in both exposed groups compared to the control. Since there is evidence that inflammatory events may contribute to the pathogenesis of neurodegenerative disorders, the results suggest that environmental exposure to particulate matter may enhance events in the central nervous system connected to disease processes. More study on the effects of inhaled particulate matter on the brain is warranted before concluding that these observations may cause adverse human health effects.

This study was supported in part by grants from the National Institute of Health (ES 7992), California Air Resources Board Agreement #98-316, and Southern California Particle Center and Supersite.

[P08-34] IMMEDIATE EFFECTS OF PARTICULATE AIR POLLUTANTS ON CARDIAC AND RESPIRATORY FUNCTION IN YOUNG, OLD, AND HYPERTENSIVE RATS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Understanding how quickly ambient particulate matter air pollution (PM) causes health effects can provide important clues about the biological mechanisms involved in PM-related morbidity and mortality. Times-series studies have shown that the lag time between elevated PM and increases in cardiopulmonary-related hospital admissions and death is one day or less. If PM does cause serious health effects shortly after exposure, one would expect to see some physiological change during exposure. We have examined the effects of various PM air pollutants on rats with implanted ECG and blood pressure (BP) transmitters to determine whether PM causes immediate effects. Spontaneously hypertensive rats (SHR) with BP transmitters (which measure BP, heart rate and respiratory rate) were exposed to concentrated ambient PM (CAPS) for 4 hrs. The SHR were also exposed to fine and ultrafine sulfuric acid aerosols because acid is one of the components of PM that could potentially activate irritant receptors and cause effects during exposure. Young and old (20 months) Sprague Dawley (SD) rats with ECG transmitters (which measure heart rate and core temperature) were exposed to fine and ultrafine acid aerosols and to resuspended carbon black. Inhalation of CAPS by the SHR caused a striking decrease in respiratory rate that was apparent soon after the start of exposure and that stopped when exposure to CAPS ceased. The decrease in respiratory rate was accompanied by a decrease in heart rate. Exposure of the same SHR to fine acid aerosol also caused a significant decrease in respiratory rate similar to the effects of CAPS. Ultrafine acid had the opposite effect on respiratory rate in SHR as CAPS. In both old and young SD rats, inhalation of fine acid aerosol caused an immediate increase in temperature (compared to air-exposed rats) that ceased when exposure stopped. Ultrafine acid caused an immediate decrease in heart rate and temperature during exposure in young SD rats and no significant effect on old SD rats. Carbon black inhalation had no significant effect on heart rate or temperature during exposure in either old or young rats. This study showed that inhalation of PM and acid aerosols have immediate effects on cardiopulmonary function during exposure. The pattern of the response to inhaled PM is consistent with activation of irritant receptors in the respiratory tract. Supported by grants from NIEHS (ES00260) and EPA (R 82735101).

[P08-35] EFFECTS OF CONCENTRATED AMBIENT PM ON THE FREQUENCY OF ARRHYTHIMIAS IN OLD RATS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Epidemiology and panel studies suggest that exposure to particulate air pollution (PM) increases the frequency of cardiac arrhythmias. However, it has been difficult to distinguish between the effects of the fine PM, ultrafine PM, and gaseous co-pollutants in these studies because PM and gases have common sources and the ambient levels of these pollutants usually show a high degree of interrelation. Animal exposure studies offer the opportunity to examine the effects of concentrated ambient fine PM without confounding effects of ultrafine PM or co-pollutant gases. In one series of experiments, 18 month-old male Fischer 344 rats with implanted ECG transmitters were used to determine the effects of PM on the frequency of spontaneous arrhythmias. We found that old F 344 rats had many spontaneous arrhythmias. A standardized definition for each type of arrhythmia was developed, and a procedure for quantifying the frequency of spontaneous arrhythmias in rats was established. The rats were exposed to concentrated ambient PM (CAPS) or air for 4 hours. The rats were exposed twice with a crossover design so each rat could serve as its own control. The CAPS concentrations were 160 micrograms/m3 and 200 micrograms/m3 for the first and second exposures respectively. ECG tracings were monitored for 10 seconds at 15 minute intervals for 24 hours before exposure, during exposure, and 24 hours after exposure. There was a significant increase in the frequency of supraventricular arrhythmias following exposure to CAPS and no change in arrhythmia frequency following air exposure. The same rats were exposed to laboratory-generated ultrafine carbon particles and to SO2 (or air) with a repeated crossover design. In these experiments there was no significant change in the frequency of any category of spontaneous arrhythmia following exposure to ultrafine carbon or SO2. Thus, this series of experiments adds supporting evidence that ambient PM increases the frequency of cardiac arrhythmias.
Supported by grants from NIEHS (ES00260) and EPA (R 82735101).

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[P08-36] FREE RADICALS ON COAL COMBUSTION EMISSION PARTICLES AND THE LUNG CANCER RISK.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Combustion-generated particles can contain large quantities of persistent radicals. These radicals were reported to have stabilities and Electron Paramagnetic Resonance (EPR) parameters that are consistent with semiquinone radicals. In a previous study on Xuanwei, a rural Chinese county which has the highest lung cancer rates in China, it was shown that free radical concentrations in coal emission particles were correlated with lung cancer mortality rates better than the BaP concentrations; the radical concentrations on some coal emission particles were much higher than those on cigarette smoke particles. The lung cancer rates vary by two orders of magnitude among communes located in the same general area inside the county. The different coals are believed to be associated with different lung cancer mortality rates of the residents who burn them for heating and cooking. In the present study, samples of 15 different coals used by the rural households in Xuanwei, China are burned in the laboratory simulating the burning style of the households. Emission particles are subjected to EPR analysis. Preliminary measurements over the emissions from one US coal, as the control group, and several coals from Xuanwei, indicate that free radicals are present in substantially high concentrations, in the order of 10^{17} spins per gram of particulate matter. The intensity of the radicals on particles varies by a factor of 6 among the samples measured so far. (Click to see figure 1)

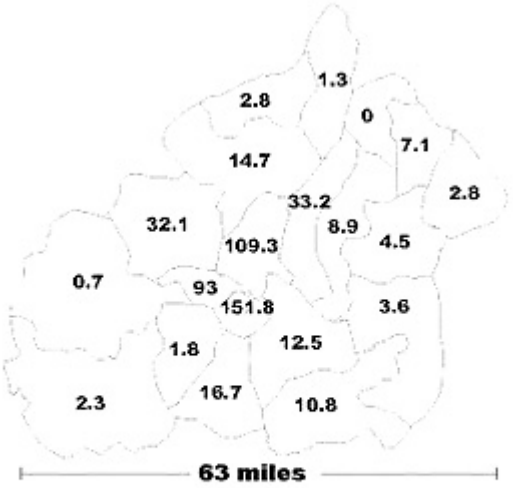

Figure 1. Map of Xuanwei County, showing commune boundaries, each commune's annual lung cancer mortality rate per 100,000 (1973-75). The rates vary by two orders of magnitude among communes in the county.

Figure

[P08-37] TOXICITY TESTING OF ATMOSPHERIC PARTICULATE MATTER EXTRACTS: SHORT-TERM AQUATIC TOXICITY METHODS VERSUS BACTERIAL LUMINESCENCE AND SUB-MITOCHONDRIAL PARTICLE METHODS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Much of the detailed chemical analysis performed on atmospheric particulate matter samples, including organic compound and trace metal characterization, requires extraction of the aerosol sampling into a liquid solutiuon. Therefore, toxicity testing of these filter extracts can be directly related to the trace chemical profiles. A variety of established bioassays are available for conducting toxicity tests of extracted material. In this paper, short-term aquatic toxicity methods using Ceriodaphnia dubia, green algae, and fathead minnows are compared to a bacterial luminescence method (Microtox) and a sub-mitochondrial particle method (Mitoscan). The sensitivities of the methods are compared using ambient particulate matter collected in the Lake Michigan airshed. Additionally, correlation of toxicity data from the different tests is explored.

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[P08-38] AIRWAY EPITHELIAL CELLS RELEASE MIP-3 alpha/CCL20 IN RESPONSE TO CYTOKINES AND AMBIENT PARTICULATE MATTER.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

The initiation and maintenance of airway immune responses in Th2 type allergic diseases such as asthma, are dependent on the specific activation of local airway dendritic cells (DCs). The cytokine microenvironment produced by local cells, influences the recruitment of specific subsets of immature DCs and their subsequent maturation. In the airway, DCs reside in close proximity to AEC. We therefore examined the ability of primary culture human bronchial epithelial cells (HBECs) to synthesize and secrete the recently described CC-chemokine, MIP-3a /CCL20. MIP-3a /CCL20 is the unique chemokine ligand for CCR6, a receptor with a restricted distribution. MIP-3a /CCL20 induces selective migration of DCs since CCR6 is expressed on some immature DCs but not on CD14+ DC precursors or mature DCs. HBECs were stimulated with pro-inflammatory cytokines TNF-a and IL-1b or, because of their critical role in allergic diseases, IL-4 and IL-13. Cells were also exposed to small size-fractions of ambient particulate matter (PM). Each of these stimuli induced MIP-3a /CCL20 gene and protein expression. Moreover, these agents upregulated mitogen-activated protein kinase pathways in HBECs. Inhibition of the ERK1/2 pathway, or p38, reduced cytokine-induced MIP-3a /CCL20 expression. These data suggest a mechanism by which AEC may facilitate recruitment of DC subsets to the airway.

[P08-02] ON-ROAD EXPOSURE TO HIGHWAY AEROSOLS: 2. ON-ROAD AEROSOL AND GAS MESUREMENTS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

On-road experiments were conducted to determine the sensitivity of rats to on-road aerosol. A Mobile Emissions Laboratory (MEL) collected aerosol and gas data and transported the rats. This poster summarizes the on-road aerosol and gas measurements and provides background for the exposure portion of the study.

A 1998 Volvo tractor carries the air-conditioned MEL, instrumentation, data acquisition and MEL operator. The flow distribution system was designed to simultaneously provide on-road aerosol to the instruments and the animal cages. Aerosol instrumentation used in this study included two scanning mobility particle sizers (SMPS) to determine the aerosol size distribution from 10 to 300 nm, two standalone condensation particle counters (CPC) to determine the total aerosol number concentration, an electrical aerosol detector (EAD) to determine the aerosol length and a thermal denuder (TD). The TD was used with one of the SMPS instruments to determine the size distribution of the non-volatile fraction. In addition, three gas analyzers were used to measure ambient levels of CO, CO2 and NO. Integrated filter samples were collected each day and were analyzed for anions, cations, organic and elemental carbon.

On-road measurements and animal exposures were carried out over 10 days, six hours each day over a route from Rochester to Buffalo, NY covering approximately 300 miles. A conscious effort was made to follow Diesel trucks as much as possible in the hopes of sampling the exhaust plume. Aerosol was drawn into the lab from a 4 in diameter sample probe, attached to the front vehicle bumper. Total flow was approximately 400 L/min, of which 20 L/min entered each of three animal exposure cages, 70 L/min was diverted to the aerosol and gas analyzers and 20 L/min was directed through particle filters for mass concentration and chemistry.

Average daily total aerosol number concentration ranged from 200,000 to 540,000 particles/cm3. The average daily NO concentration ranged from 0.10 to 0.24 ppm and the corresponding CO2 concentration ranged from 401 to 423 ppm. For comparison, our past studies on a typical MN urban highways have observed total number concentrations in the 50,000 to 300,000 particles/cm3 range in heavy traffic, 5,000 to 20,000 particles/cm3, in very light traffic. The average daily geometric mean particle size determined by the SMPS ranged from 14 to 28 nm. The TD reduced the average SMPS number concentration by 85% suggesting that most of the particles consisted of volatile material.

Supported by EPA PM Center grant R827354.

[P08-17] BIOAVAILABALE CONSTITUENTS OF AIR POLLUTION PARTICLES MEDIATE ALTERATIONS IN CARDIAC METABOLISM AND FUNCTION *EX VIVO*.

Kevin Dreher, Richard Jaskot, Scott Gabel, Elizabeth Murphy Pulmonary Toxicology Branch, US EPA, RTP, NC; Environmental Biology Program, NIEHS, RTP, NC

Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Epidemiological and clinical studies have demonstrated significant statistical associations between air particulate pollution exposure and alterations in cardiac function. Particle physicochemical properties and biological mechanisms responsible for these findings are currently not known. In this study we tested our hypothesis that bioavailable constituents of air pollution particles derived from primary combustion sources directly affect cardiac metabolism and function. Langendorff perfused rat hearts were exposed to a particle-free leachate (L) of residual oil fly ash (ROFA) to determine whether these constituents could replicate alterations in cardiac function previously observed *in vivo*. Heart rate (HR), left ventricular developed pressure (LVDP), perfusion buffer flow rate (FR), arrhythmia frequency (AF), and high-energy phosphate metabolites, were monitored before, during and following exposure of hearts to various ROFA-L doses. ROFA-L exposure produced a dose dependent decrease in FR, LVDP, ATP, and creatine phosphate levels. At the high and intermediate ROFA-L doses, FR and LVDP recovered towards pre-ROFA-L exposure levels during washout perfusion of hearts with normal buffer. An increase in AF was observed at each ROFA-L dose and only during the washout phase. A 28% decrease in HR was only observed during exposure to the high ROFA-L dose. ROFA-L induced alterations in cardiac function could be reproduced using a surrogate metal mixture consisting of vanadium, nickel and iron. These data demonstrate that bioavailable constituents are capable of directly mediating adverse cardiac metabolic and functional effects associated with ROFA exposure *ex vivo*. The ability to replicate alterations in cardiac function *ex vivo* by a ROFA-L or surrogate metal mixture suggest that bioavailable constituents act directly on the heart to manifest the observed *in vivo* cardiac pathophysiology associated with exposure to this type of air pollution particle. (This abstract does not reflect EPA Policy)

Ex Vivo Cardiac Functional Effects of ROFA-L

	Exposure	(% of Pre-	ROFA-L	Washout	(% of Pre-	ROFA-L
			Level)			Level)
ROFA-L (μg/ml)	LVDP	Flow Rate	Arrhythmia Frequency	LVDP	Flow Rate	Arrhythmia Frequency
25	14	24	61	87	65	748
6.25	55	40	60	87	70	918
3.12	58	63	87	97	61	482

[P08-03] ON-ROAD EXPOSURE TO HIGHWAY AEROSOLS. 3. EXPOSURES OF AGED AND COMPROMISED RATS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

Ambient particulate pollution is associated with adverse health effects in epidemiological studies in the elderly with cardiopulmonary diseases. We hypothesize that ultrafine particles (UFP) contribute to these effects, especially when they are freshly generated and occur at high number concentrations. Studies to determine adverse effects have been performed using laboratory-generated surrogates, diluted exhaust from stationary engines, or concentrated ambient UFPs. Methodological difficulties exist with such experiments and questions remain about how well these particles model those found in ambient air. Freshly-generated UFPs are present at high concentrations on highways and vehicle passengers are directly exposed to them. We wished to expose rats to these UFPs to test their potential to cause effects. Since such exposures have not been done before, our objectives were to: (i) demonstrate the feasibility of an on-road exposure study; (ii) determine if there are significant effects in aged rats; and (iii) determine effects after priming of the respiratory tract. Old rats (21 mo. F-344) were exposed directly on highways to either the aerosol (<1μm)/gas phase, gas phase only, or filtered air using an on-road exposure system. Some rats were pretreated with a low dose of inhaled endotoxin or with instilled influenza virus to induce lung inflammation. The exposures in compartmentalized whole-body chambers consisted of 6 hr driving periods on I-90 between Rochester and Buffalo once or 3 days in a row. Endpoints related to lung inflammation, inflammatory cell activation, and acute phase responses were measured after exposure. In addition, spontaneously hypertensive (SH) rats (7-9 mos) with implanted radiotelemetry devices were pretreated with inhaled or ip-injected endotoxin prior to on-road exposures to monitor effects on heart rate, blood pressure, and heart rate variability. The on-road exposure system did not affect measured endpoints in filtered air-exposed rats, indicating that it was well tolerated by them. Exposure dependent effects were observed in the inflammatory response, as assessed by the percentage of lavage neutrophils, and in lavage cell oxidant release. Evaluations of the contribution of priming agents and exposure atmosphere to these effects are ongoing. Sponsored by EPA PM Center grant R827354 and EPA STAR grants R828046 and R82678.

[P04-63] SPATIAL VARIATIONS OF PM2.5 DURING INTENSIVE SAMPLING OF PITTSBURGH AIR QUALITY STUDY.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (11:00 AM-12:00 PM) Grand Ballroom 2-4

As part of the Pittsburgh Air Quality Study (PAQS), characterization of PM2.5 has been conducted at a site adjacent to Carnegie Mellon University in the city of Pittsburgh and at 4 other sites in the region during the summer intensive sampling period (06/30/01 - 07/30/01). These sites include Lawrenceville (3 km north of CMU), Hazelwood (3 km south), Florence (48 km west), and Greensburg (56 km east). The CMU site is in Schenley Park, on top of a grassy hill, more than 500 m from the nearest heavily traveled road but within a few kilometers of major roads, coal combustion sources, and the densely populated Oakland area of Pittsburgh. The Lawrenceville site is in an older residential neighborhood, while Hazelwood is close to several former industrial plants. Florence is in a rural area with no major roads or stationary sources within several kilometers, and is typically upwind of Pittsburgh. The Greensburg site is a few hundred meters from a major road in a commercial district, and is typically downwind of Pittsburgh. Data were used to study the spatial variations of PM2.5 species and the contribution of urban sources. Comparison of data from the five sites suggests that the total mass, sulfate, nitrate and OC measured at all sites are the regional concentrations, with only minor contribution from the city. On the other hand, the EC concentration is consistently lower at the rural Florence site, indicating the contribution of EC by urban sources.

[P04-72] CHEMICAL COMPOSITION OF PM2.5 AND NUMBER CONCENTRATION MEASURED AT LITHUANIAN COASTAL ENVIRONMENT.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (11:00 AM-12:00 PM) Grand Ballroom 2-4

The recently revised interest can be observed in the health effect of particulate air pollution in the urban and non-urban areas during last decade. General studies have shown that short-term variation in levels of particulate air pollution are associated with adverse respiratory health effects even on the low levels of pollution observed currently in Western Europe. It may be that the adverse effect of pollution on public health is number, not mass concentration dependant.

The goal of this investigation is to study variation of the aerosol number concentration (d < 0.4 um) and the mass concentration of major inorganic ions in fine particles in a rural coastal station located in Preila.

Virtual impactor with the cutoff size of 2.5 um has been employed for the collection of aerosol particles classified into two size fractions. Two field measurement campaigns were carried out. Aerosol samples collected onto the Whatman 40 cellulose filters were extracted with 30 ml of deionized water. Concentrations of anions (SO42-, NO3-, and Cl-) in aerosol water extracts were measured by means of ionic chromatography with the conductivity detector. Meanwhile, spectrophotometric method was used for measurements of NH4+ and flame photometry - for Na+. Commercial optical aerosol counter has been used for continuous aerosol number concentration measurements.

The highest mass concentration of major inorganic ions (14.8 ug/m3) and number concentration (39 cm-3) were measured in winter season. Similar situation occurred with constituents of major ions. The lowest number concentration in both seasons was related with air mass backward trajectories from northwest and highest - from south.

The correlation coefficient is the highest between ammonium mass concentration and number concentration in winter season (R=0.604). The lowest correlation coefficient is calculated between nitrate mass concentration and number concentration in summer (R=0.257). Sometimes course of mass concentration of major ions follows the number concentration curve in a very similar way. However, on the other hand, sometimes it seems that other constituents in fine particles are more important than major ions.

The measured mass concentration of major ions and number concentration varied from 1.8 to 6.3 ug/m3, from 7 to 22 cm-3 in summer season and from 4.2 to 14.8 ug/m3, from 7 to 39 cm-3 in winter season, respectively. The calculated correlation coefficients are generally enough low (< 0.7). Nevertheless in some events the relationship between number and major inorganic ions concentrations can be high and indirectly represent variation of mass concentration of fine particles.

[P04-74] ENVIRONMENTAL DETERMINANTS OF THE METAL CONTENT OF AIRBORNE PARTICLES IN EDINBURGH.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (11:00 AM-12:00 PM) Grand Ballroom 2-4

Objective: To determine the environmental factors affecting concentrations of metals in urban particulate matter for application to the epidemiological association between metal composition and acute adverse health.

Methods: Concurrent 24 h samples of PM_{10}, $PM_{2.5}$ and Black Smoke were collected at an urban background site in Edinburgh between September 1999 and September 2000, and at a rural site. Each sample was sequentially extracted with ultra-pure water and concentrated HNO_3:HCl. All extracts were analysed by inductively coupled plasma mass spectrometry for Ti, V, Cr, Mn, Fe, Cu, Ni, Zn, Cd, As, Pb. Daily air-mass back trajectories were calculated and grouped by hierarchical clustering.

Results & Discussion: Median daily urban background water soluble metal concentrations in $PM_{2.5}$ ranged from 0.05 ng m^{-3} for Ti to 5.06 ng m^{-3} for Pb, and in PM_{10} from 0.18 ng m^{-3} for Ti to 11.7 ng m^{-3} for Fe. Median daily total acid extractable metal concentrations ranged from 0.3 ng m^{-3} for As to 27.6 ng m^{-3} for Fe in $PM_{2.5}$, and from 0.37 ng m^{-3} for As to 183 ng m^{-3} for Fe in PM_{10}.

The 11 metals analysed together constituted approximately 2% and 0.8% of PM_{10} and $PM_{2.5}$, respectively, in spring and approximately 1.5% and 0.9%, respectively in winter. Over 90% of the water soluble or total mass of metals analysed in this study was contributed by Fe, Zn, Pb and Cu, regardless of particle size fraction. Multivariate correlation identified crustal (Ti, Fe, Mn) and anthropogenic (Cu, Zn, V) and (Pb, As) groups.

For V, Mn, Cu, Zn, As, Pb and Fe, there was greater correlation of metal concentration with gravimetric concentration of Black Smoke than with gravimetric concentration of either PM_{10} or $PM_{2.5}$, suggesting that black smoke monitoring could be an effective surrogate measure of particle metal concentrations in the UK.

PM_{10} and $PM_{2.5}$ mass concentrations were 30-40% higher when air masses were from east/central Europe, and around 25% higher when air masses were centred on the UK, compared with air masses from the N, W or SW. Air masses from the UK and Europe also had a higher proportion of particle mass as $PM_{2.5}$. Water-soluble metal concentrations of UK and central Europe air masses were up to double those from the W, SW and N.

Metal enrichment factors (ng μg^{-1}) differed significantly between air-mass back-trajectory clusters for most metals. This validates the potential use of air-mass source as a means to reconstruct past daily metal volumetric concentrations, although cluster analyses based on trajectory co-ordinates actually reproduced <30% of the variation in metal concentration for the 1 year of measurements.

[P04-75] CONCENTRATION LEVEL OF FINE AIRBORNE LEAD AND ITS RELATIONSHIP WITH OTHER CHEMICAL SPECIES IN BEIJING, CHINA.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (11:00 AM-12:00 PM) Grand Ballroom 2-4

Airborne lead has drawn global attention in the past decades for its toxic characters by affecting human being health. However, because of lacking continuous study of PM2.5, the fine lead concentration level as well as the source contribution was not so clear. In this work, low-flow rate samplers (LFS, Aerosol Dynamic In., Berkeley, CA) were applied to collect fine particle samples (PM2.5) during July 1,1999 to June 1,2000 at two sampling sites (THU and CGZ site) in Beijing. Three analysis technologies XRF, IC and TOR were adopted to analyze inorganic elements, water soluble ions, and carbonaceous components (OC and EC), respectively. The average concentration of lead at THU site was $0.334\pm0.172 \mu g\ m^{-3}$, higher than that of CGZ site ($0.302\pm0.195 \mu g\ m^{-3}$). It showed obvious seasonal variation trend that the Pb concentration in winter (heating period) was higher than those of other seasons, which was consistent with the monthly variation (the highest value appeared in November). Regression analysis was applied to evaluate qualitative relationship between Pb vs. Br, EC, OC and SO_4^{2-}. During the whole sampling period, the correlation between Pb vs. Br was good with R^2 of 0.79 and 0.62 for THU and CGZ site, respectively, and with positive intercept on Pb axis. At the same time, the correlation between Pb and EC, OC, SO_4^{2-} was weak, for example, at Chegongzhuang site the R^2 were 0.64, 0.65, 0.53, respectively. Considering the seasonal and monthly variation trend discussed above, regression analysis was repeated to the heating period data, and the R^2 of Pb vs. Br was 0.77, and R^2 of Pb vs. EC, OC and SO_4^{2-} have increased to 0.82, 0.86 and 0.81, respectively. In many studies Pb and Br are usually taken as the trace elements of motor vehicle. Although the leaded gasoline has been banned from July 1997 in Beijing, a small quantity of lead (<0.013l) remains in the gasoline, and leaded gasoline was kept in use until July 2000 in most of other national areas. The good relationship between Br and Pb demonstrated that motor vehicle emission is still one of the important sources of Pb. From above results that the Pb concentration presented the highest value in winter, the good correlation between Pb and EC, OC, SO_4^{2-}, as well as the positive intercept on Pb axis, it indicated that coal burning during heating period is another important source of Pb in Beijing.

[P04-76] PM2.5 AND PM10 MASS CONCENTRATIONS IN PORTUGAL.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (11:00 AM-12:00 PM) Grand Ballroom 2-4

National guidelines for PM10 -- air particulate matter with an equivalent aerodynamic diameter (EAD) under 10 micron -- were passed into environmental rules and then made public in the Portuguese official journal (DR no. 89, series I-A) as of April 16, 2002. According to such legislation, the annual average based on a 3-year sampling should not exceed 40 microgram per cubic meter (microg/c.m.), with a tolerance of 5 microg/c.m. up to December 31, 2002, which must go down to a zero level until December 31, 2004. The 24-h samplings should not exceed the threshold of 50 microg/c.m. more than 35 times a year, with a tolerance of 15 microg/c.m. up to December 31, 2002, and further down to zero until December 31, 2004. As for PM2.5 (particles with an EAD less than 2.5 micron), Portugal and the European Union as a whole are still lagging behind the United States, where the US Environmental Protection Agency (USEPA) already limits airborne-particulate loads to 15 microg/c.m., as an arithmetic mean of annual averages over 3 consecutive years, and to a short-term metric of 65 microg/c.m., as the 98th percentile of 24-h concentrations also averaged over 3 years in a row. Despite the lack of legislation, the Nuclear and Technological Institute (ITN) has been sampling both PM2.5 and PM10 around the country since 1993, at clean, urban, industrial and rural areas, using Gent stacked-filter unit (SFU) samplers. Particulate mass concentrations have been obtained through a 0.1-microg sensitivity balance. PM10 averages are below the now-legislated values, and they are not significantly different for rural, urban and industrial areas. The 24-h measurements do reveal some important episodes of high concentrations, even though their frequency does not exceed the 35-times-a-year limit, as pointed out by the corresponding, relatively low averages. Background levels for remote (clean) sectors are significantly lower than for any of the human-impacted areas. For PM2.5, the situation appears somewhat more problematic. Except for clean areas, and comparing to USEPA's long-term metric, national figures are either above or roughly within the same magnitude. High-loading episodes seem less frequent though, as inferred from an inferior divergence between average and 24-h levels. In general terms, the contribution of finer, deeply-respirable particles (PM2.5, currently thought to reach the innermost respiratory tract, i.e. bronchioles and alveoli) to the bulk aerosol (PM10) is invariably relevant.

[P04-77] HOW MANY MEASUREMENTS FOR EXPOSURE ASSESSMENT? BALANCING COST AND PRECISION FOR AN OPTIMUM ENVIRONMENTAL SAMPLING OF AMBIENT AEROSOL.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (11:00 AM-12:00 PM) Grand Ballroom 2-4

Studies requiring ambient exposure assessments must ask the following question: How often should measurements be taken? Answers to such questions are dictated by budgetary constraints as well as spatial-temporal considerations. For example, do we obtain samples during all seasons, all months within seasons, weeks within months and days within weeks and so on? On the one hand, one can obtain a snapshot sample and regard it as an estimate of the "true" exposure mean. On the other hand, one can obtain a large number of samples and then average those to represent the "true" exposure mean. The former estimate is the least expensive but also the most imprecise. The latter, may be very precise but prohibitively costly. We propose a solution. First conduct a pilot study with a feasible and promising sampling plan and apply the statistical methodology of Variance Component Analysis (VCA) to the exposure data. We demonstrate that an optimum sampling design will maximize the precision of our exposure estimate for a pre-specified total relative cost (relative to the pilot sampling design) of sampling. Alternatively, we can minimize the sampling costs for a certain pre-specified relative precision of the estimate (relative to the precision in the pilot design). Our approach is illustrated with an on-going study of assessing exposure to diesel particulates in a birth cohort. We show that a pilot study followed by the VCA analysis, will lead to considerable savings and can also provide precise estimates for the subsequent full-fledged study based on the optimum design arrived at by the VCA approach.

[P04-57] THE VARIATION OF BACKGROUND PARTICULATE MATTER IN THE UNITED STATES.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (11:00 AM-12:00 PM) Grand Ballroom 2-4

Estimating concentrations and composition of major components of background PM is important for the EPA's health risk analyses and the assessment of ecosystem and visibility effects, especially for PM2.5. In common usage, the term "background concentrations" refers to concentrations observed in remote areas relatively unaffected by local pollution sources. However, several definitions of background concentrations are possible. The definition chosen as being most relevant for regulatory purposes is based on estimates of contributions from uncontrollable sources that can affect concentrations in the United States. These are the concentrations that would be observed if the only sources affecting PM in the United States were anthropogenic and natural emissions outside North America and natural sources within North America. Because of long-range transport from anthropogenic sources in North America, it is difficult to obtain background concentrations solely on the basis of direct measurement in remote areas in North America. However, these data may be used to place reasonable upper limits on what these concentrations might be. We investigated background PM concentrations using data from the Interagency Monitoring of Protected Visual Environments (IMPROVE) program. The IMPROVE dataset offers a unique opportunity to identify the variability of 24-hour mean PM concentrations at clean, remote sites. Using the IMPROVE dataset, we characterized 11 western sites, two sites in Minnesota, 1 site in West Virginia, 2 sites in Vermont, and 1 site in New Jersey. The 24-hour average data were summarized by determining the annual mean concentration and the 24-hour percentiles by quarter and year. We focused on the variability of the 24-hour average concentrations for PM2.5, PM10, PM10-2.5, and selected PM2.5 species constituents to determine the annual mean concentration and percentiles by season and year. The year-to-year variability at the 90th percentile for the western IMPROVE monitoring sites for PM2.5, PM10, and PM10-2.5 was characterized. The percentile distribution of the 24-hour PM2.5 concentrations by calendar quarter for the IMPROVE monitoring sites was investigated. We used a different procedure in the eastern United States because of the larger potential for contributions from anthropogenic sources, especially regional sources at IMPROVE sites. Three sites were selected for analysis (Brigantine, NJ; Lye Brook, VT, and Underhill, VT) based on their relative remoteness and the availability of source apportionment analyses using positive matrix factorization as described by Hopke et al.(1999).

[P04-58] PARTICULATE MATTER CHARACTERISTICS IN THE URBAN AREAS OF LOWER MANHATTAN AND THE BRONX, NEW YORK.

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Particulate characteristics (*i.e.* PM_{10}, $PM_{2.5}$, metals, sulfate, pH, organic carbon (OC), and elemental carbon (EC)) were measured at US EPA-approved monitoring sites in lower Manhattan and in the Bronx. These measurements were taken from January 1, 1999 through November 22, 2000 as part of a study to evaluate whether ambient levels of air pollutants differ in two New York City neighborhoods that have different rates of hospital admissions for asthma. PM_{10} and $PM_{2.5}$ real-time measurements were taken using TEOM® Series 1400a Ambient Particulate Monitors. The daily average for PM_{10} was 23.1 $\mu g/m^3$ for Manhattan and 22.3 $\mu g/m^3$ for the Bronx. Daily averages for $PM_{2.5}$ were 16.2 $\mu g/m^3$ for Manhattan and 15.3 $\mu g/m^3$ for the Bronx. Three-hour measurements of $PM_{2.5}$ OC and EC were taken using a Series 5400 Ambient Carbon Particulate Monitor. EC daily averages were 1.32 $\mu g/m^3$ for Manhattan and 1.19 $\mu g/m^3$ for the Bronx. OC daily averages were 3.09 $\mu g/m^3$ for Manhattan and 3.17 $\mu g/m^3$ for the Bronx. Twenty-four hour samples of $PM_{2.5}$, collected on a filter, were used for the analysis of metals (chromium, iron, lead, manganese, nickel, and zinc). For particulate metals, only iron and nickel were routinely detected. Mean daily iron concentrations were 72 ng/m^3 for Manhattan and 75 ng/m^3 for the Bronx. Mean daily nickel concentrations were 15 ng/m^3 for Manhattan and 12 ng/m^3 for the Bronx. Twenty-four hour samples of $PM_{2.5}$ for pH and sulfate were collected by an 8-channel annular denuder system. Daily average pH values were 5.04 for Manhattan and 5.15 for the Bronx. Particulate sulfate concentrations were 4.0 $\mu g/m^3$ for Manhattan and 3.6 $\mu g/m^3$ for the Bronx. Although small, differences in the concentrations of the analytes mentioned here (excluding particulate iron) were statistically different between Manhattan and the Bronx. Temporal fluctuations were also analyzed. $PM_{2.5}$ concentrations peak in the Bronx around 0600-0700 hours and in Manhattan around 0700-0800 hours, with a corresponding afternoon peak in both locations around 2000 hours. PM_{10} concentrations peak in the Bronx around 0700 hours and in Manhattan around 0800 hours; however, levels remain high until approximately 2000 hours. EC has a distinct peak at 0900 hours, with no corresponding afternoon rise in concentration. Beyond hourly fluctuations, statistically significant differences in particulate concentrations by day of the week were found.

[P04-71] SEASONAL TREND OF THE PHYSICO-CHEMICAL CHARACTERISTICS OF PM2.1: A STUDY BY SEM/EDX AND XPS IN AN URBAN AREA OF ROME.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (11:00 AM-12:00 PM) Grand Ballroom 2-4

A large body of epidemiology research has shown a significant statistical correlation between acute health effects and the fine fraction of urban particulate (PM2.5). It is still widely debated which characteristics of PM are responsible for the adverse health effects. A number of experimental studies has suggested that the fine particles, which act as a carrier of toxic compounds (acids, metals, organics), are related to pulmonary toxicity. Moreover some epidemiological data give indications of hospital admissions and adult mortality higher in summer season than in winter season (1).

The aim of this study was to evaluate the seasonal trend in the composition and in the physico-chemical characteristics of PM2.1 (particulate with aerodinamic diameter<2.1μm) in an urban area of Rome. The role as "carrier" of carbonaceous particles was thoroughly studied using scanning electron microscopy equipped with an EDS X-ray attachment (2) and Photo-electron spectroscopy (XPS). Atmospheric aerosol were analysed by Ion Chromatography (IC) to evaluate the soluble ions collected by annular denuder. X-ray microanalysis data were subjected to Hierarchical Cluster Analysis to classify the particles into groups (clusters) with similar chemical composition.

We identified 4 clusters of particles in the PM2.1: carbonaceous particles, soil erosion particles, sulphates and metals. EDX spectra showed the presence of a surface coating containing S or sometimes S, K, Na on a variable percentage of carbonaceous particles.

XPS data showed that the more abundant element were C, O, N, Si, S whereas Ca, Na, Fe were only present in traces.

XPS spectrum in the region of S2p peak confirm that the sulfur compounds in the PM2.1 are constituted by SO4 -2 anion. The trend of the abundances in weight of S and N obtained by XPS showed an evident maximum in summer season. The abundances of carbonaceous particles with S-coating obtained by SEM/EDX showed the same seasonal trend.

As it was demostrated that the photo-chemical oxidation of SO2 can be efficiently catalysed by carbon, our data suggest that the carbonaceous particles act, particularly in summer season, either as a carrier of sulphates, or as a determinant factor in the acidity production in the atmosphere.

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[P04-62] COMPARATIVE EVALUATION OF AMBIENT FINE PARTICULATE MATTER (PM2.5) DATA OBTAINED FROM URBAN AND RURAL MONITORING SITES ALONG THE UPPER OHIO RIVER VALLEY.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (11:00 AM-12:00 PM) Grand Ballroom 2-4

Summary

This presentation summarizes detailed findings and conclusions drawn from evaluations of data captured to date from the operation of ambient PM2.5 speciation sites in a geographical area encompassing southeastern Ohio, western Pennsylvania and northwestern West Virginia. The overall goal of this program, called the Upper Ohio River Valley Project (UORVP) was to investigate the nature and composition of fine particulate (PM2.5) and its precursor gases in the Upper Ohio River valley and provide a better understanding of the relationship between coal-based power system emissions and ambient air quality in this region through the collection of chemically resolved or speciated data.

Findings:

The following conclusions were made from the observations made:

1) The TEOM equipment performed as well as the sequential filter samplers in accounting for ambient PM2.5 levels; however, the FRM-obtained data was consistently lower than the averages from the TEOM/DRI-SFS measurements;

2) The trending in the PM2.5 levels was similar for urban Lawrenceville and rural Holbrook,

3) The absolute median PM2.5 levels were slightly higher for Lawrenceville than for Holbrook, implying that local urban environmental contributions had a minor but measurable effect on total PM2.5 mass concentration;

4) PM2.5 and PM10 mass concentration levels were consistently higher in summer than in winter, with intermediate levels observed in the spring and fall;

5) Sulfate levels predominated in the speciation data obtained from both the Holbrook and the Lawrenceville sites during winter and summer intensive sampling. Sulfate level measured at Holbrook were higher than those taken at Lawrenceville regardless of the season;

6) Ammonium levels remained relatively constant between seasons and between sites;

7) Nitrate levels measured at Lawrenceville were higher than those measured at Holbrook during winter intensive sampling. Nitrate levels measured during the summer intensive period were found to be very low at both locations;

8) In general, the predominant inorganic fraction of the samples analyzed could be described as being composed of a mixture of ammonium bisulfate and ammonium sulfate with minor amounts of ammonium nitrate;

9) Most high PM2.5 episodes occurred when the predominating wind direction was from the South-West.

[P04-59] URBAN AND RURAL CHEMICAL COMPOSITION OF FINE PARTICULATE MATTER IN NEW YORK STATE.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (11:00 AM-12:00 PM) Grand Ballroom 2-4

With the establishment of the Speciation Trends Network (STN) for urban locations by EPA, and the continuation and expansion of the rural IMPROVE network, an extensive data set of concentrations of chemical species in fine particulate matter has become available. Analysis of this data, especially the STN data, is just beginning; and promises to provide insight and guidance for scientists and policy makers as they attempt to meet air quality standards and ensure public health and welfare.

Four STN samplers are located at urban sites in New York State (in the New York City boroughs of Bronx and Queens, and in the cities of Buffalo and Rochester). Rural speciation samplers include two STN samplers at Whiteface Mountain in the Adirondacks and at Pinnacle State Park in Addison; and two IMPROVE samplers, one co-located with the STN sampler at Addison in the Southern Tier, and the other at nearby Connecticut Hill in the Finger Lakes region. The STN and IMPROVE samples are collected on identical one-in-three day schedules. In addition, daily $PM_{2.5}$ samples have been collected for more than a year at Bronx, Queens, Addison, and Whiteface and have been analyzed for sulfate and trace elements only. Data will be presented from all of these samplers and sites, with special attention to urban/rural distinctions and to specific elements like lead and the transition metals, which are sometimes implicated in adverse health effects. In addition, ion balances will be calculated from the data to estimate the acidity of the $PM_{2.5}$ aerosol.

[P04-64] SOUTHEASTERN AEROSOL RESEARCH AND CHARACTERIZATION (SEARCH) STUDY: SPATIAL AND TEMPORAL SUMMARY OF FINE PARTICULATE MATTER COMPOSITION.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (11:00 AM-12:00 PM) Grand Ballroom 2-4

The Southeastern Aerosol Research and Characterization (SEARCH) study began in July 1998 and is supported through 2005. The SEARCH network consists of 8 research sites in 4 urban-rural or urban-suburban pairs, each of which is measuring, routinely, an extensive set of gases, fine particulate (mass and composition, fine and coarse mode), meteorology, and extinction. In addition to 24-hr integrated samples for PM, the vast majority of the measurements, including the major components of PM, are made at temporal resulution of one-hour or less. Among it's many objectives, SEARCH is aimed at providing information for policy makers as they decide how to address the air quality issues they face, (e.g., the PM and ozone NAAQS, and regional haze). SEARCH has now accumulated more than four years of fine particle mass and composition data at it's eight sites. This poster will illustrate and summarize the spatial and temporal character represented by this data set. Spatially, the data represents urban, suburban, and rural sites. Sites in large inland cities (i.e., Atlanta and Birmingham) and small Gulf coastal cities (i.e., Gulfport and Pensacola). Temporally, data on mass and composition are available on scales starting at sub-hourly, allowing diurnal profiles to be established. Monthly, seasonal, and inter-annual variability will also be illustrated.

Major findings include:

· North to south gradients are observed for fine mass, sulfate, and organic matter (1.4 times organic carbon). These may represent a true regional (or super-regional) gradient, an inland versus coastal pattern, a big city versus small city pattern, or more likely, a combination of all three.

· Strong urban-rural or urban-suburban differences in EC, OM, and nitrate, but not sulfate or ammonium.

· Strong seasonality in ammonium, nitrate, and sulfate but not in EC and OM. Sulfate and ammonium tend to be highest in summer, while nitrate is highest in winter.

· A decreasing trend in fine mass, sulfate, and ammonium over the four year period at most sites. The highest annual fine mass concentrations were observed in 1999, driven in part by very high concentrations during the summer of 1999, which was unusually hot and dry in the southeast.

· Important diurnal variability in fine mass as well as it's major components and various tracer gases. Urban sites show large excursions in fine EC and OC during rush hours. These are associated with maximum concentrations of CO and NOy. At all sites, sulfate shows a small, but measureable, maximum around midday, while nitrate shows a distinct maximum in early morning.

[P04-65] AN ANALYSIS OF URBAN SPECIES DATA - A TALE OF TWO CITIES.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (11:00 AM-12:00 PM) Grand Ballroom 2-4

Urban speciated fine particulate data of the STN monitoring network from January 2001 to February 2002 were studied in both eastern and western locations of the U.S. Seasonal variability of PM2.5 mass, organic carbon, elemental carbon, sulfate ion, nitrate ion, and ammonium cation concentrations were analyzed. Their relationships with ozone and meteorology were examined. Preliminary results suggest that differences in meteorology (in particular, relative humidity) and emissions may have a significant impact on the observed seasonality in species concentrations in Fresno and Atlanta. Based on an analysis of other cities, this influence appears to be more general and may typify the difference between eastern and western cities in the United States. In Atlanta, ozone, sulfate and ammonium were high in the summer when temperature and humidity were high, whereas organic carbon concentrations were relatively flat year round. In Fresno, however, sulfate concentrations were very low even in the summer. PM2.5 concentrations were much higher in the winter and dominated by organic carbon. Organic carbon, nitrate and ammonium ion were observed to be the highest in late fall and winter when relative humidity was the highest (above ~60%). Much lower mixing height and stagnation were also the major factors for the observed high concentrations of various species. The dominance of organic carbon concentration in Fresno in winter may be closely related to its relatively mild winter temperature, high humidity, and plenty ammonium nitrate particles.

[P04-66] FREQUENCY DISTRIBUTIONS AND SPATIAL ANALYSIS OF FINE PARTICLE MEASUREMENTS IN ST. LOUIS DURING THE REGIONAL AIR POLLUTION STUDY / REGIONAL AIR MONITORING SYSTEM.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (11:00 AM-12:00 PM) Grand Ballroom 2-4

The concentrations of particulate matter (PM), its components, and source contributions analyzed by Hopke et al. (companion poster: Source Identification of Aerosol Measured at Multiple Sites across St. Louis) were determined. The purpose of this study is to characterize the spatial variability in these parameters. PM samples were collected at ten monitoring sites across St. Louis, MO between May 1975 and April 1977 during the Regional Air Pollution Study / Regional Air Monitoring System (RAPS/RAMS). A number of metrics were used to evaluate the degree of spatial heterogeneity in these parameters. These include: Pearson correlation coefficients, calculations of differences between sites, geometric means and standard deviations following Kao and Friedlander (1995. Environ. Sci. Technol. 29, 19-28). S is the most highly correlated element among all the sites, reflecting in large part its secondary nature. Correlation coefficients for other elements show a great deal of variability. A comparison of geometric mean values at the different sites clearly shows the importance of nearby discrete point sources for elements other than S. Several pairs or groups of elements have similar spatial characteristics, which indicates that these pairs or groups of elements originate from the same sources. The overall geometric standard deviation of PM mass, Si, S, K, Ca, Cr, Fe, Br, and Pb is 2.06 ± 0.21 shows reasonable agreement with 1.85 ± 0.14 from previous study for California aerosols (Kao and Friedlander, 1995). The geometric standard deviations of Ti, Mn, Cu, and Zn are higher than the others: 3.29, 2.79, 3.80, and 2.70, respectively, which suggest the presence of multiple sources that give rise to the observed broad or multimodal distributions Since these results for trace elements were derived for a 10 site network, the result also may mean that there are substantially different distributions of concentrations at different locations within a given airshed. The above results suggest that there is a significant potential for exposure misclassification when regressing health outcomes against calculated source contributions. The characteristics of the St. Louis aerosol during the RAPS/RAMS study will also be compared to the aerosol characteristics of other urban areas.

[P04-67] SPATIAL AND SEASONAL VARIATION, SIZE FRACTIONATION, AND CHEMICAL CHARACTERIZATION OF PARTICULATE MATTER IN DETROIT, MICHIGAN.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (11:00 AM-12:00 PM) Grand Ballroom 2-4

As part of a community-based participatory research project, the effects of air pollutants and the role they play in exacerbating childhood asthma are being assessed in Detroit, Michigan. One specific aim of the project is to identify sources of air pollutants through chemical characterization of particulate matter (PM), primarily $PM_{2.5}$ and PM_{10}, to which the children are exposed. In addition to daily filter collection during seasonal intensive measurement campaigns (each two weeks in duration) at two ambient monitoring locations, continuous measurements of ozone and $PM_{2.5}$ (TEOM) are made at each location.

Results from the 11 seasonal campaigns (10/99 to 5/02) indicate daily $PM_{2.5}$ levels averaged 17.6 ± 11.1 $\mu g/m^3$ and 16.1 ± 10.3 $\mu g/m^3$ at two Detroit communities (southwest Detroit and east Detroit, respectively) sampled concurrently. Daily measures of PM_{10} for the same measurement periods resulted in 28.7 ± 15.4 $\mu g/m^3$ and 23.8 ± 12.9 $\mu g/m^3$ at the two sites. Levels of both $PM_{2.5}$ and PM_{10} are significantly higher at the southwest Detroit site relative to east Detroit. In addition, while levels of organic carbon (OC) in both $PM_{2.5}$ and PM_{10} appear similar between sites, levels of elemental carbon (EC) in both particle size fractions are increased at the southwest Detroit site, with levels of coarse fraction (PM2.5-10) EC being more than 2 times higher than the east Detroit site. The increased levels of PM and EC at the southwest Detroit site, where the coarse particle fraction makes up nearly 40% of the total PM_{10}, are likely due to the close proximity of heavy industrial sources (coal combustion, refining, incineration, etc.) and interstate motorways which impact this community.

Ongoing comprehensive trace metal characterization (Sr, Mo, Cd, Sb, Pb, Mg, S, V, Cr, Mn, Fe, Ni, Cu, Zn, As, etc.) of all filter samples collected over the 11-season period (10/99 to 5/02) will provide a more complete assessment of the PM components. When combined with other project measures including concurrent twice-daily peak expiratory flow and FEV_1 spirometry and daily asthma symptom and medication diaries for 300 asthmatic children living in the two Detroit communities, and daily characterization of PM personal exposure and PM indoor home exposure for a subset of 20 of the children, these data will allow not only investigations into the sources of PM in the Detroit airshed in regard to PM exposure assessment, but also the role of air pollutants in exacerbation of childhood asthma.

[P04-68] CHARACTERIZATION OF FINE PARTICULATE MATTER ($PM_{2.5}$) IN CENTRAL AND SOUTHEAST OHIO.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (11:00 AM-12:00 PM) Grand Ballroom 2-4

This study presents results from a project on chemical characterization of fine particulate matter ($PM_{2.5}$) measured at three elementary schools in central and southeastern Ohio. The project supported a comprehensive health based study completed by Ohio University. $PM_{2.5}$ aerosol samples were collected from outdoor monitors and indoor samplers at each monitoring location for the period of February 1, 1999 through August 31, 2000. The locations included a rural elementary school in Athens, Ohio, and two urban schools within Columbus, Ohio. The collected samples were analyzed at Texas A&M University - Kingsville using an ion chromatography unit and x-ray fluorescence spectrophotometer. Concentrations of Cl^-, NO_3^-, SO_4^{-2}, PO_4^{-3}, Li^+, Na^+, NH_4^+, K^+, Mg^{+2}, Ca^{+2}, Si, P, S, Cl, K, Ca, Ti, Co, Ni, V, Mn, Fe, Cu, and Zn were determined for each site. A mass balance analysis of the major chemical components was conducted. Approximately 22-25% of the total reconstructed $PM_{2.5}$ mass was sulfates. Other abundant components included nitrate, chloride, ammonium, and sodium ions as well as calcium, silicon and iron. Elemental carbon and organic compounds were not analyzed for this study. The average $PM_{2.5}$ concentrations did not show any significant spatial variations among the three sites indicating homogeneity in the spatial distribution of $PM_{2.5}$ in Ohio. The average indoor $PM_{2.5}$ mass values were higher than the average outdoor mass concentrations. $PM_{2.5}$ and its major component, sulfate ion, showed strong seasonal variations with maximum concentrations observed during the summer months at all three sites. $PM_{2.5}$ concentrations tended to increase with rising temperatures and dropped with increasing wind speeds. High $PM_{2.5}$ concentrations were generally observed when the wind speed was lower than 8 mph and temperature was higher than 70°F. $PM_{2.5}$ concentrations were highest when the winds were blowing from the south and southwest directions at all three sites. This suggested the impact of pollutants transported from the Ohio river valley region. Results from a preliminary outdoor source apportionment using principal component analysis technique showed impact from broad source categories such as industrial, geological, and fossil fuel combustion sources.

[P08-14] CHEMICAL AND BIOLOGICAL CHARACTERISATION OF AMBIENT AIR COARSE, FINE, AND ULTRAFINE PARTICLES FOR HUMAN HEALTH RISK ASSESSMENT IN EUROPE (PAMCHAR).

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 8: Toxicology: Metals, Mixtures, and New Models (11:00 AM-12:00 PM) Grand Ballroom 2-4

The objectives of our multinational project in 2002-2004 are: (1) characterisation of variations in soluble and insoluble inorganic and organic compositions of the ambient air coarse, fine, and ultrafine particles in contrasting PM pollution situations in Europe, (2) systematic analysis of the associations of the above physicochemical characteristics with the cytotoxic, proinflammatory, and genotoxic effects on human and murine respiratory cells *in-vitro*, and (3) testing of the significant *in vitro* cytotoxic and proinflammatory associations in animal studies and in comparisons with human epidemiological data.

Coarse ($PM_{10-2.5}$), fine ($PM_{2.5-0.2}$) and ultrafine ($PM_{0.2}$) particles are collected with a high-volume cascade impactor (HVCI) in 3 + 4-day periods per week during 1-2 months in six European cities (Amsterdam, Athens, Barcelona, Duisburg, Helsinki, Prague). Numerous low-volume samples are collected with validated samplers to enable a mass balance assessment of the constituents in the PM_{10} subfractions.

Chemical analyses from the collected high- and/or low-volume PM samples include total elements (ED-XRF), watersoluble ions (IC) and watersoluble elements, such as toxic transition metals (Fe, Cu, Ni, V, Zn), (ICP-MS). Elemental and organic carbon contents are analysed with a thermal optical method, bacterial endotoxin with a lipopolysaccharide assay (LAL) and polycyclic aromatic hydrocarbons with mass spectrometry (GCMS-SIM). The oxidant activity of PM samples is measured by the electron spin resonance (EPR) determination of OH-radical generation.

Mass doses of HVCI coarse, fine and ultrafine PM are instilled into cultures of standard human and murine macrophage and respiratory epithelial cell lines. Cytotoxic (MTT test), proinflammatory (nitric oxide and cytokine productions) and genotoxic (comet assay, 8-OHdG, DNA adducts) responses are measured. In addition to whole PM suspensions, water and organic solvent washed PM samples and their leachates are tested as well as the modification of the responses by specific antagonists. The key cytotoxic and proinflammatory findings in these *in-vitro* studies are investigated in primary cultures of human nasal cells, and in intratracheal instillation exposures of healthy mice and compromised rats by measuring response markers in bronchoalveolar lavage fluid and blood.

Further information: http://www.pamchar.org/

[P04-29] CONTINUOUS PM 2.5 MASS BY THE DIFFERENTIAL TEOM® MONITOR AND A CONTINUOUS SIZE SEGREGATED NITRATE MONITOR IN CLAREMONT CALIFORNIA: EVALUATION OF THE DYNAMICS OF NITRATE VOLATILIZATION.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

As part of the Los Angeles based U.S. EPA sponsored Southern California Particle Center and Supersite (SCPCS), semi-continuous (10-minute) particulate matter less than 2.5 micrometers (PM2.5), and semi-continuous (10-minute) size segregated particulate nitrate (2.5-1.0 μm, 1.0-0.5 μm, & 0.5~0.1 μm) were measured using the Differential TEOM ® monitor (Patashnick, et al., 2000; Jaques, et al., 2002), and a cascaded Integrated Collection and Vaporization Cells (ICVC) (Stolzenburg, et al., 2002; Fine, et al., 2002), respectively. The Differential TEOM monitor employs an electrostatic precipitator to resolve artifactual changes in filter mass change related to semi-volatile PM. The electrostatic precipitator (ESP) is activated in alternating 5-min periods to remove particles from the sample air stream. The mass change of the filter with the ESP activated is subtracted from the mass change during the normal collection (with the ESP off) to provide an artifact-corrected mass.

In this paper we compare the mass lost during the "ESP-on" cycle to ambient particulate nitrate concentrations measured by the ICVC. For measurements at Claremont, episodes of PM2.5 are often highly associated with ammonium nitrate, and they generally correspond with high daytime temperatures, peaking during mid-afternoons. For days of high PM2.5 nitrate, the artifactual mass loss from the TEOM filter measured with the "ESP on" is correlated (R-squared = 0.76) with the ammonium nitrate concentrations measured by the ICVC. The correlation increases to R- squared = 0.79 when a lag of between 30 to 40 minutes is applied to the ammonium nitrate data. This suggests there is a delay between the time of particle collection and it’s volatilization from the filter. The data suggest that the rate of volatilization is non-linear, especially following high periods of PM2.5 ammonium nitrate. It appears that the volatilization of nitrate occurs more rapidly when freshly loaded onto the filter.

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[P04-60] THE BALTIMORE SUPERSITE PROJECT: HIGHLY TIME AND SIZE RESOLVED CONCENTRATIONS OF URBAN PM2.5 AND ITS CONSTITUENTS FOR RESOLUTION OF SOURCES AND IMMUNE RESPONSES.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (11:00 AM-12:00 PM) Grand Ballroom 2-4

The Baltimore Supersite project was designed to provide an extended, highly time, size, and compositionally resolved data set, including cytokine assays as a metric of cardiopulmonary response in support of testing hypotheses relating to source attribution and health effects of PM. Specific hypotheses involve investigations of the toxicity of aerosol components as affected by age, industrial vs urban character, and seasonal differences in source terms and atmospheric chemistry. The project encompass 30-min resolved metals and 30-min resolved cytokine/ROS assays of PM-fine, along with measurements of PM mass, number vs size distribution, light-scattering coefficient; PM sulfate, nitrate, organic carbon, elemental carbon, VOC, NO/NO2, and ozone at time resolutions ranging from 5 minutes to 1 hour. UDE’s third generation single particle mass-spectrometric analysis system (RSMS III) provided continuous size and semi-quantitative determination of individual aerosol particle constituents, from 10 nm to 2.5 μm. JHU's LIDAR was deployed episodically to determine boundary layer conditions and mixing height information up to 8 km. Cytokine assays will be used in correlations with PM metrics in an attempt to apportion ambient PM responses among air pollution sources. Traditional 24-hr collections for FRM mass and selected aerosol constituents were made to provide the link with PM network data. Extensive exploratory organic compound analyses were performed on 3-hr time resolved samples during two intensive sampling campaigns to reveal the presence of potentially useful tracer species for receptor modeling, and identities and concentrations of potentially toxic PM organic constituents. The Highly-time size, and species resolved composition metrics are being used to determine their source contributions and their relationships between health effects metrics and sources. Time-resolved rotating drum impactors (RDI) were employed to separate fresh accumulation aerosol from nearby sources from aged and cloud processed aerosol, and from tailing coarse particle fractions. The spectra determined from RDI measurements were collected to confirm plume hits and as a calibration reference for single particle measurements. Mulitvariate calibration models will be used to statistically interpret and interrelate data developed by the variety of new and established techniques. The prupose of this presentation is to describe the Baltimore Supersite Project and convey the kinds of data available at the various sampling sites and periods.

[P04-48] INTERLABORATORY COMPARISON STUDIES FOR CHARACTERIZATION OF ORGANIC COMPOUNDS IN PARTICUALTE MATTER.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

A working group of investigators, who are characterizing and quantifying the organic compounds in particulate matter (PM) as part of the US EPA\\'s PM 2.5 research program and related studies, was established three years ago to advance the quality and comparability of data on the organic composition of PM. This group has just completed their second interlaboratory comparison study. The first study used a subset of SRM 1649a (Urban Dust, sieved to <123 mm) that had been sieved to <63 mm (Air Particulate I) as an unknown PM sample. In addition to Air Particulate I, the participants received a dichloromethane extract of Air Particulate I as a second unknown sample and a sample of SRM 1649a for use as a control material. For the second study, initiated in March 2002, the participants received a sample of PM2.5 collected recently in Baltimore, MD along with a sample of SRM 1649a. It is a requirement that all participants return data on Air Particulate I and SRM 1649a prior to receiving the Baltimore PM2.5 material, so at this point there are participants at different stages of the two studies. The target analytes, organic source tracers and toxic species, include polycyclic aromatic hydrocarbons (PAHs), nitrated PAHs, alkanes (including hopanes and cholestanes), sterols, carbonyl compounds (ketones and aldehydes), acids (alkanoic and resin), phenols, and sugars. Because this is a performance-based study, laboratories are encouraged to use the methods that they are routinely using in their laboratories to analyze similar samples. Laboratories are requested to return data from three analyses (subsamples) of each sample provided along with a summary of the methods used. The data received from the participating laboratories, following outlier testing, are then used to assign a consensus value to each analyte in the unknown samples. Results are used in the consensus value assignment for the unknown PM sample only if the laboratory\\'s results for SRM 1649a are within 30% of the uncertainty limits of the certified values. The consensus values, accuracy and precision assessments, and the methods used by each laboratory are summarized in a report provided to the participants. In this report, laboratories are numerically identified with only the laboratory and the study coordinators knowing this numerical identification. The results from the two interlaboratory studies will be presented along with plans for future interlaboratory trials, standard reference materials, and calibration standards. This work has been funded by the U S Environmental Protection Agency. It has been subjected to Agency review and approved for publication.

[P04-61] TRANSIENT ELEVATIONS IN THE CONCENTRATIONS OF SULFATE, NITRATE, AND EC/OC MEASURED WITH SEMICONTINUOUS MONITORS AT THE BALTIMORE SUPERSITE.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (11:00 AM-12:00 PM) Grand Ballroom 2-4

Measurements of particulate sulfate, nitrate, elemental and organic carbon (EC and OC) were made at intervals ranging from 10 minutes to 1 hour for more than 10 months in 2002 at the Baltimore Supersite using commercial and prototype semicontinuous monitors. Additionally, PM2.5 measurements were recorded at 30 minute intervals using the R&P TEOM. Inspection of the data reveals that there were many periods when PM2.5 concentrations were elevated for relatively short periods during which large fractions of the mass and hence most of the excess PM2.5 mass was accounted for either Nitrate, sulfate, or EClOC. Herein, we present descriptive statistical summaries of these data and present the relative contributions of transients to elevated PM2.5 concentrations. In addition, particle size distribution data (collected every 5 minutes with mobillity and time-of-flight particle spectrometers), NOx, single-particle mass spectrometer, and meteorological data, ae used to classify the transient events in terms of the likelyhood of primary vs secondary origin.

[P04-41] HOW DOES THERMAL-OPTICAL ANALYSIS FOR BLACK CARBON IN PM BEHAVE OPTICALLY?

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

Thermal-optical measurement methods for black carbon (BC) in PM rely on changes in the optical behavior of PM carbon to indicate when organic carbon (OC) mass is analytically separate from BC mass during thermal desorption and the subsequent detection of carbon by flame ionization. The major advantage of thermal-optical analysis (TOA) is that while mass measurement is directly related to the optical behavior of PM carbon, no prior knowledge of PM absorptivity or the specific attenuation cross section is required, as with purely optical methods such as aethelometry. Nevertheless, TOA relies on three assumptions based on the constancy of optical absorptivity during analysis. First, absorptivity of PM remains constant prior to OC pyrolysis, i.e., no substantive change in the particle refractive index occurs with heating that would affect absorptivity. Second, absorptivity of instrument-produced OC char does not change during heating in either the inert (helium) environment or oxidizing (O2-He) environment. Third, OC char has the same absorptivity as BC that is native to the sample.

In this work, we tested these assumptions by determining the variation in TOA absorptivity vs. stage of analysis in three types of samples: urban dust, indoor air particles, and forest fire emissions. The apparent absorptivity was calculated from carbon mass remaining on filters and laser transmission (670 nm) as a function of analysis time. An important factor in the calculation is the spurious variation in laser response with heat, as heat induced changes in light scattering of the filter substrate fibers or the non-carbonaceous PM components imbedded in the filter.

[P04-70] SIZE SEGREGATED CHARACTERIZATION OF PM_{10}, $PM_{2.5}$, PM_1 AND LONGTERM MEASUREMENTS OF PM_{10} DOWNWIND OF A LARGE CONURBATION IN GERMANY.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (11:00 AM-12:00 PM) Grand Ballroom 2-4

For a period of ten years (1993 to 2002) daily filter samples PM_{10} were collected by a high volume sampler (HV, quartz fibre filters, *PM_{10} Sampler, Sierra-Andersen*) and additionally weekly filter samples PM_{10}, $PM_{2.5}$, and PM_1 from 1999 on by a low flow sampler (LF, Teflon filters, *Partisol 2000, Rupprecht and Patashnik*)) at the IfT-research station Melpitz (12°56' E, 51°32' N) located in the downstream plume of the Leipzig conurbation in Central Europe.

From the weekly LV samples the contributions of $PM_{2.5}$ and PM_1 to PM_{10}(100%) can be derived. Most of the $PM_{2.5}$ mass is PM_1 . During summers the mass of coarse particles (PM_{10} - $PM_{2.5}$) is higher than in other seasons. Reasons could be found in the occurrence of longer periods of dry ground surfaces and faster drying surfaces with re-emission by turbulence and from agricultural activity (Table 1).

An additional impactor for PM_1 (LF) contains a quartz filter for the determination of organic carbon (OC) and elemental carbon (EC) with a thermographic method using a *Ströhlein C-mat 5500 carbon analyser*. OC was detected at 650 °C in N_2 and EC after them during a new heating step at 650 °C in O_2. In the mean about 30% of the PM_1 mass are total carbon (TC = OC + EC). More OC was detected during the summers.

The particle mass concentration PM_{10} (HV) shows a decreasing trend. Highest values have been observed in the winters before winter 1997/1998. In the following winters no pronounced concentration peaks were found. A reason is the decreasing number of coal heating systems in the Leipzig conurbation and its surroundings.

The NO_3^-/SO_4^{2--} molar ratio shows a typical increasing trend with seasonal variation caused by the decreasing SO_4^{2--} mass concentration in PM_{10} which originates in the dramatically decrease of SO_2 concentrations, but also in NH_4NO_3-losses by evaporation from the filters during higher temperatures in summer.

The time series were integrated in a longer historical mass trend (since 1983) for Saxony. In the reconstructed data (1983 to 1990) the total particle mass concentration (TSP) shows big scatter with a mean between 60-80 $\mu g/m^3$. Since the reunification in 1990 a decrease for PM_{10} to a mean of 20-30 $\mu g/m^3$ is clearly recognizable.

Table 1: Mass contribution of $PM_{2.5}$ and PM_1 to PM_{10} (100%) distinguished between winter (W, October to March) and summer (S, April to September) for the years 1999, 2000 and 2001

PM	1999(S)	2000(S)	2001(S)	1999(W)	2000(W)	2001(W)
$PM_{2.5}$	56.7 %	56.8 %	65.2 %	82.0 %	76.4 %	82.8 %
PM_1	46.2 %	47.4 %	50.0 %	62.9 %	56.6 %	59.4 %

[P04-42] NIST PROGRAM FOR FORMATION AND CHARACTERIZATION OF ENGINEERED AEROSOL PARTICULATES: ADDRESSING NEEDS FOR GLOBAL CLIMATE CHANGE.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

An essential element in advancing the atmospheric science of aerosol particles is the ability to make unequivocal on-site measurements of the physical and chemical properties of the atmospheric particulate matter (PM). To allow measurement traceability to standards and improve interlaboratory reproducibility, three types of reference materials of increasing complexity are relevant:
1) pedigree PM (i.e., engineered PM with traceability to a stated reference),
2) simulated PM (i.e., mixtures of pedigree PM and other well-characterized substances with properties similar to real PM), and
3) real PM (serving as measurement benchmarks).
For pedigree PM, commercially available materials such as carbon black are less suitable for two reasons: 1) a specialized system is needed to provide control over the synthesis of pedigree and simulated PM; and 2) an open, unequivocal, and well-documented source is needed to be universally accepted by PM measurement communities. Thus, the capability is needed to produce carbon particles to meet the requirements of traceability and serve as an accepted standard reference material.
NIST is developing a program for PM measurement traceability to a stated reference. The Liquid Injection Test bed for Aerosol Research (LITAR) is a unique, highly controlled and characterized benchmark industrial-like facility, which can serve to generate reproducibly pedigree and simulated PM reference materials. This facility can reproduce a range of combustion conditions related to a variety of industrial sources, is well diagnosed, and it provides the opportunity to correlate well-characterized chemistries with PM. Parametric experimental investigation of PM characteristics in this facility can provide fundamental information for input and validation of climate change models.
We will also describe a new tool, the laser-driven thermal reactor (LDTR), to provide a well-controlled environment for determination of thermal physical and chemical kinetics properties of PM. Due in part to its rapid thermal response, it is expected that the LDTR studies will lead to an improved fundamental understanding of the thermal physical and chemical kinetics properties of different types of carbon in species-rich PM, and as a result provide a mechanistic \\'road map\\' toward development of a new measurement process for aerosol black carbon.

[P04-44] EXAMINING THE ASSUMPTIONS BEHIND ELEMENTAL CARBON MEASUREMENTS USING THE THERMAL-OPTICAL TRANSMITTANCE TECHNIQUE.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

Diesel particulate matter is one of the major national air toxics as per the 1996 EPA National Air Toxics Assessment. Elemental carbon (EC) is often used as a tracer for the contribution of diesel soot to ambient particulate matter. The most common way to measure elemental carbon is by analyzing an aerosol sample collected on a quartz filter with a thermal-optical method such as IMPROVE or NIOSH. Previous work has shown that measurements of elemental carbon from these different methods do not agree.

This poster examines the organic carbon-elemental carbon (OC/EC) split using a conventional Sunset Labs Thermal-Optical Transmittance (TOT) analyzer. The OC/EC split is difficult to determine because some of the organic carbon pyrolyzes during the analysis. The TOT method corrects for the pyrolysis by measuring the transmittance of the filter. The ambient EC is taken as the mass of carbon that evolves after the transmittance returns to its original, pre-analysis value. The underlying assumption of the method is that either (a) the pyrolyzed carbon (PC) and ambient EC have similar optical properties, or (b) the PC comes off completely before the EC.

Experiments were performed to examine these two assumptions. The first experiment involves washing ambient samples with organic solvents (to reduce OC and minimize pyrolysis) followed by OC/EC analysis. Comparing the washed and unwashed filters shows that PC evolves at the same time as ambient EC, and further, that the optical transmittance of these two types of carbon are different. Therefore changes in the relative rate that PC and EC evolve alter the OC/EC split.

Refractory doped filters using sucrose and ambient aerosol were also analyzed to examine the effect of refractory loading on the PC and EC evolution. Higher refractory content appears to increase pyrolysis of the OC; also, the refractory causes light absorbing carbon (PC and EC) to come off earlier (at lower temperatures) in the analysis cycle. The net effect of the refractory is to alter the relative rate at which PC and EC evolve from the filter, changing the OC/EC split assigned by the TOT technique.

An additional factor affecting the carbon evolution is the maximum temperature used in the initial, Helium mode of the NIOSH protocol. Results will also be presented showing that a higher temperature of 870 °C leads to more rapid loss of EC relative to PC, compared to using a peak temperature of 700 °C; this results in lower estimates of ambient EC with the protocols using the higher temperature.

[P04-45] THE DEVELOPMENT AND EVALUATION OF POROUS FOAM AS A DENUDER FOR A PERSONAL ORGANIC PARTICULATE MATTER SAMPLER.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

Epidemiological studies show a strong correlation between elevated particulate matter (PM) and a range of adverse health effects(1). The need for accurate measurement of personal exposure to PM and chemical components of PM has been identified by the National Research Council as a research priority of particulate matter (2). By using activated carbon impregnated foam as a denuder in a personal sampler, gas phase interferences in the measurement of semi-volatile organic compounds collect on a filter are avoided. The foam denuder is followed by a pre-fired quartz filter followed by a charcoal impregnated glass fiber filter to determine fine particulate carbonaceous material and nitrate, including semi-volatile species lost from the particles during sampling. Samples, collected at Brigham Young University, are evaluated for collection efficiency, and the data is compared with PC-Boss date (3) collected in tandem.

1. Pope, C.A. "Epidemiology of fine particulate air pollution and human health; Biological mechanisms and who's at risk?" Environmental Health Perspectives, 2001, 108(Sup4), 713-723.
2. National Research Council "Research Priorities for Airborne Particulate Matter: II. Evaluation Reasearch Progress and Updating the Portfolio", The National Academy Press 1999, pp27-38.
3. Ding, Y.; Pang, Y.; Eatough, D.; Eatough, N.; and Tanner, R. "High-Volume Diffusion Denuder Sampler for the Routine Monitoring of Fine Particulate Matter: II. Field Evaluation of the PC-BOSS." Aerosol Science and Technology, 2002, 36, 383-396.

[P04-47] SEMI-VOLATILE ORGANIC SPECIES DURING THE TEXAS AIR QUALITY STUDY -2000: PARTICULATE CARBON AND GAS/PARTICLE PARTITIONING OF HYDROCARBONS.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

During the late summer of 2000 (8/15 - 9/15/00), the Texas Air Quality Study - 2000 was conducted to improve understanding of the factors that control the formation and transport of air pollutants along the Gulf Coast of southeastern Texas. A variety of real-time and integrated samplers were deployed at three sites to characterize ambient aerosols, including semi-volatile organic compounds. The LaPorte Airport site was upwind of nearby petrochemical refineries. The Houston Regional Monitoring Site-3 was on the shipping channel between Galveston Bay and central Houston, and Aldine represented a suburban site.

Semi-volatile species were collected with Integrated Organic Gas and Particle (IOGAP) samplers that incorporates XAD-4 coated annular diffusion denuders upstream of a filter and back-up sorbent substrate. This diffusion-based measurement technology minimizes artifacts that are associated with sampling semi-volatile organic species (SVOC). During sampling, the gas phase SVOC were trapped on the XAD-4 coated denuders. Particles were collected on the filter. The post-filter sorbents (XAD-4 impregnated filters) trapped any SVOC that volatilized from the collected particles. Extracts of the denuder, filter and sorbent were analyzed separately for gas-particle partitioning.

This presentation shows gas/particle partitioning data for PAH and alkanes, as well as particulate mass concentrations. Organic and elemental carbon and PAH concentrations were compared for particles collected with the IOGAP and conventional samplers. Three specific periods were selected for analysis: A high ozone (>150 ppb) episode, a wood-smoke event and a cleaner period for comparison. Over 60 organic compounds have been analyzed. Noticeable increases in the more volatile compounds were observed in the morning of the high ozone event and several key wood-smoke markers (retene, leveglucosan) during the wood-smoke event. However, the organic speciation data, as well as the PM mass measurements, suggest there was not much variability between the three sampling sites. This observation is supported by the unique circular wind patterns observed around the Greater Houston Area.

[P04-49] ANALYSIS OF POLAR ATMOSPHERIC ORGANIC COMPOUNDS USING LIQUID CHROMATOGRAPHY/ MASS SPECTROMETRY ATMOSPHERIC PRESSURE PHOTOIONIZATION (LC/MS APPI).

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

Nearly 50% of the organic carbon mass collected as fine particles cannot be analyzed using current molecular level mass spectrometric analytical methods (e.g., gas chromatography/mass spectrometry, GC/MS) due to low volatility in the gas chromatographic system. The presence of one or more polar functional groups, high molecular weight (> 450 amu), and/or thermal instability are principal factors preventing successful analysis by GC/MS. Consequently, little chemical information is available on a substantial fraction of the organic carbon fine particle mass, the "polar" organic fraction. The presence of functional groups within molecules contained in this fraction can impart acidic or basic character to fine particles, increase solubility in aqueous media, govern fate and transport of fine particles in the atmosphere, and influence uptake by biological systems, including absorption within the human respiratory tract.

Reverse phase high pressure liquid chromatography (HPLC) is an analytical method that can be applied to highly polar, water-soluble organic compounds. Unlike GC/MS, compounds can be nonvolatile, have high molecular weight (up to 100,000 amu), and be partially to fully water-soluble. Polar organic compounds of atmospheric significance were examined using Liquid Chromatography/Mass Spectrometry combined with Atmospheric Pressure Photoionization (LC/MS APPI) and mass-to-charge (m/z) detection by an ion trap mass spectrometer. Injections of standard solutions in methanol were conducted using analyte concentrations of 2 ppm, 20 ppm and 200 ppm, and corresponding to total injected masses of 20 ng, 200 ng and 2000 ng, respectively. The standard suite was composed of basic organic compounds (nitrogen heterocycles), sulfur heterocycles (benzothiphenes), acidic aromatic compounds (benzoic acid, nitrobenzoic acid), and an aliphatic dicarboxylic acid (azelaic acid). Basic and acidic organic compounds were analyzed selectively by operating the APPI ionization source under positive mode (organic bases) or negative mode (organic acids). All standard compounds produced ions that could be detected as either [M+H]+, [M]+, or [M-H]- and exhibited good ion abundances for even the lowest standard concentrations (20 ng injected mass).

The linear response for standards and low detection limits in the ng/microliter range demonstrate the usefulness of LC/MS APPI as a new molecular level analytical tool for identifying a large range of polar organic compounds. In addition, the technique is selective for acidic and basic organic molecular constituents in fine particles.

[P04-40] EQUIVALENCE OF CARBON FRACTIONS FROM DIFFERENT THERMAL EVOLUTION METHODS AT THE FRESNO SUPERSITE.

John G Watson, Judith C Chow, Antony Chen, Hans Moosmuller, W. Pat Arnott, Dale J Crow, Kochy K Fung, Peter Ouchida
Division of Atmospheric Sciences, Desert Research Institute, Reno, NV; Executive Office, AATMA, Calabasas, CA; Monitoring and Laboratory Division, California Air Resources Board, Sacramento, CA

Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

Twelve PM2.5 samples from ~410 cm2 quartz fiber filters acquired every third day at the Fresno Supersite from September 2002 through January 2003 were submitted to the following thermal/optical analysis protocols applied with the same instrument, procedures, and standardization: 1) Oregon Graduate Institute thermal optical reflectance (TOR); 2) IMPROVE TOR and thermal optical transmittance (TOT); 3) NIOSH TOR and TOT; 4) Speciation Trends Network (STN) TOR and TOT; 5) ACE-ASIA TOR and TOT; 6) Lawrence Berkeley Laboratory continuous temperature ramp; 7) German VDI extraction/combustion; 8) French pure oxygen combustion Japanese two temperature, 9) Brookhaven National Laboratory two temperature; 10) General Motors Research Laboratory two temperature; and 11) R&P two temperature.

These methods differ from each other with respect to: 1) combustion atmospheres; 2) temperature ramping rates; 3) temperature plateaus; 4) residence time at each plateau; 5) optical monitoring configuration and wavelength; 6) standardization; 7) sample aliquot and size; 8) evolved carbon detection method; 9) carrier gas flow through or across the sample; and 10) location of the temperature monitor relative to the sample. These differences are not completely documented in the published descriptions, although they may make a difference in the comparability of the measured carbon fractions.

[P04-55] COMPARISON OF SEMI-VOLATILE ORGANIC COMPOUNDS FROM WILDFIRE EMISSION DOMINATED AMBIENT SAMPLES TO RESIDENTIAL AND AGRICULTURAL WOOD COMBUSTION SOURCE SAMPLES.

Lynn R. Rinehart, Anna E. Cunningham, Barbara Zielinska Division of Atmospheric Science, Desert Reserch Institute, Reno, NV

Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

Several wildfire emission dominated ambient samples were collected in Reno, NV during the wildfire seasons of 2000 and 2001. Wildfires were approximately 50-150 miles from collection point and ranged in size. These samples are compared to residential and agricultural wood combustion source emissions collected from a direct exhaust stack prior to release to the atmosphere. All samples were collected using teflon impregnated glass filters (TIGF) followed by polyurethane foam (PUF) and XAD-4 resin sandwich cartridges. Samples were analyzed by GC/MS methods for semi-volatile organic compounds including polycyclic aromatic hydrocarbons (PAH), higher molecular weight hydrocarbons, methoxy phenol derivatives, organic acids, cholesterol, sitosterol, and levoglucosan. Results of this comparison of semi-volatile organic compounds of wildfire emission dominated ambient samples and wood combustion source emissions will be presented.

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[P04-69] CHARACTERIZATION OF TOXIC OF COMPOUND IN ATMOSPHERIC PARTICULATE MATTER IN CATAÑO, PUERTO RICO.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (11:00 AM-12:00 PM) Grand Ballroom 2-4

Puerto Rico has experienced rapid growth and economic development in the past decades. This has led to the establishment of multiple industrial plants, power generating plant and large increase in vehicular traffic. The impact of the emission from these activities ara affecting the health of certain sector of the population.

A region known as Cataño is directly downwind from the San Juan metropolitan area. The impact in air was such that with the EPA PM-10 requirements of air quality it could not meet compliance. Parallel to the high particulate levels were found high levels of respiratory ailments in the residents of this region. Such ailments as asthma, emphysema and lung cancer are close to four times higher in this regiion other areas of Puerto Rico.

We have undertaken a study to chemically characterize by GC/MS the organic pollutants in air in the Cataño area of puerto Rico and compare this composition with other less polluted areas in the Puerto Rico. By comparing it is hoped to identify compounds could be contributing to these respiratory ailments.

Samples were taken on a standard Pm-10 samples and sequentially Soxhlet extracted with hexane, dichloromethane and finally acetone. The goal was to achieve a level of fractionation in the extraction to facilitate the chemical analysis. The more abundant compounds found were fatty acids and their corresponding ester. In addition long chained alcohols. All are indicative of biogenic origin. The anthropogenic compounds observed more consistently were derivatives of morpholine.

[P04-46] PARTICULATE CARBON AND GAS/PARTICLE PARTITIONING OF HYDROCARBONS IN SEATTLE.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

This presentation focuses on clarifying the influence of semi-volatile organic species on exposure assessment for airborne particulate matter. For this purpose we deployed conventional and diffusion-based sampling technology at a central monitoring site and both indoors and outdoors at several residential sites, during part of the extensive exposure assessment efforts of the Northwest Center for the Study of the Health Effects of Particulate Matter (Seattle, 1999-2001). Organic and elemental carbon and polycylic aromatic hydrocarbons (PAH) concentrations were compared for particles collected with several types of samplers. The role of semi-volatile species both indoors and outdoors can be clarified by comparing gas/particle partitioning data for PAH to particulate carbon and particulate mass concentrations.

Semi-volatile species were collected with Integrated Organic Gas and Particle Samplers that incorporate XAD-4 coated annular diffusion denuders upstream of a filter and back-up sorbent substrate. This diffusion-based measurement technology minimizes artifacts that are associated with sampling semi-volatile organic species (SVOC). During sampling the gas phase SVOC were trapped on the XAD-4 coated denuders. Particles were collected on the filter. The post-filter sorbents (XAD-4 impregnated filters) trapped any SVOC that volatilized from the collected particles. Extracts of the denuder, filter and sorbent were analyzed separately for PAH. Particulate organic (OC) and elemental carbon (EC) were determined from sections of quartz filters by thermal optical transmission.

The results from May 2001 suggest that indoor particulate PAH and EC track each other and infiltrate from outdoors when no cooking or combustion sources are present indoors. However, indoor particulate PAH and OC do not track each other unless diffusion denuders are used to prevent indoor gas-phase OC from adding to the apparent particulate OC.

[P04-56] SEMI-VOLATILE AND PARTICLE-ASSOCIATED NITRO-PAH AS MARKERS OF DAYTIME OH RADICAL-INITIATED OR NIGHTTIME NO_3 RADICAL-INITIATED ATMOSPHERIC REACTIONS OF GAS-PHASE PAH.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

Polycyclic aromatic hydrocarbons (PAHs) and their nitro-derivatives (nitro-PAHs) have been reported to be mutagenic and carcinogenic. PAHs containing from 2- to 4-rings will be present at least partially in the gas-phase in the atmosphere. While hydroxyl (OH) radical reactions will be the major atmospheric loss process for these gas-phase PAHs, nighttime reactions with nitrate (NO_3) radicals may also occur. Both the OH radical-initiated and the NO_3 radical-initiated reactions may produce nitro-PAHs, whose reduced volatility relative to the parent PAH may result in these products being particle-associated. The yields of the nitro-PAHs formed from the OH radical-initiated reactions are typically low ($\leq$ 5%), while for certain PAHs the NO_3 radical reaction may produce nitro-PAHs in high (>20%) yield. The pattern of nitro-PAH isomers formed may be different for the OH vs NO_3 radical-initiated formation pathways and may also be distinct from the nitro-PAH isomers present in emission sources such as diesel exhaust. The nitro-PAHs found in ambient samples are often dominated by those formed from OH radical-initiated reactions, but instances where NO_3 radical chemistry contributes to or even dominates the nitro-PAH formation have been observed. The dominant loss process for the nitro-PAHs is expected to be photolysis. Through comparisons among nitro-PAHs produced in environmental chamber reactions of selected PAHs and daytime and nighttime ambient air samples, nitro-PAHs that can serve as markers of daytime OH radical-initiated and nighttime NO_3 radical-initiated reactions will be identified.

[P04-50] ANALYSIS OF OXYGENATED ORGANICS WITH HIGH PERFORMANCE LIQUID CHROMATOGRAPHY/ION TRAP MASS SPECTROMETRY.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

Interest in the measurement of oxygenated organic species in source emissions is increasing due to the role that these molecules play in ozone and secondary organic aerosol (SOA) formation. The traditional approach to measure these compounds is derivatization in concert with gas chromatography/mass spectrometry. Previous efforts in our laboratory established the utility of O-(2,3,4,5,6)-pentafluorobenzylhydroxylamine (PFBHA) derivatization in concert with gas chromatography/ion trap mass spectrometry (GC/ITMS) for the measurement of carbonyl, hydroxy-carbonyl and dicarbonyl species present at part-per-trillion (pptv) levels in biogenic and anthropogenic emissions. With respect to anthropogenic emission however, this approach may lack the analytical range necessary for all oxygenated species present. Of particular concern are oxygenated polycyclic aromatic hydrocarbons (oxy-PAHs), due to their carcinogenic and mutagenic potential. For the analysis of these compounds, we are exploring atmospheric pressure chemical ionization (APCI) along with high performance liquid chromatography/ion trap mass spectrometry (HPLC/ITMS) as a complimentary technique to GC/ITMS. Specifically, we are evaluating the utilization of APCI/HPLC/ITMS for the analysis of underivatized and PFBHA derivatives of model aromatic aldehydes, ketones and dicarbonyls (quinones). Our results suggest equivalent or greater sensitivity for the pentafluorobenzyl (PFB) oximes when utilizing positive ion detection. Since the mass spectra of these derivatives are dominated by the pseudo molecular ion $[M+H]^+$, the APCI positive ion mass spectra can aid in the identification of unknown species. Application of negative ion detection produced at least 5x greater sensitivity for most of the PFB oximes investigated. The mass spectra base peak is typically a fragmentation ion arising from cleavage of the pentafluorobenzyl group ($[M-C_7H_2F_5]^-$), with a few exceptions exhibited by the smaller analytes. Our data suggest that APCI/HPLC/ITMS is a powerful tool to compliment existing methodologies for the analysis of oxygenated organic species present in source emissions.

[P04-54] CHLORDANES IN THE INDOOR AND OUTDOOR AIR OF THREE US CITIES.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

The indoor and outdoor concentrations of six Chlordane species (trans-chlordane, cis-chlordane, trans-nonachlor, cis-nonachlor, oxychlordane and MC5) were measured at 157 non-smoking residences in three urban areas during June 1999-May 2000. The data represent a subset of samples collected within the Relationship of Indoor, Outdoor, and Personal Air study (RIOPA). The study collected 48 hour integrated samples from homes in Los Angeles County, CA, Houston, TX, and Elizabeth, NJ. Both particle bound (PM2.5; quartz fiber filter) and vapor phase (PUF adsorbant) Chlordane concentrations were separately measured by GC / EI MS after solvent extraction.

Technical Chlordane (a mixture of ~140 poly-chlorinated norboranes) was used as a broad-spectrum pesticide from the 1940s through the 1960s, and was regulated in 1979, restricting most above aground and agricultural uses. By 1983 the only remaining application in the US was as a termiticide, primarily in new building construction, and by 1988 the termitcide registration was cancelled ending the sale and use of Chlordane in the United States. However, due to the physio-chemical properties of these compounds, they are widespread, being found in both biotic and abiotic matricies from the arctic, to mid latitudes, and tend to bioaccumulate and biomagnify.

The outdoor (gas + particle) total Chlordane (trans-chlordane + cis-chlordane + trans-nonachlor + cis-nonachlor) concentrations ranged from 36 to 4270 pg m-3 in Los Angeles, from 8 to 11000 pg m-3 in Elizabeth, and from 62 to 1770 pg m-3 in Houston. The corresponding indoor total Chlordane concentrations ranged from 37 to 111500 pg m-3 in Los Angeles, from 260 to 31800 pg m-3 in Elizabeth, and 410 to 38900 pg m-3 in Houston. Geometric mean concentrations were higher in indoor air than outdoor air (1980 vs.580 pg m-3 in CA; 1300 vs. 170 pg m-3 in NJ; 4180 vs. 280 pg m-3 in TX), which suggests that there are significant indoor sources of Chlordane species in a subset of homes in each of the three cities. Chlordane isomer ratios as well as individual indoor to outdoor concentration ratios will be presented.

[P04-53] THE DISTRIBUTION OF PARTICULATE POLYCYCLIC AROMATIC HYDROCARBONS (PAHS) IN THE ATLANTIC AND INDIAN OCEAN ATMOSPHERES.

Bernard S Crimmins, Joel E Baker, Russell R Dickerson, Bruce G Dodderidge Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science, Solomons, MD; Department of Meteorology, University of Maryland, College Park, MD

Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

Polycyclic aromatic hydrocarbons (PAH) are ubiquitous products of fossil fuel and biomass combustion. Some PAHs are carcinogenic and mutagenic. There are no direct local sources of PAHs to remote regions of the world's oceans, and the fate of PAHs is driven by atmospheric transport. Assessing the global distribution of these contaminants is difficult due to the lack of current data in the remote oceanic atmosphere. Two field campaigns, AEROSOL99 and The Indian Ocean Experiment (INDOEX) were completed in the winter of 1999. As part of these studies, the Research Vessel Ronald H. Brown sailed from Norfolk, VA to Cape Town, South Africa and then northeast through the Indian Ocean. The main objective of AEROSOL99 and INDOEX was to elucidate the aerosol and trace gas chemistry in the Atlantic and Indian Oceans' marine boundary layer. INDOEX demonstrated that a massive pall of smoke from biomass and fossil fuel combustion covers most of the Northern Indian Ocean throughout the Indian dry season, February to April. Aerosol samples obtained from an area spanning the Northern and Southern Hemispheres of the Atlantic and Indian Oceans as well as the Bay of Bengal and the Arabian Sea were analyzed for PAHs.

The samples were grouped in characteristic air regimes (5 Atlantic Ocean and 7 Indian Ocean) through back-trajectory calculations via HYSPLIT to characterize particle PAH burdens from similar continental and marine source locations. The Northern Hemisphere Indian Ocean atmosphere contained approximately an order of magnitude greater aerosol PAH concentrations and more than 90% of most of the PAH were detected. This increased anthropogenic PAH signal correlates with ancillary atmospheric measurements such as elemental and organic carbon (Bates et al., in press; Ball et al., 2002; Dickerson et al., 2002). Benzo[a]pyrene, the best known mutagenic PAH, in the highly impacted Northern Hemisphere Indian Ocean air regime (>400 km off shore) was only a factor of 4 lower than values recently measured in Baltimore, MD (45 + 14 and 190 + 110 pg/m3, respectively) indicating a strong Indian anthropogenic signal extending well into the Indian Ocean atmosphere. Source specific PAH signatures in concert with ancillary measurements, such as black carbon, were used to qualitatively identify the major sources of PAHs to the coastal Indian Ocean atmosphere. This study presents the most recent estimate of remote oceanic aerosol PAHs and an assessment of the impact and sources of anthropogenic emissions from the Indian sub-continent on the Indian Ocean atmosphere.

[P04-52] SIZE DISTRIBUTION OF NITRO-PAHS IN THE BALTIMORE, MD ATMOSPHERE.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

Adverse health effect of ambient urban aerosol is well established. The presence of nitro-substituted polycyclic aromatic hydrocarbons (nitro-PAH) have been linked to the direct mutagenicity of these urban aerosols. Specific nitro-PAHs are formed by primary emissions (diesel exhaust) and through secondary gas-phase transformation reactions of parent PAHs via O3 or NO3 oxidation. The size distribution of nitro-PAHs from primary and secondary reactions provides valuable information on the potential mutagenicity of various particle sizes and populations. In conjunction with the Baltimore PM 2.5 Supersite, 12 and 24h bulk and size resolved aerosol were collected in April 2002 using a modified Anderson Hi-Vol and Berner low-pressure impactor. The homologue distribution was used to estimate the size distribution of diesel-derived soot and to further resolve primary and secondary sources of the various nitro-PAHs congeners in the Baltimore, MD atmosphere. To our knowledge this is the first size resolved nitro -PAH data reported and explored as a potential diesel soot marker in the Eastern United States.

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[P04-51] FAST ANALYSIS OF SVOC IN THE PM2.5 FRACTION OF AMBIENT AEROSOL FOR USE IN EPIDEMIOLOGICAL STUDIES.

Juergen Schnelle-Kreis, Ralf Zimmermann Chemistry, BIfA - Bavarian Institute of Applied Environmental Research and Technology, Augsburg, Germany; Institute of Ecological Chemistry, GSF - National Research Center for Environment and Health, Munich, Germany; Analytical Chemistry, University of Augsburg, Augsburg, Germany

Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

Several epidemiological studies have investigated the influence of the particles on health effects. The association of individual specific organic pollutants or groups of pollutants with health effects, occurring in the fine dust, was not examined in epidemiological studies yet. As a new analytical approach recently the thermal desorption has been employed for extracting semi volatile compounds from ambient particulate matter. The direct thermal desorption - gas chromatography - mass spectrometry (DTD-GC-MS). technique enables fast, simple, and cheap analysis of semi volatile organic compounds e.g. in the PM2.5 fraction of ambient aerosol.

In our study besides determination of particle mass (TEOM) and number concentration (CPC) particulate matter is sampled with a PM2.5 sequential sampler on quartz fiber filters at a flow of 1 m^3 h-1. The sampling period for each sample is 24 h. The samples are analyzed for SVOC by DTD-GC-TOFMS. The DTD interface introduced in this study is a novel approach making it possible to use the liner of the GC injection interface as a sample container for the filter aliquots. Putting the liner in the injector is automated, and the analytes are thermally desorbed from the liner directly onto the capillary GC column. For analysis the filters are cut into pieces, each representing 1 m^3 of sampled air. One to four of these pieces are placed into a GC-liner. Isotope labeled reference compounds are added for quantification. For desorption the temperature is kept at 450°C for 10 Minutes. During desorption the SVOC are focused on a retention gap at 40°C oven temperature.

The measurements showed, that a filter aliquot representing 1 m^3 of sampled air is sufficient for a single analysis. Thus repeated analyses of one filter can be carried out.

In the samples among others (n-)alkanes, fatty acids, terpenes, hopanes, PAH, oxy-PAH and heterocyclic aromatic compounds have been identified and quantified. Further effort identifying unknown compounds using comprehensive GCxGC/TOFMS and peak deconvolution technique is on the way. For use in the epidemiological study the concentrations of individual compounds (e.g. n-alkanes, acids, PAH, PAH-quinones etc.)are summarized. Additionally the amount of the unresolved carbonaceous matter (UCM) is calculated for each sample. Statistical analysis is carried out using the concentrations of the single compounds as well as the summarized concentrations.

Acknowledgement: The authors wish to thank the Bavarian State Ministry for Regional Development and Environmental Affairs for supporting this work.

[P04-43] AMBIENT POLLUTANT CONCENTRATIONS MEASURED BY MOBILE LABORATORY IN SOUTH BRONX, NY.

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Wednesday, April 2, 2003, 11:00 AM, Poster Session 1: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (11:00 AM-12:00 PM) Grand Ballroom 2-4

The rate of asthma hospital admissions in the Bronx for all ages was twice that of Manhattan and Brooklyn between 1991 and 1996. In addition, most neighborhoods in the Bronx experienced a 110 to 120 percent increase in asthma hospitalizations between 1987 and 1996, as compared to 35 to 50 percent increase in most other neighborhoods in New York City. The objective of this South Bronx Environmental Study is to characterize the ambient air quality in communities of the South Bronx having high concentrations of diesel trucks and waste transfer facilities. We employed a mobile laboratory for continuous measurements of concentrations of fine particulate matter (PM2.5), elemental carbon (EC), oxides of nitrogen, sulfur dioxide, ozone and carbon monoxide at 6 locations during 2001 and 2002 for period of three to four weeks each. Integrated 24-hr PM2.5 samples were also collected for elemental and PAHs analyses. South Bronx ambient PM2.5 and EC levels were compared to levels measured at Bronx P.S. 154 (central monitoring site maintained by the NYSDEC) and at a Hunter College site located in the Manhattan's Lower East Side (maintained by NYU's EPA PM Center). The comparison of these sites indicated that although the median daily PM2.5 concentrations agreed within 20%, the median hourly EC concentrations were higher at all South Bronx sites with means ranging from 3.50 to 4.35 ug/m3, compared to means ranging from 1.23 to 2.99 ug/m3 at Hunter College. Continuous Aethelometer measurements at additional 27 sampling sites in South Bronx (1-day measurements repeated over a period of 4 weeks) were conducted along major highway with heavy truck traffic. There, EC concentrations showed variability within each site depending on time of day and a large spatial variability from site to site. Median EC concentrations varied from approximately 1.7 to 12 ug/m3 on the weekdays, and were lower (approximately 0.50 to 2.9 ug/m3) on the weekends. A weekend decrease in PM2.5 was also observed at all South Bronx sites except for Crotona Park, a local recreational park where weekend PM2.5 levels were higher. Elemental concentrations were remarkably similar between Hunter College and all South Bronx sites, with the exception of Hunts Point Avenue, an industrial location where significantly higher (approximately 2.5 fold) levels of Fe, Zn, Ba, and Ca. Further research will focus on developing a model using Geographical Information System tools to estimate local population exposure to pollutants.

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[P05-32] PM EMISSIONS OF MODERN LIGHT DUTY VEHICLES: CURRENT STATUS AND FUTURE ISSUES.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Motor vehicle particulate matter (PM) emissions vary widely not only from one engine technology to another, but also between different fuels and aftertreatment systems. Understanding these often intertwined effects is critical to developing PM emissions inventories, predicting how new technologies will alter the inventories, and formulating policy. This knowledge is also needed to deal with measuring PM at the upcoming lower tailpipe emissions standard, and to address properties other than PM mass.

Light duty diesel vehicles typically emit ~50 mg/mi over the FTP drive cycle. In general the particle size distribution is bimodal. There is always a lognormal mode with a geometric mean diameter of 40 - 90 nm that originates from soot formed in the combustion cylinder, coated to some degree by sulfate and semi-volatile organic material. Often a second mode, usually in the 5 - 30 nm range, is present from the nucleation of sulfate and semivolatile organic compounds that occurs as the exhaust exits the tailpipe, dilutes and cools. Altering the fuel structure affects these modes in distinct ways. Addition of an oxygenate, such as dimethoxy methane, can reduce mass emissions by ~15 - 30%, while not affecting number emissions, because of a reduction in soot particle size. Removal of sulfur from the fuel often reduces particle number emissions by an order of magnitude by eliminating the nuclei mode, while the reduction in PM mass is perhaps 10-20%. An oxidation catalyst does not directly affect PM emissions, but it has two indirect effects. For high sulfur fuel it oxidizes SO_2 to sulfate, thereby increasing particle emissions. But it also removes hydrocarbons that might nucleate or condense onto soot particles during exhaust dilution, and thereby decreases PM emissions.

Current gasoline vehicles have naturally very low, ~2 mg/mi, PM emissions because the air and fuel are premixed and held in the proper stoichiometric ratio. Sulfur has only a small effect on PM because the three way catalyst is ineffective at oxidizing SO_2. At this low emissions level, however, other issues emerge. Particle sizing instrumentation often indicates less PM mass than recorded by the standard filter measurement. Evidence suggests that this occurs because the filters also trap some gaseous hydrocarbons. Significant artifacts can also appear. The exhaust sampling system can act as a temporary reservoir of organic and particulate matter, that are later released and appear to originate from the vehicle.

[P13-03] PRINCIPAL COMPONENT ANALYSIS OF TRACE ELEMENTS IN $PM_{2.5}$ IN PITTSBURGH.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Results of many scientific studies support the association of elevated concentrations of atmospheric particulate matter (PM) with increases in morbidity and/or mortality. However, the chemical components of the PM that are causative agents have not yet been identified. One category implicated in contributing to potential health effects is trace elements. Examples of sources of trace elements include emissions from coal-fired power plants, oil and/or gas combustion, diesel- or gasoline-powered transportation, biomass burning, incineration, various industrial processes, and crustal sources. Factor analysis of ambient particulate matter elemental concentrations can be used to identify groups of elements that may come from the same source category. The Pittsburgh Air Quality Study (PAQS) was a large-scale ambient air quality study focused on particulate matter composition and concentration. The study was centered at an EPA supersite monitoring station, with minor measurement sites at other locations in the city as well as in the surrounding region. As part of the PAQS, ambient measurements of trace elements were taken at the supersite from July 2001 until September 2002. For most of this sampling period, the sampling duration was 24 hours, but four- to six-hour samples were collected on some days in July 2001 and August 2001. Elements analyzed include aluminum, arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, selenium, silver, vanadium, zinc and other metals. Samples were collected on Whatman 41 filters using two ThermoAndersen high volume samplers, one with a PM_{10} and one with a $PM_{2.5}$ size-selective inlet. Microwave-digested sections of filters were analyzed by Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Additional metals data will be obtained at or near sources in the Pittsburgh area to provide fingerprints of specific source types. The fingerprints and the supersite data will be used with Principal Component Analysis (PCA). PCA can be used to estimate the importance of various sources affecting ambient PM concentrations, which may aid in policy making to improve regional air quality and consequently human health. In this study, PCA will provide information on the relative contribution of sources in the Pittsburgh area to ambient PM.

[P15-28] CHARACTERIZATION OF FINE PARTICULATE MATTER IN OHIO:INDOOR, OUTDOOR, AND PERSONAL EXPOSURES.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Ambient, indoor, and personal PM2.5 concentrations were assessed based on an exhaustive study of PM2.5 performed in Ohio from 1999 to 2000. Two locations in Columbus, Ohio, were involved, one in an urban corridor and the other in a suburban location. A third rural location in Athens, Ohio, was also established. At all three locations, elementary schools were utilized to determine indoor and personal PM2.5 concentrations for 4th and 5th grade students. Continuous ambient PM2.5 mass concentrations were measured with Tapered Element Oscillating Microbalances (TEOMs). Indoor and personal PM2.5 concentrations were monitored at each location Monday through Friday throughout the school year. The ambient and personal monitoring is part of a comprehensive health based study evaluating the impact of air pollution in Ohio.

Ambient PM2.5 distributed homogeneously throughout the study area. This indicates that ambient PM2.5 concentrations monitored from a fixed site can represent the average ambient PM2.5 level over a large area. PM2.5 concentrations show clear seasonal changes at all three sites, indicating the trend of higher PM2.5 concentrations during the summer months. At all three sites, personal and indoor PM2.5 concentrations exceeded outdoor levels. Personal PM2.5 exposures were significantly affected by indoor PM2.5, presumably the result of resuspension by human activity. The I/O ratios of PM2.5 mass concentrations and of sulfate concentrations were greater than unity at all sites when school was in session. Lower I/O ratios associated with lower indoor sources were found during non-school days when the students were absent.

The impact of local sources on the PM2.5 concentration was identified at the urban location. Relatively strong correlations between indoor and personal concentrations were found among the sites.

[P15-29] INFILTRATION BEHAVIOR OF $PM_{2.5}$ CHEMICAL COMPONENTS: IMPLICATIONS FOR PM EXPOSURE ASSESSMENT AND EPIDEMIOLOGICAL ASSOCIATIONS.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Numerous epidemiological studies have reported significant associations between ambient PM concentrations and adverse health effects. Although current toxicological evidence indicates that some PM components may be more toxic than others, epidemiological associations have been predominantly for total fine particle mass rather than the mass of specific PM components. Current efforts are ongoing to develop databases of ambient PM component measures that can be used in epidemiological investigations. Because so much of people's exposures to PM occurs indoors, it is also important to better understand the relationships between ambient, indoor, and personal exposures to PM components for the proper interpretation of epidemiological findings.

As part of this process, we analyzed indoor and outdoor $PM_{2.5}$ components data from a comprehensive indoor particle characterization study conducted in nine residential homes in Boston, Massachusetts to investigate the infiltration behavior of various $PM_{2.5}$ components. Previous analyses of these study data quantified indoor infiltration of $PM_{2.5}$ and specific size fractions (Long *et al.*, 2001), and demonstrated the utility of sulfur as a tracer for $PM_{2.5}$ (Sarnat *et al.*, in press). Focusing on periods with little or no active indoor sources, new analyses were conducted for $PM_{2.5}$ components that have been linked to specific ambient PM sources: polycyclic aromatic hydrocarbons (wood smoke, vehicular exhaust), elemental carbon (diesel exhaust), nickel (oil-burning), and zinc, iron, potassium, silica and calcium (crustal materials).

Current results show that outdoor levels of PAHs, elemental carbon, Ni, Zn, Fe, K, Si, and Ca were significantly correlated with their corresponding indoor levels, with a strong effect of particle size. Data also show that home characteristics such as air exchange rate have differential effects on the infiltration of the various PM components, with larger effects being observed for indicators of crustal particles (e.g., Ca, Si). For example, similar indoor-outdoor Spearman correlation coefficients (r_s) were observed for Ni for summer and winter sampling (0.82 and 0.80), while lower and seasonally-affected r_s were observed for Si (0.65 and 0.42), a larger particle component. Additional analyses are planned to quantify component-specific penetration efficiencies and to tie in particle sizing data for the evaluation of the utility of these different $PM_{2.5}$ components as tracers for various PM fractions.

[P15-30] THE ROLE OF SUBPOPULATION, DISEASE STATE, HOUSING, SEASON AND OTHER FACTORS UPON PERSONAL EXPOSURES TO PM OF AMBIENT ORIGIN.

Ron Williams, Jack Suggs, Gary Evans, Anne Rea, Linda Sheldon, Alan Vette, Burke Janet, Carry Croghan, Kelly Leovic, John Creason, Debra Walsh, Charles Rodes, Jonathan Thornburg, Phil Lawless, Ademola Ejire, Margaret Herbst, William Sanders, Jr. National Exposure Research Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC, USA; National Health and Environmental Effects Research Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC, USA; Research Triangle Institute International, Research Triangle Park, NC, USA; Shaw University, Raleigh, NC, USA; Department of Cardiology, University of North Carolina-Chapel Hill, Chapel Hill, NC, USA

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

A series of longitudinal particulate matter (PM) and related co-pollutant human exposure panel field studies were conducted in Baltimore, Maryland (1997,1998) Fresno, California (1999) and Research Triangle Park, North Carolina (2002-2001). They were designed to evaluate the effects of personal exposures to PM of ambient origin under differing sub-populations, regions of the country, seasons, and housing conditions. Participants were monitored over time (28 days) to investigate both longitudinal and cross-sectional correlations between personal, residential indoor, residential outdoor, and ambient measurements. Measurements of $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ were routinely performed. Copollutant monitoring included CO, O_3, NO_2, SO_2, elemental-organic carbon and metals. Daily time activity diaries and questionnaires documented potential source exposures. The studies involved a variety of potentially susceptible subpopulations made up of non-smoking, ambulatory volunteers being at least 55 years old. Some of the subjects lived in communal (apartment or cottage-style) housing while others lived in single family residences. Results revealed a wide range in the magnitude and variability of daily personal $PM_{2.5}$ exposures (3 to 200 $\mu g/m^3$). Time activity patterns and estimated exposures to indoor generated sources appeared to be some of the primary factors influencing personal to ambient PM mass concentration associations (r ranging from 0.0 to 0.95). Mean personal $PM_{2.5}$ clouds ranged from 3 to 10 μ g/m^3 relative to the various study populations and were clearly influenced by individual time activity patterns among the participants. Results from the RTP-based study showed that ambient $PM_{2.5}$ sources contributed to approximately 50% of the total personal exposure mass concentration regardless of season, residence, occupational status or disease state. This work has been funded wholly by the United States Environmental Protection Agency under contract #68-D5-0040 and 68-D-99-012 to the Research Triangle Institute and assistance agreement #CR-828186-01-0 to Shaw University. It has been subjected to Agency review and approved for publication.

[P15-31] ESTIMATING OUTDOOR CONTRIBUTIONS TO INDOOR AND PERSONAL PARTICULATE AIR EXPOSURES.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Many epidemiologic studies have shown an association between adverse health effects and particulate concentrations measured at centrally located sites. Few studies quantify the contribution of ambient and indoor sources to personal exposures. This study quantifies the outdoor and indoor contributions to personal PM exposures, using $PM_{2.5}$ and PM_{10} measurements collected from 108 subjects and their residences in a large exposure assessment study conducted between 1999 and 2001. The PM data measurements consist of integrated measurements, using the Harvard impactors for fixed sites and Harvard personal environmental monitors for subjects, and continuous measurements using the Radiance nephelometers for fixed sites and personal DataRAM for a subset of subjects. The Teflon filters collected from the integrated monitors were analyzed for sulfur with XRF. We use several techniques to estimate the outdoor contribution to indoor concentrations (i.e., infiltration efficiency, F_{inf}) and to personal PM exposure (i.e., attenuation factor). These techniques include the random component superposition (RCS) model, fixed effect models with random intercepts or random slopes, recursive model, and the sulfur tracer technique. The RCS model, using 24-h integrated measurements, estimates the outdoor contribution to indoor and personal $PM_{2.5}$ concentrations to be 47% and 51%, respectively. The recursive model, using continuous measurements, estimate an average F_{inf} of 0.66 and an average attenuation of 0.68. Results from the fixed effect models using 24-h integrated measurements are similar to those from the RCS model. Based on the sulfur tracer method, the F_{inf} from home outdoor to home indoor site is 61±3% and the attenuation from central site to subjects is 0.45±0.03, and from home outdoor to subjects is 0.49±0.03, indicating that home outdoor $PM_{2.5}$ reflects more of subject exposure than the central site measurements. We examine the variability of F_{inf} and attenuation by subject, type of residence, season, and ambient particulate concentration. For indoor concentration models, the best fitting models have the infiltration efficiency varying by residence and cooking activities. For personal exposure models, the best fitting models assume a constant attenuation factor, with indoor and personal contributions varying by the age of subjects.

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[P15-33] TIME-RESOLVED DETERMINATION OF INDOOR, OUTDOOR AND REGIONAL CONCENTRATION RELATIONSHIPS FOR PM2.5 NITRATE, SULFATE AND CARBON.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Human health effects form the basis for the regulation of outdoor particulate matter, yet time activity studies show that most people, including children, spend the majority of their time indoors. Knowledge of indoor concentrations of particles of outdoor origin is needed to evaluate human exposure, especially for particles with diameters below 2.5 μm, called PM2.5, that are readily transported indoors. This paper examines the indoor concentrations for PM2.5 aerosols of outdoor origin through chemically- and time-resolved measurements in an unoccupied house, and examines the appropriateness of using regional data to model indoor concentrations from outdoor sources.

Sub-hourly concentration profiles of nitrate, sulfate, and black carbon were measured simultaneously at three locations: an unoccupied residence in Clovis, California, the backyard of the same residence, and a regional monitoring site in Fresno, California, located 6 km southwest of the residence. PM2.5 nitrate and sulfate concentrations were determined using an automated collection and vaporization system, and black carbon was assayed by light attenuation through a filter deposit. Indoor concentrations are compared to those measured immediately outside the house, and to those measured at the regional monitoring site.

Outdoors, the time-resolved data showed consistent daily, or twice-daily species concentration peaks of several hours duration. Indoors, these concentration peaks exhibited considerable attenuation and broadening as well as time-lag by comparison to the outdoor data. The indoor concentration reduction was the largest for PM2.5 nitrate, which appears to undergo phase changes in addition to indoor deposition and penetration losses. In general, much greater differences were seen across the building shell than between measurements immediately outside the house and the regional monitoring site. For this data set the regional results provide a good representation of the concentrations seen at the building exterior.

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[P05-34] PM CONCENTRATIONS AND SOURCES IN SWEDEN.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

A network of Swedish sites, ranging from regional rural background, urban background to kerbside sites, measuring PM2.5 and PM10 on one hour basis has been operated over 2 years in Sweden. The results show two important features determining the concentrations, long distance transport of particles and re-suspension of road dust. Strong low level inversions especially in the inland of Northern Sweden during lock out the long distant transport and lead to less dilution of the local emissions and induce at times very high concentrations in areas like the inland of northern Sweden during winter time.

Typical annual mean values for PM2.5 at rural background, urban background and kerb site are 5 - 10, 6 - 11 and 10 - 15 μg/m3, respectively, while for PM10 it is 7 - 13, 12 - 18 and 20 - 30. The ratio PM2.5/ PM10 is about 0.8, 0.6 - 0.7 and 0.4 - 0.6. The strongly decreasing ratio implies the strength of road dust emissions and other mechanical wearing processes giving coarse particle emissions.

Using NOx as a tracer for traffic emission and assuming a fixed relation to NOx for the particle exhaust emissions the non-exhaust emission factors for PM2.5 and PM10 is estimated to 25 and 200 mg/vehkm compared to the estimated 23 mg/vehkm for exhaust related particle emissions. Totally the non-exhaust emission factor for PM10 is 9 times larger than the PM10 exhaust emission factor but for PM2.5 the non-exhaust emission factor is equal to the exhaust emission factor.

Road dust emerges as the major local source responsible for exceedance of limit values in Sweden. However it is superimposed on strongly enhanced background concentrations due to long distance transport.

Emission factors and high resolved sixe distributions show clearly that PM2.5 is strongly disturbed by non-exhaust coarse particle sources. PM2.5 do not reflect the correct concentrations due to combustion sources and long range transported emissions. Using PM2.5 will strongly complicate the assessment of sources and the choice of abatement strategy. Use of PM1 would avoid these problems.

[P05-33] CORRELATING PARTICULATE MATTER MOBILE SOURCE EMISSIONS TO AMBIENT AIR QUALITY.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Federal Highway Administration (FHWA) has developed its research needs for understanding particulate matter (PM) emissions resulting from vehicle traffic on transportation facilities. Particulate Matter is a pollutant that impacts transportation project development and highway usage due to air quality regulations that have been implemented to protect human health. Laws and regulations such as the Clean Air Act and the transportation conformity rule as well as other initiatives covered by the National Environmental Policy Act are highlighting the need for a better understanding of PM and its association with the transportation sector.

In an effort to broaden the understanding of mobile PM emissions, the FHWA established an integrated research program to fill gaps in the current understanding of mobile source induced PM pollution, including both PM10 and PM2.5, the two size fractions currently being regulated. This effort was initiated with a strategy document listing fourteen different projects that the transportation community should undertake to understand and apportion PM emissions from vehicles. One of these projects involved working with the EPA Supersites to collect traffic and air quality data.

The PM Traffic-Air Quality Supersite Project was initiated in the summer of 2001 using traffic data collected by transportation departments and PM emission data collected at EPA Supersites and other EPA monitors. This effort, intended to continue for a two-year period, will collect data from seven Supersite cities across the United States representing different geographical regions. Source apportionment will be performed to estimate highway vehicles' contribution to ambient PM2.5 in each urban area. The two-year collection period is considered adequate to establish trends or capture anomalies resulting from weather patterns. The study will also investigate the contribution from regionally transported vehicle emissions and the fugitive dust component generated locally by vehicle traffic.

Initial data for this project is currently being collected and analyzed to determine the extent to which correlations can be made between traffic and PM emissions. Reporting from this study is intended to be quarterly to understand seasonal variations. This data and the results of this project are intended to serve as a planning resource for State and local agencies responsible for reducing PM emissions by enabling them to develop accurate apportionment of mobile source PM emissions.

[P05-31] THE RELATIVE CONTRIBUTIONS OF DIESEL AND GASOLINE EXHAUSTS TO PM-2.5 INVENTORIES.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

EPA emission inventories show that diesel engines and vehicles make a greater contribution to PM-2.5 emission inventories than do gasoline engines and vehicles. The diesel contribution is greater for both on-road vehicles (trucks and cars) as well as non-road engines (including agricultural equipment, construction equipment, lawn & garden equipment, and recreational marine). The emission inventories are prepared from models using g/mile emission factors for vehicles coupled with vehicle miles traveled. PM-2.5 emission inventories for nonroad engines are prepared from a separate model utilizing emission factors (in g/hour or g-brake horse power-hour) and usage information. These inventories are prepared at the county level. However, source apportionment studies done in various parts of the country show a range of different results. Some studies show that gasoline engines and vehicles make a greater contribution to ambient PM-2.5 while others show that diesel vehicles make a larger contribution. A major issue in preparing emission inventories is gasoline particulate emissions from passenger cars. This paper will discuss how gasoline particulate emission inventories are prepared and what test data are being obtained to improve the emission factors used in these inventories. A discussion of the strengths and limitations in receptor models in informing inventory development is also provided.

[P05-30] ASSESSING PARTICULATE MATTER EMISSIONS FROM LIGHT-DUTY, GASOLINE POWERED MOTOR VEHICLES.

Rich Baldauf, Joe Somers, Gene Tierney, Carl Fulper, Jim Warila, Peter Gabele, Brent Bailey, Steve Cadle, Doug Lawson
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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Mobile sources significantly contribute to ambient concentrations of airborne particulate matter. Recent source apportionment studies for PM10 and PM2.5 indicate that mobile sources can be responsible for over half of the ambient PM measured in an urban area. Some of these source apportionment studies have attempted to differentiate between contributions from gasoline and diesel combustion. Studies conducted in Denver and Phoenix indicated that gasoline combustion from mobile sources contributed more to ambient PM than diesel combustion. However, studies conducted in Los Angeles and the San Joaquin Valley in California indicate that diesel combustion contributed more than gasoline combustion to ambient PM. Existing emission inventories developed by the U.S. Environmental Protection Agency (EPA) also suggest diesels contribute more than gasoline vehicles to ambient PM concentrations.

The U.S. Environmental Protection Agency (EPA) is conducting a program to evaluate PM exhaust emissions from light-duty, gasoline powered vehicles. The program consists of measuring PM2.5 and criteria gases in exhaust emissions of 480 randomly selected, light-duty motor vehicles in the Kansas City Metropolitan Area using a portable chassis dynamometer. Continuous and integrated PM2.5 measurements will be collected for each vehicle. A select number of vehicle samples will be analyzed for metals, EC/OC, ions, and SVOCs. This paper details the project design, including vehicle selection and recruitment, dynamometer testing methods, and analytical procedures. Preliminary results will also be presented, and compared with existing emission inventories and mobile emission factor modeling results.

[P05-29] STATISTICAL ANALYSIS OF FUEL, EQUIPMENT, AND DRIVING SCHEDULE EFFECTS ON PM EMISSIONS FROM HEAVY VEHICLES.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Two rounds have been completed in a multi-year experimental program to evaluate the effects of ultra-low sulfur diesel fuels and passive diesel particulate filters in truck and bus fleets operating in southern California. The two rounds represent repeated measurements on the vehicles at approximately 150,000 and 300,000 accumulated miles. Along with the primary objective of evaluating the effects of the experimental factors, estimation of the deterioration of PM emissions under these conditions over time is also of interest.

Owing to the multiple factors encompassed by the experimental design, the statistical analysis of the data is not straightforward. The analysis is driven by considerations of fixed and random effects in a general linear statistical model which are operationalized through the analysis of variance (ANOVA) and analysis of covariance (ANCOVA) methodology. This presentation details the analytical approach and reports findings from the overall study.

The research is significant in that the interrelationship of factors contributing to diesel-related PM emissions in heavy vehicles is not completely understood, nor is their long term persistence due to protracted use of the vehicles fully appreciated. A faithful assessment of the significance of interacting factors and the related uncertainty requires better experimental designs and more sophisticated statistical treatment than have heretofore been applied. Further, greater reliance on heavy vehicles in the transportation sector has the potential to appreciably impact the total burden of PM emissions over time, particularly in urban areas, and thereby encumber efforts to moderate its consequences on the environment and human health.

[P05-28] MODELING VOLATILE NANOPARTICLES GENERATED BY MOTOR ENGINES.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Present engine particulate emission standards are based on mass. Recently it has been pointed out that it is not sufficient to study only the particulate mass. The main concern is that, while nanoparticles (NPs, diameter $\leq$ 50 nm) contribute a small fraction to the mass concentration of the ambient aerosol, they may contribute disproportionately to its toxicity because of their high number concentration and surface area, high deposition efficiency in the pulmonary region, and high propensity to penetrate the epithelium. In view of the potential strong adverse health effects associated with NPs, future standards might be imposed on NP emissions and NP emissions from gasoline engines may also become a concern. Effective and least costly means of NP emission reduction must be based on a firm physical understanding of the formation mechanisms of NPs in vehicle exhaust. Such an understanding is also important to interpret the NP measurements taken under different conditions and to develop emission inventories.

Most of NPs generated by motor engines are formed during exhaust dilution from low volatile precursor gases and the measured NP concentrations are very sensitive to dilution and sampling conditions. In this study, we investigate the key processes and parameters controlling formation and evolution of NPs in vehicle exhaust through model simulations and comparisons with field measurements. The detailed aerosol dynamics are simulated with an advanced multi-type, multi-component, size-resolved particle microphysics model. Measurements of NPs made both in the laboratory and in the atmosphere under various conditions are analyzed. The classical binary homogeneous nucleation of H2SO4-H2O fails to explain the observed NP properties. We find that chemiions generated in engine combustor may play an important role in the formation of NPs in vehicle exhaust (Yu, 2002). The predicted NP properties based on our ion-mediated nucleation of H2SO4-H2O consistently explain the measurements in terms of total NP concentrations, and their sensitivity to fuel sulfur contents, on-road vehicle speeds, soot concentrations, and dilution conditions. Our study indicates that total number of NPs formed in engine exhaust is very sensitive to chemiion concentrations. If our theory is confirmed, removing small ions inside tailpipe with an electrical field can reduce NP emissions. (Yu, F., Chemiion evolution in motor vehicle exhaust: Further evidence of its role in nanoparticle formation, Geophys. Res. Lett., 29, 10.1029/2002GL015004, 2002.)

[P13-25] WITHDRAWN

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00:00 PM-5:00:00 PM) Grand Ballroom 2-4
WITHDRAWN

[P05-27] SPATIAL AND TEMPORAL ASSESSMENT OF A MOBILE SOURCE AEROSOL INDICATOR DURING WINTER IN BOSTON, MA.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Many urban locations are expected to be near or over the annual U.S. EPA standard for PM2.5 of 15.0 $\mu g/m^3$. Data from PM2.5 monitors in the same metro area only a few miles apart can be substantially different, with some over and some under the standard. Variation on this spatial scale is often presumed to be driven by local mobile source particle emissions. It is important to define the spatial extent of elevated PM2.5 for compliance and control purposes, as well as for health effect assessments. One indicator of local mobile source aerosol in urban areas is black carbon soot (BC), which has been shown to be well correlated with integrated EC filter samples. BC can be measured in real-time with a commercial instrument (Aethalometer) that is relatively simple to install and operate; the principle is light absorption through a quartz filter. A pilot study was performed during the winter of 2003 to assess the spatial and temporal extent of variation in the local mobile-source aerosol over the greater Boston metro area out to more than 25 miles from downtown, using BC as an indicator for that PM component. Given that other major mass components of PM2.5 (sulfate, organic carbon) in the NE US are secondary transported aerosols and tend to be uniform over this scale, the locally generated "tailpipe" component of PM should drive the shape of PM2.5 spatial gradients over the metro area. For monitoring locations, a series of eight sites were selected heading WNW from downtown Boston, generally away from immediate large sources of local mobile-source emissions. This design avoids coastal influence and allows the pilot study to be more readily generalized to other large metro areas in the northeast. Winter is the season where this gradient is expected to be largest; that plus the prevailing upwind direction relative to downtown Boston for the sites would give us a maximum spatial gradient result; other seasons and directions could be smaller, but none would likely be larger. Two "hotspot" sites are included to demonstrate the potential range of micro-scale variability over this domain, since the core effort of this pilot study is intended to characterize only large scale spatial patterns. BC data are analyzed for spatial patterns on different time scales (overall mean, day of week, time of day, event periods). Limitations of this pilot study include the lack of seasonality, up-wind versus downwind spatial patterns, effects of local topography on measurements (including high-elevation sites), and minimal hotspot characterization. Some of these aspects are explored with short-term sites at high elevation near Boston, down-wind of Boston, and further west of the city.

[P05-26] MODELING OF THE NUMBER DISTRIBUTIONS OF URBAN AND REGIONAL AEROSOLS - EVOLUTION OF AEROSOL NUMBER DISTRIBUTION NEAR ROADWAYS.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Several studies have suggested that aerosol number concentrations may be more well correlated to health effects than mass concentrations and that particle number concentrations in the vicinity of freeways are significantly higher than their background level, which raises concerns regarding adverse health effects on people living there. Thus it is important to understand how particles transport and transform near roadways for regulatory purposes.

Dilution is the dominant process in the evolution of aerosol number distribution near roadways. We found that exhaust usually experiences two distinct dilution stages after being emitted: the first stage dilution is induced by traffic-generated turbulence and the dilution ratio usually reaches about 1000:1 in around 1s; the second stage dilution is mainly dependent on atmospheric turbulence and the additional dilution ratio is usually around 10:1 in about 10 min.

Also, the aerosol dynamical processes besides dilution were investigated in the two stages. In the first stage dilution, sulfuric acid-induced nucleation is the dominant particle production mechanism, followed by the condensation of low volatility organics, resulting in the rapid growth of nuclei mode particles and relatively slow growth of accumulation mode particles. Although its time span is very short, the first stage is crucial for activation of nuclei mode particles due to high concentrations of condensable species during this period. During second stage dilution, particles can still grow by condensation but the growth rates keep decreasing away from the roadways. At several hundred meters away, the aerosol distributions become background-like as a result of dilution.

In our model simulation, we found that that the possibility of sulfuric acid-induced nucleation strongly depends on the duration of the first stage dilution, i.e., it has to be fast enough to keep sulfuric acid in the gas phase, which otherwise will condense on pre-existing particles rather than initiate nucleation. An implication is that dilution time scale and dilution ratio are equally important for designing dilution tunnels able to simulate real world conditions.

While much effort has been put into studies of particle formation in diesel exhaust, more work needs to be done in gasoline exhaust. The conditions under which there will be a nucleation event in gasoline engine still remain unclear. It will be very helpful to conduct accurate in-cylinder measurements on aerosol size distribution as the starting point of the evolution process.

[P13-02] A SOURCE APPORTIONMENT OF FINE PARTICULATE MATTER IN LOWER MANHATTAN FOLLOWING THE WTC DISASTER.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Following the World Trade Center (WTC) Disaster in New York City (NYC), it was presumed by many that all particulate matter (PM) air pollution measured in Lower Manhattan was emanating from Ground Zero. But NYC is a polluted city even without the addition of the WTC pollution. So we sought to determine how much fine particle mass (PM2.5) measured in Lower Manhattan was associated with the WTC dust and combustion plume.

We analyzed PM2.5 samples collected daily (sometimes twice daily) by our monitors at the NYU Downtown Hospital, located some 5 blocks east of Ground Zero, from Sept 14 through December, 2001. Each sample was analyzed for trace elements via X-ray Fluorescence and for elemental carbon (EC) via reflectance. Positive Matrix Factorization (PMF) source apportionment analysis was applied to determine the PM components contributing to the ambient PM2.5 measured in September-December, 2001. The PMF identified 5 PM2.5 source components: 1) the WTC fire's plume (S, Cl, K, Cu, Zn, Pb, EC); 2) the WTC Collapse-related Dust (Mn, Cr, EC); 3) WTC Demolition-related Dust (S, Si, Ca, Ti, Fe); 4) oil combustion particles (S, V, EC); and, 5) soil (Al, Fe). Time-series plots of the source factor impacts indicate that the WTC fire plume impact were maximum during September, diminishing greatly during October. In mid-October, the demolition operations dust increased as the rescue operations ended and the clean-up began, and then decreased greatly during November. Oil combustion was a large contributor to PM2.5 throughout the entire study period, irrespective of World Trade Center operations. PM2.5 concentrations during late September averaged 35 ug/m3, and during the month of October some 22 ug/m3, while during November and December levels returned to more usual NYC levels (18 and 15 ug/m3, respectively). Analyses of the source contributions indicated that the WTC-related sources (Factors 1-3) contribution = 50% of the pollution in Lower Manhattan during September14-30th, = 27% in October, = 14% in November, and only = 6% in December. While the WTC pollution added greatly to the PM2.5 levels in lower Manhattan in September, it had a diminishing impact on this pollutant in the following months, and non-WTC sources of PM2.5 (such as fuel oil burning) were also major contributors to pollution in Lower Manhattan throughout the entire period. Clearly, any analysis of fine PM outdoor exposures seeking to assess the impacts of the WTC Disaster must take other non-WTC PM2.5 sources into account.

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[P15-27] CONTINUOUS MONITORING OF FINE PARTICLES FROM SHOWERING.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Solid particle formation from dissolved and suspended solids in domestic tap water during showering may be attributed to evaporation of micron-sized satellite droplets produced during showerhead spray formation or from splashing of millimeter-sized spray droplets on surfaces. Duplicate continuous particle monitors were used to measure particle size distributions in residential bathroom air under various showering conditions, changed by adjusting spray settings and water temperature, flow rate, pressure, and total dissolved solids content. A full-size mannequin was positioned in the shower to simulate splashing effects during showering. Mass concentrations were estimated from the measured bathroom particle number concentrations and used to predict emission factors for various particle size ranges under different showering conditions. Fine particle accumulation rates of 2.7 - 41.3 mg/m3/min were projected for various test conditions with the shower on. Estimated PM2.5 concentrations in bathroom air reached several hundred micrograms per cubic meter. Rates of particle formation tended to be highest for coarse shower spray settings and with direct impact on the mannequin. No consistent pattern was apparent for water temperature and pressure effects on emission rates.

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[P15-07] EIGHT YEAR TRENDS IN FINE PARTICLE CONCENTRATIONS, COMPOSITION, AND GASEOUS CO-POLLUTANTS IN THE SOUTHERN CALIFORNIA CHILDREN'S HEALTH STUDY.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Ambient air quality data have been collected in twelve central and southern California communities since 1994 to support the ten-year Children's Health Study conducted by the University of Southern California. The objective of the Children's Health Study is to identify chronic health effects of ambient air pollution and determine which pollutants are responsible for the effects. Twelve communities with differing levels of air pollutants and distinct chemical profiles were selected for prospective air quality and health outcome monitoring. A new sampler was developed to obtain long-term air pollutant data in a cost-effective manner. The novel 5-legged Two-Week Sampler (TWS) collects two-week integrated samples of PM2.5 mass, sulfate, nitrate, chloride, ammonium, elemental carbon, organic carbon, trace metals, and gaseous nitric acid, hydrochloric acid, formic acid, and acetic acid. The TWS measurements were supplemented with continuous measurements of ozone, NO, NO2, CO, PM10 mass, and particle number.

In this presentation, we describe the quality, uses, and trends in the Children's Health study air quality data. Specifically, we discuss the precision of the TWS data based on 8 years of collocated sampling at numerous locations and the accuracy of the TWS based on comparison with reference methods, including the daily FRM samplers. The various uses of the data, ranging from short-term to long-term analyses, are described. Lastly, the trends in ambient concentrations from 1994 to 2001are presented along with their relevance for the health effects study.

[P13-01] REVIEW OF SOURCE APPORTIONMENT TECHNIQUES FOR AIRBORNE PARTICULATE MATTER.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Epidemiological studies have established a relationship between the concentration of airborne particulate matter smaller than 2.5 microns in aerodynamic diameter (PM2.5) and increased morbidity and mortality. In response to this finding, the United States Environmental Protection Agency has developed a National Ambient Air Quality Standard for PM2.5 concentrations. Air quality managers at the national, state, and local levels will soon need to characterize their particulate air quality problems and devise a strategy to reduce PM2.5 concentrations to protect public health. The most effective set of emissions controls is not obvious, however, since a variety of sources are response for fine primary and secondary particulate matter to the atmosphere.

A large number of statistical source apportionment techniques have been proposed in the past 30 years to identify source contributions to airborne particulate matter concentrations. In recent years, a mechanistic source apportionment technique also has been developed for this purpose. Each of the statistical and mechanistic techniques has individual strengths and weaknesses. In this paper, the mathematical basis for each state-of-the-art source apportionment techniques will be discussed and contrasted. The strengths and weaknesses of each method will be identified, and promising areas for further research will be recommended.

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[P15-16] CHARACTERIZING PERSONAL EXPOSURES TO AMBIENT AND NON-AMBIENT PM2.5 FOR THREE SENSITIVE COHORTS IN BOSTON AND BALTIMORE.

Kathleen W Brown, Jeremy A Sarnat, Petros Koutrakis Environmental Health, Harvard School of Public Health, Boston, MA

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

BACKGROUND: Epidemiological studies of PM have indicated that specific sub-populations may be at greater risk from PM-associated morbidity and mortality as compared to healthy adults. To date, it is unclear whether exposures for these cohorts differ from those for healthy cohorts. The objectives of this study are to characterize the personal PM2.5 exposures for susceptible cohorts and examine factors that influence their exposures. METHODS: Personal PM2.5 exposures and corresponding ambient concentrations were measured for 99 subjects (40 healthy senior citizens, 44 children and 15 individuals with COPD), living in the Baltimore, MD and Boston, MA, areas. Mixed regression models were used to assess the contribution from ambient PM2.5 and non-ambient PM2.5 to total personal exposures. RESULTS: Contributions of ambient PM2.5 to total personal PM2.5 were comparable among the measured cohorts, as evidenced by the similar slopes from the mixed model analysis among cohorts in a guven city during the same season (Table 1). Exposure to ambient PM2.5 comprised a greater fraction of total exposures for subjects from all cohorts in both cities during the summer as compared to the winter. Ambient PM2.5 contributed almost twice as much to total personal exposures during the summer and may be due to the fact that individuals spent greater periods of time outdoors and within poorly sealed indoor environments in the summer. The only significant difference in exposure to non-ambient PM2.5 among the cohorts was between children and seniors in Baltimore during the summer.

Table 1. Mixed model results by cohort.

CITY	SEASON	COHORT	SLOPE (SE)	INTERCEPT (SE)
Baltimore	Winter	Seniors	0.25 (0.09)*	13.1 (3.7)*
		Child	0.27 (0.07)*	18.0 (3.9)**
		COPD	0.15 (0.09)	14.7 (3.8)*
	Summer	Seniors	0.52 (0.05)**	8.5 (1.7)**
		Child	0.70 (0.11)**	5.6 (2.7)*
Boston	Winter	Seniors	0.20 (0.06)**	12.9 (1.6)**
		Child	0.29 (0.09)*	14.6 (1.7)**
	Summer	Seniors	0.74 (0.10)**	9.9 (1.6)**
		Child	0.79 (0.07)**	15.3 (1.6)**

(**significant at 0.0001 level; *significant at 0.05 level)

[P15-06] COMPARISON OF COLLOCATED PERSONAL MULTI-POLLUTANT SAMPLERS VS. A CENTRAL AMBIENT AIR MONITORING STATION IN STEUBENVILLE, OHIO.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Several epidemiological studies have shown an association between PM2.5 concentration and adverse health effects. As a result, the U.S. EPA promulgated new ambient air standards for PM2.5. However, the National Research Council recommended that scientific uncertainties regarding the relationship between PM2.5 and health effects be clarified before PM2.5 standards are finalized. For example, do measurements conducted at a central outdoor ambient air monitoring station accurately reflect personal exposure? Is total PM2.5 mass, a component(s) of PM2.5, a co-pollutant, or a combination responsible for the observed association with adverse health effects? To help address these uncertainties, CONSOL Energy launched a three-year study called the Steubenville Comprehensive Air Monitoring Program (SCAMP). SCAMP is funded by the US DOE National Energy Technology Laboratory, Ohio Coal Development Office, Electric Power Research Institute, American Petroleum Institute, American Iron and Steel Institute, National Mining Association, Edison Electric Institute, National Institute of Environmental Health Services, US EPA, and CONSOL Energy.

SCAMP is comprised of two overlapping and interdependent sampling programs focused on measuring fine particulate and gaseous pollutants in the outdoor ambient air, inside the home, and in the breathing space of individuals. The outdoor ambient air program utilizes a central ambient air monitoring station equipped with federal reference method particulate samplers and federal equivalent method gaseous pollutant analyzers. The indoor and personal sampling program utilizes an integrated, filter-based, multi-pollutant sampler, developed by the Harvard School of Public Health. The multi-pollutant sampler is a modular sampling system that collects both particulate and gaseous pollutants simultaneously and can be deployed to sample in different environments (i.e., on a person, indoors, and outdoors).

A comparative analysis is presented of the federal reference method particulate sampler, federal equivalent gaseous pollutant analyzers, and the multi-pollutant sampler. The analysis is based on 20 weeks of collocated sampling data. The data establish a foundation for quantifying the relationship between personal exposure and a central ambient air monitoring station. Instrumental issues, such as accuracy, precision, and sensitivity, are discussed for the following pollutants: PM2.5, sulfate, sulfur dioxide, nitrogen dioxide, and ozone.

[P13-26] SHORT-TERM PM2.5 SOURCE APPORTIONMENT USING CONTINUOUS SAMPLERS.

Delbert J. Eatough, Russell W. Long, Norman L. Eatough, C. Arden Pope, William E. Wilson Chemistry and Biochemistry, Brigham Young University, Provo, UT; Ecomonics, Brigham Young University, Provo, UT; U.S. Environmental Protection Agency, Research Triangle Park, NC

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

As part of the Salt Lake City and Bountiful EPA EMPACT and STAR programs, PM2.5 mass was determined on a continuous basis in Salt Lake City and Bountiful, Utah using two different monitoring techniques. A TEOM monitor operating at 30 °C in the winter and 50 °C in the summer collected the nonvolatile fraction of the fine particulate material, but not semi-volatile nitrate or organic material. The BYU RAMS monitor measured total fine particulate material, including the semi-volatile nitrate and organic material. The difference between these measurements is the semi-volatile fine particulate material. In addition to these mass measurements, measurements were made on a continuous basis of other species associated with primary emissions or with secondary gas phase reaction processes. These included both the EC and UV adsorption measurements with an Anderson Aethalometer, NOx, NO2, CO and O3. Concentrations of nonvolatile and semi-volatile PM2.5 mass, determined from the 1-h average TEOM and RAMS measurements, and the listed marker species, were used in the EPA UNMIX program to identify both primary sources and secondary processes leading to observed concentrations of fine particulate matter. The analysis was successful in identifying the major primary sources of PM2.5, including emissions from diesel vehicles, other motor vehicles, refineries near Bountiful, smoke from home combustion of wood during the winter, and the impact in the urban area of wildfires in the mountains above Salt Lake City in the summer. Both nonvolatile and semi-volatile contributions to this primary PM2.5 were identified. Consistency was seen in all cases in the analysis of these two classes of primary fine particulate material for each source identified. In addition, PM2.5 signatures were identified which were not related to the primary emission markers, but were related to the markers of secondary chemistry. This included the identification of both nonvolatile and semi-volatile secondary material. During active photochemical periods, the pattern of secondary PM was similar to that of ozone, implying a photochemical production mechanism. During the time period when Salt Lake was impacted by the mountain forest fires, the bulk of the PM2.5 in the valley was secondary nonvolatile and semi-volatile products. The analysis technique will be illustrated with examples from both winter and summer pollution episodes. This apportionment method should be generally applicable to the identification of primary and secondary sources of fine particulate material on a short-term basis for use in the interpretation of data collected in epidemiologic and standard attainment studies.

[P15-08] AIR QUALITY AND COMPARATIVE EXPOSURE: A PARCEL-LEVEL CUMULATIVE RISK ANALYSIS.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

The study assesses the potential impacts at the parcel level of air toxics emitted from area sources in sections of the lower South Providence, Washington Park, and Elmwood neighborhoods of Providence, RI. Estimating potential risk at the parcel level enables a more detailed and comprehensive analysis, especially when comparing exposure.

Using emission rates provided by the RI Department of Environmental Management's Air Emissions Inventory, the SCREEN3 dispersion model, and generally accepted chemical toxicity values, estimated risk levels were calculated for each facility and chemical in the study area. Geographic Information System (GIS) was then used to estimate the cumulative maximum risk from exposure to multiple pollutants and sources. Demographic variables within these areas of risk were also addressed.

In order to assess human exposure to toxic and criteria air pollutants in Washington Park and Lower South Providence, this study created and utilized a four-pronged system of comparative exposure analysis. First, the manner in which chemical concentration decreases as distance from a facility increases was determined using the Rhode Island Department of Environmental Management Office of Air Resource's (OAR) Air Emissions Inventory This data was then used as input for the SCREEN3 dispersion model to assess the concentration of chemicals at different distances from facilities.

It is impossible, however, to determine a pollutant's risk to surrounding populations based solely on its concentration in the air. Thus, to evaluate the actual hazard these dispersed concentrations pose to exposed individuals, the Environmental Defense Fund's (EDF) listing of toxicity/potency factors and reference concentrations was incorporated into the model.

The model, coupled with EDF risk factors, determined how risk increased as chemical concentration increased. This study assumed that both cancer and non-cancer risks are additive across pollutants. Next, GIS combined the dispersed risk levels of each chemical from each facility and mapped cumulative risk isopleths. This technique generated maps displaying additively overlapping risks from multiple chemicals emitted from multiple facilities. The study then used these risk isopleths to evaluate comparative exposure of residents in Washington Park and South Providence.

[P13-04] DETERMINATION OF THE SOURCES CONTRIBUTING TO $PM_{2.5}$ IN TORONTO USING POSITIVE MATRIX FACTORIZATION.

Patrick K.H. Lee, Jeffrey R. Brook, Scott A. Mabury Meteorological Service of Canada, Environment Canada, Toronto, ON, Canada; Department of Chemistry, University of Toronto, Toronto, ON, Canada

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

There is a growing need to routinely monitor fine particulate matter ($PM_{2.5}$) in ambient air to better understand the processes controlling its concentration, to determine its sources and to learn more about its health effects. The chemical composition of Toronto $PM_{2.5}$ was measured daily from Feb. 2000 to Feb. 2001 to help address these issues. Source apportionment was undertaken using Positive Matrix Factorization (PMF). $PM_{2.5}$ is mainly generated from combustion processes or from gas-particle interactions and transformations. In Toronto, $PM_{2.5}$ levels are influenced both by local urban activities and also by regional-scale transport. The PMF analysis identified eight sources contributing to Toronto $PM_{2.5}$. The four main sources were coal combustion (26%) related to regional transport, secondary nitrate (36%) related to both local and upwind sources of NO_x and NH_3, secondary organic aerosols (SOA)+biomass burning (15%) and motor vehicle traffic (10%). The other detectable sources were road salt (winter), smelters or related industry and oil combustion. Low molecular weight organic acids, such as oxalic acid, were used to identify the SOA/biomass component. Without organic acids measurement this portion of the observed $PM_{2.5}$ was assigned to the coal combustion component, increasing its contribution significantly. This suggests that in the northeastern part of North America receptor modeling results that are unable to separate SOA/biomass from the sulfate-rich coal component may have attributed too much of the mass to coal combustion.

[P15-10] ASSESSING HUMAN EXPOSURES OF COPD-DIAGNOSED INDIVIDUALS TO PARTICULATE MATTER IN LOS ANGELES COUNTY.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Epidemiological studies link particulate matter (PM) exposure to increased cardiovascular and respiratory morbidity and mortality. These studies use central outdoor monitors as surrogates for community exposure. The relationship between personal exposure and centralized measurements is key to understanding whether this is a suitable surrogate, or whether its use as a surrogate could lead to epidemiological measurement error and misclassification of risk.

Personal, indoor, and outdoor air pollution concentrations (24-h) were measured in Los Angeles County during the winter and summer of 2000 for individuals with compromised respiratory systems. Fifteen participants with COPD were sampled in each season for seven consecutive days. Eight of these individuals were sampled during both seasons. Three participants were sampled concurrently during each seven-day period. Measurements include PM10, PM2.5, O3, NO2, SO2, and air exchange rate. A central-site monitoring station provided concurrent measurements over the entire study. Home characteristics, potential sources of pollutants, and participant location throughout the day were documented using household surveys, daily questionnaires, and time activity information.

A total of 855 PM10, 852 PM2.5, and 790 O3, NO2, and SO2 samples were collected. PM samples were weighed in a controlled environmental facility at EOHSI following EPA weighing protocols. Aqueous extracts from gas samples were analyzed by Ion Chromatography at the Meadowlands Environment Center. Field blanks, independent standards, and replicate analyses were used to determine detection limits, analytical accuracy, and precision.

Study participants spent in excess of 80% of their day in their residences. Mean personal PM2.5 was 27 and 53 micrograms/m3 for winter and summer, respectively. Mean indoor PM2.5 was 17 and 26 micrograms/m3 for winter and summer, respectively. Outdoor winter and summer PM2.5 means were 15 and 17 micrograms/m3. Individual correlations between personal and outdoor PM2.5 were sometimes quite high, with Pearsons correlation coefficients as high as 0.92. Outdoor O3 was higher than indoor and personal O3. In some homes, indoor and personal NO2 was substantially higher than outdoor, suggesting the importance of indoor sources to indoor NO2 concentrations for those homes. Mean personal O3 for winter and summer was 8 and 3 ppb (13 and 3% greater than MDL), while outdoor means were 9 and 14 ppb (25 and 53% greater than MDL). Mean personal NO2 for winter and summer was 11 and 7 ppb (81 and 27% greater than MDL), while outdoors was 13 and 10 ppb (91 and 40% greater than MDL). Few SO2 measurements were above detection limits (MDL = 4 ppb).

[P15-11] PERSONAL EXPOSURES TO PARTICULATE MATTER AND ITS COMPONENTS AMONG CHILDREN WITH ASTHMA.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

As part of Community Action Against Asthma, a community-based participatory research project in Detroit, MI, the role of PM on asthma exacerbation is being studied. Over a two-year period, two-week seasonal intensive measurement campaigns were conducted in which daily ambient and indoor measurements of PM2.5 and PM10 were collected at two elementary schools that represent community-level exposure and exposure in the classroom, respectively. Concurrent measurements of PM2.5 and PM10 were also made inside the homes of 20 asthmatic children as well as personal measurements of PM10 for the same 20 children using personal exposure monitors.

Gravimetric examinations of personal PM measurements from 2001 suggest that there are contributions to the children's PM10 personal exposures that are not captured by the fixed community-level monitoring sites. Average concentrations of the personal exposures among children in homes with smokers were 50.1 + 43.4 μg/m3, and for those in homes with no smokers, 39.4 + 29.2 μg/m3-both of which are 2-2.4 times greater than the PM10 measurements made at the community-level sites.

According to the activity data completed by the 20 children conducting personal exposure measurements, they spend, on average, 85% of their day indoors. The children's personal PM concentrations are significantly correlated with their home environment when categorized by smoking status ($p<0.0001$). As a result, the indoor micro-environmental measurements are important in the identification of major contributions to the children's exposures. In order to effectively assess the specific contributions to the children's personal exposures, comprehensive chemical characterization of the filter samples, including trace element and elemental and organic carbon, is conducted. Complete evaluation of the PM components will lend valuable insight on the sources contributing to the children's exposures. Furthermore, in conjunction with other project measurements including lung function and symptom information, the data will be helpful in assessing the role of air pollutants in the aggravation of childhood asthma.

[P15-12] HOURLY PERSONAL EXPOSURE TO INDOOR- AND OUTDOOR-GENERATED PARTICLES AMONG SENSITIVE POPULATIONS IN SEATTLE.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Epidemiologic studies have demonstrated an association between ambient particulate matter (PM) and health effects, and a few other studies have shown that health effects are associated with short-term spikes in PM levels. Very few studies have attempted to separate PM exposure into indoor- and outdoor-generated components, although these two classes of particles may have different chemical compositions and toxicities. In this paper we make such a separation on an hourly basis.

Our data were obtained as part of a larger exposure assessment study that collected indoor, outdoor, and personal PM concentrations from 108 subjects including elderly adults with and without chronic obstructive pulmonary disease (COPD) and coronary heart disease (CHD), as well as asthmatic children. This paper focuses on 55 subjects whose residences and personal air were measured continuously using the Radiance nephelometers and the Thermo-MIE personal DataRAM (pDR) on a subset of 14 subjects, respectively. Indoor, outdoor, and personal filter samples were also collected, and the subjects completed a time-location-activity diary (TAD). This paper uses a recursive mass balance model and the light scattering data to estimate particle infiltration (Finf) for each residence. Using these Finf values and the TAD data in a microenvironmental model, we then estimate hourly personal exposure to indoor- and outdoor-generated particles. In addition, we estimate the fraction of outdoor particles that result in personal exposure to outdoor-generated PM (i.e. the attenuation factor, α)

The overall mean Finf was 0.66±0.23, which was lower during the heating season (0.53±0.18, Oct.-Feb.) than during the non-heating season (0.80±0.19, Mar.-Sep.; $p<0.001$). Outdoor PM2.5 concentrations were higher during the heating season ($p<0.001$), but there was no seasonal difference in indoor or personal PM2.5 concentrations, indicating that the seasonal difference in outdoor PM2.5 concentration is counteracted by an opposite seasonal difference in Finf. The α estimates varied by subject and season, showing the same seasonal trend as the Finf estimates ($p<0.001$). However, there was no difference in α among the four cohorts. Estimates of exposure to outdoor-generated PM did not show any differences between seasons or health groups. Among the pDR subjects, the median longitudinal R2 between the modeled and measured personal exposures was 0.39.

This work was funded by the U.S. EPA under EPA Cooperative Agreement #R827177 and the EPA NW Research Center for Particulate Air Pollution and Health (#R827355).

[P15-13] SPATIAL VARIABILITY OF PM EXPOSURES AS DETERMINED IN THE THE FRESNO ASTHAMTIC CHILDREN\\'S ENVIRONMENT STUDY (FACES).

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

The overall goal of the Fresno Asthmatic Children's Environment Study (FACES) is to examine associations between air pollution and the extent, severity, and evolution of asthma symptoms in 6 to 14 year old children. The exposure assessment portion of the project is particularly aimed at developing estimates of each child's exposure to each pollutant and possible co-factors, such as pollen grains, fungal spores, and endotoxin, on each day of the study. A key hypothesis of the study is that different chemical species have concentrations that vary on urban, neighborhood, and household scales in the Fresno/Clovis study area. The FACES exposure assessment incorporates a variety of air quality and bioaerosol measurements to evaluate and characterize the spatial variability of air pollutants in Fresno as well as indoor/outdoor differences. The spatial variations are evaluated by comparing concentration data collected at homes, schools, and local air quality monitoring sites with those collected at the EPA-sponsored Supersite in Fresno.

The extent of spatial variation depends on the pollutant and proximity to source emissions. Significant spatial differences in the pollutants emitted by combustion sources, particularly PM2.5 elemental carbon, are observed. PM2.5 mass and PM10 mass concentrations also display significant spatial differences in Fresno that are consistent with the proximity of roadways. Likewise, the outdoor concentrations of pollen grains, fungal spores, and endotoxin depend on the local source strength and are shown to vary considerably across Fresno. In contrast, most secondary pollutants, such as PM2.5 sulfate and PM2.5 nitrate are spatially homogeneous on an urban and neighborhood scale. It is more difficult to interpret the spatial variability in the PM2.5 organic carbon concentrations because OC results from both primary formation, that varies on the local scale, and secondary formation, that does not typically vary on a local scale. Overall, the air quality data show spatial variations in concentrations of numerous agents large enough to warrant their inclusion in the exposure assessment methodology.

[P15-09] WOMEN'S PERSONAL AND INDOOR EXPOSURES TO PM2.5 IN MYSORE, INDIA - IMPACT OF DOMESTIC FUEL USAGE.

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The Indian economy is industrializing at an unprecedented pace, and the urban population is undergoing a rapid risk transition, facing both traditional and modern risks. Such risk overlaps are most frequent among poor urban women. However, little systematic information has been gathered on women's exposures to $PM_{2.5}$ and indoor concentrations, and the exposure variation due to fuel usage patterns and income class (Kandlikar and Ramachandran, 2000).

The results presented here are part of an ongoing larger study that is investigating the relationship between fuel usage for domestic cooking, $PM_{2.5}$ personal exposures and indoor levels, and respiratory health symptoms and spirometry parameters. Personal and indoor 24-hour average exposures to $PM_{2.5}$ were measured gravimetrically for 30 women (15 using kerosene and 15 using LPG for cooking) during summer and winter in Mysore, India. Concurrent gravimetric measurements of indoor $PM_{2.5}$ levels were also made. Gravimetric measurements were made using inertial impactors with $PM_{2.5}$ inlets (PEM Model 200, MSP Inc., Minneapolis, MN). Real-time measurements using a light scattering photometer (DustTrak, TSI Inc.) and a surface area monitoring diffusion charger (LQ1-DC) were obtained in selected residences.

Personal exposures of women using kerosene ranged from 49 to 268 $\mu g/m^3$, while those for women using LPG ranged between 8 and 236 $\mu g/m^3$. Kerosene users had a least squares mean exposure of 111 $\mu g/m^3$ (SE = 11 $\mu g/m^3$) and this was statistically significantly higher than the mean of the personal exposures of LPG users (LS mean = 68 $\mu g/m^3$, SE = 11 $\mu g/m^3$). Indoor concentrations ranged between 25 and 218 $\mu g/m^3$ for kerosene-using homes, while the levels for LPG-using homes ranged between 11 and 156 $\mu g/m^3$. Again, kerosene using homes had a least squares mean $PM_{2.5}$ level of 104 $\mu g/m^3$ (SE = 10 $\mu g/m^3$) and this was statistically significantly higher than LPG-using homes (LS mean = 76 $\mu g/m^3$; SE = 10 $\mu g/m^3$). Although indoor levels were lower than personal exposures, the difference was not statistically significantly. The preliminary data indicate that women who use kerosene as their main cooking fuel face higher exposures to $PM_{2.5}$ than women who use LPG.

Kandlikar, M. and Ramachandran, G. (2000). "The causes and consequences of particulate air pollution in urban India: A synthesis of the science", *Annual Review of Energy and Environment*, Vol. 25: 629-684.

[P15-15] COMMUTERS' EXPOSURE TO PM2.5, CO AND BENZENE INSIDE THE PUBLIC TRANSPORT IN MEXICO CITY:

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In the last 10 years, the levels of criteria pollutants in Mexico City have decreased substantially with the implementation of Air Quality Programs such as PICCA 1990-1995 and PROAIRE 1995-2000. Replacement and improvement of fossil fuels and introduction of clean technologies for the industry and transport sector are some examples to consider in order to understand why the ambient air pollution levels are now lower than 10 years ago. However, the concentrations of PM2.5, CO and benzene have not been evaluated using an integrated sampler during commuting periods in Mexico City to establish the impact produce from mobile sources as well as other anthropogenic sources that might represent a potential threat for commuters inside public transport.

We carried out a study to measure commuters' exposure to PM2.5 and its composition, to compare CO levels with a previous study carried out in 1991, to sample benzene using an integrated sampling technique and finally to use the data collected to prepare a main campaign to be conducted in winter 2003.

PM2.5 (N=84), CO (N= 78) and benzene (N=26) were measured during morning (6:30-9:30 am) and evening (17:30-20:30) rush hours on minibuses, buses and metro from the 6th of May to the 1st June 2002. Additionally, 2 midday journeys (11:00-14:00 and 14:00-17:00) using the same modes of transport were sampled to compare the differences among morning, evening and midday hours. Three corridors were selected from a previous study conducted in 1991 (1.Indios Verdes-San Angel, 2.Pantitlan-Tacubaya, and 3.La Villa-Auditorio Nacional). For PM2.5, mass concentration was determined in all samples. Nitrates, sulfates, inorganic elements and carbon fraction were evaluated. CO samples were taken using passive monitors and 6-liter canisters were used to collect integrated samples for benzene using flow controller devices. The highest GM concentration for PM2.5 (84 μg/m3) was detected in morning rush hour journeys inside minibuses. A maximum PM2.5 value of 137 μg/m3 was detected in a bus journey during an evening rush hour. The main component identified on PM2.5 samples was carbon fraction (more than 50%). The sulfur element presented the highest concentration among the elements identified in all samples. Carbon monoxide levels were approximately 3 times lower than those found in a study conducted in 1991. Finally, the maximum GM concentration for benzene was detected inside minibuses (8 ppb) during morning peak hours.

[P15-26] WITHDRAWN

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WITHDRAWN

[P15-17] FACTORS AFFECTING PERSONAL AND INDOOR CONCENTRATIONS OF $PM_{2.5}$, PARTICULATE NITRATE, AND ELEMENTAL CARBON FOR INDIVIDUALS WITH COPD IN LOS ANGELES, CA.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

A study characterizing the personal, indoor, and outdoor concentrations of $PM_{2.5}$ and its components, including nitrate (NO_3^-) and elemental carbon (EC), was conducted in Los Angeles, CA for individuals with chronic obstructive pulmonary disease (COPD). Monitoring was performed for 15 participants for 7 consecutive days in the winter and summer of 2000, respectively. During each sampling day, 24-hr personal, indoor, and outdoor samples of the targeted pollutants were collected simultaneously. Housing characteristics and time-activity diaries were also obtained. In the current paper, the ANOVA procedures and the longitudinal regression analyses were performed to examine the effects of potential particle-emitting activities, geographical location, traffic, and population density on the personal exposure and indoor levels.

Results showed that particle-generating activities were not important contributors to indoor particulate levels, as cooking, cleaning and ETS were statistically insignificant predictors of indoor concentrations. This result was due to the relative inactiveness of the participants. For indoor NO_3^-, air exchange rates were found to be an important effect modifier, with its penetration efficiency increasing and the indoor source contribution decreasing with air exchange rates. For other particulate species, air exchange rates were neither a significant covariate nor an important effect modifier.

Microenvironmental models were constructed to evaluate the importance of indoor and outdoor concentrations to personal exposures. In general, especially in the winter, time-weighted indoor exposures were better predictors of personal $PM_{2.5}$ exposures as compared to time-weighted outdoor levels. In the summer, the intercepts of the personal $PM_{2.5}$ exposure models were comparable to those for the indoor models, suggesting that the contribution of indoor and personal sources to indoor concentrations and personal exposures were the same. Microenvironmental models explained more than 40% of the variability in personal exposures for all particulate measures in both seasons with the exception of summertime $PM_{2.5}$. As was the case with indoor concentrations, few particle-generating activities were found to contribute to personal exposures. ETS exposures were also found to be important contributors to personal $PM_{2.5}$ exposures. Finally, in the summer, the personal NO_3^- exposures for participants living in homes within 100 meters of a major road were on average 0.58 (±0.23) $\mu g/m^3$ higher than participants living farther away from major roads.

[P15-18] MICROENVIRONMENTAL MODELING OF PERSONAL EXPOSURES TO PARTICULATE MATTERS AMONG ASTHMATIC CHILDREN.

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Most epidemiologic studies estimate air pollution exposures from fixed-site monitor measurements, as personal exposure measurements are rarely available. Our previous studies have shown that we can predict PM2.5 exposures among elderly populations reasonably well with a microenvironmental model. However, for asthmatic children, the prediction power of the microenvironmental model is usually low. This study demonstrates how real-time monitoring instruments may help improve the performance of the prediction model.

This paper uses a subset of data from a larger panel study conducted in Alpine, CA. Continuous PM concentrations were measured using the Thermo-MIE personal DataRAM (pDR) on 14 pediatric asthmatic subjects, at their residences indoors and outdoors, and at a central site. Three approaches were applied to model personal exposures: (1) The pDR data at the central site were averaged over a 24-hr period to represent the personal exposures; (2) The pDR data at the monitored microenvironments were averaged over a 24-hr period to simulate the conventional time-integrated filter samples. A time-weighted three-microenvironment (μe) model was then used to calculate the 24-hr average personal exposures; and (3) The 15-min personal exposures were estimated from the continuous pDR data with a similar three-μe model. The estimated 15-min exposures were then averaged over a 24-hr period.

The prediction powers (R^2) for the three approaches were 0.07, 0.12 and 0.18, respectively, indicating that applying continuous data (Approach 3) to the μe model improved the prediction power. Further analysis with 1-hr average pDR data with Approach 3 shows that the R^2 between modeled and measured personal exposure in the home-indoors μe is 0.33 while the R^2 between modeled and measured personal exposure in the other μe's range between 0.03 to 0.05. To more accurately estimate the exposure levels in major μe's where no monitoring data are available, a model with spatial and temporal variants (e.g. latitude, longitude, elevation and time of the day) is developed.

This study is funded by the NIH/NIEHS grant ES-06214 and EPA Northwest Research Center for Particulate Air Pollution and Health grant R827355.

[P15-20] RELATION BETWEEN AMBIENT AND EXPOSURE CONCENTRATIONS FOR PARTICULATE MATTER AND ITS TOXIC CONSTITUENTS IN AN INDIAN METROPOLITAN REGION.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

In India, as well as in most other countries standards for protection of human health are prescribed for Ambient Air quality (AAQ), which is therefore routinely measured by regulatory authorities,.However,it is well accepted that Personal Exposure (PE) concentration is the true indicator of health risk. Hence, the objective of this work was to carry out simultaneous monitoring of AAQ and PE to investigate the relation between them.

This study was carried out in Mumbai City in India. Outdoor workers like traffic policemen, watchmen, and roadside workers were chosen as respondents, since they are exposed to very high levels of both outdoor and indoor air pollution and bear the worst exposure in the city. The daily integrated exposure of the outdoor workers consists of two major microenvironments viz. occupational and indoor residential. AAQ was measured as prescribed by NAAQS, India by a Hi Vol Sampler with a PM10 attachment. The personal sampler had a 50% removal efficiency for Respirable Particulate Matter (RPM) of size 5 μm. The particulates collected were analyzed for toxic elements by Atomic Absorbtion Spectrophotometer and Voltametry.

The results given in Table 1 show that the average 24-hr integrated exposure exceeded the measured AAQ level by a factor of 2.3. This ratio will be higher if AAQ monitoring of PM5 is done. No correlation was found between paired samples of AAQ and PE, which questions the logic of using AAQ data for health studies. The daily integrated exposure to lead exceeded the corresponding NAAQS, India (1.0 $\mu g/m^3$) by a factor of 4.2, although ambient concentration conforms. The residential concentration of metals is less than occupational except for potassium, since this metal originates from an indoor source. Thus, this study clearly shows that the health risk to city population is significantly more severe than that indicated by AAQ data collected for regulatory purposes.

TABLE 1 : COMPARISON OF AMBIENT AND EXPOSURE CONCENTRATION OF PARTICULATE MATTER (PM) AND ITS TOXIC CONSTITUENTS IN $\mu g/m^3$

Concentration Type	PM	Pb	Cd	Mn	K
Ambient	140	0.34	0.02	0.15	0.54
Occupational Exposure	358	4.38	0.20	1.98	3.47
Residential Exposure	308	4.09	0.11	0.18	4.59
24 Integrated Exposure	322	4.20	0.13	1.98	3.30

[P15-21] WILDFIRES AND PRESCRIBED BURNS IN COLORADO: IMPACT ON AIR QUALITY.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

The wildfires of the summer of 2002 have increased awareness of the influence of wildfires on urban air pollution. Our current research focuses on two areas. First, we have looked at the impact of wildfires on indoor air quality and the effect of mitigation measures. Secondly, we are looking at determining the contribution of wildland fires to urban fine particulate matter.

Acute exposure to PM2.5 has been linked to increased mortality rates, increased hospitalizations, increased emergency room visits, and decreased lung function. PM2.5 from wildland fires in particular may have adverse affects on the respiratory health of people living in western cities. Information about the impact of wildfires on indoor air quality and the effect of mitigation measures can help residents near wildfires and prescribed burns keep themselves safe from acute exposure to particulate matter. Determining the contribution of wildland fire smoke to urban PM2.5 levels will provide important information for public health agencies and wildland fire managers.

The first prong of our research was conducted from October of 2001 to July of 2002. During this time, air quality characterization equipment was taken to ten different houses during four separate fires. This equipment included particle counters, PM2.5 impactors, and air cleaners. Measurements were taken simultaneously both inside and outside of the residences. Homeowners were instructed to keep windows closed, and half of the houses were equipped with electrostatic air cleaners. Closing the windows yielded a 20% - 50% reduction in PM2.5 levels, while the result of using air cleaners in a house was a 60% - 90% reduction.

The second prong of our research was started in September of 2002. There will be three phases to the project: sample collection, chemical analysis of the samples, and then source apportionment using the chemical data. The samples from the wildfires will be used to find compounds specific to wildland fires. This information will be used in a chemical mass balance model to apportion the affect wildland fires have on urban air pollution. Urban PM2.5 samples have already been collected in Denver and will be compared to the Urban PM2.5 samples.

[P15-22] CHARACTERIZATION OF RESUSPENDED HOUSE DUST AS A SOURCE OF PM EXPOSURE.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

House dust resuspended by human activity can be a major source of human exposure to particulate matter (PM). For a non-smoking home in Redwood City, California with typical human activity levels, we found that 45-65% of the indoor PM-5 was from particles resuspended by the human activities. Two separate studies were performed to characterize resuspended house dust as a source of human PM exposure. The first study compares the personal exposure monitor (PEM) and stationary indoor monitor (SIM) particle concentration during a series of 6 vacuuming events in a home. PEM PM-2.5 and PM-5 concentrations were on average 1.3 and 1.6 times as high as SIM levels, respectively. PEM levels of particles greater than 10 μm were on average 10 times as high as the concentration measured at the SIM location, and up to 200 times as high as the background concentration measured before the activity began. By correlating real-time data with activity patterns, specific activities were associated with increased exposure levels.

For the second study, a series of prescribed human activities were performed while collecting concurrent real-time and integrated filter measurements from PEM, SIM, and stationary outdoor (ambient) monitor (SAM) locations. PEM PM-2.5 and PM-5 concentrations were on average 1.4 and 1.6 times as high as SIM levels, respectively. All prescribed human activities resuspended particles with a similar particle size distribution. Approximately 90% of the total suspended particle (TSP) volume was greater than 5 mm in diameter, and 10% of the TSP volume was less than 2.5 mm in diameter. The submicron particles accounted for less than 1% of the indoor TSP volume.

Indoor, outdoor, and personal PM-5 filters were microwave digested and analyzed for elemental ions using inductively coupled plasma-mass spectrometry (ICP-MS). For most elements, the indoor and personal concentrations were higher than the outdoor concentrations. The indoor and personal profiles matched closely, indicating that the composition of the indoor and personal filter samples was similar. The elemental profile of a dust sample collected from the vacuum cleaner matched the profiles from the personal filter samples collected after human activity periods. This finding suggests that elemental profiles from dust samples collected from respondents' vacuum cleaners can be used to represent resuspended house dust in chemical mass balance (CMB) source apportionment analyses. Using this approach, the source contribution of resuspended house dust could be resolved for larger-scale exposure studies where indoor sources are not prescribed or temporally isolated.

[P15-23] ANALYSIS OF INDOOR, OUTDOOR AND PERSONAL PM2.5 SPECIES TO ASSESS THE SOURCES OF EXPOSURE: RESULTS FROM RIOPA.

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The Relationship of Indoor, Outdoor and Personal Air (RIOPA) study measured indoor, outdoor and personal concentrations of VOCs, carbonyls, PM2.5, and PM2.5 species in residences of Houston, TX, Los Angeles County, CA, and Elizabeth, NJ. A total of 212 homes were sampled for PM2.5 and 162 of those homes were sampled a second time approximately three months later. Approximately two-thirds of homes were selected because of their close proximity (less than 0.5 miles) to one or more sources of a target compound. Indoor and outdoor samples were collected on both Teflon filters and on quartz fiber filters for 48 hour periods at 10 lpm. A quartz fiber filter was also placed behind the Teflon filter to serve as a dynamic blank for particulate organic carbon measurements, which are subject to adsorption artifacts. Personal samples were collected on Teflon filters for 48 hours at 3.2 lpm. Teflon filters were analyzed gravimetrically for mass, by Fourier Transform Infrared Spectroscopy (FTIR) for functional groups, and by X-ray Fluorescence (XRF) and Inductively Coupled Plasma- Mass Spectroscopy (ICP-MS) for elements. Quartz fiber filters were analyzed by Thermal-Optical Transmittance (TOT) for organic and elemental carbon and by Gas Chromatography-Mass Spectroscopy (GC-MS) for polycyclic aromatic hydrocarbons (PAHs).

This poster presents the quality control results for the elemental analyses, the species mass balance results, and examines insights that can be gained about the contribution of indoor and outdoor sources on indoor and personal concentrations when numerous species are measured concurrently. Reasonable agreement was obtained for elements measured by both XRF and ICP-MS. Recoveries, based on analysis of NIST standards, were 90-105%. Replicate analysis yielded estimates of analytical precision of better than 5% to 35% for different elements. Estimates of measurement precision, based on analysis of collocated samples, were 10-20% for most elements. A single-component mass balance model was used with elements from homes expected to have minimal indoor sources to examine the mechanistic dependence of air exchange rate, decay rate, and penetration on the contribution of outdoor sources of PM on indoor concentrations.

[P15-24] MECHANISTIC ANALYSIS OF FTIR SPECTRA FROM OUTDOOR, INDOOR AND PERSONAL PM2.5 SAMPLES COLLECTED DURING RIOPA.

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Personal, indoor and outdoor PM2.5 samples (48 hrs, stretched Teflon filters) from the Relationship of Indoor, Outdoor and Personal Air (RIOPA) study were analyzed for functional groups using Fourier Transform Infrared Spectroscopy. FTIR spectra were obtained from 350 homes in Elizabeth, NJ, Houston, TX and Los Angeles County, CA from summer 1999 to spring 2001. Because organic particulate matter is a mixture of hundreds of compounds with a wide variety of properties, typically only 10-20% of the organic mass is identified on the molecular level. FTIR spectroscopy provides functional group and bond information for the entire sample, providing a more holistic analysis of the aerosol, on a compound class basis. Filters were analyzed without extraction or other sample preparation before and after sampling in a Mattson 100 Research Series Spectrometer containing a deuterated triglycine sulfate (DTGS) detector. Filters were scanned 200 times at 4 1/cm resolution from 450 to 4000 1/cm.

Sulfate was almost always present, and was largest in outdoor spectra. This is consistent with the generally accepted understanding that sulfate is of outdoor origin. Strong aliphatic absorbances and amides were found in many personal and indoor samples, suggesting the influence of indoor sources in these homes. We hypothesize that amides form as a result of high temperature reactions between organic acids and amines during the cooking of meat or meat products. Carbonyl absorbances, present in most samples, showed substantial variation in strength, number of peaks, and wavenumber shift from sample to sample, indicating variability in composition and sources. Spectra were sorted based on major distinguishing spectral features, resulting in the identification of a typical outdoor spectrum, and identification of homes with indoor and personal spectra that differ chemically from the paired outdoor spectrum. Using these results, we were able to identify homes impacted by indoor and personal sources and to provide the spectra characterizing the indoor and personal source composition on a home-by-home basis.

[P15-25] CONTROLLED EXPOSURE CHAMBER STUDIES AND THE IMPACT OF $PM_{2.5}$ ON HUMAN HEALTH.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

A controlled exposure chamber is being used to elucidate the influence of changing the chemical composition of fine particles, including semi-volatile components, on human health. A 40 m^3 Teflon bag equipped with UV lights to simulate atmospheric photochemical conditions, is used to generate a stable test aerosol. Adjacent to the Teflon bag is a 15 m^3 controlled exposure room. An aerosol of approximately 500 $\mu g/m^3$ $PM_{2.5}$ is introduced into the Teflon bag and circulated to the exposure room via a dedicated recirculation system until a desired concentration of approximately 150 $\mu g/m^3$ is obtained in the exposure room. The exposure room will be used to study the effect of $PM_{2.5}$ exposure on cardiovascular function. Several real-time and integrated instruments are being used to characterize and monitor the test aerosol including; a TEOM monitor to measure non-volatile $PM_{2.5}$, a RAMS monitor to measure total $PM_{2.5}$ including semi-volatile components (nitrate and organic), a TSI CPC monitor to determine detailed particle size distribution, an Anderson Aethalometer to measure elemental carbon, a BOSS sampler to determine detailed $PM_{2.5}$ chemical composition, and gas phase monitors for CO, NO_x, NO_2, and NO. Aerosols to be studied include those typical of ambient Wasatch Front $PM_{2.5}$ including; fresh wood smoke generated from a typical wood burning stove, wood smoke aged 4-6 hours, and concentrated ambient particles (CAPS). One minute real-time RAMS and TEOM data are obtainable and are being used to measure the formation and concentration of non-volatile and semi-volatile $PM_{2.5}$ in the Teflon bag and exposure room. Thirty minute BOSS samples give detailed chemical composition of $PM_{2.5}$ in the Teflon bag and exposure room. Results obtained with wood smoke emissions indicate a significant increase in semi-volatile $PM_{2.5}$ is associated with photochemical aging of the wood smoke aerosol.

[P15-14] INVESTIGATIONS OF THE SENSITIVITY OF A PREDICTIVE MODEL OF INDOOR CONCENTRATIONS OF OUTDOOR PM-2.5 TO CHANGES IN HOUSE OPERATIONAL AND ENVIRONMENTAL PARAMETERS.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Interest in determining human exposure to fine PM has intensified due to recent findings associate particulate air pollution with increased morbidity and mortality in the United States. Although people spend an average of 85 to 90 percent of their time indoors, the National Ambient Air Quality Standards for particulate matter (PM) focus on outdoor concentrations. However, the relationship between indoor and outdoor particulate levels is not well established, particularly at more detailed levels of characterization like chemical speciation and size distribution. We conducted a field study in California\\'s San Joaquin Valley to investigate indoor particles of outdoor origin. The objective of the study is to develop a physically-based, semi-empirical model that describes the indoor concentration of PM2.5 sulfate, nitrate, organic carbon and black carbon derived from outdoor sources. The study was conducted in an unoccupied, single-story residence in Clovis, California, manipulating the house to effectively use it as a research laboratory. Intensive measurements were performed for four weeks in the fall and winter of 2000/2001. Measurements included many of the physical and chemical properties of both the indoor and outdoor aerosol as a function of time, as well as important housing and meteorological characteristics.

The use of real-time measurements during the experiment allows for both parameterization and testing of a transient mass balance model for the house. Ventilation rates are predicted using the LBNL/AIM infiltration model with inputs of the leakage characteristics of the house, regional meteorological characteristics, and additional corrections determined from assumptions concerning the human factors affecting building operation (e.g. window and door opening or HVAC operation). The physical parameters affecting particle dynamics are modeled using size-resolved penetration factors and deposition rates directly measured in the research house. A model for the chemical transformation of ammonium nitrate upon transport into the house and subsequent uptake of reactive gases to indoor surfaces is incorporated. The model is evaluated by the degree to which the model captures the important physical and chemical mechanisms affecting particulate sulfate, nitrate, and black carbon. In addition, the sensitivities and uncertainties of the model to individual parameters are assessed for their importance in predicting indoor concentrations of outdoor PM-2.5.

[P06-01] DEMONSTRATION OF A TECHNIQUE TO ESTIMATE INDIVIDUAL, DAILY VALUES FOR THE AMBIENT AND NONAMBIENT COMPONENTS OF TOTAL PERSONAL EXPOSURE TO PARTICULATE MATTER.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (4:00 PM-5:00 PM) Grand Ballroom 2-4

Total human exposure (*T*) to particulate matter (PM) may be divided into two major components: (1) exposure to ambient PM while outdoors plus exposure while indoors to ambient PM that has infiltrated indoors (ambient exposure, *A*) and (2) exposure to nonambient PM due to indoor sources and personal activity or personal cloud sources (nonambient exposure, *N*). For epidemiology using panel studies with measurements of individual health outcomes, it is desirable to know total, ambient, and nonambient exposures as well as ambient concentrations. A data set from a panel study in Vancouver, BC, Canada, that contains measurements of total personal exposure and ambient concentrations of both $PM_{2.5}$ and sulfate, provides sufficient information to estimate daily, individual values of ambient and nonambient exposure to $PM_{2.5}$, and ambient exposure to $PM_{10-2.5}$ and PM_{10}. The technique requires the assumption that either there are no indoor sources of sulfate, or if such sources exist a correction may be made, and the assumption that some information is available on the values of the penetration factor (*P*) and the deposition or removal rate (*k*) for the PM mass or composition fractions of interest. This technique is based on the equilibrium mass balance model which relates ambient exposure (*A*) to ambient concentration (*C*), i.e., A = yC + (1-y)(Pa/[a+k])C, where *y* is the fraction of time spent outdoors, and *a* is the air exchange rate. Also A/C = \{y + (1-y)(Pa/[a+k])\}= the attenuation factor. In the Vancouver panel study, subjects kept activity diaries so it was possible to estimate individual, daily measured values of the fraction of time spent outdoors (*y*). Since *T* = *A* for sulfate, *T/C* = *A/C* for sulfate = the attenuation factor for sulfate. If estimates of *P* and *k* for sulfate are available, then daily, individual values of *a*, which does not depend on the particle size, may be estimated. The *A* for $PM_{10-2.5}$ is estimated using the measured values of *y*, the estimated value of *a*, and estimated values of *P* and *k* for $PM_{2.5}$. Plots of *T* vs. *C* for sulfate, for individual subjects, and for the entire panel, are used to check for the presence or absence of indoor sulfate sources and to check for outliers. If a subject is found to have an indoor source of sulfate, the attenuation coefficient is taken from the regression of personal sulfate on ambient sulfate. The time series of individual, daily exposures have been used to investigate the association of various health effects with the different indicators of exposure.

[P13-23] LONG-TERM MEASUREMENT OF ULTRAFINE PARTICLE NUMBER CONCENTRATION IN ROCHESTER, NY.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

During the measurement period of December, 2001 to January, 2003, number concentrations and size distributions of fine particles in the size range of 10 to 500 nm were conducted at New York State Department of Environmental Conservation (NYSDEC) ambient monitoring site in downtown Rochester. Mass concentrations of fine particulate matter ($PM_{2.5}$) and gaseous pollutants were measured at the same site as well as meteorological data. The particle number and size distributions were measured by a Scanning Mobility Particle Sizer (SMPS) system comprising of a differential mobility analyzer (DMA, TSI 3071) and a condensation particle counter (CPC, TSI 3010). Approximately 60% of total number concentration was associated with particles in the size range 11 to 50 nm, 20% was associated with particles 50 to 100 nm. The total number concentrations during the winter, December to February, tended to be higher than those during the summer. Two peaks of the number concentrations were typically found in the size range 11 to 50 nm as a function of time of day. The first peaks occurred around 9 a.m. while the second peaks appeared around 3 p.m. in the period of December 2001 to March 2002. During the measurement period of April to August 2002, the intensity of the first peak slowly decreased while the second peak remained relatively constant. The number concentrations of particles in the size range 50 to 100 nm were also related with morning rush-hour and evening rush-hours, 5 to 7 p.m. during winter months while the number concentrations measured over summer were somewhat increased after 6 p.m. Advanced factor analysis of the particle size distributions was performed to obtain sensible source identification and apportionment. It was necessary to remove the growth periods from the particle size distribution record since the system is non-stationary during that time since there is active growth occurring that cannot be modeled by the superposition of stable source profiles.

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[P06-14] WITHDRAWN

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WITHDRAWN

[P06-09] DISTRIBUTION PATTERNS OF INHALED ULTRAFINE SILVER PARTICLES IN THE RAT LUNG.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (4:00 PM-5:00 PM) Grand Ballroom 2-4

In general, alveolar macrophages play a key role in the fate of inhaled particles. However, it is speculated that ultrafine particles may not be readily detected and phagocytized by alveolar macrophages in the alveolar region, but instead directly enter the alveolar wall. To test this hypothesis, distribution patterns of inhaled ultrafine elemental silver (EAg) particles were investigated on the basis of morphology and ICP-mass spectrometry.

Methods: Male Wistar rats were exposed to ultrafine EAg particles, generated by a spark generator in an argon atmosphere, for 24 hours at a concentration of 180 $\mu g/ m^3$ ($3*10^6/cm^3$, 15 nm modal diameter). Up to 7 days, rats were serially sacrificed, and lavaged cells and lung parenchyma were examined ultramicroscopically. The Ag content in the lavage fluid and the lung after lavage was estimated by ICP-mass spectrometry.

Results: Elemental analysis detected 8 μg Ag in the whole lung immediately after the end of exposure (about 20 % of the estimated total inhaled cumulative dose). Even immediately after the end of exposure, 20 % only was detected in the lavaged fluid (pellet and supernatent). 80 % of Ag in the lung was not lavageable. On days 4 and 7, only 12 % and 3 %, respectively, were lavageable.

The amount of Ag in the whole lung decreased rapidly with time. Nevertheless, Ag particles were morphologically detectable in the alveolar septum up to 7 days.

Most particles were located in the cytoplasm and perinuclear regions of lavaged macrophages, type I epithelial cells and endothelial cells. This is quite different from the localization of intratracheally instilled agglomerated Ag particles which were mainly found in the phagolysosomes of alveolar macrophages (Takenaka et al., 2000).

Conclusions: These results indicate that the uptake of inhaled ultrafine particles by alveolar macrophages is limited, instead, prompt access to the alveolar septum occurs. Further investigations using particles with other physicochemical properties, e.g., solubility, size or binding affinity, must be performed to prove whether findings obtained in this study are general features for ultrafine particles.

[P06-08] TURBULENT THREE-PHASE FLOWS IN BUBBLE COLUMNS.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (4:00 PM-5:00 PM) Grand Ballroom 2-4

Gas-liquid-particle three phase turbulent flows at various particle loadings in bubble columns are studied. The liquid flow is modeled using a volume averaged system of governing equations, whereas motions of bubbles and particles are evaluated by a Lagrangian trajectory analysis procedure. A k-epsilon turbulence model is used to describe the motion of the liquid phase. The bubble and particle turbulent dispersion is considered by using a stochastic model. The two-way interactions between bubble-Liquid and particle-liquid are included in the analysis. The interactions between bubble-bubble and particle-particle are accounted for by the hard particle collision model. The bubble coalescence and bubble-particle interactions are also included in this approach. The predicted results for bubbly flow are compared with the experimental data, and good agreement is obtained. The effect of bubble and particle diameters, and particle loading on variation of the flow pattern are discussed. The results show that the bubble size has major effects on the flow pattern.

Key words: Gas-liquid-particle flow, three-phase flow, turbulent flow

[P06-07] CALCULATIONS OF EQUIVALENT HUMAN EXPOSURE CONCENTRATIONS FROM RAT INHALATION EXPOSURE STUDIES.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (4:00 PM-5:00 PM) Grand Ballroom 2-4

In many cases, risk assessment for particulate matter (PM) exposure requires data extrapolation from laboratory exposure settings for animals to equivalent human exposure scenarios. Dosimetric adjustments are essential for realistic interspecies data extrapolations. An appropriate dose metric depends largely on the biological responses under consideration. But, the choice of a relevant dose metric, even within a specific region of the lung, is not clear-cut because of variations in cell composition and potential of biological sensitivities between animals and humans. Here various dose metrics are postulated and equivalent human exposure concentrations (EHEC) obtained based on these metrics. The calculations were carried out using a user-friendly software package (MPPD, CIIT, Research Triangle Park, NC) to determine dose in the respiratory tracts of humans and rats. A realistic asymmetric lung geometry using detailed morphometric measurements of the TB airways in rats was employed in deposition calculations for rats. The use of asymmetric lung geometry allowed for more precise site-specific dose calculations. Various dose metrics were considered for the TB and pulmonary (P) regions. EHEC were found for particle sizes 0.3-5 μm. Particle inhalability for both humans and rats was taken into account. A dose metric based on deposited mass in the TB and P regions yielded an unrealistic low EHEC, leading to severely underestimating the risk from PM exposure. Dose metrics based on different deposited mass per unit areas in the TB region indicated EHEC of 1 to 4 times those of rats. There was an increase in the EHEC with particle size for particles $\leq$ 2 μm; inhalability of particles $\leq$ 2 μm is 100% in humans but not in rats. Due to the limited inhalability of particles $\geq$ 2 μm in rats, EHEC decreased with particle size except when the dose metric was based on deposition in bronchus airways. Due to TB filtering effects, dosimetric values in the P region decreased with particle size and dropped even more profoundly for particles with limited inhalability (i.e., > 2 μm). While dosimetric adjustments based on mass per unit area were similar between TB and P regions, EHEC was less than unity when the dose metric was based on the number of particles deposited per unit of ventilatory units or alveoli. A comparison of various dose metrics indicates that a dose metric based on mass per unit area yields the most conservative EHEC estimate. Results obtained from this study can assist in judging the reasonableness of extrapolating the outcome of toxicological studies in rats to potential risk in humans.

[P06-06] MATHEMATICAL MODEL OF DISPERSION AND DEPOSITION OF PARTICLES IN PULMONARY AIRWAYS.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (4:00 PM-5:00 PM) Grand Ballroom 2-4

Particle dispersion and deposition in the pulmonary airways is the link between exposure and dose, and leads to enhanced risk compromised individuals. In this work, mathematical model will be demonstrated to quantify the amount of particle dispersion as a function of breathing patterns and anatomical parameters. A simplified approach, that the stretch and mix process transports air between the distal and proximal compartments of the lung, is applied to describe dispersion and deposition of particles in the deeper lung. This simple mathematical model can lay the groundwork for simulating multiple breathing cycles, the transport of particles to distal regions during these cycles, and their consequent deposition.

[P06-05] FACTORS INFLUENCING AEROSOL DEPOSITION IN HUMANS AND RATS USING A MULTIPLE PATH PARTICLE DOSIMETRY MODEL (MPPD V1.0).

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (4:00 PM-5:00 PM) Grand Ballroom 2-4

Knowledge of the tissue-specific dose of PM is a critical link between individual exposure and health outcomes. Computer models are suited to analyse PM dosimetry. A Multiple Path Particle Dosimetry model (MPPD) has been developed by CIIT (Chemical Industry Institute of Toxicology, USA) in close collaboration with RIVM (National Institute of Public Health and the Environment, the Netherlands). The MPPD model allows calculation of PM deposition fractions and exposure doses for humans and rats, and includes age-specific human lung models.

The results of monodisperse aerosol deposition calculations with the MPPD model and its sensitivity to various parameters are described. Regional, lobar and alveolar depositions are calculated with a stochastic lung model for human adult.

Age dependency of PM deposition for children and young adults is studied. Coarse mode particles (5-10 μm) thoracic deposited mass is found to be significantly larger for children and adolescents of a specific age group compared to adults (age 18 and older), mainly due to the larger deposition in the head for adults. Increasing coarse particle size from 5 μm to 10 μm reduces the lower boundary of this age group from 8 years to 2 years and increases the difference in thoracic depositions between children and adults. Pulmonary deposition per alveolus is higher for 8-14 years old children compared to adults for particles of about 5 μm.

Dependency of regional deposition on the level of physical exertion is studied for human adults. Increasing physical exertion results in a higher thoracic deposition. The thoracic deposition of ultrafine particles is higher than the thoracic deposition of fine and coarse mode particles for light to modest exercise. When breathing is changed from nasal to oronasal the thoracic deposition behaviour of fine and coarse particles changes - for modest to heavy exercise the thoracic deposition of larger particles is higher.

Thoracic deposition depending on particle size is 45-200 times larger for humans than for rats at rest. Coefficients for the rat-human deposition extrapolation have been determined for three levels of human physical exertion (sleep, rest and light exercise).

In conclusion, age of the subject, physical activity, the functional capacity of the lungs and breathing parameters as well as the individual lung morphometry are factors that significantly affect the particle deposition and can explain differences in responses among people.

[P06-04] CAN AEROSOL SURFACE-AREA EXPOSURE BE ESTIMATED ADEQUATELY FROM MEASURED NUMBER AND MASS CONCENTRATION?

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (4:00 PM-5:00 PM) Grand Ballroom 2-4

In-vitro and in-vivo studies using low-solubility aerosol particles have shown a number of health-related end-points to be more closely associated with aerosol surface-area than mass concentration. These and similar studies have led to the hypothesis that health effects associated with environmental exposure may show a closer correlation with particulate surface-area. Collection of appropriate exposure data necessary to validate the hypothesis is currently restricted by the available instrumentation: Although a number of static monitoring sites now include size distribution measurements that may be used to estimate aerosol surface area, there are few options available for assessing localized and personal exposures.

Personal (or close-locality) measurements of ambient aerosol number and mass concentration are currently made routinely using readily available instruments. If aerosol surface-area could be estimated with sufficient accuracy from these measurements, it would be possible to begin investigating associations between surface area and health effects prior to the development and implementation of more sophisticated instrumentation. However, any method using number and mass measurements to estimate surface-area would be subject to potentially large errors, as insufficient information would available to characterize the simplest of aerosol size distributions. It is possible though that such a method may provide some useful information if suitable assumptions were made about the aerosol being sampled.

A method to estimate aerosol surface area from number and mass measurements is proposed assuming a lognormally distributed size distribution with a given geometric standard deviation. Estimation errors for a range of conditions have been evaluated using simulated number and mass measurements. Simulations show that surface-area estimates made on unimodal lognormal aerosols will frequently lie within 100% of the actual value. Simulations using bimodal distributions indicate estimates of surface area vary from the actual value by less than an order of magnitude. Calculations based on experimental data confirm these findings, with estimated surface area rarely being a factor of 4 greater than the actual value. The proposed method appears to be suitable for estimating aerosol surface area to well within an order of magnitude, and may be sufficient for placing exposed individuals within broad exposure groups. However comparison between the method and established techniques is required to verify these conclusions, and to evaluate the estimated errors with respect to the range of aerosol size-distribution exposures commonly encountered.

[P13-27] CHARACTERISTICS OF DAILY FINE PARTICULATE MATTER AT ATLANTA, GA.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Epidemiological studies have shown that increased concentrations of atmospheric fine particulate matter in urban areas are associated with adverse health effects. To better understand the relationship between adverse health effects and particulate matter concentrations, a clear understanding of the detailed chemical composition as well as the sources of the fine particles is required. To support these efforts, daily PM2.5 samples were collected during January 2002 at Jefferson St., Atlanta, Georgia using the Thermo-Andersen high volume sampler. The primary objective of this study is to characterize the fine particles including their concentrations, sources, and chemical compositions such as EC (elemental carbon), OC (organic carbon), inorganic ions, major and trace elements as well as organic compounds in Atlanta on a daily basis. The results are compared with those from daily samples collected during July 2001 at the same site and analyzed under the same analytical protocol to investigate the seasonal variation of fine particle characteristics.

Each daily sample was spiked with 16 deuterated internal standards and extracted with solvents. Identification and quantification were performed using deuterated standards, quantification standards as well as secondary standards. These standards contain more than one hundred organic compounds. Gas chromatography/mass spectrometry (GC/MS) was used to quantify and identify the particle-phase organic compounds, which include n-alkanes, PAHs (polycyclic aromatic hydrocarbons), oxy-PAHs, resin acids, fatty acids, hopanes, steranes, and other key tracer compounds. Organic tracer analysis has been shown to be an effective method for estimating source contributions to ambient fine particles.

Preliminary results show that not only the concentrations of organic compounds exhibit a distinct seasonal variation, but also the sources of fine particles at this site. For example, the source contribution from wood smoke, a contributor to ambient air pollution, shows a significant increase in the winter. Daily variation of the concentrations of inorganic and organic species, especially PAHs, which are known to be mutagenic and carcinogenic, and the characteristics of PM2.5 in the winter and summer will be discussed.

[P06-02] SELECTING REALISTIC PM DOSES FOR IN-VITRO STUDIES.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (4:00 PM-5:00 PM) Grand Ballroom 2-4

In-vitro studies are important for understanding the health effects of inhaled urban particulate matter (PM). Such studies can explore biologic mechanisms of injury, comparative toxicity of PM components, effects of particle size, and species differences in responses. Selecting realistic PM doses for in-vitro studies poses an interesting dosimetric challenge. As an example, a potentially sensitive human subpopulation is postulated, and the surface PM deposition doses calculated for various surface target sizes within the tracheobronchial region. It is suggested that similar surface PM exposures are realistic for in-vitro studies.

The sensitive subpopulation is assumed to: a) have inhomogeneous airflow (due to disease or abnormal anatomy); b) be a mouth-breather; c) be exercising; d) have small body size (and thus small airways); and e) to be exposed to PM at a location near significant PM sources. The effect of inhomogeneous airflow in the respiratory tract can increase PM deposition in well-ventilated regions by a factor of 3 to 5. Mouth breathing, exercise and small body size can increase the deposition of particles in the tracheobronchial tree over that of an average person by a factor of about 10 to 50 (depending on particle size). Considering enhanced deposition at bifurcation zones can lead to surface PM depositions that are as great as 100 times the average for certain particle sizes. Considering these factors, local groups of cells can see PM deposition surface doses that are several thousand times the average surface doses for average subjects. Suggested realistic surface doses for in-vitro studies are presented for a range of particle sizes and biological target sizes. One concludes that substantial PM surface doses can be justified in in-vitro studies that are intended to realistically mimic in-vivo surface doses. (Supported by US EPA grant number R827352, but not subjected to the agency's peer and policy review. Therefore, it does not necessarily reflect the views of the agency, and no official endorsement should be inferred.)

[P15-19] EXAMINING FACTORS THAT INFLUENCE THE POTENTIAL FOR CONFOUNDING IN PM EPIDEMIOLOGY.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Introduction: Strong associations between ambient particles and gases have raised concerns about the potential for confounding by gaseous pollutants in epidemiological studies of particulate matter. Single-pollutant studies of gaseous exposures, however, have found weak associations between personal and ambient concentrations, indicating that ambient gas concentrations are poor surrogates of their own exposures. In a recent multi-pollutant study, ambient gases were found to act as surrogates of personal PM and not personal gas exposures (Sarnat et al. 2001). Together, results from these studies suggest that ambient co-pollutants cannot confound PM-associated health effects. We examine this issue further using data from a panel study of older adults in Steubenville, OH and identify factors that could modify the potential for confounding. **Methods:** Data were collected in summer and fall 2000. 25 participants (non-smokers; age 65+) were recruited from 3 apartment buildings in downtown Steubenville; a few participants lived in single-family homes. 24-h PM ($PM_{2.5}$, SO_4^{2-}, EC) and gas (O_3, NO_2, SO_2) measurements were made inside each participant's home twice each week. Corresponding personal particulate and gaseous measurements were also made for a subset of 10 participants. Indoor follow-up questionnaires and time-activity diaries were collected for each indoor and personal sample. Daily outdoor measurements were taken on the roofs of two apartment buildings as well as at a central site. The relationships among personal, indoor and outdoor levels of the measured pollutants were examined using regression techniques that account for the repeated measures structure of the data. **Results:** Ambient PM was significantly associated with ambient O_3 in summer and ambient NO_2 and SO_2 in fall. Similar associations were found between indoor PM and indoor O_3 and NO_2. Univariate analyses of ambient pollutants and their respective indoor levels showed highly significant relationships for all pollutants, except for SO_2 in summer. Home ventilation was found to influence the indoor-ambient relationships significantly for PM in both seasons, for O_3 in the summer, and for NO_2 and SO_2 in the fall. Slopes of indoor-ambient regressions were significantly higher in well-ventilated environments (PM slope: 0.86±0.03) as compared to poorly ventilated environments (PM slope: 0.54±0.05). Building of residence was also found to be an important modifier of the indoor-ambient association. Future analyses will expand these analyses to include examination of the personal-outdoor association and of other building related factors and time-activity patterns.

[P05-20] THE FORMATION OF NANOPARTICLES IN THE ATMOSPHERE FROM DIESEL AND NATURAL GAS STATIONARY ENGINES.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Nanoparticle formation in the atmosphere from natural gas and diesel engine exhaust has been a recent concern. Research has found high nanoparticle number concentration on and near urban roadways. In addition the relationship between nanoparticles and lung cell inflammatory response and heart attack from animal studies has been also studied. The objective of this study is to investigate the formation of nanoparticles near the tailpipe of two large generator sets, one powered with diesel and one powered with natural gas. The nanoparticle formation as a function of distance from the exhaust outlet, temperature, and relative humidity during idling, medium and maximum engine loads was characterized. This work thus represents the measure of nanoparticles under true ambient conditions as opposed to conditions in a dilution device.

A Scanning Mobility Particle Sizer (SMPS) was used to measured nanoparticle number concentration. The Taped Element Oscillating Microbalance (TEOM) Monitor was used to measure the nanoparticle mass concentration. The Micro-Orifice Uniform Deposit Impactor (MOUDI) was used to measure mass concentration at different particle sizes. A remote weather station is used to monitor airflow and direction as well as humidity, pressure, and temperature. Distance data provides information to understand the time scales and distance from the emissions source that are important to nanoparticle growth. It is expected that low ambient temperature will accelerate particle growth, whereas high relative humidity would increase the formation of nanoparticles. A combination of maximum load, high relative humidity, and low ambient temperature would produce the most of nanoparticle concentration.

[P05-21] MEASURED REAL-WORLD TRAFFIC EMISSION FACTORS OF PARTICLE NUMBER SIZE DISTRIBUTION AND MASS IN STOCKHOLM, SWEDEN.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Measurements in a road tunnel in Stockholm, Sweden performed during winter 1998/1999 give the preliminary emission factors (E_{LD} and E_{HD}) for particles divided between the two vehicle types, light duty (LDV) and heavy duty (HDV) respectively. The average PM emission factors and emission factors divided by different vehicle speed intervals are presented in the Table below. It can clearly be seen that the PM2.5 emissions of resuspended dust increase with vehicle speed and that a large fraction of this dust consists of NaCl and metal-oxides. The emissions of carbohydrates and elemental carbon explain 50% of the PM0.6 fraction (not resuspended PM fraction).

An example of the difference between the number size distribution emission factors of an average LDV and HDV is presented in the Figure below, here for the speed interval 70-75 km/h. The "nuclei"- and the "soot"-mode" peak around 20 and 100 nm particle diameter respectively. It can be seen that the HDV emissions are about one size-order higher than the LDV emissions. On average, with a fleet consisting of about 5% LDV diesels, 90% LDV petrol cars and 5% HDV, the total contribution to both particle mass and number from the whole HDV fleet is about 40%.

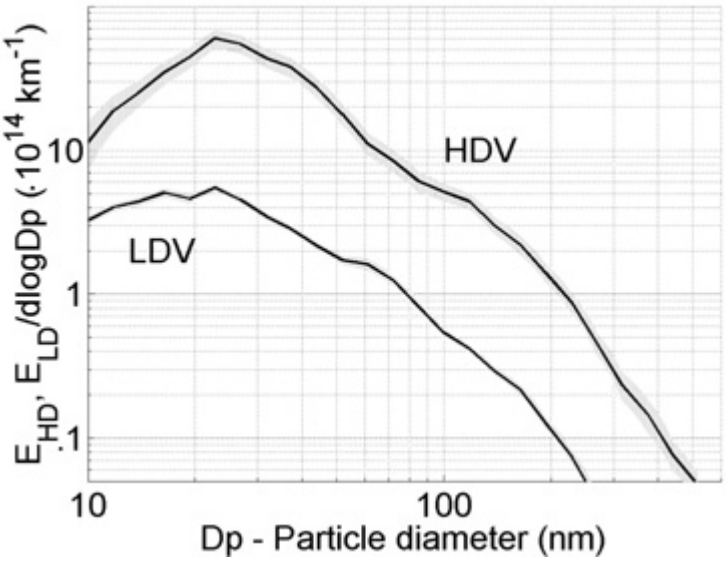
Emission factors of PM10/PM2.5/PM0.6 (mg m^{-3})

Species	Average fleet	35-70 km/h	70-75 km/h	75-95 km/h
PM10	236	91	154	329
PM2.5	67	33	41	100
PM0.6	40	36	31	51
Fraction resuspended PM2.5 (PM2.5-PM0.6)/PM2.5	40%	$\approx$0%	24%	50%
Fraction oxides (Al/Fe/Si) and NaCl of resuspended PM2.5	33%			
Fraction carbohydrates and elemental carbon of PM0.6[1]	47%	38%	45%	50%

[1]Assuming carbohydrates are CH_3 and PM0.6 is the non-resuspended part of PM2.5

(Click to see figure 1)

[P05-21] MEASURED REAL-WORLD TRAFFIC EMISSION FACTORS OF PARTICLE NUMBER SIZE DISTRIBUTION AND MASS IN STOCKHOLM, SWEDEN. (continued)



Figure

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[P05-22] ULTRAFINE PARTICLES NEAR MAJOR HIGHWAYS IN LOS ANGELES.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Ultrafine particles (diameter < 100 nm) have been suggested as a possible causative agent for the observed increases in mortality and morbidity with increases in particulate matter (PM) concentrations. We conducted systematic measurements of the concentration and size distribution of ultrafine particles in the vicinity of Interstate 405 (mostly gasoline traffic) and Interstate 710 (heavy-duty diesel traffic) in Los Angeles during the summer, 2001 and the winter 2002. Particle number concentration and size distribution in the size range from 6 to 220 nm were measured by a condensation particle counter (CPC) and a scanning mobility particle Sizer (SMPS). Measurements were taken at increasing distances downwind from each of the freeway. At each sampling location, concentrations of carbon monoxide (CO) and black carbon (BC) were also measured. For the conditions of these measurements, relative concentration of CO, black carbon and particle number track each other well as one moves away from the freeway. Particle number concentration (6-220 nm) decreased exponentially with downwind distance from the freeway. Both atmospheric dispersion and coagulation appear to contribute to the rapid decrease in particle number concentration and change in particle size distribution with increasing distance from the freeway. The maximum number concentration that was observed near the freeway was about 25 time greater than that for the background location. It suggests that people, who live, work, or travel within 100 m downwind of major traffic sources, will have much higher ultrafine particle exposure than those who live farther away from such sources. The decay rates of CO and BC are slightly greater in summer than in winter for both freeways suggesting a weaker atmospheric dilution effect in winter. Particle number concentration in the size range of 6-12 nm is significantly higher in winter than in summer. The associated concentration in that size range decreased at a slower rate in winter than in summer. These results suggest that wintertime conditions favor greater ultrafine particle formation, possibly due to increased condensation of organic vapors. These data may be useful for epidemiological studies to estimate exposure to ultrafine particles in the vicinity of major highways and to evaluate their adverse health effects.

[P05-23] AMBIENT FINE PARTICULATE MATTER CONCENTRATIONS IN NEW YORK CITY TRAFFIC.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Fine particulate matter (PM) has increased in concentration over the past 100 years due to industrial emissions, automobiles, and other pollution sources. In addition to environmental impacts, such as decreased visibility, PM-2.5 (particles less than 2.5 μm in diameter) can cause cardiovascular and respiratory problems for susceptible populations. This study utilizes data taken with an Aerodyne Research, Inc. Aerosol Mass Spectrometer (AMS) as it was transported around the streets of New York City in a mobile laboratory. With the AMS one can measure both the chemical concentration and size distribution of particles on short time scales.

This study focuses on the total concentration of PM-2.5 across varying traffic densities. Traffic events are categorized according to automobile density and movement along the streets of New York City, and PM-2.5 concentrations are correlated to these traffic indices based on AMS measurements taken in both Manhattan and Queens. As the density of traffic intensified, the concentration of PM-2.5 increased as well. The concentration of PM-2.5 in Manhattan was higher, on average, than pollution concentrations of the same traffic density in Queens. In addition, driver exposure to ambient PM-2.5 concentrations on the streets of New York City are compared to stationary monitors in Manhattan and Queens which are used to assure compliance with the Clean Air Act. The average concentration of ambient PM-2.5, as measured with the AMS, is on the same order of magnitude as the stationary monitors.

[P05-24] INVESTIGATIONS OF DIESEL SOOT WITH CLASSICAL AND NOVEL TECHNIQUES.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

We have studied soot particles that were generated from diesel and oxygenated diesel in a test engine under load and idle condition. The soot particles had been collected on filters and were then subject to various classical and novel analytical techniques. With X-ray diffraction, the crystallite size and ratio of aliphatic and aromatic carbon was determined. The former results are in line with recently published NMR data, the latter results are in line with thermogravimetric analysis of the samples. X-ray absorption near edge spectroscopy was applied to single soot particles that were selected with a state-of-the-art scanning transmission X-ray microscope. By using a leach technique, we were able to distinguish between spectra from the graphitic core of the particle and spectra of the residual oil and fuel in the particle. Using small angle X-ray scattering, we were able to determine the size distribution of the particles as well as the fractal dimension of the soot aggregates. We found that oxygenates suppress graphitization of soot to the favour of aliphatic carbon. Soot generated under idle condition contains more unburned fuel and generally yields larger primary particles, but smaller graphitelike crystallites, while soot generated under load has larger crystallites, but smaller primary particles. Our results are in line with results obtained from a different research group that used nuclear magnetic resonance spectroscopy.

[P05-25] COMPARISON OF CHEMICAL COMPOSITION OF IN-USE DIESEL AND GASOLINE VEHICLE EMISSION SAMPLES.

Barbara Zielinska, Jake D. McDonald, John C. Sagebiel, Kevin Whitney, Douglas R. Lawson Division of Atmospheric Sciences, Desert Research Institute, Reno, NV, USA; Lovelace Respiratory Research Institute, Albuquerque, NM, USA; Southwest Research Institute, San Antonio, TX, USA; National Renewable Energy Laboratory, Golden, CO, USA

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Emission samples for toxicity testing and for detailed chemical characterization were collected from a variety of gasoline- and diesel-fueled in-use vehicles operating over the Unified Driving Cycle on a chassis dynamometer. Gasoline vehicles included average PM emitters (tested at 72° F and 30° F), black and white smokers, and two new technology vehicles (tested at 72° F). Diesel vehicles included current technology vehicles (tested at 72° F and 30° F), a high PM emitter, and a new technology light-duty vehicle (tested at 72° F). In addition, samples were collected in the two bores of Fort McHenry Tunnel (Baltimore, MA), one bore dominated by light-duty gasoline vehicles and the other by heavy-duty diesel trucks. Samples for toxicity testing were extracted and submitted to the Lovelace Respiratory Research Institute in Albuquerque. Chemical characterization included the determination of organic and elemental carbon (by the Thermal-Optical Reflectance method), elements (by X-ray fluorescence), ions (by ion chromatography) and a variety of particulate and semi-volatile organic compounds (by gas chromatography/mass spectrometry) including PAH, nitro-PAH, oxy-PAH, hopanes, and steranes. The results of these chemical analyses indicate that the composition of emissions is highly dependant on the fuel type (gasoline versus diesel), the state of vehicle maintenance (low, average or high emitters; white or black smokers), the operating conditions (i.e. rate of acceleration, cold start), and ambient conditions (i.e. temperature) of the vehicles. This paper presents the individual species emission rates for different vehicle categories.

[P13-29] CHARACTERIZATION OF AMBIENT FINE PARTICULATE MATTER IN DELHI, MUMBAI, AND KOLKATA.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Fine particulate matter is characterized in three Indian megacities: Delhi, Mumbai, and Kolkata, including estimating the contributions of biomass and fossil fuel burning using Receptor-based Chemical Mass Balance Modeling. This study is an extension of the work conducted during INDOEX. During March, June, October, and December of 2001, atmospheric fine particle samples were collected over 24-hr periods in Delhi, Mumbai, and Kolkata using PM2.5 samplers. The peak of the average PM2.5 mass concentration occurred during the Winter Dry Monsoon and the lowest concentrations occurred during the Summer Wet Monsoon in all of the three cities sampled. Average fine particulate mass concentrations during the Winter Dry Monsoon were 189.95 $\mu g\ m^{-3}$ in Delhi, 88.47 $\mu g\ m^{-3}$ in Mumbai, and 302.26 $\mu g\ m^{-3}$ in Kolkata. Average fine particle mass concentrations during the Summer Wet Monsoon were 49.24 $\mu g\ m^{-3}$ in Delhi, 20.97 $\mu g\ m^{-3}$ in Mumbai, and 25.65 $\mu g\ m^{-3}$ in Kolkata. Most of the observed daily PM2.5 concentrations in Delhi and the wintertime daily PM2.5 concentrations in both Mumbai and Kolkata exceeded the EPA PM2.5 daily standard of 65 $\mu g\ m^{-3}$ signifying unhealthy air quality during that time. During December the mass percentage of organic matter (OM) and elemental carbon (EC) were 71% OM and 9% EC in Delhi, 53% OM and 9% EC in Mumbai, and 68% OM and 9% EC in Kolkata. EC can be attributed to the burning of fossil fuels and biomass. The presence of potassium during the year was an indication that biomass burning occurred in all three cities since potassium is a tracer for biomass smoke. Biomass burning seemed to peak during December. Relative contribution of crustal oxides or dust to the fine particle mass reached a peak during the Spring Pre Monsoon and the Summer Wet Monsoon in all of the 3 cities. These crustal elements were probably emitted to these cities principally in the form of fugitive dust from both local sources and long range sources of desert dust. Lead concentrations were as high as 2.4 $\mu g\ m^{-3}$ on January 4, 2002 in Delhi, 0.5 $\mu g\ m^{-3}$ on December 11, 2001 in Mumbai, and 3.4 $\mu g\ m^{-3}$ on Dec 17, 2001 in Kolkata, showing that lead is still present at high quantities in the air of Indian cities despite the complete phase out of leaded gasoline in Delhi. More than 100 organic species are currently being characterized, and once those data become available Chemical Mass Balance (CMB) modeling will be used to source apportion the fine particles using organic chemical tracer techniques.

[P13-30] SPECIATION OF ORGANIC FINE PARTICULATE MATTER IN HOUSTON AND SOURCE APPORTIONMENT USING MOLECULAR MARKERS.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Samples of atmospheric PM2.5 were collected in Houston, TX every second day during the summer of 2000 as part of the EPA sponsored Houston Fine Particle Matter Supersite program. Sampling occurred at three sites, including one industrial location (HRM-3), one suburban location (Aldine) and one coastal location (La Porte). Twenty samples collected over a 24 hour period have been analyzed to quantify the concentration of 95 individual organic compounds, including: n-alkanes (C20 to C36), aromatic hydrocarbons (PAHs), n-alkanoic acids (C5 to C34), n-alkenoic acids (C18:1 and C18:2), carboxylic diacids (C3 to C10), petroleum biomarkers and others. As a whole, the extractable compounds were dominated by acids, especially by octadecanoic acid and hexadecanoic acid. The measured concentration of n-alkanes exhibited a peak at C29, with carbon preference index (CPI) values in the range of 0.97 to 2.0.

Using organic molecular markers, including seven alkanes, four petroleum biomarkers, seven PAH, one alkanoic acid, one alkenoic acid, levoglucosan, and three chemical components (Al, Si and Elemental Carbon), Chemical Mass Balancing (CMB) calculations have been performed on the ambient speciation data. These calculations are used to determine the contribution of seven different primary emission sources including: diesel powered vehicles, gasoline vehicles, wood combustion, fuel oil combustion, road dusts, meat cooking and vegetation waxes. The contribution of diesel powered vehicles and gasoline powered vehicles are the most important primary sources at all three sampling locations, with road dusts important at the industrial location. Meat cooking emissions were significant at all three locations. Wood combustion is an important contribution during a four-day period when uncontrolled wildfires in eastern Texas and Louisiana brought biomass combustion aerosols into the sampling region.

[P06-03] ESTIMATED RELATIONSHIPS BETWEEN AEROSOL NUMBER, SURFACE-AREA AND MASS EXPOSURE METRICS USING A SIMPLIFIED NUMERICAL MODELING APPROACH.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (4:00 PM-5:00 PM) Grand Ballroom 2-4

Recent laboratory-based studies using low-solubility particles have shown a number of health-related end-points to be closely associated with aerosol number or surface-area, thus challenging the current practice of characterizing ambient aerosol exposure in terms of mass concentration. A simplified numerical model has been used to estimate relationships between aerosol number, surface-area and mass in an idealized ambient setting. The resulting relationships provide insight into possible consequences of masuring exposure in terms of mass concentration if either particle number or aerosol surface-area are more closely associated with health effects.

Assuming a constant lognormally distributed aerosol source, variations in particle number with aerosol mass, and surface-area with mass, can be approximated by well-defined functions that are independent of source conditions. Aerosol number concentration is shown to increase linearly with mass concentration up to a critical value, above which it becomes approximately constant. Surface-area concentration is also predicted to vary linearly at low mass concentrations, deviating sub-linearly with mass concentration according to a power law above a critical value.

Although the derived relationships are based on a highly simplified model of ambient aerosol behavior, they provide useful insight into possible associations between the various exposure metrics. There is no evidence of health effects associated with ambient aerosol exposure reaching a plateau with increasing mass concentration, indicating number concentration to be an inappropriate exposure metric. Limited evidence exists to indicate that the relationship between surface-area and mass above the critical value may explain non-linearities in exposure-response data at high exposures, supporting the surface-area metric hypothesis. However the most striking conclusion to be drawn is that if the model is a reasonable approximation of ambient aerosol evolution, a threshold mass concentration can be identified for a given set of conditions below which exposure metrics of number, surface-area and mass vary linearly. Below this threshold a good correlations between exposure and health effects is predicted irrespective of the metric used.

While these results need to be validated using field measurements, they do indicate a basis for continuing to use mass as an exposure basis for environmental samples at low mass concentrations despite evidence of toxicity being closely associated with surface-area.

[P13-16] IMPROVING SOURCE IDENTIFICATION OF ATLANTA AEROSOL USING THERMAL OPTICAL CARBON FRACTIONS IN POSITIVE MATRIX FACTORIZATION.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Data characterizing daily integrated particulate matter samples including seven individual organic carbon (OC) and elemental carbon (EC) fractions collected at the Jefferson Street (SEARCH/AIRES) monitoring site in Atlanta were analyzed through the application of Positive Matrix Factorization (PMF). Particulate carbon was analyzed using the thermal optical reflectance method that divides carbon into four OC and three EC fractions. A total of 529 samples and 28 variables measured between August 1998 and August 2000 were used in the analysis. In the preliminary results, PMF identified eleven sources: sulfate-rich secondary aerosol I, on-road diesel emissions, nitrate-rich secondary aerosol, sulfate-rich secondary aerosol II, wood smoke, gasoline vehicle, metal processing, airborne soil, bus station, cement kiln, and rail yard diesel emissions. The extracted three independent diesel emission sources indicate that fractional carbon data can be utilized to enhance source apportionment study. Conditional probability functions were computed using surface wind data and identified mass contributions from each source. The results of this analysis agreed well with the locations of known local point sources.

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[P13-06] SEPARATING DIESEL AND SPARK-IGNITION VEHICLE PARTICLES IN THE SAN GORGONIO NATIONAL MONUMENT.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Airborne particulate matter has been shown to have adverse effects on public health and welfare. A wide variety of sources (including natural and anthropogenic) emit particles, so identification of particle sources is a key aspect of the development of an effective and efficient control strategy.

In this study, positive matrix factorization (PMF), an advanced factor analysis method, was used to examine the separation of diesel engine exhaust from spark ignition vehicle particles in particle samples collected in the San-Gorgonio National Wilderness. This IMPROVE location that is downwind of the Los Angeles area is likely to contain a variable mixture of gasoline and diesel emissions. In the IMPROVE protocol for OC/EC, subfractions of both the OC and EC are determined. The concentrations of these subfractions are viewed as key components in this task. The results of this analysis will be compared to other source resolutions made in Seattle and Atlanta and thus, the value of these subfractions can be assessed.

[P13-07] ASSESSING SOURCE CHARACTERISTICS FOR PM2.5 IN THE EASTERN UNITED STATES USING THE MULTILINEAR ENGINE TECHNIQUE.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

The main objective of this project is to characterize the spatial and temporal variations of PM2.5 concentrations at nearly 300 of monitoring sites in the eastern United States. A multilinear factor analytic model (Mutltilinear Engine) is being applied to a set of data collected over a period of two years within the US PM2.5 measurement network. The data consists of PM2.5 concentrations as daily averages and hourly concentrations of ozone, CO, NO, NO2, and SO2. Meteorological parameters, such as wind direction, temperature and humidity are included into the analysis to reveal how spatial factors correlate with meteorological data. The results will be applied to discern the influences of local and regional influences to PM2.5 levels. Model results will be compared with emission inventories and previous studies.

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[P13-08] SPECIATION OF AMBIENT PARTICULATE MATTER USING ELECTRON MICROSCOPY TECHNIQUES.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

A major part of current air quality studies initiated with the implementation of the US Environmental Protection Agency (EPA) revisions to the National Ambient Air Quality Standards (NAAQS) has focused on identifying and quantifying sources that contribute to PM2.5. Electron microscopy (EM) techniques offer the potential to increase the amount of information on PM2.5 by characterizing individual particles. Samples for EM analyses were collected at the DOE-NETL ambient air monitoring research sampling station, the Holbrook and Lawrenceville monitoring sites, and the CMU ambient air monitoring supersite. This approach to apportion ambient PM2.5 to a source relies primarily on the individual particle characteristics such as morphology and elemental composition. Spherical aluminum-silicate (SAS) particles are being evaluated because emissions of this nature are indicative of coal-fired power plants. Regional and localized impact from power plants is being addressed based on the measurement of SAS concentrations in ambient samples collected from rural and urban locations. EM data on carbonaceous particles are being used to help resolve organic and elemental components based on distinctive morphological characteristics. EM data is also being compared to results obtained from analyses using time of flight mass measurements.

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[P13-10] SOURCE APPORTIONMENT OF PM2.5 IN SEATTLE, WA URBAN IMPROVE SITE: COMPARISON OF THREE RECEPTOR MODELS AND SOURCE PROFILES.

Joellen Lewtas, Naydene Maykut, Eugene Kim, Timothy Larson NERL, US EPA, Port Orchard, WA; Puget Sound Clean Air Agency, Seattle, WA; Clarkson University, Potsdam, NY; Univ. of Washington, Seattle, WA

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

IMPROVE protocol data were collected at the urban Beacon Hill monitoring site in Seattle, WA from 1996-99. The 289 sets of PM2.5 filters were analyzed for: metals using PIXIE and XRF, anions using ion chromatography, elemental hydrogen (H) by proton scattering, and elemental and organic carbon fractions (OC1-OC4 and EC1-EC3) by thermal optical reflectance (TOR). The data was analyzed by CMB8, Positive Matrix Factorization (PMF) and UNMIX. The CMB8 model determined the contribution of minor industrial sources (7%), two combustion sources, vegetative burning (16%) and mobile sources (44%), soil (4%), and 3 marine and secondary sources. The PMF model was able to utilize all of the data (30 species) to derive 8 sources. The sources with the highest contribution of the 5 most abundant carbon fractions (OC1-OC4 and EC1), all appear to be combustion sources. We have designated those as gasoline vehicles, diesel, vegetative burning, and fuel oil based on the profiles derived from the PMF model. The following components are found in relatively high abundance for each of these sources: OC3, Pb, Zn, K, and Ti in the gasoline profile; EC1, Fe, Zn, and Mn in the diesel profile; OC3, OC4, EC1, OC2, and K in the vegetative burning profile; OC4 and V in the fuel oil profile. The other 4 profiles derived from the PMF model we have designated as follows with the distinguishing elements indicated in parentheses: soil (Si, Al, Ti), marine (Na, Cl), Na rich (nitrate, Na, and both OC and EC fractions, Ca, and K), and a sulfate (secondary) source (sulfate, nitrate, and EC1). UNMIX was more restrictive in deriving 6 sources based on a statistically acceptable model solution using 15 out of the 30 available species including OC2, OC3, OC4 and EC1 but not OC1 or EC2. Both of these receptor models derived source profiles for 4 different combustion sources containing OC fractions and EC1 whose abundance differ between the sources. Both models derived a profile for soil (Si and Al) and marine/sulfate source(s) (sulfate, Ca, and K). The marine and sodium rich source(s) containing EC1/EC2 fractions may contain some marine diesel combustion emissions. Both of these multivariate models agree in the estimated relative contributions of the combustion sources to the PM2.5 mass as follows: vegetative (28-37%), diesel (18-19%), fuel oil (10-15%), gasoline (4-9%).

This work has been funded by the U S Environmental Protection Agency. It has been subjected to Agency review and approved for publication.

[P13-11] SOURCE APPORTIONMENT OF PERSONAL EXPOSURE TO PM2.5 USING THE CHEMICAL MASS BALANCE MODEL COMBINED WITH PMF-DERIVED SOURCE PROFILES.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Our overall goal is to understand the relationships between exposures to different sources of ambient PM and the effects of such exposures. To do this, we need to be able to trace the sources of particles in outdoor, indoor and personal environments. The immediate goal of this work is to better understand how the sources of outdoor PM2.5 in urban areas contribute to personal exposures of PM2.5. This work is part of a larger panel study being conducted in Seattle, WA. 24-hr PM2.5 samples were collected both inside and immediately outside the residences of study subjects, as well as on their person. Particles were collected on Teflon filters for subsequent gravimetric analysis followed by x-ray fluorescence (XRF) analysis. Indoor and outdoor samples were also collected on quartz filters for particulate carbon analysis using TOT. A total of 198 indoor/outdoor pairs of Teflon and quartz filters were taken between Autumn 2000 and Autumn 2001. Positive Matrix Factorization was applied to these data in order to derive source profiles separately for both indoor and outdoor samples. We found five features that were similar in the outdoor and indoor samples- vegetative burning, marine, soil/dust, motor vehicle, and a source rich in S, Mn, Fe, Ni, Br and Pb. The identification of a vegetative burning source that readily penetrates indoors was aided by the measurement of levoglucosan on a subset of the data.. A sixth profile that was rich in OC was also found to be associated with a major fraction of the mass on the indoor Teflon filter. We then regressed the five indoor/outdoor PMF derived source profiles onto the personal Teflon filter samples using the chemical mass balance model (CMB8). This additional step was necessary because the personal PM2.5 teflon filter samples did not contain any information on organic carbon (only XRF species). Of 161 personal filters, 138 had satisfactory diagnostic statistics according to the CMB criteria. On average, the five indoor/outdoor profiles accounted for 44% of the personal mass. The remaining unexplained mass was correlated with the mass contribution from the 6th OC rich indoor source. However, this source could not be included in the CMB model due to the lack of distinctive trace element features in its source profile.

[P13-12] SOURCE APPORTIONMENT OF PM10 AND PM2.5 AT A BACKGROUND SITE IN SOUTHERN SWEDEN.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

PIXE (Particle Induced X-ray Emission) data on the elemental composition of fine (equivalent aerodynamic diameter EAD < 2.5 μm) and coarse fraction (2.5 μm < EAD < 10 μm) aerosol particles were used to apportion PM2.5 and PM10 aerosol mass to various natural and anthropogenic sources. The samples were collected during spring 2000 at the EMEP background air quality monitoring station Vavihill (56° 01′ N, 13° 09′ E, 172 m a.s.l.) in southern Sweden. At the Vavihill site, PM10 average concentrations (12.7 μg/m3) were only 26% higher than the PM2.5 average (10.1 μg/m3). Two statistical source-receptor models were used in the PM source apportionment; COPREM (Constrained Physical Receptor Model) and PMF (Positive Matrix Factorization). Both models give non-negative solutions regarding the source profiles and source contributions. The two models yielded similar results. Fine and coarse fraction PIXE data for the elements Si, S, K, Ca, Ti, Cr, Mn, Fe, Co, Ni, Cu, Zn, Se, Br and Pb were used in the models, in addition to coarse fraction Cl and Sr and fine fraction V. Four sources were chosen to represent the influence of the long-range transported aerosol on the Vavihill background monitoring station: Sea spray, Soil dust, General Pollution and Oil/Coal combustion. The models apportioned the measured PM2.5 and PM10 mass to the four sources as follows (the ranges indicate the results of the two models):

PM10: Soil 19-22%, Sea 16-22%, Pollution 28-34%, Oil/Coal 23-24%

PM2.5: Soil 16-18%, Sea 15-21%, Pollution 34-40%, Oil/Coal 23%

About 4% (COPREM) and 7% (PMF) of the average measured PM2.5 and PM10 mass was not accounted for by the models. According to these results, the twosources sea spray and soil dust, usually considered natural coarse particle sources together account for 38-44% (≈5 μg/m3) of the PM10 and 33-36% (≈4 μg/m3) of PM2.5. This points out the need to incorporate these sources in the modelling of PM levels over Europe for regulatory purposes. A fair portion of the soil dust is likely emitted by anthropogenic activities, as traffic.

[P13-13] DETERMINATION AND CHARACTERIZATION OF THE AIR POLLUTION SOURCES IN BEIJING.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

The source characteristics of three major criteria pollutants, PM10, SO2 and NOx, were analyzed for Beijing according to the emissions, their contributions to the ambient air concentrations. Based on a series of field measurements, source investigation and model calculation, the sectoral share of the emissions and their contributions to the air concentrations of 1999 was determined for those three pollutants. It was found that the fugitive sources (emission shared 38%, air quality contributed 26%) and the industrial sources (emission shared 28%, air quality contributed 11%) were the primary local sources of PM10 in Beijing. The heating boilers (emission shared 26%, air quality contributed 36%) and the industrial sources (emission shared 24%, air quality contributed 29%) were the primary local sources of SO2.The vehicles (emission shared 35%, air quality contributed 64%) and the industrial sources (emission shared 26%, air quality contributed 11%) were the primary local sources of NOx. At the same time, the ambient air concentrations of the three pollutants of Beijing impacted by the regional pollution sources were also determined. It was found that the regional source contributed 47%, 26% and 14% to the ambient air quality of PM10, SO2 and NOx in Beijing respectively, which was one of the most important sources of Beijing and should be controlled together with the local sources. And also, the geographic distributions of the emission and their contribution were formulated for Beijing metropolitan area gridded by the size 1km x 1km. From those results, the Shijingshan areas, the south Chaoyang areas, the center urban areas and the main transportation roadways were found to be the seriously polluted areas, which should be controlled in priority.

[P13-14] AEROSOL ELEMENTAL COMPOSITION AND SOURCE APPORTIONMENT IN CHILLAN CHILE.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

In order to study air pollution in that Chillán area located in the southern Biobío Región of Chile, an aerosol monitoring study was established to measure ambient aerosol composition for one sampling site at the University of Concepción. The Chillán campus is located approximately 2 km North of the city's downtown. The aerosol monitor was operated on the campus from October 9th to December 9th, 1998. The study employed an IMPROVE sampler with PM_{10} Anderson inlet at 3 meters collecting PM_{10} on Teflon membrane filter. Proton Induced X-ray Emission (PIXE) and X-ray Fluorescence Analysis (XRF) were used to measure the concentration of 22 elements to levels below 0.48 ng/m^3.

Moderate aerosol concentration was observed (up to 60 $\mu g/m^3$). The main aerosol particle sources in Chillán are resuspended soil dust, which accounts for 55% of the PM_{10} aerosol. Aerosol associated with transportation activities accounts for only 2%. Sulfate particles account for only 3%, mainly originating from SO_2 gas-to-particle conversion. Organics associated with hydrogen measured by Proton Elastic Scattering Analysis (PESA), are an important component accounting for 24%. Direct traffic emissions are generally mixed with resuspended soil dust. The presence of Pb, Br, and Cl, and other heavy metals in analyzed samples points to traffic emissions in the city. In addition, presence of several trace metals, including Mn, Zn, Cu, Ga, As, and Sr in our sample seems to correspond well with industrial emissions in the city.

[P13-28] CHARACTERIZATION OF CHEMICAL COMPOSITION OF ORGANIC AEROSOL IN THE NORTHEASTERN UNITED STATES.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

PM10 sample collection started in January 2000 until November 2000 in North Piladelphia to study the chemical composition of organic aerosol in the Northeast US. Fifteen to twenty daily samples were collected continuously in each season with a total number of 71 samples. Chemical composition of organic particulate matter collected was determined by GC-MS analysis after soxhlet extraction. Over 50 potential organic source markers were identified and quantified, including: n-alkanes, n-alkanoic acids, dicarboxylic acids, hopanes, polycyclic aromatic hydrocarbons (PAHs), levoglucosan and cholesterol. Daily and seasonal variation of those compounds will be discussed and compared, with an emphasis on potential variation correlations. The relative importance of sources contributing to the PM in the Northeast area will be estimated.

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[P13-15] A DIRECTIONAL PROFILE APPROACH TO SOURCE-RECEPTOR MODELING.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

As qualitatively observed in previous studies, a major source of pollutants transported to the NETL sampling site, located in a suburban area 20 km southwest of Pittsburgh, PA, originate from the general direction of the Ohio River Valley to the west and southwest of site. A quantitative directional source profile approach was investigated to model the source / receptor relationship among these remote sources and local sources. Directional source profiles are $PM_{2.5}$ compositional profiles measured at NETL when the geographic origin of the plumes reaching the NETL sampling station was known with reasonable certainty. The CMB8 and UNMIX models were applied to test the hypothesis that directional source profiles could be developed to determine directional apportionment of $PM_{2.5}$ transported into the region.

Initial directional source profiles were developed from a combination of inorganic compositional data from PIXE analysis and elemental carbon / organic carbon (EC/OC) analysis of NETL $PM_{2.5}$ samples from August 2000. The directional source profiles developed from the regression slopes are plotted in Figure 1. (Click to see figure 1) Figure 2. is an example of the CMB8 model results for the distribution of all species, including the primary inorganic + elemental carbon material for August 2000. The amounts of primary $PM_{2.5}$ attributed to sources from different geographic directions are illustrated in the small chart in the bottom right of this figure. (Click to see figure 2) Further data analysis and modeling efforts are underway with an expanded data set to further characterize and clarify the source / receptor relationships.

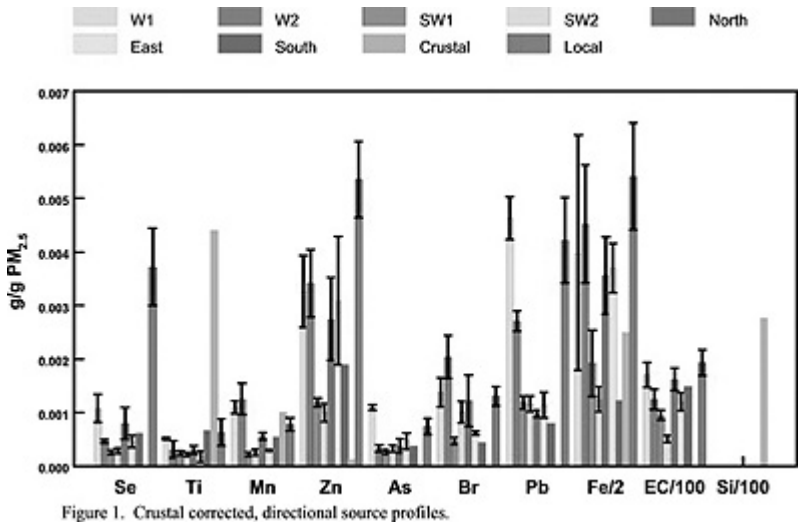

Figure 1. Crustal corrected, directional source profiles.

Figure

[P13-15] A DIRECTIONAL PROFILE APPROACH TO SOURCE-RECEPTOR MODELING. (continued)

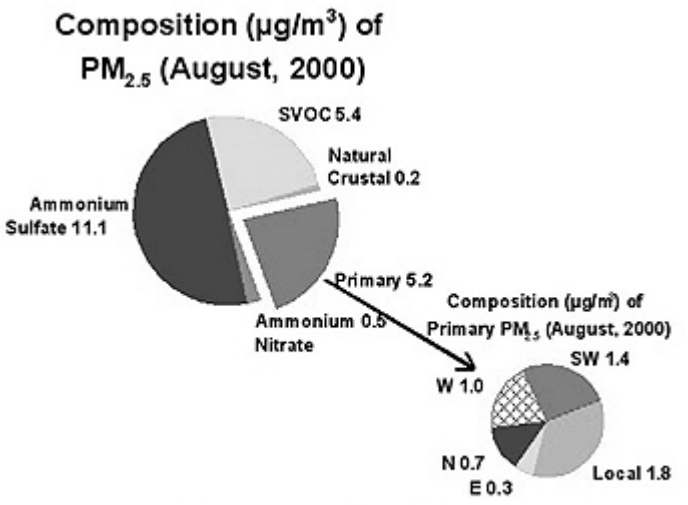

Figure 2. Average $PM_{2.5}$ during August 2000, with associated geographic source directions for crustal corrected primary particles (EC and inorganic)

Figure 1

[P13-05] SOURCE ALLOCATION OF CARBON IN PM2.5 USING C-14 AND TRACER INFORMATION.

Eric S Edgerton, Mei Zheng, Callie J Waid, John J Jansen, Benjamin E Hartsell HQ, Atmospherice Research & Analysis, Inc., Cary, NC; Data Management, Atmospherice Research & Analysis, Inc., Plano, TX; Southern Company, Birmingham, AL; Department of Earth and Atmospheric Sciences, Georgia Institute of Technology, Atlanta, GA

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Ambient particulate organic carbon (OC) consists of hundreds, if not thousands, of idividual compounds in a dynamically evolving medium of water, inorganic ions, elemental carbon (EC), crustal and trace elements. The sources of OC include primary emissions from motor vehicles, forest fires and other forms of combustion, as well as secondary production from gas phase precursors (e.g., sesquiterpenes and aromatics). This poster synthesizes data from various measurements to estimate major source categories for OC at research sites in the southeastern U.S. Measurements include: carbon-14 analysis, tracer/CMB analysis for primary carbon species and continuous CO and EC. The analysis hinges on the notion of a source matrix for OC. In its simplest form, a source matrix is a 2x3 grid with primary, secondary and total carbon along the rows, modern and fossil carbon along columns. Other categories can be used for the columns, if desired, and these can be subvdivided to add detail as data and creativity permit. Thus, the simplified source matrix contains six cells and specification of any four solves for the remaining two. Carbon-14 analysis differentiates between modern and fossil carbon and is a more or less direct measure of total (i.e., primary plus secondary) OC in each category. Exploratory carbon-14 measurements at three SEARCH sites in the southeastern U.S. show that modern sources, on average, contribute ≥80% and ≥]60% of OC observed at rural and urban sites, respectively, and that this percentage is surprisingly constant across seasons. Differentiation between primary and secondary OC is technically demanding and generally requires detailed chemical analysis of tracer species in air samples or sophisticated air quality models. Zheng et al. (2002) have used the former approach and recently published seasonal estimates for major sources of OC at SEARCH sites. Results for wintertime samples show that primary sources can account for virtually all OC in air samples. Results for summer, in contrast, consistently show that primary sources cannot account for observed OC, thus providing evidence of secondary production. Sources used in the above analyses can also be classified, to a first approximation, into fossil and modern categories, then combined with carbon-14 results in the OC source matrix. Results show interesting contrasts across sites and seasons. Winter data for rural southern MS show that OC is almost entirely primary-modern. Summer data for Atlanta, GA suggest that OC is about 35 % primary-modern, 35% primary-fossil, 25% secondary-modern and ≤5% secondary fossil.

[P13-17] SOURCE IDENTIFICATION OF AEROSOL MEASURED AT MULTIPLE SITES ACROSS ST. LOUIS.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

The purposes of this study are to identify the source contributions of ambient particulate matter (PM) at multiple sites in an urban area. Epidemiologic time-series studies typically rely on data for PM and its components that were collected at a single ambient monitoring site of a study area. However, there can be considerable heterogeneity in the within-area concentrations, depending on the study area chosen. There have been very few data sets collected in urban areas from which one could determine the spatial heterogeneity of PM and its components. The Regional Air Pollution Study / Regional Air Monitoring System (RAPS/RAMS) conducted in St. Louis is one such study in which data are available to evaluate the spatial heterogeneity of PM, its components and source contributions across an urban area. In addition, St. Louis was one of the study areas used in the Harvard Six-Cities Study (Schwartz et al., 1996. J. Air & Waste Manage. Assoc. 46, 927-939). We have analyzed composition data for PM collected in St. Louis, MO between May 1975 and April 1977 by Positive Matrix Factorization (PMF). PM samples were collected at ten monitoring sites using dichotomous samplers, analyzed by X-ray fluorescence for elemental composition, and the total PM mass values were determined by beta-gauge. PMF identified six to nine sources of fine PM and four to nine sources of coarse PM at each of the ten sites. Conditional probability functions were computed using surface wind data and identified mass contributions from each source. The results of analyses agreed well with existing information about the location and nature of local point sources.

[P13-18] APPLICATION OF UNMIX AND CMB CALCULATIONS TO AMBIENT PM2.5 AIR QUALITY DATA IN THE CINCINNATI AIR SHED.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

An epidemiological study to evaluate the impact of ambient PM on children's health has been ongoing in the Greater Cincinnati area. One of the objectives of the study is to conduct a detailed characterization of the ambient aerosol, and establish the contribution of diesel engine emissions. The hypothesis of the study is that diesel engine exhaust particulate matter is adjuvant with naturally occurring bioaerosols (such as pollen) in the onset of allergic sensitization. There are several controversial viewpoints on apportionment of the contribution of diesel engine type sources. One of the important aspects is establishing the signature of the truck emissions. The air sampling was performed at specified ambient locations at different distances from interstate highways; in addition, the samples were collected at truck stops and locations that represented truck/bus emissions as the primary sources.

Ambient PM 2.5 samples were analyzed by X-ray fluorescence to determine concentrations of elemental species. The thermal optical analysis was used to determine elemental and organic carbon (EC/OC) concentrations. An optical reflectance method has been used to also determine the EC concentrations from teflon filter samples. A calibration curve was established based on the thermal optical measurements from co-located quartz filters. Thus, a richer database of EC concentrations can be readily developed for use in the models.

The measurements of diesel engine emissions in areas concentrated with trucks and buses are being compared to published source signatures for diesel engine exhausts, and to those obtained by UNMIX analysis of ambient PM 2.5 data. The entire ambient dataset is also being analyzed by UNMIX and CMB modeling approaches. Preliminary analysis indicates that the sulfate component is a large fraction of the PM 2.5 aerosol. Several regions were identified which clearly show an impact of diesel truck emissions, whereas in other areas it is difficult to decipher contributions of diesel engine emissions. The data generated in this study will be used to classify the region into three sections: high, moderate and low contributions of diesel engine exhausts. Strategies to improve the source apportionment specifically to establish contributions of diesel engines are discussed.

[P13-19] SOURCE APPORTIONMENT USING PARTICLE SIZE DISTRIBUTION DATA FROM THE PITTSBURGH AIR QUALITY STUDY(PAQS).

Liming Zhou, Eugene Kim, Philip K. Hopke, Charlie Stanier, Spyros Pandis Department of Chemical Engineering, Clarkson University, Potsdam, NY; Department of Chemical Engineering, Carnegie Mellon University, Pittsburgh, PA

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Previously, Positive Matrix Factorization (PMF) was successfully applied to one month of particle size distribution data acquired during the Pittsburgh Air Quality Study (PAQS) (Zhou et al., 2002, submitted to Aerosol Science & Technology). In this study, a larger set of particle size distribution data acquired in Pittsburgh from July 2001 to August 2002 were analyzed. The data were obtained from Scanning Mobility Particle Spectrometers (SMPS) and Aerodynamic Particle Sampler (APS) with a temporal resolution of 15 minutes. Each sample contained 165 evenly sized intervals from 0.003 to 2.5 μm. Those days with strong nucleation events and particle growth were excluded from this study. The values for each set of five consecutive size bins were summed to produce 33 new size channels. The particle size distributions were analyzed as a bilinear model problem solved by Positive Matrix Factorization (PMF). The factors could be assigned to particle sources by examination of the number size distributions associated with the factors, the time frequency properties of the contribution of each source (Fourier analysis of source contribution values) and the correlations of the contribution values with the gas phase data. Seasonal trends and weekends effects were compared. A conditional probability function (CPF) analysis was performed for each source to ascertain the likely directions in which the sources were located.

[P13-20] SOURCE - RECEPTOR RELATIONS OF PM MASS FRACTIONS AND PARTICLE NUMBER CONCENTRATION.

Bostian Gomiscek, Helger Hauck, Hans Puxbaum, Silke Stopper, Othmar Preining Clean Air Commission, Austrian Academy of Sciences, Vienna, Austria; Institute of Environmental Health, University of Vienna, Vienna, Austria; Institute for Chemical Technologies and Analytics, Vienna University for Technology, Vienna, Austria

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Introduction

Within the Austrian Project on Health Effects of Particulates (AUPHEP) TSP, PM_{10}, $PM_{2.5}$, $PM_{1.0}$ and particle number concentration were monitored continuously at four sites for one year. Besides gaseous pollutants and meteorological parameters, daily filter samples of PM_{10} and $PM_{2.5}$ were taken to obtain their chemical composition (OC, EC, main ions, selected polar organic compounds and heavy metals). The sites are representative for a good part of the country and characterize different emission situations: conurbation (Vienna), background/rural and pre-burden of Vienna, industrial area and residential area in a basin.

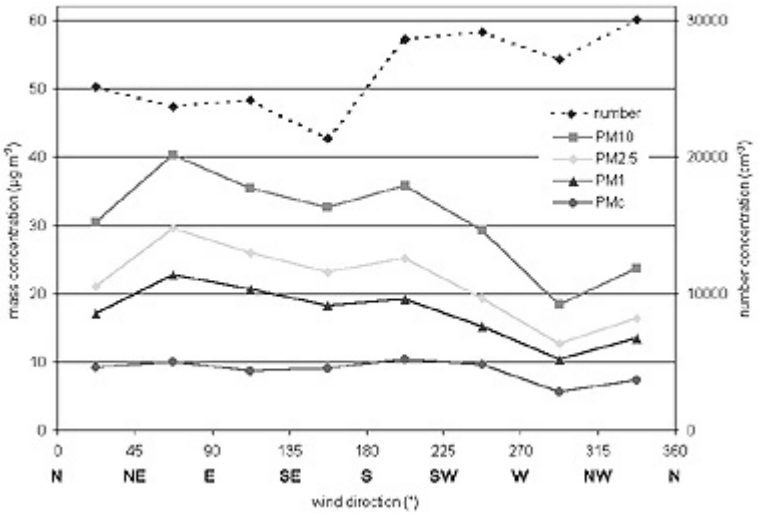
This contribution will focus on sector analyses of wind direction and trajectory calculations related to particle number and mass concentration of the various size fractions and their chemical composition.

Results and discussion

The 30-minutes average PM concentration data set was divided into 8 classes, corresponding to 45° sectors. In the figure the related data for the urban site of Vienna is presented as an example. The lowest mass concentrations were observed in the sector from 270° to 315°, followed by the sector from 315° to 360°. This result is rather surprising, because one of the busiest streets in Vienna runs about 200 m from the site towards W-N. However, in this sector there are almost no other sources than traffic - this part of Vienna is an exclusively residential area. The highest particle number concentrations, however, were found in the less polluted sectors regarding PM mass concentrations.

Conclusions

For the four different receptor sites depending on the strength, characteristics and spatial distribution of the main emitters different source-receptor relations can be found. However, the vicinity of even a main street is not obviously a predominant source of elevated PM fractions. The local traffic situation clearly steers the number concentration of fine and ultrafine particles. Epidemiologic studies focused on mass or number concentration, therefore, may come to contradicting conclusions if time courses of these two parameters are contrary. (Click to see figure 1)



Figure

[P13-21] HIGHLY TIME-RESOLVED MEASUREMENTS OF ELEMENTAL COMPOSITION AT THE BALTIMORE, ST. LOUIS, PITTSBURGH, AND TAMPA SUPERSITES USING THE UM HIGH-FREQUENCY AEROSOL SLURRY SAMPLER: UNPRECEDENTED RESOLUTION OF THE SOURCES OF PRIMARY ATMOSPHERIC AEROSOL.

John M Ondov, J Patrick Pancras, Sarala Gazula, Megan NS Yu, Jay Turner, Allen Robinson, Spyros Pandis, N. D. Poor, R. K. Stevens Department of Chemistry and Biochemistry, University of Maryland, College Park, MD; Department of Chemical Engineering, Washington University, St. Louis, MO; Department of Civil Engineering, Carnegie Mellon University, Pittsburgh, PA; USF College of Public Health, Tampa, FL; Florida Department of Environmental Protection, Tallahassee, FL

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Simultaneous multielement graphite furnace atomic absorption spectrometry was used to determine Al, As, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Sb, Se, and Zn in ambient air sampled for 30 or 60 minute intervals after dynamic preconcentration using the University of Maryland Elements in Semicontinuous Elements in Aerosol Sampler (SEAS). The instrument was operated for more than 10 months in Baltimore, 18 months in St. Louis, and 3 months in Pittsburgh, as a part of the EPA Supersites Program; and for nearly 2 months inTampa under the Florida Department of Environment's Bay Regional Atmospheric Chemistry Experiment. Additional measurements were made near selected, isolated, industrial sources (e.g., Coke plant) in Pittsburgh. Data for a total of nearly 3500 30-min or hourly intervals will ultimately be available. Herein, results are presented for nearly 2000 samples. Trends in elemental concentrations were correlated with wind direction and other meteorological factors to identify the influences of local industrial emissions, including motor vehicle traffic, coal- and oil-fired power plants, and municipal incinerators. The results reveal 10- to 500-fold excursions in concentrations of elemental constituents of aerosol particles during typical periods of influence from plumes of local sources. As might be expected, their concentrations are largely independent of aerosol mass, and are often low when PM2.5 mass is elevated. Interpretation of these highly time-resolved data further show unprecedented resolution of aerosol from high-temperature combustions sources; notably, contributions of individual coal- and oil-fired power plants, a battery recycling plant, copper smelter, steel plants, and other important heavy metal sources are often clearly resolved. The data are being used to develop source profiles for use in Chemical Mass Balance Receptor models and identification of sources in Factor Analysis models and to provide true measures of short term exposure.

[P13-22] MIDDLE SCALE SOURCE CONTRIBUTIONS TO HIGH TIME RESOLUTION PARTICULATE MEASUREMENTS AT THE SAINT LOUIS - MIDWEST SUPERSITE.

Jason S Hill, Bradley P Goodwin, Jay R Turner Environmental Engineering Program, Washington University, Saint Louis, MO

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Epidemiologic studies of air pollutant impacts on human health often rely upon measurements at a single receptor site to describe pollutant concentrations for a relatively large geographical domain (e.g., an entire urban or metropolitan area). High time resolution measurements of air quality indicators (e.g., gases, aerosol chemical composition, aerosol physical properties) can be used to probe the extent to which the levels of such indicators at a receptor site are influenced by sources from various spatial scales. Such information provides insights into the zone of representation and thus the robustness in using the monitor data to represent a given geographic domain. Following the methodology of Watson and Chow (*J. Air & Waste Manage. Assoc. 51*: 1522-1528 (2001)) which exploits the time scales for fluctuations in an air quality indicator reported at high time resolution (in this case, 5-minute resolution), middle scale contributions (sources nominally 0.1-1 km from the receptor) have been estimated for aethalometer black carbon and selected other parameters at the St. Louis - Midwest Supersite core monitoring location in East St. Louis, IL. This presentation summarizes the estimated middle scale contributions conditioned on day-of-week, season, and wind direction. These estimates are interpreted in light of our knowledge of the geographic characteristics and emissions-generating activities in the neighborhood of the receptor site.

[P15-05] THE EFFECTS OF OZONE AND FINE PARTICULATE MATTER ON THE PULMONARY HEALTH OF ADULT HIKERS IN THE GREAT SMOKY MOUNTAINS NATIONAL PARK.

Steven P Girardot, Catherine C Collins, Ryan W Malone, Cynthia A Atterholt, Wayne T Davis, Charles B Hamilton, James R Renfro, P. Barry Ryan, Susan M Smith, Gregory D Reed Department of Chemistry, Emory University, Atlanta, GA; Department of Health and Safety Sciences, University of Tennessee, Knoxville, TN; Department of Civil and Environmental Engineering, University of Tennessee, Knoxville, TN; Department of Chemistry and Physics, Western Carolina University, Cullowhee, NC; National Park Service, Great Smoky Mountains National Park, Gatlinburg, TN; Rollins School of Public Health, Emory University, Atlanta, GA

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

As part of an ongoing effort to monitor and improve air quality in the Great Smoky Mountains National Park, the effects of ambient ozone (O_3) and fine particulate matter ($PM_{2.5}$) on the short-term pulmonary function of adult hikers were assessed at Newfound Gap, a popular high-elevation (5048 ft) site in the Park. During August 2002-October 2002, adult (18 and over) day hikers embarking upon hikes of approximately 4 miles or longer along a portion of the Appalachian Trail that originates at Newfound Gap were solicited to participate in the study. Volunteers were asked to have their height and weight measured, submit to pulmonary testing before and after their hike, complete a trip log documenting their pulse and arrival times at certain trail markers, and respond to a health history survey. Pulmonary function was measured using spirometry, with percentage changes in forced expiratory volume in 1 second (FEV_1), forced vital capacity (FVC), the ratio of FEV_1 to FVC, peak expiratory flow rate (PEFR), and forced expiratory volume between 25 and 75 percent of total expiration duration ($FEV_{25-75\%}$) calculated for each hiker who met eligibility criteria, gave acceptable and reproducible tests, and provided a complete set of covariates (age, fitness level, gender, smoking status, history of asthma or wheeze, and hiking time and duration) (N = 270). Continuous ambient ozone and $PM_{2.5}$ concentrations along with meteorological conditions (temperature and relative humidity) were monitored on-site at the trailhead on each sampling day. Local air quality measurements were correlated with continuous Park air monitoring stations located at nearby sites at similar elevations. Ozone exposures ranged from 30 to 90 ppbv, while $PM_{2.5}$ exposures ranged from 5 to 40 $\mu g/m^3$ during this time period.

[P13-24] SINGLE PARTICLE CHARACTERISTICS OF GASOLINE AND DIESEL POWERED VEHICULAR EMISSIONS: CLASSIFICATION, DIFFERENTIATION, AND SOURCE APPORTIONMENT.

Sergio A Guazzotti, Michele Sipin, David A Sodeman, Yongxuan Su, David T Suess, Stephen M Toner, Kimberly A Prather
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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 13: Receptor Modeling and Source Apportionment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Source apportionment of gasoline and diesel particles in the atmosphere constitutes a major challenge due to close similarities in the chemical composition of these particles. With traditional standardized filter collection/ analysis methods, it is virtually impossible to identify the number of particles arising from each of these sources, due to the fact that these methods provide as an output an average chemical composition, combining the contributions from many sources. Using aerosol time-of-flight mass spectrometry (ATOFMS), the size and chemical composition of individual particles can be evaluated with high temporal resolution, therefore providing information on the properties of single particles at a level of detail which allows distinction between different particle sources.

ATOFMS source characterization studies of particulate combustion emissions from gasoline vehicles and heavy duty diesel vehicles were carried out with the objective of determining the presence of unique combinations of ion markers (fingerprints) in the mass spectra of single particles from these vehicular emissions. By using the single particle fingerprints from these sources, differentiation between carbonaceous particles emitted from gasoline powered and diesel vehicles are readily established and source apportionment of the respective contributions can be successfully tested using ambient datasets acquired with ATOFMS. This poster will provide results from initial dynamometer testing and the application of unique fingerprints to identify and track particles in various locations in the United States including Atlanta, New York, Texas, and California.

[P06-11] LONG-TERM CLEARANCE KINETICS OF INHALED ULTRAFINE INSOLUBLE IRIDIUM PARTICLES IN THE RAT LUNG.

Manuela Semmler, Jürgen Seitz, Franz Erbe, Paula Mayer, Joachim Heyder, Günter Oberdörster, Wolfgang G. Kreyling Institute for Inhalation Biology, GSF-National Research Center for Environment and Health, D-85758 Neuherberg/Munich, Germany; Focus Network Aerosols and Health, GSF-National Research Center for Environment and Health, D-85758 Neuherberg/Munich, Germany; Medical Center, University of Rochester, Rochester, NY

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (4:00 PM-5:00 PM) Grand Ballroom 2-4

Currently there is concern about translocation of ultrafine particles (UFP) from the lungs into systemic circulation and uptake in transpulmonary organs causing adverse cardio-vascular effects. While there are conflicting reports about short-term translocation and accumulation in liver ranging from about 50% (Oberdoerster et al., 2002) to 7% (Nemmar et al., 2001) to 0.5% (Kreyling et al., 2002), nothing is known about long-term translocation and whether clearance kinetics of ultrafine particles differs from that of larger particles as one may expect from differing clearance mechanisms for micron-sized versus ultrafine particles.

We have studied lung retention and clearance kinetics in 12 healthy male adult WKY rats over 6 months after a one-hour-inhalation of Ir-192 radiolabeled, insoluble, ultrafine 20 nm iridium particles. Whole body retention was followed by external gamma counting and particle clearance kinetics was determined by excretion radio-analysis. Four rats each were sacrificed after three weeks, two and six months; all organs as well as tissues and the carcasses were radio-analyzed to balance the entire deposited radioactivity of the particles.

The most prominant fraction was retained in the lungs at each time point of sacrifice (26%, 15%, 6%), respectively, and clearance out of the body was solaly in feces. Extrapulmonary particle uptake did not continue to increase but decreased with time in liver, spleen, heart and brain comparably to previous data obtained during the first seven days (Kreyling et al., 2002). UFP long term clearance rates (0.0082 d-1) derived from whole body measurements was comparable to previously reported data using insoluble micron-sized particles (0.01 - 0.007 d-1 (Bellmann et al. 1994)). However, a more detailed analysis including excretion data suggests a twofold faster particle clearance rate (0.016 d-1)of most of the ultrafine iridium particles towards the larynx with a very small fraction (0.05) being virtually not cleared at all.

[P05-13] PARTICULATE CARBON EMISSIONS FROM COAL FIRED POWER PLANTS: STACK TESTING AND FIELD OBSERVATIONS.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Organic and elemental carbon (OC and EC, respectively) are significant contributors to PM2.5 mass in many areas of the United States. In the southeast, for example data from the SEARCH network show that carbonaceous material (EC plus OC*1.4) is the dominant component of PM2.5 at urban sites and comparable to sulfate at rural sites. Sources of atmospheric particulate carbonaceous material include primary emissions from gasoline and diesel powered vehicles, biomass burning (e.g., fires and fireplaces) and cooking, as well as secondary products of photochemistry. Limited information is available on primary carbon emissions related to fossil fuel electricity generation. This poster presents results from two investigations designed to estimate: 1) primary emissions of carbonaceous material from coal fired power plants (CFPPs); and 2) the contribution of CFPP emissions to ambient concentrations carbonaceous material. The first of these involves stack testing at 15 facilities in the eastern (primarily southeastern) U.S. The facilities tested approximate the distribution of boiler type, burner configuration, control configuration and coal type for the population of US CFPPs. Particulate material collected on quartz fiber filters at 135-150C during routine stack tests were analyzed for OC and EC using the thermal-optical reflectance method. Results are used to estimate carbon emissions, both on an absolute basis (e.g., tpy) and a relative basis (e.g., % of particulate emissions). Particulate carbon occurs in measurable quantities in CFPP effluents and the split between EC and OC varies from facility to facility. However, total carbon is usually less than 2%, and invariably less than 10%, of CFPP particulate emissions. The second investigation examines the issue from the standpoint of a rural research site in NW GA. In this case, high temporal resolution SO2 data are used to identify plumes from specific CFPPs. Continuous measurements of EC and OC sampled at ambient temperatures are then analyzed to determine if there is a significant increment above background during the plume excursion. Analysis of CFPP plume events shows very weak or non-existent relationships between SO2 and EC or OC. In other words, the contribution of CFPPs to ambient carbon concentrations is nearly undetectable, even under conditions of substantially elevated CFPP SO2. Based on annual mean SO2 concentrations, these findings suggest that CFPPs typically contribute much less than 1% of total particulate carbonaceous material to atmospheric aerosols.

[P05-03] PROGRESS TOWARD A DUST EMISSIONS MODEL FOR THE COLUMBIA PLATEAU.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

The Columbia Plateau is a region susceptible to wind erosion due to the preponderance of strong winds that typically occur in spring and autumn when soils are dry. These conditions have resulted in severe dust storms that not only have impaired driving of automobiles, but that may also have adversely affected human health. A model for predicting fugitive dust emissions from agricultural soils in the Columbia Plateau was introduced in 1996. Dust emissions are predicted based upon the amount of eroded soil, a dustiness index, and wind speed. The amount of soil eroded by wind is a function of surface characteristics (i.e. wind energy, quantity of surface crop residue, soil surface roughness) and soil physical properties (i.e. soil crusting, soil erodibility, soil moisture). The dustiness index is the fraction of fine particulates (smaller than 10 microns) in the eroded soil and is assumed to be equivalent to the fraction of fine particulates within the upper soil profile. Progress has been gradual in defining all parameters in the model. Field studies were undertaken to define the relationship between soil loss and wind energy, surface residue cover, surface roughness, and soil erodibility. In addition, the dustiness index has been defined for a range of soil types common to the Columbia Plateau. Parameters have not been defined for the relationship between soil loss and soil moisture and soil surface crusting. For non-crusted and dry soils, the model has performed reasonably well in simulating field dust emissions. Further efforts are needed in parameter specification to predict dust emissions from agricultural soils that are variably moist and subject to crust formation.

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[P05-04] WITHDRAWN

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4
WITHDRAWN

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[P05-05] PM10 EMISSIONS FACTORS FOR UNPAVED ROADS: CORRECTION FOR NEAR-FIELD DEPOSITION.

Vic Etyemezian, Dale Gillette, John Gillies, Hampden Kuhns, Djordje Nikolic, John Veranth, John Watson Division of Atmospheric Sciences, Desert Research Institute, Las Vegas, NV; ARL, NOAA, Research Triangle Park, NC; University of Utah, Salt Lake City, UT

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Compared to other primary PM_{10} emissions, fugitive dust emissions appear to be overstated. There is a discrepancy between source attribution perfomed on ambient samples and concentrations predicted by regional air quality models. Fugitive dust emissions may be overstated because of incorrect emissions factors or activity levels. It is also likely that regional air quality models do not account properly for the deposition of coarse particles that occurs in the first several hundred meters downwind of a fugitive dust source. Instead, particles are assumed to be instantly mixed up to the height of the first grid cell in the model. The extent of near-source removal of fugitive particles from unpaved roads was investigated. Results from a field study near El Paso, TX were compared with modeling predictions. The field study occured in April under neutral and unstable atmospheric conditions. Three 12-meter towers were placed downwind of an unpaved road at distances of 7, 50, and 100 meters. The profiles of dust plumes generated by vehicles traversing the unpaved road were captured by nephelometer-style instruments located at several heights along the towers. Particle size distributions were also measured at some locations with optical particle counters. Two methods were used to model the near-source removal of the coarse fraction of PM_{10} dust emissions, a simple box model, and a numerical solution to the one-dimensional atmospheric diffusion equation. Modeling results indicated that the box model may be adequate to estimate near-source removal under some conditions, provided it is applied over a limited distance. Furthermore, coarse particle removal in the near source region may reduce the effective PM_{10} emissions by as much as a factor of two. However, model and field study results indicated that under conditions similar to the desert southwestern United States, the fraction of PM_{10} that is removed in the near-source region cannot entirely account for the discrepancy between regional air quality models and source attribution results.

[P05-06] ESTIMATING SURFACE PARTICLE EMISSION AND HUMAN EXPOSURE IN URBAN STREET CANYONS.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Resuspension of fugitive dust is commonly modeled by using similarity theory based on atmospheric momentum and heat fluxes. Iterations of this strategy applied to empirical studies over the last several decades continue to decrease uncertainty surrounding the mechanisms and intensities of particle emission for many surface types. Similarity theories, however, fall short when applied to areas such as urban street canyons where the roughness elements create atmospheric wind profiles that, when modeled with standard estimations, place the logarithmic zero plane displacement value above the level of most human receptors in the environment. When the goal is to better understand PM release and receptor availability within that region, complex turbulence patterns inherent in lower portions of urban canopies necessarily preclude simple interpolation and an alternative method is needed.

Fine mode PM agglomerates readily with larger soil particles and is released by external mechanical forces. Previous studies in open environments have shown that much of the released PM that becomes airborne is deposited near to its origin and a smaller fraction becomes airborne. This effect is increased greatly in areas where particle saltation and entrainment layers (0-3m) are physically bounded. To account for saltation fluxes and turbulence patterns that vary PM concentrations at human receptor level, an approach is developed based on recent micro-scale models of urban momentum flux and kinetic energy balances for particle entrainment. Statistical distributions of turbulence, wind velocity, and ground particle characteristics combined with geometry of local features and changing atmospheric conditions above can allow vertical extrapolation by joining kinetic/friction models for sub-layer approximations with standard logarithmic friction layer theories above. This allows the entire vertical range of urban PM concentrations to be estimated based on data that is attained at or above the local roughness height. For this study, theoretical sub-layer concentrations are anchored by empirical ambient data from the South Coast Air Basin during 2000-2001. Estimates for human exposure are then derived by considering activity levels and biological susceptibility coincident in time with modeled concentrations. These theories are a sub-component of a regional model being developed to estimate the concentration, transport, and exposure potential of entrained lead particles throughout the basin.

[P05-07] EFFECT OF OPERATING VARIABLES ON PM EMISSIONS FROM WOODSTOVES.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

The adverse effect of PM, particularly PM2.5, on human health and the environment has resulted in Canada setting standards for the ambient concentration of PM2.5. Residential wood combustion (RWC) has been targeted as one of the primary sources of anthropogenic PM in Canada. In order to achieve the PM2.5 ambient standard, PM emissions from RWC require investigation to aid in determining reduction strategies.

The objective of this study was to investigate the effect of operating variables on the amount and size of PM produced from woodstoves currently present in Canadian homes. A factorial experimental design was used to statistically investigate the effect of burn rate (1.5 kg/hr and 3 kg/hr), fuel type (softwood and hardwood) and fuel moisture content (15% and 25%) on total PM, PM10 and PM2.5 emissions. Two conventional woodstoves were set up and operated according to CAN/CSA B415.1-92 Performance Testing of Solid-Fuel-Burning Stoves with the exception of using cordwood as the fuel. Particulate matter was collected using the EPA's Draft Method for Determination of PM10 and PM2.5 Emissions.

Total PM emissions from 16 experiments ranged from 1.7 g/kg fuel to 70.8 g/kg fuel. Averages for the PM10 and PM2.5 size fractions were 95% and 87%, respectively. Burn rate was determined to be the most statistically significant variable. At the 99% confidence bound a woodstove operated at a high burn rate showed a main effect reduction of 30 g/kg in total PM emissions. Fuel type was significant at the 90% confidence bound: the use of a hardwood fuel reduced PM emissions by 11 g/kg. Although moisture content did not have a strong statistical significance, burning fuel with a high moisture content (25%) had a trend of producing fewer PM emissions. High burn rates exhibited at the 99% confidence bound, a reduction in the PM10 and PM2.5 emissions; however, the effect of fuel type and moisture content on PM10 or PM2.5 was not significant. None of the operating variables had a statistically significant effect on the size distribution of PM emissions from woodstoves. The results from this study indicate that woodstoves produce primarily PM2.5. Emissions can be reduced by changing operating practices, but the PM emission size distribution does not vary significantly.

[P05-08] ESTIMATING PM EXPOSURE FROM WOOD SMOKE IN RESIDENTIAL NEIGHBORHOODS DURING WINTERTIME INVERSIONS.

Terry E. Baxter Civil and Environmental Engineering, Northern Arizona University, Flagstaff, AZ

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Particulate matter from residential combustion of wood typically represents a relatively low fraction (<10%) of an area's total annual PM inventory. However, the period over which these emissions occur is seasonal, during the four or five coldest months of the year when radiation inversions are frequent and the wood smoke PM can concentrate within specific neighborhoods. Neighborhoods that are dominated by residents using wood for heating can experience a significant increase in PM exposure, particularly during nighttime hours. Thus, a simple but reliable methodology for estimating wood smoke PM concentrations in these neighborhoods is needed to economically support studies evaluating potential health effects in those areas.

This paper presents results from a study designed to evaluate the use of emission inventory data to estimate residential wood smoke PM concentrations in individual neighborhoods. Results from six neighborhoods are presented and discussed. Statistical analysis of results comparing an intensive (100% distribution rate) and limited survey effort (10% distribution rate) within one neighborhood indicates that the methodology of a limited survey effort can provide usable data. The significance of a neighborhood's meteorological conditions, topography, seasonal wood fuel consumption and wood-burning device distribution on the potential PM exposure experienced is also evaluated. Ongoing work that continues to focus on the study of wood smoke PM exposure in individual residential neighborhoods and related health effects is briefly discussed.

[P05-09] WITHDRAWN

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4
WITHDRAWN

[P05-10] FENCELINE SAMPLING ADJACENT TO A LARGE COKE PRODUCTION FACILITY IN PITTSBURGH, PA.

Emily A Weitkamp, Eric Lipsky, Allen Robinson, Natalie Anderson, Heather Leifeste, R Subramanian, Juan Cabada-Amaya, Andrey Khlystov, Charles Stanier, Leonard Lucas, Satoshi Takahama, Beth Wittig, Cliff Davidson, Spyros Pandis, Andrea Polidori, Ho-Jin Lim, Barbara Turpin, Patrick Pancras, John Ondov Mechanical Engineering, Carnegie Mellon University, Pittsburgh, PA; Civil Engineering, Carnegie Mellon University, Pittsburgh, PA; Chemical Engineering, Carnegie Mellon University, Pittsburgh, PA; Environmental Sciences, Rutgers University, New Brunswick, NJ; Chemistry and Biochemistry, University of Maryland, Baltimore, MD

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

As part of the Pittsburgh Air Quality Study, measurements were performed on a hill adjacent to a large coke production facility in Pittsburgh, PA. The goal of the effort is to update chemical fingerprints and emission factors for an important source category in the Pittsburgh Region. A large suite of continuous and integrated measurements was made at both the fenceline and a background site. Continuous measurements included meteorological data, CO, SO2, NOx, NO, PM2.5 mass, and particle size distributions from 3 nm to 1 μm. A combination of meteorological data and pollutant measurements at the fenceline and background sites were used to determine when the coke plant plume was impacting the fenceline site. For example, ratios of SO2 at the fenceline sampling site to the background site as large as 25 are observed when the fenceline site is in the plume. Semi-continuous measurements of OC/EC (2 hr resolution) and trace metals (30 minute resolution) were made to obtain highly time-resolved composition data. The plume contains greatly elevated OC/EC concentrations; for example, ratios of peak plume OC and EC concentrations to the background site were 18 and 48, respectively. The plume also contains greatly elevated metals concentrations; for example ratios of peak plume Se levels to the background were often greater than a factor of 8. Integrated PM2.5 samples were also collected and analyzed for organic and elemental carbon (OC/EC), organic composition (speciation), trace metals, and inorganic composition.

[P05-02] CONTRIBUTION OF FUGITIVE DUST TO REGIONAL PM.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

The contribution of fugitive dust to ambient PM is an issue for both attainment of National Ambient Air Quality Standards (NAAQS) and for visibility protection, but there is considerable uncertainty regarding the contribution of unpaved roads to regional PM inventories. A key hypothesis is that near-source deposition of vehicle generated dust can reduce the amount of material that is carried high in the atmosphere and transported long distances.

Recent field studies testing various aspects of this hypothesis will be summarized in the poster. One study involved measurement of the total dust flux under stable atmospheric conditions from a road at a site with large roughness elements simulating an urban area. Another study measured particle deposition on flat substrates and on simulated vegetation downwind of a test road on a military training range. Source sampling and receptor analysis studies are being used to determine the ability of Chemical Mass Balance (CMB) to resolve the geological material and quantify the contribution of dust from specific source areas.

The ongoing field studies support the hypothesis that exposure to geological PM is dominated by nearby sources, except during extreme wind events. Also the studies suggest that current inventory methods may overstate the fugitive dust sources in regional-scale air quality models.

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[P05-35] SENSITIVITY OF VISIBILITY AND REGIONAL HAZE TO EMISSIONS REDUCTIONS.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

The Environmental Protection Agency (EPA) has established a national goal that calls for a return to natural visibility conditions within the next 60 years. Five Regional Planning Organizations (RPOs) have been established to develop emissions reduction strategies that will begin the process of moving toward that goal. A component of the work to be performed by the RPOs will be photochemical modeling to evaluate the relative efficacy of alternative emissions reduction strategies for the purpose of making recommendations to states for their use in developing State Implementation Plans (SIPs). This application of photochemical models puts untested demands on the models and the interpretation of the modeling results. The work presented in this paper describes winter and summer season Community Multiscale Air Quality (CMAQ) modeling performed to better understand the implications of the use of CMAQ for regulatory decisionmaking.

The models-3 system was used to determine the sensitivity of regional haze and visibility in the southeastern United States to changes in emissions of SO_2 and NH_3. CMAQ-ready input files of meteorological and emissions data (outputs from MM5/MCIP and SMOKE) for the year 1996 were obtained from EPA. Model simulations were conducted for the months of January and July 1996 in order to determine the sensitivity to wintertime and summertime conditions. Four sets of simulations were conducted for each month: a basecase simulation, a simulation in which SO_2 emissions were reduced, a simulation in which NH_3 emissions were adjusted for seasonality and a simulation which included both the SO_2 and NH_3 emissions changes. The grid covered the entire continental United States and was made up of grid cells that were 36 km in size.

The simulation results were analyzed by looking at the differences in visibility between the basecase and other scenarios to determine the effects of these emissions reductions on visibility in the southeastern United States.

[P05-12] CCSEM ANALYSES OF FINE PM DERIVED FROM THE COMBUSTION OF COAL AND RESIDUAL OIL.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Computer-controlled scanning electron microscopy (CCSEM) is an excellent method for determining the chemical composition, particle size, and morphology of large numbers of individual particles in a reasonable measurement time. In this study, CCSEM has been applied to the analysis of particulate matter (PM) derived from combustion experiments on three eastern and four western U.S. coals and two residual oils. Samples were separated aerodynamically by a cyclone with a nominal 2.5 μm cut-point into fine ($PM_{2.5}$) and coarse ($PM_{2.5+}$) fractions. The particle size distribution results show that particles with mean diameter less than 2.5 μm constitute more than 80% of the total number of particles, whereas particles with mean diameter larger than 2.5 μm constitute 80-95% of the total volume. Most western coal fly ash (CFA) PM samples have major amounts of Ca and lesser amounts of S, Mg, and Na, while eastern CFA PM samples typically have abundant amounts of Fe and lesser amounts of S and K. The two residual oil fly ash (ROFA) samples are dominated by carbon, while S and V are the major inorganic elements. Single particle classifications show that Si-rich, Si-Al, Si-Al-Ca, Si-Al-Fe are the major chemical categories for CFA PM samples, while V-rich, V-S, and V-S combined with metals and P dominate the ROFA PM samples. Compositional scatter plots superimposed on various ternary equilibrium phase diagrams were used to display the CCSEM data graphically. Results show that most particles in western CFA PM samples are distributed along the join from the Ca apex to the $Si_{50}Al_{50}$ point in the Ca-Al-Si phase diagram. Major phases along this join include anorthite ($CaO{\cdot}Al_2O_3{\cdot}2SiO_2$), gehlenite ($2CaO{\cdot}Al_2O_3{\cdot}SiO_2$), and lime (CaO). Most particles in eastern CFA PM samples are present as Fe-oxides and iron-bearing aluminosilicates.

[P05-15] ESTIMATION OF TRACE-ELEMENTS EMISSION BY LIGHT-DUTY VEHICLES IN SAO PAULO METROPOLITAN AREA, BRAZIL.

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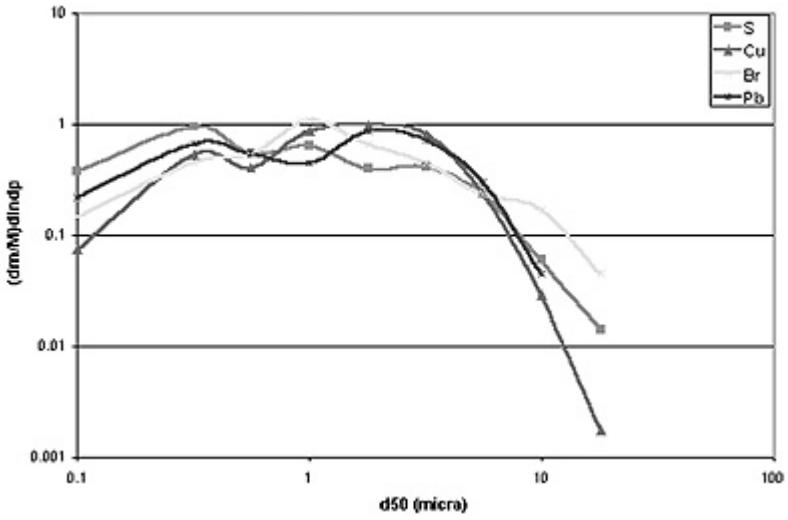
Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Particulate matter short-term measurements data were collected in a tunnel in São Paulo city in order to provide an emission profile for characteristic trace-elements. The tunnel chosen is used only for light-duty vehicles (LDV). Field sampling took place in August 13, 2001. São Paulo Metropolitan Area (SPMA) is one of the largest metropolitan area in the world with a population of more than 17 million inhabitants and almost 6 million vehicles, light and duty. One important characteristic is that the LDV are fulled with a blend of gasoline with 22% alcohol or pure ethanol, resulting that approximately 40% of the total volume of consumed fuel in SPMA is ethanol . Previous studies involved in the estimating the impact of vehicular emission to air pollution by particles in the SPMA pointed out the lack of a vehicular particulate emission profile. The measurements resulted in a first estimation of this profile for SPMA, and some interesting results were achieved. The particles were collected with a Cascade Impactor MOUDI with ten stages and a system of stacked filter unit (MiniVol system). The trace-elements concentrations were obtained by means of PIXE (Particle Induced X-Ray Emission) analysis and the ionic concentration by ion chromatography. Samples were collected inside - in the middle of the tunnel and outside, to have the background concentration. Fuel-based particulate emission factors were computed by relating total carbon emissions in the tunnel to the carbon content of fuel using the equation based in the work of Kirchstetter et al., 1999. The emission factor for some important trace-elements were in mg/g: Al 8.15, Si 8.64, S 10.97, Ca 5.59, Ti 2.04, Mn 1.47, Cu 6.68, Zn 2.95, Br 0.29, Pb 0.33 and Black Carbon 235.78. The concentration size distributions for sulphur and other trace-elements are present in Figure 1.

References:

Kirchstter T.W., Harley R. A., Kreisberg N. M., Stolzenburg M.R., Hering S. (1999). On road measurement of fine particle and nitrogen oxide emissions from light- and heavy-duty motor vehicles. (Click to see figure 1)



Figure

[P05-16] IN-USE VEHICLE EMISSIONS SOURCE CHARACTERIZATION STUDY: SQUIRREL HILL TUNNEL, PITTSBURGH, PA.

Eric M Lipsky, Allen Robinson, Natalie Anderson, Heather Leifeste, R Subramanian, Juan Cabada-Amaya, Sarah Rees, Andrey Khlystov, Charles Stanier, Leonard Lucas, Satoshi Takahama, Beth Wittig, Cliff Davidson, Spyros Pandis, Andrea Palidori, Ho-Jin Lim, Barbara Turpin Mechanical Engineering, Carnegie Mellon University, PIttsburgh, PA; Civil Engineering, Carnegie Mellon University, Pittsburgh, PA; Chemical Engineering, Carnegie Mellon University, Pittsburgh, PA; Engineering and Public Policy, Carnegie Mellon University, Pittsburgh, PA; Environmental Sciences, Rutgers University, New Brunswick, NJ

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Measurements were performed in a highway tunnel to quantify in-use vehicle emissions in Pittsburgh, Pa. Continuous measurements of CO2, CO, SO2, NOx, NO, PM2.5 mass, and particle size distributions from 3 nm to 1 mm were made for the entire study period. PM2.5 samples were collected and analyzed for organic and elemental carbon (OC/EC), organic composition (speciation), trace metals, and inorganic composition. MOUDIs were collected to determine the mass, OC/EC, and trace metals size distributions. Volatile organic compounds were also measured. Videotapes of traffic were analyzed to determine fleet composition and vehicle speed. The sampling focused on three different periods to characterize the effects fleet composition and mode of operation on emissions. The 12 AM to 6 AM period is dominated by fast moving truck traffic (average speed 50 mph, greater than 30% trucks). The 7 to 9 AM period is dominated by slow moving cars (average speed of 20 mph, less than 5% trucks). The 10 AM to 4 PM period is dominated by fast moving cars (average speed of 50 mph, less than 5% trucks).

[P05-17] GAS AND PARTICLE EMISSION RATES AND SOURCE PROFILES FROM NON-ROAD MILITARY DIESEL ENGINES.

John G. Watson, Waye Miller, Hans Moosmuller, Hampden D Kuhns, Peter W Barber, W. Pat Arnott, Judith C Chow, Barbara Zielinska, David R Cocker Division of Atmospheric Sciences, Desert Research Institute, Reno, NV; College of Engineering-Center for Environmental Research and Technology, University of California, Riverside, CA

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

A four-year testing project has been initiated to develop source-, use-, and fuel-specific emission estimates for representative Department of Defense (DoD mobile and stationary diesel equipment, most of which is not extensively used on paved public roadways. These estimates must meet the minimum requirements of the Consolidated Emissions Reporting (CER) rule for emission rates of CO, NOx, VOC, PM10, PM2.5, SO2, and NH3. CER guidance also requests chemical source profiles that can be used to divide PM and VOC emissions into groups useful for chemical transformation models, source-apportionment receptor modeling, and HAPs inventories. The project will also develop, test, and apply new methods for quantifying non-road emissions that more efficiently and realistically represent actual operations than engine dynamometer certification tests. These results will be integrated into U.S. EPA non-road emissions and source profile software. An emissions modeling system will permit quick and efficient estimates to be made and delivered to appropriate agencies in CER-compatible formats.

This project will accumulate information about engine types, fuels, and uses, critically reviews previously published literature, and develop a representative matrix of test parameters. It will assemble and evaluate test equipment for a mobile lab, on-board activity and pollutant monitoring, in-plume measurements, and cross-plume remote sensing, then apply on-board activity monitors to focus the subsequent emissions tests and quantify real-world engine uses. Stationary sources will be tested first with a mobile laboratory that reproduces dilution and methods associated with standard test cycles, then with in-plume and remote sensors for the same engine operating cycles, and finally for a larger number of engines using in-plume measurements during actual operations. The data base for stationary emitters will be interpreted in terms of emission factors, emission distributions, and emission compositions. Non-road mobile sources will be tested using on-board exhaust monitors as well as in-plume and remote sensing. Products of this research are: 1) modern non-road exhaust test methods; 2) documented data bases of emissions rates and chemical profiles for many different fuel/engine/use combinations; 3) integration into national NONROAD and SPECIATE software; and 4) an easy to use emissions model tailored to military applications.

[P05-18] MEASUREMENT OF PARTICULATE MATTER EMISSIONS FACTORS FROM IN-USE MOTOR VEHICLES USING LIDAR.

Hampden D Kuhns, Peter W Barber, Hans Moosmuller, John G Watson Division of Atmospheric Sciences, Desert Research Institute, Reno, NV

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

A new technique developed using an ultraviolet LIDAR was used to measure particulate matter (PM) emissions factors from the in-use fleet of motor vehicles in Las Vegas, NV. Fuel based emissions factors in mass of pollutant per quantity of fuel burned from nearly 150,000 vehicles from all parts of the Las Vegas Valley were measured during this study. By comparing license plate images with registration information from the Department of Motor Vehicles, emissions factors were related to vehicle age, weight class, and fuel type. Average emissions factors were calculated from the real world measurements for four different classes of vehicles: light-duty gasoline vehicles (LDGV), light-duty diesel vehicles (LDDV), heavy-duty gasoline vehicles (HDGV), and heavy-duty diesel vehicles (HDDV). Diesel vehicles were found to emit ~10 times more particulate matter than gasoline vehicles. Vehicle age was found to correlate with particulate emissions from gasoline vehicles. The LIDAR remote sensing technique has the ability to identify smoking vehicles under real world conditions. Potential applications of this instrument include (1) monitoring improvements in motor vehicle emissions as new low emitting vehicles replace older higher emitting vehicles, (2) notifying vehicle owners of malfunctioning vehicles that service is needed to reduce emissions and improve fuel economy, and (3) screening and exempting clean vehicles from mandatory vehicle emissions tests.

[P05-19] RELATIONSHIPS BETWEEN THE CHEMICAL COMPOSITION OF BRAKE PADS AND BRAKE WEAR EMISSIONS.

Glynis C Lough, Martin M Shafer, James J Schauer Environmental Chemistry and Technology Program, University of Wisconsin - Madison, Madison, WI

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Brake wear is one of the components of particulate matter and trace metal emissions from motor vehicles. However, the composition of these emissions and their contribution to metals levels in the urban atmosphere are still not well characterized. While the chemical composition of brake pads may be easy to determine, isolation and measurement of brake wear emissions is not. On-road motor vehicle emissions also include those from tailpipes, tire wear, and resuspended road dust, and measurement of emissions with dynamometers has similar complications. To obtain more information about real-world particulate matter emissions from motor vehicle brake wear, brake wear samples were obtained by two methods. First, samples were collected from the non-tailpipe emissions of vehicles operating on a chassis dynamometer. Second, samples were collected from the resuspension and collection of ground brake pads and dust from the brake housings.

In order to compare particulate matter emissions from brake wear with the chemical composition of brake pads and brake-housing dust, the brakes used in the chassis dynamometer tests and the dust from their housings were used for the resuspension tests. To get a broader view of the characteristics of brake wear emissions from on-road vehicles, crushed used brake pads and dust collected from their housings at local garages were also resuspended. These tests provide significant insight into the relationship between the chemical composition of brake pads and of the particulate matter emissions from brake wear.

In all tests, fine (PM2.5) and coarse (PM10) particulate matter were sampled, and size-resolved chemical composition of emissions was also explored. Measurements of trace metals, mass, inorganic ions, and elemental and organic carbon for brake wear emissions are presented. These measurements allow specific source apportionment of metals from brake wear to those in the urban atmosphere.

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[P15-04] INDOOR AND OUTDOOR ORGANIC PM2.5: ANALYSIS OF RIOPA DATA.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Numerous epidemiological studies have shown a positive association between outdoor PM2.5 and mortality and morbidity, suggesting an association between exposure to outdoor sources of PM2.5 and adverse health effects. However, people are exposed to air contaminants generated indoors, outdoors and in other microenvironments. Little is known about the composition of indoor and personal PM2.5 and the relative contributions of outdoor and indoor sources to indoor and personal exposure. However, it is known that organic matter comprises a substantial fraction of total outdoor PM2.5 mass (typically 30-70%). In this poster we describe organic (OC) and elemental carbon (EC) measurements made inside and outside of residences.

During the "Relationship of Indoor, Outdoor and Personal Air" study (RIOPA), indoor and outdoor PM2.5 samples were collected for 48-h at 10 lpm in Houston (TX), Los Angeles County (CA), and Elizabeth (NJ). Roughly 2/3 of the houses were within 0.5 miles of an outdoor source of one or more target compounds (VOC, aldehyde and/or PM2.5). Samples for OC and EC were collected on a quartz fiber filter (baked) and on a quartz fiber filter placed behind a Teflon filter. The later provides an estimate of the quantity of organic vapor that adsorbs on the single quartz filter. Thus, particulate OC is calculated by subtracting the Teflon-quartz backup (dynamic blank) from the single quartz filter. Samples were analyzed by thermal-optical transmittance (TOT). Instrument and field blanks, replicates, independent standards, FID sensitivity and samples from collocated samplers were also analyzed.

Mean (48-h) indoor particulate OC (after artifact correction) was higher than mean outdoor particulate OC, suggesting the existence of indoor sources of particulate OC. Mean indoor and outdoor EC concentrations were comparable. The adsorption artifact is approximately 30-40% of measured OC in these samples. The adsorption artifact is a function of the filter face velocity, surface area, and the composition and concentration of organic vapors in the sampled air. OC and EC concentrations, along with other species measurements, will be used to examine the species mass balance for PM2.5 in RIOPA homes, providing a comprehensive assessment of PM2.5 composition indoors and out.

[P15-02] FIELD EVALUATION OF A PERSONAL CASCADE IMPACTOR SAMPLER (PCIS).

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

This paper presents field evaluation of a Personal Cascade Impactor Sampler (PCIS). PCIS is a miniaturized cascade impactor, consisting of four impaction stages, followed by an after-filter, which separates particles in the following aerodynamic particle diameter ranges: <0.25, 0.25-0.5, 0.5-1.0, 1.0-2.5 and 2.5-10 μm. The PCIS operates at a flow rate of 9 LPM at a pressure drop of 11 in H_2O (2.7 kPa). For field data comparisons, the collocated samplers were Micro Orifice Uniform Deposit Impactor (MOUDI, Model 110, MSP Corp, Minneapolis, MN), Scanning Mobility Particle Sizer (SMPS, TSI Model 3936) and Aerodynamic Particle Sizer (APS, TSI Model 3320). The results show excellent agreement between PCIS and MOUDI for coarse PM ($PM_{2.5-10}$) mass. The fine PM ($PM_{2.5}$) mass as measured by PCIS is in extremely close agreement with SMPS-APS measurement (~1.03 times) but is slightly higher (~1.2 times) than MOUDI measurement. The size fractionated mass concentrations between PCIS, SMPS-APS and MOUDI were also compared. PCIS and SMPS-APS agree reasonably well for particle size ranges from 2.5-0.5 μm however, the size ranges <0.5 μm are slightly different probably due to the differences between the aerosol sizing principles underlying each instrument. The SMPS-APS and PCIS concentrations for <0.5 μm are in much closer agreement (within 15%) than those measured by the MOUDI. Size fractionated $PM_{2.5}$ Elemental Carbon (EC) and Organic Carbon (OC) measurements by PCIS and MOUDI were compared with those measured by MOUDI. For these measurements MOUDI and PCIS agree well for particles in the range 0.5-0.25 μm, however MOUDI underestimates the carbonaceous matter content for particles < 0.25 μm by about 15%. The lower MOUDI concentrations, observed particularly in the lower stage and the after-filter, could be attributed to volatilization of carbon particles collected under low pressure in these stages. The ability of the PCIS to preserve labile species during sampling is a highly desirable feature, particularly as a significant fraction of fine particles is associated with such species. Finally, $PM_{2.5}$ nitrate and sulfate measurements by MOUDI and PCIS were also compared and found to be in very good agreement.

The performance of PCIS was also evaluated in the wind tunnel. The results show that the particle penetration characteristics of the PCIS 2.5 μm stage are unaffected by the wind speeds. The size-dependent particle penetration for all the wind speeds tested, viz., 3 and 8 km/h show a very close agreement. This is particularly important because it demonstrates that the PCIS can be used throughout the various ambient conditions found in all normal environments.

[P05-36] GEOGRAPHIC INFORMATION SYSTEMS AND PM10 EXPOSURE MODELING

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

This research investigates the use of a Geographical Information System (GIS) method for the spatial distribution of air emissions, to estimate environmental exposures over a geographic area. The research uses PM10 emission sites as the source of pollution emissions. The region of interest is Allegheny County and its neighbors in Southwestern Pennsylvania. The dispersion of emissions from PM10 emission sites is used to estimate PM10 exposure over the six county region. Two issues are important when using GIS for exposure estimation in this setting. The first is called the edge effect, which examines the effect of border county emission sites on the exposure estimates within the county. The second issue concerns the appropriate emission sites to contribute to a receptor site estimate. We explore, and illustrate by GIS mapping, the effect of these factors.

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[P05-11] COMBINING XAFS SPECTROSCOPY AND LEACHING FOR THE SPECIATION OF ELEMENTS IN PM.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

There is much need to increase our knowledge concerning the occurrence of key elements in particulate matter (PM) from combustion sources. Recent evidence increasingly supports the proposition that metals in fine airborne PM are associated with adverse health effects. Furthermore, elemental concentrations in primary PM samples are used as input to chemical mass balance models for apportioning the contribution of primary sources of PM to ambient PM. Despite these major roles in both health-effect and source apportionment studies, there have been relatively few investigations of how metals actually do occur in PM.

In this work, we have used XAFS spectroscopy to characterize elements in primary PM samples derived from combustion of coals and residual oils in laboratory-scale combustion experiments. A cyclone separator was used to separate the PM into >2.5 μm ($PM_{2.5+}$) and <2.5 μm ($PM_{2.5}$) size fractions. Leaching experiments were also performed on the size-separated PM fractions to generate a suite of samples for more reliable interpretation of the XAFS data.

For PM samples from residual oil fly ash (ROFA) combustion, XAFS spectroscopy established that, in addition to sulfur as sulfate, sulfur also occurred as thiophene derivatives, elemental sulfur, and metal sulfide forms. The thiophene forms comprised between 30 and 40% of the total sulfur in the $PM_{2.5+}$ samples, but lesser amounts in the $PM_{2.5}$ samples, and clearly mirrored the unburned carbon in the ROFA PM samples. XAFS spectroscopy showed that most metals were present as sulfates. However, additional metal species were also encountered in aqueous and acid leached residues; oxides, such as V_2O_4, $NiFe_2O_4$ and ZnO were more prevalent in the $PM_{2.5}$ fractions, whereas sulfides, such as $Ni_{1+x}S$, $Fe_{1-x}S$, and CuS were more prevalent in the coarser $PM_{2.5+}$ fractions. With a firm identification of the different species likely to be present for a given element, least-squares fitting of the XANES spectra was then used to quantify the different forms of an element.

For PM samples derived from coal combustion, XAFS spectroscopy showed that sulfate was the dominant form of sulfur in coal PM, with minor amounts of thiophenic and elemental sulfur forms also present. Arsenic was found to exist in the coal PM predominantly in the As^{5+} oxidation state. Chromium was observed to be exclusively present as Cr^{3+} in PM from eastern bituminous coals, but PM from western coals contained up to 30% of the chromium in the more toxic and carcinogenic Cr^{6+} oxidation state.

The authors acknowledge financial support from NSF (CRAEMS grant CHE 0089133) and the US DOE for its support of US synchrotron facilities.

[P09-03] SEASONAL AND SPATIAL VARIABILITY OF THE SIZE-RESOLVED CHEMICAL COMPOSITION OF PM2.5 IN THE LOS ANGELES BASIN.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 9: Regional, Seasonal and Temporal Factors in Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4

Previous studies of PM2.5 size-resolved chemistry in the Los Angeles Basin (LAB) have included only a few days or weeks of sampling. In order to provide a more complete picture of LAB aerosol characteristics, more extensive sampling is needed. As part of the routine sampling activities of the Southern California Supersite, one 24-hour size-fractionated PM2.5 impactor sample is collected and analyzed each week. The mobile sampling trailer was moved to different locations in the Los Angeles Basin over the approximately two years of continual sampling. The sites (and corresponding dates) are Downey (10/00 - 2/01), Riverside (2/01 - 6/01), Rubidoux (6/01 - 9/01), Claremont (9/01 - 7/02), and Downtown Los Angeles/University of Southern California (9/02 - present). Micro-orifice uniform-deposit impactors (MOUDIs) collect particles in the following size bins: 1.0 - 2.5 μm; 0.56 - 1.0 μm; 0.32 - 0.56 μm; 0.1 - 0.32; and <0.1 μm. Samples are collected on aluminum and Teflon substrates and analyzed for gravimetric mass, sulfate and nitrate by ion chromatography, and elemental and organic carbon by thermal evolution/optical transmission analysis. High organic and elemental carbon levels in the smaller particles were observed in the upwind sites which are strongly influenced by vehicular emissions. The highest concentrations of nitrate were found in the larger particles at the inland, downwind sites during the warmer months when photochemical secondary particle formation occurs. Correlations within size bins for the different chemical components are also presented.

[P06-10] INHALED ULTRAFINE CARBON PARTICLES CAN TRANSLOCATE TO THE CNS.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (4:00 PM-5:00 PM) Grand Ballroom 2-4

Ultrafine particles (UFP <100 nm) are ubiquitous in ambient urban and indoor air from multiple sources and may contribute to adverse respiratory and cardiovascular effects of PM. Depending on their particle size, inhaled UFP are efficiently deposited in nasal, tracheobronchial and alveolar regions due to diffusion. In previous rat studies we have shown by electronmicroscopy and mass spectrometry that certain UFP translocated to interstitial sites (ultrafine PTFE particles) in the respiratory tract as well as to extrapulmonary organs such as liver (ultrafine carbon) within 4-24 hrs post-exposure. Small increases in the olfactory bulb of the Central Nervous System (CNS) were also measured by 24 hrs, however, they did not reach statistical significance, possibly because the post-exposure observation period may have been too short. Our objective in a follow-up study, therefore, was to determine translocation of ultrafine ^{13}C particles to regions of the brain. We hypothesize that UFP deposited on the olfactory mucosa of the nasal region will translocate along the olfactory nerve to the olfactory bulb thereby resulting in high increases in that region as opposed to other areas of the CNS. We generated ultrafine elemental ^{13}C particles (CMD = 36 nm; GSD = 1.66) from ^{13}C graphite rods by electric spark discharge in an argon atmosphere at a concentration of 160 $\mu g/m^3$. Rats were exposed for 6 hrs. by whole body inhalation, and lungs, cerebrum, cerebellum and olfactory bulbs were removed after 1,3,5 and 7 days. ^{13}C concentrations were determined by isotope ratio mass spectroscopy and compared to background ^{13}C levels of sham-exposed controls (day 0). The background corrected pulmonary ^{13}C added as ultrafine ^{13}C particles was 1.34 μg. This corresponds to a lung ^{13}C concentration of 1.39 $\mu g/g$ (day 1) which decreased to 0.59 $\mu g/g$ by day 7. There was a significant and persistent increase in added ^{13}C in the olfactory bulb with concentrations of 0.35 $\mu g/g$ (day 1) to 0.43 $\mu g/g$ (day 7), with respective ^{13}C levels of 30-40 ng per organ. Day 1 ^{13}C concentrations of cerebrum and cerebellum were also significantly increased but the increase was not always significant over the following days. We conclude from this study that the CNS can be targeted by inhaled ultrafine particles and that a neuronal route of translocation of nasally deposited ultrafine particles via the olfactory nerve may exist. Whether such translocation of inhaled UFP can cause CNS effects needs to be determined in future studies.

Supported by EPA PM Center grant R827354

[P09-07] INFLUENZA AND AIR QUALITY: A TIME-SERIES ANALYSIS OF WEEKLY MORTALITY IN LONDON RELATIVE TO THE MAJOR AIR POLLUTION EPISODES OF THE 1950s.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 9: Regional, Seasonal and Temporal Factors in Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4

The London air pollution disaster of December 1952 has recently received renewed attention, in part because of a recent paper that claims a death toll much higher than that reported by the original publications of the time. At issue is whether the excess mortality seen in the three months following the episode should be attributed to delayed air pollution effects or to sequellae of influenza, since a flu epidemic was experienced in the south of England in early 1953 (although influenza was not then an officially reportable infectious disease) and such epidemics may trigger excess mortality from other causes.

This question is addressed through time-series analysis, based on published weekly data from late 1949 to 1958, a period during which 5 additional major air pollution episodes were reported. The analysis uses air quality data from these episodes, reports of influenza deaths, and seasonal adjustments based on weekly sequence numbers, as a means of separating air pollution from influenza effects. The influenza effects are based on data from England and Wales, which show that total deaths associated with flu are about 3.5 times those actually coded as flu. These national flu deaths are then used as a surrogate for London flu deaths, a paradigm that was highly statistically significant.

Major findings from this analysis include:

Flu epidemics occurred regularly during this period, often biennially, but varying in severity and the hardest-hit locations. This periodicity makes it problematic to assess pollution effects solely by contrast with the previous year.1

The apparent delayed (lag) effects of air pollution depend on how well seasonality is controlled in the regression model. Evidence for a 1-week lag effect is strong, but any additional lag effects up to 9 weeks are small or negative. Such negative effects suggest mortality "harvesting."

The absence of persistent excess mortality after the 1952 "Great Fog" is consistent with the relatively constant annual mortality rates reported for the 1950s in London.

The pollution regression coefficients are consistent with others based on daily time-series methods (0.2% excess deaths per 10 mg/m3 smoke; 0.16% excess deaths per ppb SO2). Using the coefficient for a 2-week period and the average SO2 level over (assumed) background yields an excess mortality of about 3900 deaths for the London Administrative County, from 1949-58, or about 1.1%. The same model predicts total influenza deaths of 9500 (2.6%) for the period.

[P15-03] INDIVIDUAL PARTICLE ANALYSIS OF PERSONAL SAMPLES FROM THE 1998 BALTIMORE PARTICULATE MATTER STUDY.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

The United States Environmental Protection Agency (U.S. EPA) conducted the 1998 Baltimore Particulate Matter (PM) Epidemiology Exposure Study of the Elderly, the primary goal of which was to establish the relationship between outdoor PM concentrations and actual human PM exposures within a susceptible (elderly) sub-population. The study design included PM2.5 personal exposure samples obtained from elderly (65+ years of age) residents of an eighteen story retirement facility near Baltimore, Maryland. In addition, the personal exposure sampling devices were used to obtain PM2.5 samples at fixed locations within the personal monitoring subjects' apartments. Apartment residence and personal samples collected on Teflon® fiber filters were examined using scanning electron microscopy with individual-particle X-ray analysis (SEM/EDX) to provide a qualitative assessment of the chemical and physical characteristics of geological and trace element particles collected within these micro-environments at the retirement facility. Qualitative differences among the selected personal and apartment residence samples were observed. Differences between the paired personal and apartment samples indicate the localized nature of certain particle types.

[P05-14] MEASUREMENT OF PM2.5 EMISSION FROM STATIONARY SOURCE: BIAS IN TRADITIONAL SAMPLING METHOD AND THE DEVELOPMENT OF DILUTION SAMPLING TECHNOLOGY.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

The promulgation of new ambient air standards for particulate matter with aerodynamic diameter smaller than 2.5 micrometers (PM2.5) by United States Environmental Protection Agency (EPA) in 1997 resulted in the great need of emission and characteristic profiles of fine aerosols from petroleum industry combustion sources. Majority of PM emitted from gas combustion is condensable PM2.5. However, stationary source air emission sampling methods used for compliance testing (Method201/202A) tend to underestimate or overestimate the emitted PM2.5 because the hot front filter does not collect condensable species and the cold aqueous impingers collect gaseous as well as condensable components. On the other hand, the advanced PM control technology has reduced emission level so low that the error noise in manual method can obscure the actual PM emission rate. The dilution technology has been used as reference method (ISO 8178) for mobile source testing but only serves as research application in stationary sources. Dilution technology can simulate actual plume conditions and collect samples by means of ambient sample so that the emission profiles can be readily compared. However, current dilution system is often too bulky for limited space in stack. The various dilution sampling system designs and the impact of dilution process on particle formation are investigated and reviewed for designing a more compact dilution sampling system, which can be deployed to developing PM2.5 profiles from stationary sources.

[P05-01] ATMOSPHERIC EMISSIONS OF AMMONIA FROM DAIRY FARMS.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 5: Emissions: Measurement, Characterization, and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Dairy farms are one of the largest sources of atmospheric ammonia emissions. Aerosol nitrate concentrations depend on ammonia concentrations; therefore, predicting PM 2.5 concentrations and developing control strategies require accurate ammonia emissions inventories. Since most of the sources of ammonia are either agricultural or biological, emissions of ammonia have a seasonal variability. Farming practices and climate conditions differ regionally, so emissions of ammonia also vary geographically. Finally, our scientific understanding of these processes is incomplete, which leads to uncertainty in emissions as well. The purpose of this research is to develop an emission inventory for dairy farms that accounts for both seasonal and geographical variation in emission factors and uncertainty.

This research first developed a semi-mechanistic, semi-empirical model for the volatilization of ammonia from major types of manure management systems found in a modern dairy operation. Bayesian parameter estimation has been used to tune the model parameters to match experimental results and to explicitly account for uncertainty. By combining data that describes the national distribution of manure management practices on dairy farms with the model results for the different farm configurations, it is possible to estimate the ammonia emissions for a particular region of the country. By compiling these results with county dairy cow populations, historical climate data, and soil properties data, this research constructed a national ammonia emission inventory for dairy operations that captures both the geographical and seasonal variability and rigorously derives the uncertainty in emission rates.

The second stage of this research is to use the improved emissions inventory as input to a 3-D air quality model of the Eastern United States. The modeled concentrations will be compared against measured concentrations of ambient particulate matter and measured concentrations of wet deposition of ammonium. The air quality model will also be used to estimate the sensitivity of concentrations of particulate matter to reductions in a ammonia emissions.

[P09-06] WITHDRAWN

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 9: Regional, Seasonal and Temporal Factors in Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4
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[P09-05] RESPIRATORY ALLERGY AND INFLAMMATION DUE TO AMBIENT PARTICLES - A EUROPEAN-WIDE ASSESSMENT (RAIAP).

Erik Dybing, Flemming R Cassee, Konrad Rydzynski, Marco Martuzzi, Martinus Lövik, Per E Schwarze, Peter A Steerenberg
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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 9: Regional, Seasonal and Temporal Factors in Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4

The overall objective of this multinational project in 2001-2004 is to assess the role of ambient suspended particles (PM) in causing local inflammation in the respiratory tract and in induction and elicitation of respiratory allergies, in order to understand the underlying mechanisms for involvement of particles in the development of these diseases.

Coarse (PM10-2.5) and fine (PM2.5-0.1) particles were collected during 4-6 week periods during spring, summer and winter in Amsterdam (NL), Rome (I), Lodz (PL) and Oslo (N), as well as from a Dutch sea-side background site. Samples were collected using a high-volume (900 litres/min) cascade impactor. During the same time periods samples were collected by low-volume sampling for electron microscopic characterisation. Chemical analyses from the high- and low-volume PM samples included inorganic ions, metals, PAHs and traffic markers (hopanes, steranes).

The collected samples are being screened for allergenic potential using the popliteal lymph node assay and measurement of total IgE-production in mice. Human lung cell cultures and primary rat macrophages and type 2 cells are being screened for respiratory inflammation potential by studying cytokine release from the cells.

Verification of allergenic potential of samples is carried out using a mouse ovalbumin model after intranasal application. Studied parameters include antibody response (IgE), eosinophils and cytokines in bronchoalveolar lavage as well as phagocytic activity in macrophages. Inflammation verification is studied in a rat model after intratracheal instillation of samples. Inflammatory parameters include determination of Clara cell protein, albumin and neutrophils in lavage fluid, as well inflammatory reactions studied by histopathological methods.

Later mechanistic studies will focus on modulation of molecular and cellular functions of the immune system, of signalling pathways in lung cell cultures and of immune responses in the respiratory system.

The project will end with a workshop summarising the scientific knowledge on the role of ambient particles for respiratory allergies and the implications of this knowledge for regulators, the general public and industry.

Contract number: QLRT-2000-00792. http://www.raiap.org

[P15-01] REAL-TIME EXPOSURE MEASUREMENTS OF AEROSOL NUMBER, SURFACE-AREA AND MASS (PM2.5) CONCENTRATION IN THE SOUTHERN INDIAN CITY OF MYSORE.

Pramod Pai, Andrew D Maynard, Belagur Prasad, Siddappa Belagali, Penny Andressen, Gurumurthy Ramachandran DOS in Environmental Science, University of Mysore, Mysore, India; National Institute for Occupational Safety and Health, Cincinnati, OH; University of Minnesota, Minneapolis, MN

Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Despite increasing awareness of the environmental and health effects associated with aerosol exposure, particulate matter (PM) levels in the developing regions of the world remain orders of magnitude above those in the more industrialized countries. In countries such as India, data on PM emissions, exposure and associated health effects are sparse. Consequently there is a need to develop a database on aerosol exposures specific to each country. In recent years, particle number and surface-area concentrations have been hypothesized as being more health-relevant metrics of exposure than the traditional mass metric. It is, therefore, desirable to investigate the association between the particle number and surface area concentration with health effects.

Ambient urban exposures in India have become dominated by vehicle emissions in recent years. However in many other respects exposure patterns in the subcontinent differ from those in the West. Many households rely on burning biomass, kerosene or liquid propane gas on simple stoves to heat water and cook food, often resulting in incomplete combustion and high aerosol exposures. Women and children are exposed to combustion-related aerosols in the home on a daily basis. There is consistent evidence that indoor air pollution increases the risk of chronic obstructive pulmonary disease in childhood and of acute respiratory infections - the most significant cause of death amongst children under 5 years in developing countries.

Aerosol measurements have been carried out in the southern Indian city of Mysore since June 2002. This work is focused on three specific zones: urban areas with heavy vehicular traffic, borderline urban/rural zones and indoor-exposures associated with the fuel used for cooking. Within each group gravimetric determination of PM2.5 levels, along with simultaneous real-time measurements of particulate number, surface-area and mass concentration have been carried out. Results show very high PM2.5 exposures in central urban areas, which fall rapidly towards more rural regions. Measurements of cooking-related PM2.5 exposure in a number of homes indicate time-averaged exposures of around 100 μg/m3, although peak exposures are considerably higher, and seems to be associated with both the type of fuel used and the cooking method. Comparisons between the three exposure metrics show distinct differences associated with aerosol source and mass concentration.

[P09-04] QUALITATIVE DIFFERENCES IN PARTICULATE AIR POLLUTION AT DIFFERENT LOCATIONS THROUGHOUT EUROPE.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 9: Regional, Seasonal and Temporal Factors in Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4

Given the widely different prevalence rates of respiratory allergies and asthma between the countries of Europe and the substantial exposure to ambient particles in urban environments, the EU project Respiratory Allergy and Inflammation Due to Ambient Particles (RAIAP) project aimed to relate the chemical composition of collected ambient particulate matter (PM) to different health end-points. PM samples were collected in urban areas in Amsterdam (NL), Rome (I), Lodz (PL) and Oslo (N), as well at a Dutch sea-side background site over a 4-6 week period during spring, summer and winter. High-volume (900 litres/min) cascade impactor technology for simultaneous sampling of ambient air coarse (PM10-2.5) and fine (PM2.5-0.1) particles on large-capacity polyurethane foam (PUF) substrate was used. A multiple chemical analyses was performed on these two size fractions focused on inorganic ions, metals, polycyclic aromatic hydrocarbons and traffic markers (hopanes and steranes, constituents of diesel oil and lubricants).

Levels of PAHs were high in samples collected in Lodz in the cold seasons, and which was less evident in samples collected in Oslo. Steranes and hopanes, indicators of traffic emissions, were generally higher in the fine than the coarse mode, but were still substantial in the latter. The contribution to the total mass varied for the different locations though was in general higher in the winter. Sulfates in the fine fraction were markedly higher in Amsterdam compared to the other locations. This contrast was not observed for the coarse mode. Relatively high levels of potassium, iron and aluminum (indicators for crustal material) were measured in the Rome samples, whereas zinc levels were markedly higher in the fine mode samples collected in Lodz. Although the collection and pretreatment method might alter the samples slightly the results show that distinct differences are present among PM fractions collected at various locations and seasons. The samples will further be screened for the adjuvant allergic activity and capacity to induce respiratory inflammation.

[P09-02] ISSUES IN THE USE OF SOURCE-ORIENTED PARTICULATE MATTER INDICES FOR AIR POLLUTION EPIDEMIOLOGY.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 9: Regional, Seasonal and Temporal Factors in Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4

Particulate matter (PM) is a chemically non-specific pollutant, and may originate or be derived from different emission source types. Thus, its toxicity may well vary depending on its chemical composition. If the PM toxicity could be determined based on source types, the regulation of PM may be done more meaningfully. A large number of monitors started collecting chemical speciation data from $PM_{2.5}$ filters starting 2000-2001 in the U.S. The data from this chemical speciation network may be useful for source-oriented evaluations of PM health effects. Current approaches in such investigations compute factor-analysis (or its variants) derived PM or air pollution indices, and include them in time-series health effects regression models. While such approaches have merit, there are several issues that need to be considered in the analysis and interpretation of these data. One major issue is a monitor's representation of regional, sub-regional, and local air pollution exposures to the population in a city or metropolitan area. Because health outcomes in time-series air pollution epidemiological studies are aggregated over a wide geographical boundary, the regional pollution may have smaller \\"error\\" in exposure estimates than does local pollution. Under such a condition, the relative significance of associations between health outcomes and various \\"source-oriented\\" pollution indices may not necessarily reflect the source's relative toxicity, due to their differing relative error (spatial variation and analytical uncertainty) in representing population exposure estimates. We examined this issue using newly available speciation data from multiple cities. For example, the speciation data from three monitors (a few miles apart) in New York City during 2001-2002 period showed that the correlations among the three monitors for sulfate (regional secondary aerosol) were higher (0.92 to 0.99) than those for sub-regional soil related element, Si, (0.77 to 0.49), or elemental carbon (0.22 to 0.52), which can be strongly influenced by local traffic patterns. Factor analyses of these data from three monitors also suggest that regional or sub-regional factors are more stable than factors that appear to reflect more local impacts. The implication of these monitor-to-monitor differences in source-specific exposure spatial representativeness on health effects analyses results are illustrated using 2001 elderly hospital admission data.

This work has been funded by the United States Environmental Protection Agency STAR grant R82799701 and PM Center grant R827351, but may not reflect EPA policy.

[P09-01] HOW CAN SOURCE APPORTIONMENT AND RECEPTOR MODELLING DATA BE USED IN EPIDEMIOLOGY?

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 9: Regional, Seasonal and Temporal Factors in Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4

Human health effects models based on pollution sources have been proposed as easier to fit and interpret, and more relevant for public health and regulation. We will show that the first of the claims is not entirely correct.

Measurement error in the concentrations of chemical species or size fractions will often be well approximately by a classical additive independent error model. The estimates from a source apportionment model, however, have very complicated non-independent errors due to both the original measurement error and uncertainty in the model.

We will describe possible approaches to this estimation problem. One approach is to regress health outcomes on the concentrations of chemical species, where standard measurement error correction methods are applicable, and then apply an estimated source apportionment model to convert these health effects to the scale of interest. Another approach, when replicate measurements of chemical species are available, is to use instrumental variable methods from econometrics.

[P06-19] DEVELOPMENT OF URINARY METABOLITE BIOMARKERS TO ASSESS POPULATION EXPOSURE TO PM2.5 FROM VARIOUS COMBUSTION SOURCES.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (4:00 PM-5:00 PM) Grand Ballroom 2-4

A primary goal of our research is to validate the use of urinary biomarkers to apportion the sources of human exposure to PM2.5. Organic source tracers have been used in source apportionment studies of ambient PM2.5 to distinguish a range of combustion sources. Both gas and particle-phase organic tracer species have been used as biomarkers of exposure to combustion sources. The nicotine urinary metabolite, cotinine, is an example of a well-validated biomarker of exposure to tobacco smoke that has been successfully used in large population studies. Polycyclic aromatic hydrocarbons (PAH) and their urinary metabolites have been used as exposure markers for combustion sources including traffic and coal sources. Levoglucosan (1,6 -anhydro-β-D-glucose) found in particles and methoxyphenols (lignin combustion products found in both gas and particle phase) are source tracers for woodsmoke. Levoglucosan is a conserved and stable organic tracer for ambient exposure measurements. Methoxyphenols, although less stable when collected on filters, are metabolized and excreted as urinary metabolites. In ongoing ambient and personal exposure studies in Seattle, where woodsmoke and mobile sources (diesel and gasoline) are the major sources of PM2.5, both organic and inorganic source tracers are measured in personal, indoor and outdoor filter samples. Urinary samples are collected and metabolites of these source tracers are measured using GC/MS and HPLC. Validation studies include 1) correlating the exposure to methoxyphenols, levoglucosan and PAH in home-indoor and home-outdoor samples, and 2) examining the relationship between exposure to levoglucosan and PAH in personal air samples and excretion of methoxyphenols and PAH metabolites in urine. Initial studies are examining the time course of exposure and excretion over 10 day sampling periods in susceptible and normal populations. These studies have been conducted in subjects (n=6) that experienced a range of PM2.5 exposure variations over the 10 day period. Mean home-outdoor PM2.5 concentrations for these subjects were 18.8 $\mu g/m^3$; (range 5.0-41.5 $\mu g/m^3$), and mean home-outdoor levoglucosan concentrations were 501 ng/m^3; (range 88-1214 ng/m^3). Studies to determine the half-life of these urinary metabolites are also in progress. *This work has been funded by the U S EPA (Cooperative Agreement #R827177 & EPA Northwest Research Center). It has been subjected to Agency review and approved for publication.*

[P06-17] RISK FACTORS ASSOCIATED WITH INCREASED FINE PARTICLE DEPOSITION IN HEALTHY CHILDREN.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (4:00 PM-5:00 PM) Grand Ballroom 2-4

Inter-child variability in particle deposition may contribute to variability in observed morbidity associated with inhaled particulate air pollution. We have measured fractional deposition (DF) of fine particles (2um monodisperse, carnauba wax particles) in healthy children, age 6-13 (n=36) while they followed a breathing pattern previously determined by respiratory inductance plethysmography (i.e. that child's spontaneous pattern at rest). Breath-by-breath DF (ratio of particles not exhaled/total particles inhaled) was determined by photometry at the mouth. The variation in DF among the children was most strongly predicted by their tidal volume (Vt) ($r = 0.79$, $p < .001$). Multiple regression analysis further showed that Vt was predicted by age, height and body mass index (BMI), i.e. at any given age and height, Vt increased with increasing BMI ($p = 0.001$). The most obese children (>90th percentile BMI) (n=10) had twice the DF of those in the lowest BMI quartile (<25th percentile) (n=9), 0.28+/- 0.11 vs. 0.15+/-0.06 respectively, $p < 0.01$. In the same groups, resting minute ventilation (Ve) was also significantly higher in the obese children, Ve = 8.1+/- 2.1 vs. 5.9+/-1.1 L/min, $p = 0.01$. Consequently, the rate of deposition, Drate (i.e. particles depositing/time), in the obese children (proportional to the product of DF and Ve) was 2.8 times that of the leanest children ($p = 0.01$). Among all children Drate was significantly correlated with BMI ($r = 0.46$, $p = 0.004$). These results suggest obese children may be at increased risk associated with the inhalation of pollutant particles in ambient air. This is an abstract of a proposed presentation and does not necessarily reflect EPA policy.

Supported by USEPA Cooperative Agreement CR829522.

[P06-12] FILTRATION EFFICIENCY OF A REPLICA OF THE HUMAN NASAL AIRWAYS.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (4:00 PM-5:00 PM) Grand Ballroom 2-4

The adverse health effects of airborne particulate matter (PM) exposure, particularly among sensitive subpopulations, have been recognized in recent years. To assess potential health risks from PM exposure, the initial deposition and subsequent clearance of inhaled material to sites in the lung must be estimated. Since the filtration of particles by the nasal passages strongly influences the amount of PM introduced to the lung, accurate assessments of nasal filtration are critical to the estimation of lung dose. Nasal filtration efficiency is also an important consideration when targeting therapeutic drug delivery to the respiratory tract following nasal administration of the drug. Although the filtration efficiency of nasal airway replicas has been studied previously, more work on the subject is warranted. Discrepancies exist among previous results, and several studies were limited by the use of cadavers in test airway manufacture. Moreover, previous studies focused on either ultrafine or fine and coarse aerosol deposition, whereas a single study of deposition for the entire range of respirable particles is desirable. The goal of this work was to measure the filtration efficiency of a replica of the nasal airways of a human for the respirable range of particle sizes and typical flow rates. A plastic replica of an adult male's nasal passages was manufactured by stereolithography using airway surface coordinate information obtained from MRI scans. The resolution of the digitized data was 1.5 mm. Monodisperse aerosols were generated in the size range of 0.03-10 μm. Aerosols consisted of di-2-ethyl hexyl sebacate (DEHS) droplets formed from larger primary particles produced from a DEHS and ethanol solution. The filtration efficiency of the nasal model was determined for nonoscillatory flows in the inspiratory direction. Filtration efficiency was determined by comparing particle concentrations measured upstream and downstream of the test airway. Flow rates of 20, 30, and 40 LPM, which correspond to slow, normal, and fast breathing rates, were used. For particles < 1 μm, filtration efficiency reached a minimum value of less than a few percent for particle sizes ranging from 0.1 to 1 μm. For particles > 1 μm, filtration efficiency increased from minimal to nearly 100% with increasing particle size and flow rate. The filtration efficiency for particles > 1 μm for different flow rates formed nearly a single curve when plotted as a function of particle inertia. This result indicates that deposition for these particle sizes and flow conditions is dominated by the inertial impaction mechanism.

(Research supported by Bespak Europe Ltd)

[P06-13] PERFORMANCE OF A NEW MOBILE WHOLE BODY MOUSE EXPOSURE SYSTEM.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (4:00 PM-5:00 PM) Grand Ballroom 2-4

A mobile whole body exposure system was developed for exposing mice to concentrated ambient particulate matter less than 2.5μm in mass median aerodynamic diameter (MMAD). The compact 20-liter exposure system was designed to simultaneously expose nine mice in individual compartments and enable transportation of the mice to various locations in the Los Angeles basin for acute exposure to concentrated ambient particulate matter. The performance of this exposure system was determined for 0.5 to 2.0μm aerosols by measuring, 1) uniformity of aerosol distribution, and, 2) particle deposition in the tracheobronchial and pulmonary region of mice exposed in the system, in order to detect particle losses to animals/system surfaces. The uniformity of particle distribution in the mobile exposure system is also being studied using computational fluid dynamic predictions.

A 0.6μm MMAD (GSD = 2.0) aerosol was used to experimentally measure the uniformity of aerosol concentration in each of the nine individual compartments. The average data from three runs showed no statistically significant difference among individual compartments. Particle deposition efficiency in adult male Balb/c mice was measured using monodisperse fluorescent polystyrene latex particles (0.5, 1, and 2μm aerodynamic diameter). Animals were exposed for 30 minutes and were euthanized immediately after exposure. First, the trachea was tied shut to prevent further clearance from the tracheobronchial airways and then the lung was removed. The lungs from all animals were pooled into one sample, homogenized and subsequently digested in NaOH. Fluorescent microscopy was used to count the monodisperse fluorescent particles in the digested lung fluid. The measured deposition efficiency in this mobile exposure system for the tracheobronchial and pulmonary region of the adult male Balb/c mice is: 21% for 0.5, 11% for 1.0, and 6.5% for 2.0μm particles respectively. These deposition efficiencies are similar to those predicted by mechanistic computer models, which indicates that particle losses to exposure system surfaces were acceptable.

Supported by the US EPA grant number R827352, but not subject to the agency's peer and policy review. Therefore, it does not necessarily reflect the views of the agency, and no official endorsement should be inferred.

[P06-15] REGIONAL DEPOSITION OF ULTRAFINE, FINE, AND COARSE PARTICLES IN THE HEALTHY AND OBSTRUCTED LUNG.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (4:00 PM-5:00 PM) Grand Ballroom 2-4

Relative to the general population, individuals with obstructive airways disease have an increased susceptibility to adverse health effects following exposure to urban particulate matter. The site of respiratory particle deposition may be an important determinant of pathological response. We have studied the regional deposition (RDep) of various sized technetium labeled aerosols using gamma scintigraphy. The RDep of ultrafine (0.06 um) and fine (1.5 um) aerosols were investigated in 9 healthy controls and 10 patients with chronic obstructive pulmonary disease (COPD). In an additional 11 controls and 9 COPD patients, the RDep of coarse (5 um) particles was characterized. Measurements of regional lung volume and ventilation were obtained for all subjects from a xenon-133 equilibrium and multi-breath washout, respectively. Twelve regions of interest (ROI) were established by dividing each lung into thirds by height and half by width. The lower regions of the left lung were not analyzed due to activity from particles in the stomach. Remaining regions were categorized as central (2 interior-most regions) and peripheral (8 exterior regions). RDep and RVent were computed for the 8 peripheral regions. RDep was computed as the fraction of aerosol deposited within a region normalized to volume. RVent for each region was determined by normalizing the Xe washout rate for that region by the total washout rate for the 8 peripheral regions. Central to peripheral ratios (C/P) were calculated for the right lung as the fraction of deposition normalized to volume in the central relative to peripheral regions. In general, the RDep of the ultrafine and fine aerosols, but not the coarse aerosol, were significantly associated with RVent in both the patients and controls ($p<0.01$), i.e. deposition followed ventilation. However, relative to the controls, the patients had significantly greater variability in RDep for both the ultrafine and coarse aerosols ($p<0.05$). C/P ratios in patients were also significantly increased relative to controls for the ultrafine and coarse aerosols ($p<0.05$). C/P ratios for the coarse particles were significantly greater than for the fine and ultrafine particles in both patients and controls ($p<0.001$). Our data suggest that COPD patients receive a less uniform dose of inhaled particles (especially coarse and ultrafine) than do healthy subjects. This finding is probably due to the combined effects of airways obstruction and abnormal ventilation distribution on particle deposition in the diseased lung. Funded by USEPA Cooperative Agreement CR829522.

[P06-18] HEALTH EFFECTS INDICATORS IN HUMAN LUNG IN RELATION TO PARTICLE CONCENTRATION AND METAL CONTENT.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (4:00 PM-5:00 PM) Grand Ballroom 2-4

Little information exists about retained particle/metal burden in human lung and associated health effects. We have shown that anatomical remodeling of the terminal and respiratory bronchioles occur at sites of carbonaceous and mineral dust deposition. We extend the value of these findings by providing information on lung particle and metal content in relation to indicators of effect as classified by standard diagnostic criteria for 1) chronic bronchitis 2) asthma 3) mineral dust disease and 4) smoking-related disease. Lung autopsies were examined from 40 male Hispanics from the Central Valley of California who had died from non-respiratory related causes. Computer-controlled scanning electron microscopy was used to determine particle concentration (No.particles/cm2 sample area/mg ashed tissue) and inductively coupled plasma emission spectrometry for metal analysis. Lung samples w/wo indicators of effect were compared. Significant ($p < 0.05$) fold increases in no. of particles was observed for indicators of mineral dust disease (4.0X); lymph node fibrosis (2.0X) smoking related disease (2.2X). In contrast, no. of particles were (1.6X) lower in samples with indicators of an asthma effect. All samples,. irrespective of disease state, >90 % of the 24,000 particles analyzed were < 2.5 m in diameter, 70 % < 1 m and 42 % <0.5 m. Significant inter-individual variability in metal concentrations was observed. Ti, V and Mn concentrations were significantly ($p < .05$) elevated in mineral dust disease and lymph node fibrosis. Consistent with tobacco contaminants, significant fold increases were shown for Ni (2.9X), Cr (3.6X), and Cd (4.6X) respectively, in samples with indicators of smoking related disease. Elevated metal concentrations were not observed in asthmatic lung tissue. We recently applied PIXIE analysis, monitoring) by adapting the procedure for tissue analysis to provide important data relative concentrations Si. Determining the fate/dose of particulates in humans is essential for predicting health effects and elucidating the mechanisms by which particles cause these effects. Our data support the association between particulate exposure and increased risk of lung disease. Microdissection, histology and evaluation of tissue changes coupled with characterization and measurement of internal particle/metal burden provide a means toward establishing dose levels and anatomical sites in human lung required to produce adverse health outcomes.

[P06-16] NASAL UPTAKE OF FINE PARTICLES: EFFECT OF AGE, RACE, AND GENDER.

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Wednesday, April 2, 2003, 4:00 PM, Poster Session 2: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (4:00 PM-5:00 PM) Grand Ballroom 2-4

The nose acts as a partial filter to prevent penetration of particles to the lower respiratory tract. Nasal efficiency for removing fine particles may be affected by variations in nasal structure associated with age, race, and gender. In healthy children (age 6-13, n=22) and adults (age 18-31, n=22) we measured the fractional deposition (DF) of fine particles (1 and 2um MMAD) for oral and nasal breathing using individual breathing patterns measured by respiratory inductance plethysmography during a graded exercise protocol. DF for both nasal and mouth breathing were measured separately by laser photometry at the same tidal volume and breathing rate for resting and light exercise (20% max work load) conditions. From these DF measures, nasal deposition efficiency (NDE) was calculated for each condition. We found that NDE for 2um particles was significantly less in the children vs. adults for their light exercise ventilation patterns, 0.25+/-0.14 vs. 0.37+/-0.14 respectively, $p<0.01$. For light exercise conditions in adults, NDE for both 1 and 2um particles was less in African Americans vs. Caucasians, 0.15+/-0.07 vs. 0.24+/-0.11 for 1um ($p = 0.03$) and 0.29+/-0.13 vs. 0.44+/-0.11 for 2um ($p = 0.006$). Finally, females tended to have lower NDE than males with a significant difference found under resting conditions for 2um particles, 0.12+/-0.07 vs. 0.27+/-0.12 for females vs. males respectively ($p=0.002$). These results suggest that, due to less efficient nasal uptake of particles, the lungs of children, African Americans, and females may be exposed to higher concentrations of inhaled, ambient particles than their counterparts. This is an abstract of a proposed presentation and does not necessarily reflect EPA policy.

Supported by USEPA Cooperative Agreement CR829522.

[P02-11] THE SUSCEPTIBILITY OF OLDER ADULTS TO AIR POLLUTION.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:30 PM-9:30 PM) Grand Ballroom 2-4

While older adults clearly have higher overall risks of dying from air pollution due to their higher underlying risks, it is less clear that their relative risk (RR) from air pollution is higher. We consider two data sets, one looking at the risks of long-term exposure to PM, and one at the risk of acute exposures. We compare the RR's of dying from Particulate Matter (PM) air pollution to investigate the age dependence of risk from PM air pollution.

In the analysis of long-term pollution exposures, we consider the national American Cancer Society (ACS) Cancer Prevention II cohort. After controlling for other risk factors, using a Cox-Proportional Hazards Model we found that there is a 1.06 RR of death from Cardiopulmonary disease associated with long-term exposure to 10 ug/m3 of PM2.5 over the period 1982-1998 (Pope et al, JAMA, 2002). We have now reanalyzed these data to consider the pollution RR's for adults <75 yrs. old vs. those 75+ . We find the 10 ug/m3 PM2.5 Cardio-pulmonary RR for 75+ to be greater than for those <75 years of age (RR = 1.049;CI=1.023-1.076 for those < 75, vs. RR = 1.098;CI=1.050-1.148 for those 75+).

In an analysis of short-term PM exposures, we consider daily mortality in New York City for the years 1985-1994. After controlling for other factors such as season and weather using a Generalized Additive Model (GAM), the PM10 RR for Circulatory Deaths without Respiratory disease listed as a cofactor on the death certificate is similar for both adults <75 and adults 75+ years of age (RR per 18 ug/m3 PM10 = 1.027; CI=1.012-1.043 vs. RR=1.022; CI=1.008-1.035, respectively). However, for deaths in which respiratory disease was listed as a co-factor, the PM10 RR for persons <75 is approximately half that for those 75+ years of age (RR per 18 ug/m3 PM10 = 1.033; CI=0.98-1.089 for those <75 vs. RR=1.066; CI=1.027-1.106 for those 75+ years of age). This indicates that higher acute cardiovascular risks from air pollution are found in older adults who have co-existing respiratory disease. Thus, the cardiovascular Relative Risk from long and short term exposure to air pollution are apparently higher per ug/m3 in older adults than younger adults, especially among those who have respiratory disease.

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[P02-05] ASSOCIATION OF SINGLE AND MULTIPLE COMPONENTS OF PM AND HUMAN MORTALITY IN ATLANTA, GA.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:30 PM-9:30 PM) Grand Ballroom 2-4

Aerosol Research and Inhalation Epidemiological Study (ARIES) is a program sponsored by the Electric Power Research Institute (EPRI) that involves the collection of air quality and meteorological data at a single site in Fulton County of Atlanta, GA. High-resolution air quality indicators (AQI) are used to examine statistical relationships between air quality and health outcome endpoints. Contemporaneous mortality data are collected for Fulton and DeKalb counties in Georgia. Currently, 24 months of AQI, weather, and mortality data are available for analysis, from August 1998 through July 2000.

We compare the estimated associations of daily mortality and two dozen AQI using Poisson regression in a generalized linear models (GLM) framework. The estimated log-linear association of mortality with various AQI is adjusted for smoothed functions of time and meteorological data using natural splines. Our analysis considers daily deaths due to non-accidental causes by whether the decedent was at least 65 years of age. Associations are also investigated by subgroups of decedents defined by cause of death: deaths due to respiratory conditions, deaths due to circulatory conditions, deaths due to non-circulatory or non-respiratory conditions, and deaths due to cancer.

We also investigate the interaction of various AQI by using comparable models with two AQI, the impact of the placement and number of knots on the estimated associations, and whether the death occurred in Fulton or DeKalb Counties. A chart compares the effect of degrees of freedom for time in the estimated association of fine particles in Atlanta compared to six other cities, and a parallel chart shows the changes in the standard error of the estimated associations. In general, as the number of degrees of freedom for time increases, the estimated associations decrease, and the standard errors eventually begin to increase. The drop is very fast for Atlanta, partly due to a shorter time series and less seasonality.

$PM_{2.5}$, PM_{10} and oxygenated hydrocarbons (OHC) appear strongest in the presence of other AQI in Atlanta. Graphical displays illustrate differences in estimated associations, by AQI alone, and in combination with other AQI. The impact of the number and location of knots are graphically compared by cause of death and AQI. They show, for example, that deaths due to respiratory conditions are more sensitive to whether time is smoothed using monthly knots or quarterly knots. Results are not sensitive to changes in fixed placement of the knots within each month or quarter.

[P03-03] SEPARATE AND COMBINED EFFECTS OF AMBIENT FINE PARTICULATE POLLUTION AND NITROGEN DIOXIDE IN ELDERLY VOLUNTEERS.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:30 PM-9:30 PM) Grand Ballroom 2-4

Volunteers of mean age 72, including 13 with moderate chronic obstructive pulmonary disease (COPD) and 6 healthy, were exposed to 0.4 ppm NO_2, approximately 200 $\mu g/m^3$ concentrated ambient fine particles (CAP), NO_2 and CAP together, and filtered air alone. Exposures lasted 2 hr with intermittent exercise. No meaningful changes in symptoms or spirometry were attributable to NO_2 or CAP, separately or combined. Arterial oxygen saturation (SaO_2) showed significant ($P < .01$) negative changes associated with CAP (estimated mean -0.4%) and NO_2 (estimated mean -0.2%) which appeared to be additive in the combined exposure, and not significantly different between healthy and COPD. Preexposure SaO_2 showed a negative association with prior 24-hr mean ambient PM_{10}, significant ($P < .05$) in COPD but not in healthy subjects. Conclusion: Ambient fine particle pollution, and to a lesser extent NO_2, may have acute negative effects on blood oxygenation.

[P12-02] AN ANALYSIS OF THE ASSOCIATION BETWEEN AIR POLLUTION AND PULSE OXIMETRY, HEART RATE, AND BLOOD PRESSURE IN ELDERLY SUBJECTS IN SEATTLE.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 12: Integrating Epidemiology, Toxicology, and Human Clinical Studies (8:30 PM-9:30 PM) Grand Ballroom 2-4

The objective of this intensive panel study was to recruit subjects from groups thought to be susceptible to particulate matter (PM) air pollution and study their exposures and health outcomes. Three groups of subjects were recruited: healthy subjects and subjects with chronic obstructive pulmonary disease (COPD) over the age of 65 and subjects with heart disease 50 years of age and older. Each subject participated for 10 consecutive days in a session for up to 3 sessions that required daily collection of PM and health outcomes. To determine whether PM influenced pulmonary or cardiac function, each subject underwent repeated daily measures of oxygen saturation of arterial blood, pulse rate, and blood pressure during each session. Associations between health outcomes and PM2.5 values measured indoors and outdoors at subjects' homes with Harvard impactors, personal PM2.5 measured with Harvard personal environmental monitors, and central site agency TEOM measurements were tested using mixed effects models with random intercepts. For a 10 μg/m3 increase in PM2.5 from personal monitors on the same day, we found a 2.5 (CI .31-4.62) mmHg increase in systolic blood pressure (SBP) and an increase of 1.6 (CI 0.36-2.84) beats per (bpm) in heart rate in subjects with heart disease. We also saw a 1.8 (0.39-3.26) bpm increase in heart rate associated with a one day lag in PM2.5 for the outdoor monitors and a 1.6 (CI 0.07-3.19) bpm increase in heart rate on the same day with the indoor monitor. We observed similar magnitude decreases in SBP (-2.8mmHg, CI -4.5 to -1.0) and heart rate (-2.2 bpm, CI -4.0 to -0.3) in subjects with respiratory disease for the personal and outdoor monitors respectively. These effects were not seen in healthy control subjects. No associations between PM2.5 and oxygen saturation were observed.

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[P12-01] THE ASSOCIATION BETWEEN AIR POLLUTION AND CARDIOVASCULAR MORTALITY IN GREATER PHOENIX, 1995 TO 1997.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 12: Integrating Epidemiology, Toxicology, and Human Clinical Studies (8:30 PM-9:30 PM) Grand Ballroom 2-4

In a previous study on mortality and air pollution in Phoenix, AZ we found that cardiovascular mortality was associated with PM10, PM2.5, and coarse fraction (PMCF = PM10 - PM2.5). In that study mortality counts were restricted to zip codes that were considered most represented by the air pollution monitors. The goal of the current study is to assess the effect of various PM metrics, PM composition elements, and source contributions from a receptor model on cardiovascular mortality in the elderly (≥ 65 years) in a larger geographical area. Cardiovascular mortality counts were obtained for the greater Phoenix area: Phoenix, Glendale, Scottsdale, Mesa and Tempe. Daily PM10, PM2.5 and PM2.5 chemical composition elements were obtained from the EPA NERL platform in central Phoenix. Poisson regression models that controlled for time trends, day of week, temperature, relative humidity, and extreme temperatures were used to evaluate the association between air pollution and cardiovascular mortality. GLM, implemented in SPLUS, was used in order to avoid the convergence and standard error problems encountered with GAM. All results are reported for an interquartile range increase in air pollutant. We found that PM10 and PMCF were significantly associated with cardiovascular mortality (RR=1.04 [95% CI: 1.01, 1.08] and RR=1.04 [95% CI: 1.1, 1.07]) respectively at 1 day lag. The association with PM2.5 was similar to PM10 and PMCF with a RR=1.03 (95% CI: 1.00, 1.07). Cardiovascular mortality was also significantly associated with various composition elements ($p<0.05$): organic carbon, Cu, and Pb. The association with elemental carbon was marginal ($p<1.0$). No associations were found with the gaseous pollutants CO, NO2 and SO2. Soil components were found to have a negative association ($p<0.05$): Al, Si, Fe, Ca, and K. Analysis of source contribution data from the UNMIX receptor model indicated that cardiovascular mortality was marginally associated with diesel exhaust with a RR=1.03 (95% CI: 1.00, 1.07) and motor vehicle exhaust with a RR=1.06 (95% CI: 1.01, 1.11). Consistent with the negative association found with the soil components, the crustal source from the UNMIX model was also negatively associated with mortality ($p<0.05$). No associations were found with the vegetative burning source. This abstract has been subjected to EPA review and approved for publication. It does not necessarily reflect EPA policy. This research was supported by Grant # 5T32 ES07262 (NIEHS) and R827355 (EPA).

[P02-14] AIR QUALITY AND RESPIRATORY HEALTH IN OHIO.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:30 PM-9:30 PM) Grand Ballroom 2-4

The relationship between air pollution and human health has attracted the attention of the public, scientists, and policy makers worldwide. Despite the mounting evidence identifying a relationship between air pollution and negative health effects, few data are available to make informed decisions in the state of Ohio. Epidemiological data from one region are not necessarily applicable to another; therefore, it is necessary to evaluate air pollution levels and their influence on public health as it relates to specific geographic regions.

Recognizing the gap in the data about the health effects of air quality in Ohio, the need for geographically-based research, and the emphasis on children's health issues, researchers at Ohio University and Texas A&M University -Kingsville initiated the Air Pollution and Pediatric Health Impact project.

First, in this study we have presented the adjusted long-term trends analysis for air pollutants from major cities in Ohio. Second we statistically correlated hospital admission with air quality. In this analysis we controlled for the confounding affects of meteorology and seasonal variations.

Long-term trends of ozone, PM10, CO, SO2, and NO2 concentrations in the major urban centers were analyzed using an advanced technique called the Kolmogorov-Zurbenko (KZ) filter. Long-term trends analysis for ozone at several of the sites shows an increase trend in ozone levels. For PM10 the trend line remained fairly constant at all sites. All the sites showed visible decreasing trends in CO and SO2, while NO2 concentrations slightly increased.

After partitioning out the effects of seasonality and weather, there was little evidence of a consistent relationship between any of the air pollutants and any of the measures of respiratory health across the major metropolitan areas in Ohio. No general pattern for a given pollutant across the state was identified.

[P03-11] CONCENTRATED AMBIENT PARTICLES ATTENUATE ALLERGEN-INDUCED AIRWAY RESPONSES IN THE LUNGS OF BROWN NORWAY RATS.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:30 PM-9:30 PM) Grand Ballroom 2-4

Health effects of inhalation co-exposures of air pollutants and airborne allergens have not been thoroughly investigated. The purpose of the present study was to determine the effects of inhalation exposure of concentrated ambient particles (CAPs) on the lungs of rats that were concurrently exposed to a pulmonary allergen (ovalbumin; OVA). A mobile air research laboratory, equipped with inhalation chambers and ambient particle concentrators, was used to conduct the study. The mobile lab was parked in a residential site in Claremont, CA. OVA-sensitized, male, Brown Norway rats were exposed to filtered air (controls), concentrated ambient coarse (2.5-10μ m; CCAPs), fine (0.15-2.5μm; FCAPs) or ultrafine (0.01-0.15μ m; UFCAPs) particles for 5 h/day (11am -4pm) for three consecutive days. Immediately prior to each daily inhalation exposure, the rats were intranasally challenged with saline alone or a 0.5% solution of ovalbumin in saline. Rats were exposed to average mass concentrations of 554, 515 and 45 μg/m3 for CCAPs, FCAPs, and UFCAPs, respectively. 24 hours after the end of the exposures, rats were sacrificed, their airways lavaged with saline, and their lungs processed for microscopic and mRNA analyses. OVA-instilled rats had allergic bronchiolitis with mucous cell hyperplasia and allergic alveolitis with marked increases in eosinophils in the bronchoalveolar lavage fluid (BALF). OVA-instilled and air-exposed rats had 538% more eosinophils in the BALF, 104% more stored mucosubstances in the bronchiolar epithelium, and a 6-fold increase in mucin-specific gene expression in bronchiolar airways than saline/air controls. Exposures to FCAPs or UFCAPs, but not CCAPs, caused a marked attenuation (50-100%) of the OVA-induced allergic alveolitis, mucous cell metaplasia and mucin-specific gene expression. These results indicate that fine and ultrafine particulate matter may significantly interfere with allergen-induced airway responses during co-exposure of these airborne agents. (Research funded in part by USEPA Grant #R-82921601)

[P03-10] EXPOSURE TO CONCENTRATED FINE AND ULTRAFINE AMBIENT PARTICLES NEAR HEAVILY TRAFFICKED ROADS INDUCES ALLERGIC REACTIONS IN MICE.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:30 PM-9:30 PM) Grand Ballroom 2-4

The goal of this study was to test the hypotheses that: (1) mobile emissions will exacerbate airway inflammation and allergic airway disease; (2) the magnitude of allergic airway disease responses will be greater at sites with higher concentrations of ultrafine particles; and (3) organic and inorganic PM constituents that can generate ROS will be associated with responses. Ovalbumin (OVA)-sensitized Balb/c mice were exposed to concentrated fine and ultrafine ambient particles (CAPs), to purified air, at three sites at increasing distances downwind from a heavily trafficked roadway. The three sites were 50m (BH1), 100m (BH2) and 500m (BH3) downwind. The average mass concentration for the CAPs exposures at each of the 3 sites was maintained at 400 micrograms per cubic meter. The exposures were conducted for 4 hours per day, 5 days per week for 2 weeks. Prior to each day's exposure, OVA was administered to each mouse by nasal instillation. Two weeks after the final exposure the mice were challenged with OVA aerosol. Their lungs were lavaged and blood samples were obtained. The numbers of inflammatory cells (PMN) and eosinophils (EOS) in BAL were determined. The lavage fluid was analyzed for interleukin-5 (IL-5) and interleukin-13 (IL-13). The serum was analyzed to quantitate the amounts of OVA-specific antibodies (IgE and IgG1). These endpoints represent important hallmarks of allergic and asthmatic responses.

Exposure to CAPs elicited significant increases in numbers of eosinophils, increased concentrations of IL-5 in lavage fluid and increased concentration of OVA-specific IgG1 in blood serum in mice exposed at BH1, but not BH2 or BH3, compared to measurements in mice exposed to purified air. A 2-factor analysis of variance showed that for each of these endpoints mice exposed at BH1 showed changes consistent with allergic responses to the OVA-challenge following CAPs exposure but not after purified air exposure (EOS, $p = 0.04$; IL-5, $p < 0.001$; IgG1, $p = 0.002$). Particle numbers at BH1 were 5 to 8 times those measured at BH2 or BH3 during the exposures.

The results of this study suggest that exposure to fine and ultrafine particles at sites near a heavily trafficked roadway can elicit allergic responses. The importance of this finding is that it is consistent with the role of an environmental contaminant (ambient fine and ultrafine particles) in the exacerbation and/or development of allergic airway diseases, such as asthma.

This project was funded by the California Air Resources Board and the U.S.E.P.A. Southern California Particle Center and Supersite.

[P03-13] LACK OF EFFECT OF AGE AND ANTIOXIDANT DEPLETION ON RESPIRATORY RESPONSES TO CONCENTRATED AMBIENT PARTICULATES (CAPs) IN RODENTS.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:30 PM-9:30 PM) Grand Ballroom 2-4

Metal-mediated generation of reactive oxygen species (ROS) and oxidative stress have been proposed as one of the main mechanisms for emission source PM toxicity. Oxidative stress has also been implicated in aging and in the pathogenesis of asthma. Asthma, an inflammatory airways disease, has become an urgent health problem; with elderly asthmatics experiencing some of the highest mortality rates of any age group. Thus, we evaluated whether antioxidant responses were important in the respiratory effects associated with ambient PM exposure. In study 1, 12-wk Sprague Dawley (CD) rats were exposed to CAPs from central North Carolina (NC). Buthionine sulfoximine (BSO) was administered systemically to deplete lung glutathione prior to and during air or CAPs nose-only exposure (4h/day x 2 days). Airway responsiveness (AR) to methacholine wasalso assessed. In study 2, young adult (10-wk) and geriatric (15-mo) spontaneously hypertensive (SH) and WKY (background) rats were exposed to air or CAPs in a whole-body chamber (4h/day x 2 days). In addition to hypertension, SH rats have neutrophilic lung inflammation seemingly related to antioxidant deficits. Lung, blood, bronchoalveolar, and nasal lavage fluid (BALF, NALF) samples were collected 20h later. In study 1, PM chamber levels were 150-800 μg/M^3. Although BSO treatment depleted lung glutathione levels by 50%, neither saline- nor BSO-treated rats exhibited increased AR after CAPs exposure. Likewise, regardless of antioxidant status, neither group developed significant lung injury /inflammation. In study 2, PM concentrations were 1400-1800 μg/M^3. Data indicated that for many BALF indices, relative to WKY rats, SH rats had higher levels (e.g., albumin, TP, lysozyme, cytokines) and cell counts (due to more macrophages). While the magnitude of these differences increased with age, relative to these changes, CAPs-induced effects in geriatric rats were negligible. In young rats, CAPs exposure was associated with minor increases in BALF GGT and trends towards increased albumin, TP, and neutrophils. In summary, reduction in lung antioxidant levels failed to predispose CD rats to developing greater lung changes after exposure to summertime CAPs from the NC airshed. Similarly, although geriatric SH rats had greater changes in BALF biochemical and inflammatory indices, advanced age alone did not predispose these rats to developing greater CAPs-induced lung injury or inflammation. (Abstract does not reflect EPA policy.)

[P02-06] ASSOCIATIONS BETWEEN PARTICULATE MATTER COMPONENTS AND DAILY MORTALITY AND MORBIDITY IN PHILADELPHIA, PA.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:30 PM-9:30 PM) Grand Ballroom 2-4

In evaluating the health risks from particulate matter (PM), the question remains as to which component(s) of PM are most harmful. We investigated this issue using PM mass, PM constituents, mortality, and the elderly hospital admission data in Philadelphia, PA. Daily paired $PM_{2.5}$ and PM_{10} samples were collected at one site in downtown Philadelphia between May 1992 and September 1995. Trace elements as analyzed by energy dispersive X-ray fluorescence from $PM_{2.5}$ filters (including Br, Ca, Fe, K, Mn, Ni, S, Se, Si, V, and Zn), gaseous pollutants (CO, NO_2, SO_2, and O_3), and coefficient of haze (CoH) were also analyzed. Daily cardiovascular mortality, total (non-accidental) mortality, cardiovascular elderly (age over 65) hospital admissions, and respiratory elderly hospital admissions were aggregated for the Philadelphia Metropolitan Statistical Area. Generalized Linear Poisson regression Model (GLM) was used to estimate the excess health outcomes associated with PM components and gaseous pollutants adjusting for temporal trends, weather, day-of-week, and major holidays. Several alternative weather models as well as varying extent of seasonal smoothing were applied to examine the sensitivity of results to model specifications. Among the PM components examined, the most consistent associations with health outcomes were observed for S, $PM_{2.5}$, and PM_{10} (70% of whose mass, on the average, was $PM_{2.5}$). Of these, S often showed the most significant associations. For example, the estimated relative risks for cardiovascular mortality at lag one day in a GLM model were 1.055 (t = 2.50), 1.044 (t = 2.04), and 1.039 (t = 1.68) for S, $PM_{2.5}$, and PM_{10}, respectively per corresponding 5th-to-95th percentile distribution increment. $PM_{10-2.5}$ was not significantly associated with any of the health outcomes. These results suggest the strongest PM associations are between regionally uniformly distributed secondary aerosol and health outcomes in Philadelphia during this time period.

This work has been wholly funded by the United States Environmental Protection Agency under cooperative agreement number CR827358 to New York University School of Medicine. It has been subjected to Agency Review and approved for publication

[P02-07] FURTHER ANALYSIS OF THE ASSOCIATIONS BETWEEN AIR POLLUTION SOURCE FACTORS AND MORTALITY IN A SMALL AREA NEAR THE MONITORING SITE IN PHOENIX, 1995-1997.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:30 PM-9:30 PM) Grand Ballroom 2-4

Recent questions concerning the validity of results from the General Additive Model (GAM) using nonparametric smooths, as implemented in current statistical software packages, has led to concerns about the reliability of results from epidemiologic studies using GAM. In addition, new studies using the Phoenix data base have led to an interest in re-investigations in which missing temperature and relative humidity are replaced with imputed values using measurements from the Phoenix Sky Harbor airport (thus increasing the data days from 700 to 765). Also, we were interested in examining the difference between replacing missing source factor data with the average value compared to omitting days with missing source factor data. Results for various models including GAM-D (default convergence criteria), GAM-S (stricter convergence criteria), and GLM (General Linear Model with natural splines) will be reported for both treatments of missing values. Although there are some variations in calculated values of beta and standard error among the models, the major conclusions are unchanged. Factors associated with regional sulfate, vehicular traffic (including resuspended road dust), and vegetative burning are statistically significant. Regional sulfate yields a higher statistical significance and beta than sulfate from XRF measurements of sulfur, presumably because the regional sulfate factor discriminates against coarse particle sulfate from soil or construction/demolition activities. The three source factors are statistically significant on different lag days, regional sulfate on lag day zero, vehicular traffic on lag day one, and vegetative burning on lag day three. These difference in time between exposure and death suggest the possibility of different biological mechanisms for the different types of particles.

% Increase in Risk of Cardiovascular Mortality per Interquartile Increase in Source Factor with 95% Confidence Intervals

	GAM-D (Missing values replaced with average)	GLM +60days (Days with missing values omitted)
Regional Sulfate	5.8 (0.2-11.7)	7.1 (0.9-13.6)
Vehicular Traffic	6.7 (1.7-12.0)	5.0 (0.1-10.1)
Vegetative Burning	5.0 (1.3- 8.8)	4.3 (0.4- 8.3)

[P02-08] A COMPARISON OF HEALTH EFFECTS FROM EXPOSURE TO AMBIENT AND NON-AMBIENT PARTICLES.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:30 PM-9:30 PM) Grand Ballroom 2-4

The plausibility of epidemiological associations between adverse health effects and outdoor concentrations of airborne particulate matter (PM) is supported by studies demonstrating high correlations between individual exposures to ambient PM and ambient PM concentrations. Since personal exposure to PM is dominated by exposure to non-ambient particles, it is also important to evaluate the potential health impacts of these exposures. In summer 1998, personal exposures to $PM_{2.5}$ and sulfate, and ambient concentrations of PM_{10}, $PM_{2.5}$ and sulfate were measured for a repeated measures (7 repeats) panel study of respiratory and cardiovascular effects in chronic obstructive pulmonary disease (COPD) patients (n=16) in Vancouver. In a further analysis of this dataset, we used an estimation method based on time-activity data and the use of sulfate as a marker for the infiltration of ambient particles with the same size distribution, to develop separate estimates of exposures to ambient $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ and to non-ambient $PM_{2.5}$. The concentrations and health effects of these estimated exposures were compared to the originally measured total personal exposures and to measured ambient concentrations. As in previous studies, personal exposures to $PM_{2.5}$ were dominated by exposures to non-ambient $PM_{2.5}$ (56% on average) which were uncorrelated with exposures to ambient $PM_{2.5}$ and to measured ambient $PM_{2.5}$. For lung function the largest effect estimates were for exposures to ambient $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$. Systolic blood pressure was negatively associated with ambient PM_{10} and $PM_{10-2.5}$ and to a lesser extent with exposures to ambient PM_{10} and $PM_{10-2.5}$. Increased heart rate and increased supraventricular ectopic heartbeats were associated with all ambient PM measures except for sulfate and with exposures to ambient $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$. Heart rate variability measures showed less consistency; decreased r-MSSD was associated with ambient concentrations of $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$, however no associations between SDNN and any PM parameters were observed. Neither exposures to non-ambient PM nor measured personal PM were associated with any of the health outcomes. Results, especially for the lung function, heart rate and heart rate variability outcomes, were sensitive to inclusion of one day of exposure associated with transported Asian dust, with larger effect estimates observed when this day was excluded. Overall, these results indicate the lack of associations between non-ambient PM and any of the measured health outcomes, whereas ambient coarse fraction ($PM_{10-2.5}$) mass, in addition to ambient $PM_{2.5}$, was associated with some adverse effects.

[P02-09] THE METAL CONTENT OF AIRBORNE PARTICLES: APPLICATION TO EPIDEMIOLOGICAL RESEARCH.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:30 PM-9:30 PM) Grand Ballroom 2-4

This work is the first long-term study in the UK of the quantitative relationship between elevated respiratory & cardiovascular mortality and morbidity rates and the variance in daily metal composition of PM10 in urban background air.

Concurrent 24-hour samples of PM10 and PM2.5 were collected at an urban background site in Edinburgh between September 1999 and September 2000. Each sample was sequentially extracted with ultra-pure deionised water followed by a concentrated acid mixture. Extracts were analysed by inductively coupled plasma mass spectroscopy for Fe, Cu, Ni, V, Zn, Mn, Cd, Cr, As, Ti, Pb.

The time series of particle-bound metal concentrations were extended backwards in time to 1992 by analysis of the influence of air mass source region on metal content. A statistical hierarchical clustering method was used to group 2800 daily meteorological air mass back trajectories for the period October 1992 to September 2000. Metal content enrichment factors were computed for each trajectory cluster to enable retrospective estimation of daily airborne concentration of each metal from archived PM10 and back trajectory data for Edinburgh.

Generalised additive Poisson regression models were used to determine whether adjustment for specified metals explained a higher proportion of the variance in health outcome data (deaths and hospital admissions (classified by ICD codes) in Edinburgh during the period January 1981 to September 2000) than the gravimetric measure alone. The relationship between health outcomes and particle pollution metric (particle mass and metal concentration expressed as the mean of the three days prior to outcome) was examined, with adjustment for day of the week, and minimum temperature.

To minimise statistical artefacts from multiple testing, a subset of 60 primary analyses was defined. These primary analyses comprised three health outcomes (cardiovascular admissions, respiratory deaths and all-cause deaths in subjects aged over 65) in relation to five of the eleven metals (Fe, Cu, Ni, V, Zn) in aqueous and total (water plus acid) filter extracts of PM10 and PM2.5.

For the eight-year cluster-based analyses there was a significant association with cardiovascular admissions for both total PM10 (consistent with previous analyses) and some of the metal fractions. However, further multiple regressions showed that the metal effects were no longer significant after adjusting for total PM10.

These epidemiological analyses have not excluded the hypothesis that the concentration in PM10 of one or more of the metals analysed here is the explanatory factor in the observed association between gravimetric PM10 and acute adverse health outcome.

[P03-07] FINE AND COARSE PARTICLES OF THE CALIFORNIA CENTRAL VALLEY DIFFERENTIALLY INDUCE ADVERSE EFFECTS IN THE LUNGS OF RATS.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:30 PM-9:30 PM) Grand Ballroom 2-4

Epidemiological studies have suggested particle size is an important determinant in adverse health effects. Fine particles with a diameter less than 2.5 μm are thought to be the most deleterious, while coarse particles with a diameter between 2.5 to 10 μm are considered to produce less injury to the cardiopulmonary system. During the fall and winter, rats were exposed in Fresno, CA to the fine fraction of PM_{10} in 6 separate experiments. Additional rats were exposed to the coarse fraction of PM_{10} in both Fresno and Davis, CA in 4 separate experiments. Fine PM was concentrated 20-fold and coarse PM 40-fold, while preserving chemical composition, size distribution and surface morphology. Exposures were for 4 hours per day for 3 consecutive days. Mass, particle numbers, and chemical composition of the concentrated PM were determined for each study. The mean mass concentration ranged between 200 to 900 $\mu g/m^3$ for fine PM and 200 to 1100 $\mu g/m^3$ for coarse PM. Both fine and coarse PM were enriched with nitrate, organic and elemental carbon, metals and other inorganics. Viability of cells recovered by bronchoalveolar lavage (BAL) from rats exposed to fine PM was significantly decreased during 4 of 6 weeks. Total cell number was significantly increased during 1 week and neutrophils during 2 weeks, compared to rats exposed to filtered air ($p<0.05$). Total BAL cells from rats exposed to coarse PM were increased during 3 of 4 weeks, while neutrophils were increased for all 4 weeks, and lymphocytes were increased during 2 of 4 weeks. A decrease in cell viability is indicative of cell membrane damage, while increased neutrophil numbers is reflective of an inflammatory response. These observations suggest that exposure to enhanced concentrations of fine or coarse PM in Fresno and Davis, CA is associated with significant effects in the lungs of rats. However, striking differences were observed following exposure to fine or coarse PM. Elevated toxicity to alveolar macrophages was noted with fine, but not coarse particles, while neutrophil influx was most prevalent with coarse particles. These observations strongly suggest additional studies are needed to more fully characterize the toxicological effects of particles in the complete size range for PM_{10} in the California Central Valley.

USEPA 827995 and NIEHS ES05707

[P03-12] EFFECTS OF ACUTE AND SUBCHRONIC EXPOSURE TO CONCENTRATED AMBIENT PARTICULATES IN HEALTHY AND COMPROMISED RODENTS.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:30 PM-9:30 PM) Grand Ballroom 2-4

A host of epidemiological studies have reported a slight but consistent association between exposure to higher concentrations of ambient particulate matter (PM) and excess cardiopulmonary-related morbidity and mortality. To further examine this phenomenon, we exposed various rodent models of cardiopulmonary dysfunction to Concentrated Ambient Particulates (CAPs) from Research Triangle Park, NC, and monitored changes in indices of cardiopulmonary function and injury. Animal models used included young (3 mo) Spontaneously Hypertensive (Y-SH), old (11 mo) Spontaneously Hypertensive (O-SH), and healthy (SD) and monocrotaline-treated Sprague-Dawley (MCT-SD) rats. Subsets of animals were implanted with radiotelemeters (Data Sciences International) to monitor (5-min intervalsX24h/d) electrocardiogram (ECG), heart rate (HR), systemic blood pressure (BP), and core temperature (T_{co}). Exposure protocols for Y-SH rats were either Continuous (4h/dX2-3d/wkX11wk) or Intermittent (4h/dX1d/wkX11wk) while SD, MCT-SD, and O-SH were exposed 4h/dX2-3d/wkX1wk. All exposures were conducted in nose-only exposure chambers. Pulmonary function tests (Buxco Electronics) were performed on all animals before, during, and after exposures. At the termination of the study, animals underwent bronchoalveolar lavage (BAL) and the BAL fluid was examined for biochemical indices of pulmonary injury and inflammation. Heart and lung tissues were harvested for histological and morphological analyses. PM exposure concentrations ranged from 135-1600$\mu g/m^3$. In general, despite the variety of exposure protocols and compromised animal models used, these studies demonstrated minimal adverse effects on cardiopulmonary and thermoregulatory function in cardiopulmonary-compromised rats after exposure to RTP CAPs. As such, these studies underscore the inherent complexities of conducting discrete, limited toxicology studies using environmentally-relevant exposure protocols in order to verify large scale epidemiological studies. Furthermore, these studies emphasize the importance of companion source characterization/apportionment studies to the overall PM research effort. (Abstract does not represent USEPA policy. This research was supported in part by EPA CT826513.)

[P02-10] THE EPRI-WASHINGTON UNIVERSITY VETERANS COHORT STUDY: MODEL SENSITIVITY STUDIES AND RESULTS FOR ADDITIONAL AIR POLLUTANTS.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:30 PM-9:30 PM) Grand Ballroom 2-4

The Veterans Cohort comprises about 50,000 male veterans who had been diagnosed as hypertensive; 35% were African-American and 81% had smoked. We considered all-cause mortality with county-level air quality.

Sensitivity studies showed that successive deletion of individual subjects' height, interactions between age and body-mass index (BMI), and interactions between age and systolic blood pressure (SBP) had no effect on model fit (AIC) or on the effect estimates for PM10 or peak O3. Further, deletion of all blood pressure variables increased AIC, decreased the PM10 effect by 12% and increased the peak O3 effect by about 5%.

The additional variables tested included peak and mean SO2; average (as opposed to peak) O3, 1999 PM10, PM2.5, and PM10 - PM2.5; and vehicle-miles traveled (VMT/area, an index of vehicular pollution). The results for SO2, PM2.5, and PM10 were sensitive to the inclusion of ecological variables (EVs) in the model, as shown in the first paper. With EVs included, mean and peak SO2 showed similar effect estimates that were largely negative, significantly so for the more recent exposure and follow-up periods. These findings are similar to those for SO42-.

Without EVs in the model, 1999 PM2.5 was associated with an excess 1989-96 mortality risk of about 12%, which lost significance and dropped markedly to about 3% excess risk when EVs were included. The corresponding PM10 values were similar but slightly lower; the risks associated with PM10 - PM2.5 were nil.

In contrast, the risks associated with O3 and vehicles were not sensitive to the inclusion of EVs. Effects of mean O3 were negative for all exposure and follow-up periods, largely significantly so. This is consistent with findings from other cohort studies and in sharp contrast with the previous positive findings for peak O3. For the vehicular pollutant variable (ln[VMT/county land area]), attributable mortality risks were significant at about 2-3% when all U.S. counties were considered, but increased to 5-8% when the analysis was limited to counties having the 1979-84 PM2.5 data used in previous studies.

[P02-13] AMONG CHILDREN WITH ASTHMA, LUNG FUNCTION IS DECREASED WITH THE COMBINATION OF COCKROACH ALLERGY AND EXPOSURE TO AMBIENT OZONE, BUT NOT WITH EXPOSURE TO PARTICULATE MATTER.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:30 PM-9:30 PM) Grand Ballroom 2-4

Asthma prevalence is increasing worldwide among children living in urban settings. Cockroach allergy is a recognized risk factor for asthma severity in the urban environment. Exposure to air pollutants, such as particulate matter (PM) and ozone, has been associated with decreases in lung function and increases in respiratory symptoms among asthmatics. We hypothesized that children with asthma who are allergic to cockroach may have an increased sensitivity to the negative efects of air pollution compared to those who are non-atopic.

This study was conducted as part of Community Action Against Asthma (CAAA). CAAA is a community-based participatory research project that combines investigation of the role of the indoor, outdoor, and social environments on asthma with interventions to reduce exposure to environmental asthma triggers. The project takes place in predominantly African-American and Hispanic communities in Detroit, MI. Measures of ambient air pollution, including PM_{10}, $PM_{2.5}$, and ozone were made on the rooftops of two elementary schools in the communities of interest. Lung function was measured for approximately 100 children with asthma twice daily for two weeks each season for 2 years. Sensitization to cockroach antigen was assessed by skin prick test. The impact of air pollutants on the day of exposure and 1 or 2 days after exposure was assessed using generalized estimating equation (GEE) statistical models.

A pattern of reduced lung function was seen with exposure to ozone among cockroach allergic children compared to non-allergic children. Of 24 ozone models assessed, 10 showed a negative impact of ozone on lung function and 9 of the 10 showed a stronger impact among children with allergy to cockroach compared to those without allergy. The strongest observed effect was a 2% decline in peak flow at 2 days post exposure for every 10 ppb increase in daily average ozone among allergic children ($p=0.0001$), whereas no significant effect was seen for the same exposure among non-allergic children. No similarly consistent pattern was identified for cockroach allergic children with exposure to coarse or fine fraction PM.

For children with asthma, an interaction is seen between the lung function effects of ozone exposure and cockroach allergy. A similar interaction has not yet been demonstrated between cockroach allergy and fine or coarse fraction particulate matter exposure.

[P03-04] RELATIVE CONTRIBUTIONS OF $PM_{2.5}$ CHEMICAL CONSTITUENTS TO ACUTE ARTERIAL VASOCONSTRICTION.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:30 PM-9:30 PM) Grand Ballroom 2-4

Introduction: We have recently reported a significant ($p=0.007$) decrease of 0.09 ± 0.15 mm (mean ± SD) in the mean brachial artery diameter (BAD) of humans immediately following exposure to 153 ± 36 $\mu g/m^3$ concentrated ambient $PM_{2.5}$ (CAP) and 120 ± 3 ppb O_3. Subsequent analyses of the major $PM_{2.5}$ chemical constituents now allow us to compare the strength of the associations between each constituent and individual BAD responses. Such knowledge is critical for public health risk management and abatement strategies. **Methods:** Twenty-four healthy adults underwent a randomized, controlled, double-blind, cross-over study in which we measured the change (post - pre) in BAD (ΔBAD) over a 2-hr exposure at rest, to CAP+O_3 and particle-filtered air (FA). Filter samples were collected from the CAP+O_3 airstream for gravimetric measures of $PM_{2.5}$ mass concentration (MC) followed by IC analyses for inorganic ions. In addition, co-located 24-hr ambient $PM_{2.5}$ measures were used to estimate exposures to trace elements and elemental & organic carbon EC/OC. Linear regression analyses using two response variables were performed with each single PM constituent as a predictor. One response variable was the individual's ΔBAD on the CAP+O_3 exposure day (model #1), and the other was the difference in an individual's ΔBAD with CAP+O_3 minus their Δ BAD with FA (model #2). A standardized regression coefficient (SRC) was then calculated by dividing the regression coefficient by the ratio of the SD of the response variable to the SD of the predictor. **Results:** Total MC poorly predicted ΔBAD in both model #1 (SRC=-0.07, r=0.07, p=0.74) and model #2 (SRC=0.18, r=0.18, p=0.40). There were no significant ($p \leq 0.05$) associations between ΔBAD and any PM constituents with model #1. In model #2 we observed significant SRCs for both OC (-0.45: r=0.45, p=0.036) and EC (-0.42: r=0.42, p=0.05). OC accounted for 89 ± 3% of total carbon MC (EC+OC). **Conclusions:** We have shown that carbon in $PM_{2.5}$ accounted for a significant amount of the variability of ΔBAD. Studies of PM with high organic carbon (CAP and diesel exhaust) have demonstrated cytokine production/release *in vitro* and cytokine and cellular inflammation in the lungs and circulation of animals and humans. It follows that organic carbon may initiate a pulmonary response capable of systemic effects, such as altering vascular tone.

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[P01-07] CONCEPTUAL DESCRIPTION OF PM OVER MEXICO CITY.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 1: The NARSTO North American PM Assessment (8:30 PM-9:30 PM) Grand Ballroom 2-4

Mexico City has 18 million inhabitants in an enclosed valley, with among the highest concentrations of ozone and PM in the world. The Mexican 24-hour PM_{10} standard (150 $\mu g/m^3$) is violated on about 30% of days, and the annual average PM_{10} standard (50 $\mu g/m^3$) was violated at eight of ten stations in 2000. Average concentrations range from 50 $\mu g/m^3$ southwest of the city, to 95 $\mu g/m^3$ NE. There is currently no Mexican standard for $PM_{2.5}$, and $PM_{2.5}$ is not measured routinely. Measurements of $PM_{2.5}$ during the IMADA campaign (Feb.-Mar. 1997) show that average $PM_{2.5}$ is 25 (SW) to 55 $\mu g/m^3$ (E), with peaks exceeding 150 $\mu g/m^3$. IMADA measurements show that $PM_{2.5}$ is about half of PM_{10}, and is ~50% organic and black carbon, ~30% secondary sulfate, nitrate and ammonium, and ~15% crustal. PM_{10} is ~50% crustal, ~32% organic and black carbon, and ~17% sulfate, nitrate and ammonium.

PM concentrations are highest in the winter due to dry conditions that favor dust suspension and reduce wet deposition. Morning thermal inversions are common, causing a morning PM_{10} peak. An afternoon PM_{10} peak is likely due to increased dust suspension and secondary aerosol formation, as predominant winds transport pollution from the NE industrial area to the city. Meteorological modeling shows that the valley is well-ventilated overnight, meaning that pollution is primarily due to same-day emissions. Ammonia exists in abundance, causing sulfate aerosol to be fully neutralized and allowing the formation of ammonium nitrate. Preliminary analysis suggests that 30% of the organic aerosol is secondary, appearing mainly during daylight hours.

The official emissions inventory attributes 40% of primary PM_{10} to dust, and 36% to transportation, mainly diesel trucks. This suggests that diesel vehicles are the largest sources of primary $PM_{2.5}$, and of carbonaceous particles. The inventory also reports that NO_X emissions are dominated by transportation, SO_2 by industry, and VOCs by services and transportation. The influence of sources outside of the valley is not well understood, but much of sulfate may be regional.

The contribution of organic and black carbon to $PM_{2.5}$ suggests that it is important to control primary emissions from diesel vehicles. SO_2 and NO_X emissions reductions are expected to effectively reduce $PM_{2.5}$, while NH_3 emissions reductions may be less effective. Proposed ecological actions to reduce windblown dust should be effective at reducing PM_{10}. Finally, creating an emissions inventory for primary $PM_{2.5}$ and implementing routine $PM_{2.5}$ measurements are clearly important recommendations.

[P01-06] CONCEPTUAL MODEL FOR PARTICULATE AIR POLLUTION IN LOS ANGELES.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 1: The NARSTO North American PM Assessment (8:30 PM-9:30 PM) Grand Ballroom 2-4

Airborne particulate matter and the processes that govern its formation in any given area can be described in a conceptual model that accounts for its sources, and chemical and meteorological processes. A conceptual model is a qualitative compilation of the physical and chemical processes that govern the formation of PM, which to the extent possible, is supported by quantitative information. These models describe the processes that affect emissions, transport and transformation and are used to identify the limiting processes, or those aspects of the PM problem, which if addressed will most effectively reduce the ambient mass or chemical concentration, for a given area or airshed. The elements of the model are: source characterization, chemical processes, physical processes (transport) and meteorological influences. Conceptual models when complete are used to: 1) define the important components of an air quality management strategy for effective control of PM concentrations by identifying limiting processes, 2) guide data collection to characterize important processes and to fill key knowledge gaps, and 3) point out where chemical transport models should be used to examine the likely opportunities to maximize multi-pollutant control opportunities and minimize potential co-pollutant.

In this paper, a conceptual model for particulate matter formation in Los Angeles will be presented. PM10 and PM2.5 monthly average concentrations (by species) will be presented for two annual average sampling periods: 1993 and 1998-99 at multiple locations in the Los Angeles area. Spatial and temporal trends for various PM components will be discussed, and underlying meteorological, emissions, and chemical influences will be identified. Recommendations then will be made about appropriate strategies to reduce airborne particulate matter concentrations to meet State and Federal standards.

[P01-05] NARSTO PM ASSESSMENT: RECOMMENDED RESEARCH TO INFORM PUBLIC POLICY.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 1: The NARSTO North American PM Assessment (8:30 PM-9:30 PM) Grand Ballroom 2-4

The NARSTO Particulate Matter Assessment addresses the state-of-science pertinent to managing particulate matter air quality in North America. Experts in the areas of health effects, atmospheric processing, emissions characterization, particle and gas measurements, spatial and temporal characterization, receptor methods, chemical transport models, and visibility and radiative balance effects synthesized what is known in those areas, and what additional knowledge is needed to provide information that would enable policy makers to make more informed decisions. This poster summarizes the consensus of the NARSTO authors regarding future research that is needed to inform public policy.

The recommendations for these science needs fall into five broad themes:

(1) The need to continue the development and evaluation of chemical transport models for particulate matter.

(2) The need to invest more resources in archiving, evaluating and synthesizing data from ambient measurements

(3) The need for a better understanding of carbonaceous aerosols.

(4) The need for long-term monitoring of mass, aerosol composition, gas phase precursors of secondary aerosols, copollutants, and size distributions. The importance of using measurement methods and sampling networks that facilitate comparison across national borders is emphasized.

(5) The need to refine emissions inventories and to develop more detailed emissions models.

These recommendations are interconnected, so work must be done in all areas at the same time. Therefore, the recommendations are not prioritized. The poster will provide a more detailed summary of each recommendation along with its policy rationale.

[P01-04] VISIBILITY EFFECTS DUE TO PM-2.5: IMPLICATIONS FROM THE NARSTO PM ASSESSMENT.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 1: The NARSTO North American PM Assessment (8:30 PM-9:30 PM) Grand Ballroom 2-4

NARSTO has completed an assessment of the scientific understanding of air pollution by particulate matter in Mexico, Canada, and the United States, including a review of the policy implications of that understanding. One component of the assessment addresses effects of PM-2.5 concentrations and chemical composition on visibility through the atmosphere, discusses current understanding of visibility effects in all three countries, and addresses approaches being taken to manage visibility.

Knowledge about spatial and temporal variability of visibility differs in the three countries and reflects the regulatory emphasis that has been placed on visibility in each. The United States has implemented a program for mitigating visibility impairment in national parks and wilderness areas. The geographic distribution of rural visibility and concentrations of the chemical components of PM are relatively well known and measurements have been made long enough to discern trends. Development of atmospheric models for evaluating the visibility effects of emission management strategies has advanced rapidly, but application of such models requires significant improvement in emission inventories for PM-2.5 and its precursors. Canada is addressing visibility, both rural and urban, in the context of the health-based Canada-Wide Standard for PM-2.5. While aerosol composition is not as well characterized in Canada, a recent assessment suggests that maintenance of air quality at the level of the Canadian standard will result in improvements in visibility in some eastern urban areas and degradation of visibility elsewhere. Mexico does not have a national program for managing visibility, but efforts to reduce ambient PM concentrations in urban areas will have beneficial effects on visibility. Visibility is used as an indicator of particulate air pollution trends in Mexico City, where visibility has decreased markedly over the past several decades.

Since visibility-impairing air pollution is a regional phenomenon that does not respect political boundaries, increased coordination of measurements and analyses among the three countries is essential if national goals are to be met. This will be facilitated by development of consistent, comprehensive emission inventories; measurements of the chemical components of PM by consistent methods; and continent-wide air quality modeling.

[P01-03] RECEPTOR METHODS: A REVIEW FOR NARSTO'S PARTICULATE MATTER ASSESSMENT.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 1: The NARSTO North American PM Assessment (8:30 PM-9:30 PM) Grand Ballroom 2-4

Receptor methods for source apportionment include a variety of approaches for interpreting measurements of the physical and chemical properties of ambient particles to infer their possible or probable sources and to quantify the contributions from these sources. In areas with a $PM_{2.5}$ or PM_{10} problem these techniques help identify possible solutions, especially when applied in a systematic fashion in combination with a detailed examination of the local emissions inventory and of the available observational data.

Also called "receptor models," receptor methods, use the differences in chemical composition, particle size, and concentration patterns in space and time to identify source types and to quantify source contributions that affect particle mass concentrations, light extinction, or deposition. Receptor models provide a theoretical and mathematical framework for quantifying source contributions. The goal of this presentation/poster is to summarize the contents and findings/recommendations reported in the receptor methods chapter (Chapter 6) of the recent NARSTO Particulate Matter Assessment.

The main recommendations of this chapter are that receptor methods should be part of a corroborative approach for source identification and that quantitative receptor modeling should be preceded by extensive semi-quantitative receptor-oriented data analyses. These analyses can provide useful insights regarding the sources or source regions influencing the PM concentrations in an area. They will also help develop or refine a conceptual model, which can help guide future studies, including application of source-oriented models (i.e., chemical transport models).

[P01-02] NORTH AMERICAN EMISSIONS INVENTORIES APPLICABLE TO MANAGEMENT OF AIRBORNE PARTICULATE MATTER (PM).

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 1: The NARSTO North American PM Assessment (8:30 PM-9:30 PM) Grand Ballroom 2-4

A part of the 2003 NARSTO PM Assessment concerns the current state-of-the-art of emission inventory development in North America. Emissions inventories serve a variety of needs, ranging from regulatory responses by government and industry to research on PM origins, and the health and environmental effects of PM. Examples of annual inventories at the national and local levels are compared for primary partricles, and for precursor gases, SO2, NOx, VOC and NH3. The major emissions categories are similar in all three countries, and derive largely from the historical evolution of development beginning in the 1970s. While the nationwide inventories of Canada and the U.S. have improved substantially for regulatory and modeling applications, the Mexican effort until recently has focused on the Valley of Mexico. Emissions characterization for research, including air quality modeling, has placed additional requirements for spatial, temporal and species resolution on inventories. These requirements are facilitated with emissions models coupled with air quality codes. Emissions models are complex mathematical treatments that require evaluation and validation, which generally is accomplished through comparison with ambient data and specialized source testing. The uncertainties and limitations in inventories are noted. Uncertainties are attributable both to the paucity and aggregation of direct measurements characterizing different sources, and to methodology for deriving emissions. The uncertainties in PM components appear to be highest for ammonia, carbon constituents and fugitive components such as soil dust. The three nations are working closely to develop methods and analyses to reduce uncertainties in the current inventories.

[P01-01] THE NARSTO NORTH AMERICAN PM ASSESSMENT: CHAPTER 6 - SPATIAL AND TEMPORAL CHARACTERIZATION OF PARTICULATE MATTER.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 1: The NARSTO North American PM Assessment (8:30 PM-9:30 PM) Grand Ballroom 2-4

Geographical and temporal variations of the concentration and composition of particulate matter provide important insights into the processes that influence particle formation and distribution. This presentation summarizes the findings of Chapter 6 of the NARSTO North American PM Assessment. Spatial patterns of PM concentration and composition in Canada, the United States, and Mexico are discussed, with consideration given to spatial variations over distance scales ranging from a few to over 1000 km. Trends, and their detectability, are considered for periods of 10 to 50 years. The principal conclusions of interest to PM management are:

(1) The composition of $PM_{2.5}$ varies with region and locale. Sulfates and organic carbon are relatively abundant in eastern North America; the contribution of nitrates increases in winter, when low temperatures favor the condensed phase. Organic carbon and nitrates are abundant in much of California.

(2) Forest fires or biomass burning can contribute significantly to local particulate mass concentrations. Satellite images and measurements of composition can be used to determine periods when such fires are significantly affecting PM concentrations. Intercontinental transport of dust from Asia or Africa occurs but does not contribute significantly to annual average concentrations of particulate mass concentrations in North America. It occasionally contributes significantly to 24-hour average concentrations.

(3) In both eastern and western North America, local emissions lead to urban fine PM concentrations that are typically ~25% higher than fine PM concentrations at nearby nonurban sites.

(4) $PM_{2.5}$ concentrations in eastern North America tend to reach their highest values during summer, when high relative humidities and solar radiation favor the formation of sulfates from regional sulfur dioxide emissions, while in Mexico PM_{10} concentrations reach their maxima during the dry period from November through May.

(5) Relatively coarse spatial and temporal resolution is typically adequate to describe regional pollutant distributions. For locally emitted pollutants or pollutants that vary diurnally due to photochemical production or variations in temperature and relative humidity, measurements must be made with much higher spatial and temporal resolution.

(6) Long term measurements (typically 10 years) are required to assess trends. Comprehensive measurements of the multipollutant mixture are needed to understand relationships between emissions, ambient concentrations, and effects.

[P03-08] META ANALYSIS OF DUTCH INHALATION TOXICITY STUDIES WITH CONCENTRATED PARTICULATE MATTER IN COMPROMISED RATS.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:30 PM-9:30 PM) Grand Ballroom 2-4

Ambient particulate matter (PM) can be seen as a complex mixture of fractions with greater and with lesser health relevance. The most efficient and cost-effective reduction of health effects will be achieved by reducing the most toxic part of PM. Although significant progress has been made over the past few years, there are currently only suggestions for the causal fractions, as they have not yet been identified. Studies with concentrated ambient PM0.15-2.5 (CAPs) have been performed in experimental animals since 1998. This paper will present an overview on the only CAPs studies performed in Europe.

Experiments were focussed on 1-day inhalation exposures in healthy and compromised rats thereby mimicking possible human risk groups primarily focussing on pulmonary inflammation and blood hypertension. Studies have been performed in an industrialized area in the city of Utrecht as well as a location that is strongly dominated by freeway emissions. It was hypothesized that exposure to CAPs resulted in an oxidative stress, which subsequently induces (pro) inflammatory mediators, endothelium damage and blood viscosity, supporting the plausibility of PM induced cardiovascular effects. The effects of CAPs exposures were studied two days post exposure focussing on pathology and cell proliferation, bronchiolar lavage analysis (including cytokines, cell viability and proliferation, Clara cell protein CC16), and blood analyses (endothelines, fibrinogen, cell differentials). There is no PM mass concentration-effect relationship for the investigated parameters. Inhalation up to 2000 ug CAPs/m3 did not induce severe toxic or pathological effects in the lung. Cell proliferation (BrdU-labeling of predominantly Clara cells in the terminal bronchioles) is frequently increased after exposure to CAPs, as well as indicators for oxidative stress in the lungs. Signs of PM being able to cause adverse effects in both healthy and compromised animals and humans are emerging. The available evidence from CAPs exposures studies in healthy and compromised animals advocates that PM mass concentrations are not evidently correlated with the adverse health effects. This suggests that other metrics might be more appropriate, like chemical composition or physical properties.

[P12-08] ON HEALTH RISKS OF AMBIENT PM IN THE NETHERLANDS.

Editors: Eltjo Buringh, Antoon Opperhuizen, Authors team: Aben, J.;Ameling, C.B.; Beck, J.; Boere, A.J.F.; Breugel, P.B. van;, Brink, H.M. ten; Brink, R.M.M. van den; Buijsman, E.; Brunekreef, B.;, Buringh, E.; Cassee, F.R.; Dekkers, A.L.M.; Dolmans, J.; Eerens, H.C.;, Fischer, P.H.; Harmelen, A.K. van; Keuken, M.P.; Kooter, I.M.; Loon, M. van; Loon,, W. van; Loveren, H. van; Marra, M.; Matthijsen, J.; Noordijk, H.; Opperhuizen, A.;, Schaap, M.; Schlesinger, R.B.; Slanina, J.; Smeets, P.;, Smeets, W.L.M.; Spoelstra, H.; Steerenberg, P.A.; Visschedijk, A.J.H.;, Visser, H.; Vries, W.J. de; Weijers, E.; Winter, R. de; , National Institute of Public Health and the Environment, Bilthoven, Netherlands; Netherlands Aerosol Programme, Coordinated by NOVEM, Utrecht, Netherlands

Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 12: Integrating Epidemiology, Toxicology, and Human Clinical Studies (8:30 PM-9:30 PM) Grand Ballroom 2-4

There are significant associations between particulate air pollution (PM) and mortality and morbidity in time-series studies. However, the causal factors within this complex mixture are not yet clear. It is recommended that PM10 be retained as a standard for the time being, as it covers effects of both fine and coarse particles. In view of the emerging evidence implicating fine particles in health effects, it is recommended to develop a standard for fine PM and/or a source related fraction as well.

Even with PM concentrations well below the European Union (EU) standards, there will be an impact on health because no threshold has been found for the occurrence of health effects. PM is a complex mixture containing fractions that are to a greater or lesser extent health-relevant. This differentiation in potency has profound implications for an efficient reduction of health impacts when abating PM emissions.

PM abatement can be justified with the precautionary principle. Further source- oriented actions could focus on reduction of the total PM10 aerosol mass or could first of all focus on those PM fractions that are expected to be more health-relevant. This last option is preferred. These fractions are probably transport-related (diesel soot) and, more generally, combustion-related primary PM emissions. Abatement should therefore focus on such sources. In this respect, the abatement of uncontrolled shipping emissions has been identified as one of the more cost-effective control options. Abatement of other combustion sources such as industrial combustion, wood burning in fireplaces and off-road machinery are also possible, but less cost-effective.

Compliance with the yearly average EU standard seems feasible for PM10 in the Netherlands in 2005, although local exceedances at ‘hot spots’ cannot be ruled out. Compliance in 2005 of the EU daily standard is not possible everywhere. Compliance in 2010 with the indicative EU standards of 20 μg/m3 as annual average or 7 daily exceedances of 50 μg/m3 is not feasible, even at high cost.

[P12-03] THE USE OF EXHALED NITRIC OXIDE AS A NON-INVASIVE MEASURE OF INFLAMMATION IN OLDER SUBJECTS WITH CARDIORESPIRATORY DISEASE.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 12: Integrating Epidemiology, Toxicology, and Human Clinical Studies (8:30 PM-9:30 PM) Grand Ballroom 2-4

Nitric oxide is known to play a pivotal role in biological inflammation. Recently methods for exhaled nitric oxide (eNO) collection have been shown to be useful for documenting airway inflammation. As part of a large exposure assessment study in Seattle, eNO was measured in 12 older adult subjects with cardiorespiratory disease during the winter of 2001-2002. An exhaled breath sample was collected daily from each subject in her/his home over 5 days during potentially high PM periods. An offline collection device scrubbed ambient NO from the inhaled air and provided flow restriction on exhaled breath to prevent contamination by nasal NO. Flow rate was not controlled. The samples were analyzed within 24 hours of collection using an API chemiluminescent nitrogen oxides monitor. The range of concentrations of eNO in subjects with cardiovascular disease (CV) (n=8) was between 5.2 and 66 ppb (mean ± SD = 22.3 ± 13.5 ppb). The range of concentrations of eNO in subjects with chronic obstructive pulmonary disease (COPD) (n=4) was between 6.1 and 51 ppb (mean ± SD = 17 ± 10 ppb). $PM_{2.5}$ was measured using Harvard personal environmental monitors, at the subjects' residences with Harvard impactors (indoors and outdoors), and at a central site with an FRM monitor. For this analysis, the central site 24 hour average of $PM_{2.5}$ from the previous day was used. The results were analyzed using a linear mixed effects model with random intercept controlling for age and temperature to test for within subject associations between eNO and $PM_{2.5}$. A 10 $\mu g/m^3$ increase in $PM_{2.5}$ was associated with a 11.4 ppb increase in eNO (p=0.018; 95% CI: 1.93, 20.93) in the CV subjects. No significant associations were seen in the COPD subjects. This research was supported by Grant # R 827355 (EPA) and # PO ES 07033(NIH).

[P03-05] EFFECTS OF CONCENTRATED FINE AMBIENT PARTICLES ON RAT PLASMA LEVELS OF ASYMMETRIC DIMETHYLARGININE.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:30 PM-9:30 PM) Grand Ballroom 2-4

Background and Aim: The health effects of fine ambient particulate matter ($PM_{2.5}$) and its potential impact on vascular endothelial function have not been thoroughly investigated. As endothelial dysfunction plays an important role in atherosclerosis and cardiovascular disease, we examined the effects of concentrated fine ambient particles (CAPs) on the plasma levels of asymmetric dimethylarginine (ADMA) in a pilot study. ADMA is an endogenous inhibitor of nitric oxide synthase that is associated with impaired vascular function and an increased risk of cardiovascular events.

Methods: A mobile air research laboratory (AirCARE 1), equipped with whole body inhalation chambers and a Harvard type ambient fine particle concentrator, was used in the study. AirCARE 1 was designed and constructed collaboratively by Michigan State University and the University of Michigan. The CAPs exposures for this study were conducted in the urban community of southwest Detroit. Fourteen Brown Norway rats were exposed to filtered air (FA) (n=7) or CAPs (0.1-2.5 μm) (n=7) for 3 consecutive days (8h/day) in July, 2002. Rats were exposed during these periods to average particle mass concentrations of 367 $\mu g/m^3$. Rat plasma samples were collected 24h post-exposure.

Results: Plasma concentrations of ADMA were significantly elevated in the rats exposed to CAPs versus those exposed to FA (1.49 ± 0.18 vs 1.29 ± 0.26 μM, $p \leq 0.05$ by 1 tailed t-test).

Conclusion: Fine particulate air pollution exposure at high concentrations triggers an acute increase in circulating ADMA level. This could potentially cause impaired vascular endothelial function and enhance the risk for cardiovascular disease.

[P03-06] CARDIOPULMONARY EFFECTS OF ASIAN DUST EVENT IN DISEASE ANIMAL MODELS.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:30 PM-9:30 PM) Grand Ballroom 2-4

To investigate the health effect of Asian dust event, we used two animal models to evaluate the cardiopulmonary toxicity of concentrated ambient particles (CAPs) of Asian dust event on March 18 and 19, 2002 in Taiwan.

MCT pulmonary hypertensive rats were used to examine inflammation markers in the lung and peripheral blood, and DNA damage in peripheral blood after exposure to CAPs of dust storm. Eight rats were exposed to CAPs generated by a particle concentrator by nose-only inhalation exposure system during dust storm (n=4 for 315.6 ug/m3; n=4 for 684.5 ug/m3), and four rats as controls were exposed to room air. Inflammation markers in peripheral blood and bronchoaleolar lavage were analyzed. Whole blood was collected to analyze the DNA single strand breakage in leukocyte using comet assay in CAPs (n=8) and room air (n=4) exposed groups.

Spontaneously hypertensive rats (SHRs) were used to investigate the hemodynamic changes. After implanted with radiotelemetry, three were exposed to CAPs (315.6 ug/m3, 6hr) and two were exposed to room air. Hourly averaged heart rate and blood pressure were compared between CAPs and room air groups. Further, heart rate and blood pressure of these CAPs exposed rats were compared between Asian dust event period and non-Asian dust event period for adjusting inter-individual differences. Elemental components were determined using XRF. Main component were silica and aluminum (53.3 and 14.0μg/m3).

In pulmonary hypertensive rats, WBC counts in peripheral blood, total cell and the proportion of neutrophil in BAL increased with CAPs levels ($p<0.05$). Positive dose-response relationship between CAPs exposure and total protein, LDH activity and IL-6 were observed ($p<0.05$, test for trend). In the evaluation of single strand DNA breakage, CAPs group demonstrated higher percentage of tail intensity then room air group ($p<0.05$) and similar finding was also observed for the tail moment ($p=0.08$). SHR exposed to CAPs have higher heart rate than those exposed to room air ($p<0.05$). Heart rate of these CAPs exposed rats was higher during dust event than that during the corresponding hours of non-Asian dust event ($p<0.05$). However, blood pressure was not significantly between CAPs and room air exposed groups.

Our results revealed that exposure to CAPs during Asian dust event could cause lung inflammation and injury, and DNA damage in peripheral blood in pulmonary hypertensive rats. Heart rate in SHRs also increased after CAPs exposure. We conclude that CAPs of dust storm may cause adverse cardiopulmonary outcome. The component of particles leading to the toxicity need further study.

[P12-07] AIRNET - THEMATIC NETWORK ON AIR POLLUTION AND HEALTH IN EUROPE.

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AIRNET was initiated within the Quality of Life and Management of Living Resources programme of the European Commission (QLRT-2001-00441, Key Action 4, Environment and Health) to develop an European-wide framework for air pollution and health research to strengthen the science-policy interface and to integrate information from individual projects. Apart from its function as a Network project, the focus and output of AIRNET is harmonised with focus of the EU Clean Air For Europe (CAFE) programme (http://www.europa.eu.int/comm/environment/air/cafe.htm). This programme has been initiated by EU Commission to strengthen their air pollution policy, based on the best available science and created in a broad, open, and transparent dialogue with a scientific community, as well as the public and the stakeholders. The specific AIRNET objectives are:

• Develop an information, interpretation and communication framework for the results of research of EU-funded as well as nationally supported studies

• Function as a Thematic Network project including researchers, regulatory bodies, stakeholders, and public and professional organisations

• Link the findings from exposure assessment, epidemiology, toxicology, risk and health impact assessment, to build and strengthen a science-policy interface (the project includes separate working groups targeting on these issues)

• To provide comprehensive views and reports on risk assessment and risk management of air pollution that supports more effective and cost-efficient air pollution control policy and decision-making in Europe.

AIRNET consists of co-ordinators and additional key investigators of EU funded projects of the 4th and 5th Framework Programmes, key investigators of non-EU funded major recent or ongoing studies on air pollution and health. In addition, WHO and UN ECE representatives, policy makers at EU and national levels, representatives of the automotive, oil, gas and metal industries, as well as key consumer organisations and environmental NGOs are also participating. The (net)working structure of AIRNET is Working Groups, Annual Conferences, and Website information (http://airnet.iras.uu.nl).

Current activities, workplans of the working groups, as well as the contributions to the EU air pollution control strategy will be presented.

[P12-06] HEPMEAP - AMBIENT PM10 AND PM2.5 AND THE ROLE OF MOTOR ENGINE EMISSIONS - THE FIRST EUROPEAN HYBRID APPROACH LINKING AIR QUALITY, TOXICOLOGICAL, AND EPIDEMIOLOGICAL INFORMATION.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 12: Integrating Epidemiology, Toxicology, and Human Clinical Studies (8:30 PM-9:30 PM) Grand Ballroom 2-4

PM fractions or components responsible for adverse health effects associated with ambient particulate matter (PM) exposure still remain largely unknown. This uncertainty seriously limits PM risk assessment and standard setting as well as identifying of cost-effective emission source and risk control measures. Clean air legislation has resulted in significant reductions of certain emissions and in improvement of air quality. However, the volume of traffic has increased substantially, and despite improvements in engine technology the total amount of emissions from the current number of automobile engines has increased significantly, especially the amount of particles related to diesel engines. Remarkably, an increasing number of health effects studies show positive associations between traffic-related air pollution indicators and adverse health effects, including increased morbidity and premature mortality.

The EU-funded HEPMEAP project (QLRT-1999-01582; http://www.hepmeap.org) therefore focuses on the role of traffic exhaust emissions in PM-related toxicity and health effects and is the first integrated approach where air quality and toxicological/epidemiological disciplines work closely together.

The overall objectives of HEPMEAP are:

1. to assess the (human-)toxicity potency (in vitro, in vivo) of ambient PM10 and PM2.5 collected at places across Europe with contrasts in traffic intensity (using ISAAC-2 network of epidemiological studies), as well as from ambient sites with high (tunnel site)and low (marine and rural sites) traffic exhaust emissions, and to compare this with diesel and gasoline exhaust PM,
2. to characterise the (chemical) properties of all these particles, and,
3. to determine the PMsize/composition-PMtoxicity-PMhealth effects relationships and the role of traffic exhaust PM emissions.

The PM sampling campaign across Europe has now been completed and the chemical characterisation is ongoing. Toxic potency is currently analysed, including the chamber studies with human volunteers. An overall analysis plan has been developed to determine the relationships and to assess the traffic emissions' impact. The first results of this study will be presented.

[P03-09] EFFECTS OF CONCENTRATED AMBIENT PARTICLES ON HEMODYNAMIC PARAMETERS IN SPONTANEOUS HYPERTENSIVE RATS.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:30 PM-9:30 PM) Grand Ballroom 2-4

Epidemiological studies have shown that increased concentration of ambient particles is associated with cardiovascular morbidity and mortality. However, the exact mechanisms remain unclear. Recent studies have revealed that particulate air pollution exposure is associated with indicators of autonomic function including heart rate (HR), blood pressure (BP), and heart rate variability (HRV). However, this association has not been clearly demonstrated in animal studies. To overcome the problems of wide variations in diseased animals and circadian cycles, we have developed a novel approach using mixed-effects model to investigate whether ambient particle exposure was associated with the changes of HR, BP, QA interval (QAI), and HRV in diseased animals. QAI reflects the ventricular contractility, anwas calculated to represent HRV. In this study, spontaneously hypertensive rats were implanted with radiotelemetry and exposed to concentrated ambient particles generated by an air particle concentrator developed by Sioutas et al. Four rats were held in nose-only exposure chambers for 6 hours per day exposing to concentrated particles for 2-6 times and filtered air for 2-5 times in the periods of February-March and June-July, 2002. The particle number concentrations for tested animals ranged between 7-46x104/m3 in February-March and 13-40x104/m3 in June-July. Statistical analysis using mixed-effects models revealed that particle exposure was associated with changes in HR, BP, and QAI after particle exposure, the hourly-averaged heart rate increased for a maximal of 53 beats per minute in the period of February-March ($p < 0.01$) and 38 beats per minute in the period of June-July ($p < 0.01$). The hourly-mean blood pressure also increased after the particle exposure for a maximal of 11 mmHg ($p < 0.01$) in February-March but not in June-July. QAI was found to decrease after PM exposure in the periods of February-March and June-July. These changes of HR, BP and QAI were observed during the particle exposure, then returned to the baseline within 2-3 hours after the end of exposure. The results of the particle effects on SDNN will be presented in the meeting. Our findings suggest that ambient particles may induce alterations in the autonomic nervous function.

[P12-05] IS PM MORE TOXIC THAN THE SUM OF ITS PARTS? DISCORDANCE BETWEEN "EFFECT FUNCTIONS" FOR PM MASS *VS.* RISK-ASSESSMENT TOXICITY FACTORS.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 12: Integrating Epidemiology, Toxicology, and Human Clinical Studies (8:30 PM-9:30 PM) Grand Ballroom 2-4

PM impact analyses use linear "effect-functions" that relate ambient PM mass concentration to increments in disease and death rates. A key assumption is that generic PM causes increments in mortality and morbidity. For each "effect-function," the impact analyses assume all varieties of PM have identical potency, regardless of PM physical or chemical form. Unlike risk assessment, where personal exposure is estimated, the impact analyses utilize PM levels reported as daily or annual averages at central monitoring locations. Unlike established risk-assessment procedures for non-cancer endpoints, where no-effect thresholds for sensitive populations are identified, the impact analyses assume that any increase in PM mass (as recorded at central monitors) will quantitatively result in increases in death and a variety of diseases. Such predictions for generic PM disagree with the absence of health effects predicted for equivalent concentrations of a wide range of chemicals, many of which are constituents of PM. We examined chemical-specific health-effects data available in a broad range of sources (IRIS, HEAST, DWCD, HSDB, ACGIH, NIOSH, and ATSDR). In these sources, we were unable to find chemicals likely to be present in outdoor PM that would, for example, lead to mortality at ambient PM concentration levels. Available data indicate that the major constituents of ambient PM (sulfate, nitrate, and elemental carbon) have limited toxic potential, even at occupational concentrations. Reference concentrations (RfC's) and unit risk values (UR's) for chemicals of known toxicity are not in accord with the RfC's and UR's that would be predicted for PM constituents from epidemiologic associations. Hence, the predictions of impact analyses appear to be at odds with results that would be projected by a standard health-risk-assessment approach. The resolution to this paradox may be that (1) the mixtures of chemicals present in ambient PM are vastly more toxic than the sum of individual components, (2) small portions of the general population are vastly more sensitive to certain ambient PM chemicals than currently appreciated, or (3) generic PM *per se* is not the causal factor in the epidemiologic associations underlying the "effect functions." The unexpectedly high level of toxicity per unit PM mass suggested by epidemiologic associations may instead be due to unmeasured co-pollutants (*e.g.*, HAPs), residual confounding by weather variables, or confounding by unmeasured societal, behavioral, or stress factors.

[P12-04] FINE PARTICULATE ($PM_{2.5}$) AIR POLLUTION EXPOSURE AND PULMONARY FUNCTION IN AN ADULT POPULATION.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 12: Integrating Epidemiology, Toxicology, and Human Clinical Studies (8:30 PM-9:30 PM) Grand Ballroom 2-4

Studies have shown increased morbidity and mortality in susceptible individuals associated with ambient levels of particulate matter (PM). We studied adults >50 years of age with and without chronic obstructive pulmonary disease (COPD) or cardiovascular disease (CVD) from the first two years of a continuing study of PM exposure in Seattle, Washington. Personal $PM_{2.5}$ measurements were made with Harvard personal exposure monitors, while indoor and outdoor $PM_{2.5}$ levels at subjects' homes were collected with Harvard Impactors (HI) during ten consecutive 24-hour periods. Seattle area central site TEOM measurements were collected from three sites and an average daily (24 hour) value was computed. During the 10-day monitoring period, coached FEV_1 measurements were obtained from subjects at each daily home visit using VM+ portable spirometers. Associations between changes in FEV_1 and $PM_{2.5}$ measurements were evaluated using mixed-effects random intercept regression models to test for a within-subject effect of $PM_{2.5}$ exposure on FEV_1. Models were adjusted for time of year, temperature, relative humidity, age, gender, height, weight, body mass index, and anti-inflammatory pulmonary medication use. Subjects were stratified by health status: normal (n=14), COPD (n=30), CVD (n=31). Overall mean age was 77 years (range 57-92 yrs). In subjects without reported COPD or CVD, we observed a decrement in FEV_1 of 107ml (95%CI: [-206, -7]; 123 observation days) for a $10ug/m^3$ increase in Seattle area central site $PM_{2.5}$ values. Similar results [-82ml (95%CI: [-169, 4]; 121 observation days)] were obtained using local outdoor $PM_{2.5}$ measurements, but not for indoor or personal $PM_{2.5}$ measurements. No significant association between same day $PM_{2.5}$ exposure and coached FEV_1 was observed among subjects with COPD (271 observation days) or CVD (284 observation days). Funded by: EPA Grant R827355 (NW PM Research Center) & Cooperative Agreement #R82717701 (This abstract does not necessarily reflect EPA policy.)

[P02-04] A CASE CROSSOVER ANALYSIS OF PARTICULATE AIR POLLUTION AND CARDIAC ARRHYTHMIA IN PATIENTS WITH IMPLANTABLE CARDIOVERTER DEFIBRILLATORS.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:30 PM-9:30 PM) Grand Ballroom 2-4

We investigated the relationship between air pollution and cardiac arrhythmia in a study of patients with implantable cardioverter defibrillators (ICDs). Thirty-four patients (ages 15-85, 80% male) with ICDs residing in the Vancouver area were included in the analyses, representing all patients attending the two ICD clinics in the study region who had recorded at least one ICD discharge during the February 14 to December 31, 2001 study period. Air pollutant ($PM_{2.5}$, PM_{10}, SO_4^{2-}, elemental carbon [EC], organic carbon [OC], O_3, SO_2, NO_2 and CO) concentrations on days with ICD discharges ('case days') were compared to control days (7 days before and after each case day) in case crossover analyses. ICD discharges occurring within 72 hours of one another were grouped and considered as one discharge event-day. Temperature, relative humidity, barometric pressure, rainfall and windspeed were included simultaneously as covariates. Sensitivity analyses were conducted to examine the effect of grouping ICD discharges, of including meteorological variables, and including/excluding discharges that were considered inappropriate by a cardiologist. As in previous studies, mean concentrations and interquartile ranges of air pollutants in Vancouver were low. Although in general there were no statistically significant results, there were consistent trends indicating associations between pollutants and ICD discharges. Odds ratios (OR) were consistently higher in summer (7 of 9 were > 1) than in winter (only 1 of 9 > 1) and the highest ORs were observed for lag 0. While an OR of 1.5 (0.51 -4.7) was found in summer at lag 0 for PM_{10}, no indications of associations were observed for $PM_{2.5}$ or SO_4^{2-}. For local combustion-source pollutants, EC, OC, CO and SO_2, ORs were elevated above 1 at all lags (0-3 days) in summer. These findings suggest a weak association between summertime combustion-source primary air pollutants and cardiac arrhythmia.

[P07-22] INTECOMPARISON OF SEMI-CONTINUOUS PARTICULATE SULFATE AND NITRATE MEASUREMENT TECHNOLOGIES AT A NEW YORK STATE URBAN AND RURAL LOCATION.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

Two intensive field measurement campaigns have been performed as part of the PM2.5 Technology Assessment and Characterization Study (PMTACS-NY). The first, an urban campaign, operated on the campus of Queens College, CUNY, Queens NY during the Summer 2001 and the second, a rural campaign at Whiteface Mountain, NY, a rural site located in the northern part of Adirondack Mountains during the Summer 2002.

One of the objectives of PMTACS-NY program is to study and evaluate semi-continuous PM-2.5 chemical speciation measurement technologies. To this end several semi-continuous PM2.5 sulfate and nitrate instruments were deployed and operated side-by-side during the field intensive campaigns. The instruments included a Rupprecht and Patashnick Ambient Particulate Sulfate and Nitrate Monitors (8400S and 8400N), an Aerodyne Research, Inc. Aerosol Mass Spectrometer (AMS), a Particle-into-Liquid Sampler with IC developed at Georgia Institute of Technology (PILS-IC) and a Continuous Ambient Sulfate Monitor developed by George Allen at Harvard School of Public Health (CASM).

The performances of these instruments are compared and contrasted for these two distinctly different environments, as are the semi-continuous particulate sulfate and nitrate mass concentration measurements. In addition, comparisons of the semi-continuous sulfate measurements with 24-hr filter based measurements are presented and assessed in terms of the effects of local environmental variables on observed instrument biases.

[P11-09] MODELING PHOTOCHEMISTRY AND AEROSOLS IN POLLUTANT PLUMES WITH THE CMAQ PLUME-IN-GRID APPROACH.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 11: Air Quality Modeling (8:30 PM-9:30 PM) Grand Ballroom 2-4

Significant emissions of NOx and SOx are released into plumes emanating from the tall stacks of point sources, such as isolated power plants. These primary species are important precursors of a variety of secondary pollutants, including ozone and aerosol species. However, important characteristics of point sources plumes are their initially small dimensions and their finite growth rates downwind due to meterological processes. Since the traditional Eulerian grid model method is to instantly mix point source emissions into a large grid cell volume, considerable artificial dilution can occur which adversely impacts chemical and aerosol processes. The plume-in-grid (PinG) approach integrated into the EPA Community Multiscale Air Quality (CMAQ) grid modeling system was specifically designed to provide a realistic treatment of the physical and chemical processes affecting pollutant concentrations in major point source plumes. The PinG method simulates the gradual horizontal and vertical expansion of subgrid scale plumes and more properly treats the chemical evolution in individual plume cells during the subgrid scale phase within a CMAQ Chemical Transport Model (CCTM) simulation.

The PinG treatment has been extended with the incorporation of the same aerosol module being applied in the CCTM grid model, which allows gas-phase chemistry and aerosol processes to be performed concurrently in the PinG submodel. The aerosol module employs a modal approach with the size distribution defined by Aitken, accumulation, and coarse modes. The fine aerosol mass for secondary species, including sulfate, nitrate, ammonium, and organics from anthropogenic and biogenic sources are determined. Simulations have been performed for a group of major point sources exhibiting a range of NOx, SOx, and particulate emission rates located in the region surrounding Nashville, TN during summer periods from the Southern Oxidant Study (SOS) experimental studies in 1995 and 1999. Model runs were conducted with two different chemical mechanisms (Carbon Bond IV and RADM2) and two different chemical solvers (QSSA and SMVGEAR) to explore the impact on aerosol species concentrations. Comparisons of model results for selected gas species and aerosol concentrations will be examined against plume data obtained by research aircraft traverses across plumes. Initial results are encouraging as the evolution of ozone and aerosol sulfate appears to agree with emerging plume data. More fine sulfate was generated in the SO2-rich plumes which exhibited lower NOx emission rates than in plumes containing greater NOx levels.

[P03-18] COMPOSITION MATTERS: INVESTIGATION OF TOXIC POTENCY VERSUS CHEMICAL COMPOSITION IN MOTOR VEHICLE EMISSIONS.

Jacob D. McDonald, JeanClare Seagrave, Barbara Zielinska, Kevin Whitney, Ingvar Eide, Joe L. Mauderly Toxicology, Lovelace Respiratory Research Institute, Albuquerque, NM; Atmospheric Sciences, Desert Research Institute, Reno, NV; Engine Emissions, Southwest Research Institute, San Antonio, TX; Statoil, Stavanger, Norway

Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:30 PM-9:30 PM) Grand Ballroom 2-4

Exposure to engine exhaust has been linked to adverse health effects. However, little is known about the effect of different engine types, operating conditions, fuels, technologies, and emission chemical composition on the relative toxic potency of vehicular emissions. To this end, a study was conducted with the aim of evaluating the relative mutagenic, cytotoxic, and inflammatory potencies of particulate matter (PM) and semi-volatile organic compound (SVOC) co-pollutant emissions collected from a range of different vehicle types operating under varying conditions. The vehicles included normal- and high-emitter gasoline and diesel passenger vehicles operated at 72°F, and normal-emitter groups operated at 30°F. Emissions were characterized for over 150 different chemical components, including carbon (organic/elemental), inorganic ions, metals and other non-metal elements, and several classes of speciated organics including polycyclic aromatic hydrocarbons (PAH), oxygenated/nitrated PAH, and hopanes/steranes. All samples induced bacterial mutagenicity, and the highest mutagenic potency was observed from diesel exhaust at 30°F. This same vehicle operated at 72 ° F yielded ~5 times less mutagenicity. The former sample contained a larger relative portion of organic carbon and higher amounts of the more complex higher molecular weight PAH. Intratracheal instillation of rats with the combined PM+SVOC demonstrated that cytotoxic and inflammatory potencies per unit mass were similar for normal-emitter gasoline and diesel vehicles, and for emissions collected at different temperatures. However, equivalent masses of emissions from high-emitter diesel and gasoline vehicles were more potent than those from normal-emitters. These higher emitting vehicles generally contained higher relative proportions of particle bound organic carbon, average to lower metal contents, lower relative proportions of PAH compounds, and higher proportions of the hopane/sterane compounds. Since the hopane/sterane compounds are components of oils, and the PAH compounds are formed during combustion, the observed proportions of these components in these high emitter samples suggest that emissions with higher proportion of unburned lubrication oil cause greater *in vivo* cytotoxic and inflammatory responses. *Supported by the Office of Heavy Vehicle Technology, US. Department of Energy.*

[P11-01] INORGANIC AEROSOL THERMODYNAMIC MODEL WITH N(III).

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 11: Air Quality Modeling (8:30 PM-9:30 PM) Grand Ballroom 2-4

Heterogeneous reactions are generally taken as the major formation mechanisms of atmospheric nitrous acid. The concentrations of nitrous acid in the South Taiwan are 0.16~ 18.3 $\mu g/m^3$ and those of nitric acid are 0.14~13.6 $\mu g/m^3$. Thus, the concentrations of nitrous acid are greater than those of nitric acid in Taiwan. Although the concentrations of nitrite have been measured in many studies, there are few studies including nitrite and nitrous acid in aerosol model development and application. Because of the importance of nitrous acid and particulate nitrite, the purpose of this study is to establish an aerosol thermodynamic model with nitrous acid and nitrite.

In this aerosol thermodynamic aerosol, Pitzer method and Bromley method are used to estimate binary activity coefficients and multi-component activity coefficients, respectively. ZSR relationship is used to calculate the aerosol water content. The species in this model include aqueous phase species (K^+, Na^+, Ca^{2+}, Mg^{2+}, NH_4^+, Cl^-, NO_2^-, NO_3^-, SO_4^{2-}, CO_3^{2-}, H^+) and gaseous phase species (HCl, HNO_3, HNO_2, NH_3). Atmospheric gaseous species and $PM_{2.5}$ samples were collected at Annan in southern Taiwan. Gaseous species (HCl, HNO_3, HNO_2, NH_3) were collected using annular denuder system and filter pack was used to collect particles. The samples were then analyzed by ion chromatography to determine the concentrations of Cl^-, NO_2^-, NO_3^-, SO_4^{2-}, K^+, Na^+, Ca^{2+}, Mg^{2+}, NH_4^+, .

The average concentrations and standard deviations of gaseous HNO_2, HNO_3, NH_3, particulate (<2.5 μm) NO_3^- and NH_4^+, NO_2^-, SO_4^{2-}, Na^+ were 4.5(±2.6), 1.6(±2.3), 22.1(±9.62), 0.7(±0.4), 3.0(±2.0), 0.64(±0.76), 7.3(±3.8), 0.29(±0.16) $\mu g/m3$, individually. Meteorological conditions were humid with relative humidity from 74%~84% and temperatures were between 297.2 K~302.2 K during sampling. Note that the concentrations of nitrous acid were greater than those of nitric acid. Nitrous acid may be important than nitric acid at this site.

The measurements of nitrous acid and nitrite($PM_{2.5}$) were used to evaluate this thermodynamic model. The measured and simulated results of nitrous acid are in good agreement. The average relative error, defined as [simulated-measured]/measured, was 0.185 and the correlation coefficient was 0.937. The acidity of HNO_3 is much greater than that of HNO_2. Therefore, more HNO_2 volatilizes into gaseous phase while most of HNO_3 remains within aerosol.

Aerosol thermodynamic model that include nitrite/nitrous acid has been established in this study. The measured and simulated results are in good agreement. Due to the weaker acidity of nitrous acid, the concentrations of nitrite are lower than those of nitrous acid.

[P11-02] PERFORMANCE EVALUATION OF MULTI-PHASE INORGANIC AEROSOL THERMODYNAMIC MODULE: UHAERO.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 11: Air Quality Modeling (8:30 PM-9:30 PM) Grand Ballroom 2-4

Over the past decade, several atmospheric aerosol thermodynamic modules predicting the equilibrium partition of inorganic compounds have been developed. The most popular modules are SCAPE2 and ISORROPIA. These models have been used in a number of studies for the analysis of ambient measurements. However these models rely on a priori knowledge of the presence of components in certain relative humidity, and often fail to accurately predict delequescence point depression in the multi-phase aerosol growth. The present approach, relying on the Extended UNIQUAC activity coefficient model, incoperates the TABLEAU analysis and Newton-type active-set method to determine the right set of governing equations automatically given temperature, relative humidity and the total ammonia, nitric acid, sulfate, sodium and hydrochloric acid. The comparison is conducted between our approach and available experimental results. The current model agrees with experimental results for single salt systems. For multi-component systems, our model reproduces observed multi-stage growth patterns and deliquescence point depression.

[P11-03] USE OF HIGH-TEMPORAL-RESOLUTION PM DATA FOR MODEL PERFORMANCE EVALUATION.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 11: Air Quality Modeling (8:30 PM-9:30 PM) Grand Ballroom 2-4

Speciated, high-temporal-resolution particulate data available from the SouthEastern Aerosols Research and CHaracterization Study (SEARCH) and concurrent monitoring programs were used to evaluate the performance of two particulate matter (PM) air quality models, as applied to two multi-week modeling episode periods. The SEARCH measurements include speciated particulate matter with diameters of less than 2.5 microns (PM2.5) and between 2.5 and 10 microns (PMCOARSE), and trace gas measurements of ozone, oxides of nitrogen (NO, NOx), NOy, carbon monoxide (CO), and sulfur dioxide (SO2). The SEARCH data provide a basis for beginning to evaluate in detail the ability of PM models to simulate hourly variations in PM species for a variety of geographical locations (including urban, suburban, rural sites and both coastal and inland locations).

Several air quality models are being developed and tested for the purposes of evaluating strategies for reducing PM concentrations and exposure. The reliable application of such models requires that the models be rigorously evaluated and tested - not only relative to whether longer-term averages of PM constituents can be reproduced, but also with regard to whether the detailed daily and hourly concentrations that comprise the longer-term averages are consistent with available speciated, high-temporal-resolution data.

This poster presents the methods and results of the evaluation of the REgional Modeling System for Aerosols and Deposition (REMSAD) and the particulate version of the variable-grid Urban Airshed Model (UAM-VPM), with emphasis on the ability of the models to represent hourly variations in particulate and gaseous concentrations of several species. Ratios of various species are also used to compare the modeling results with observed data and obtain information about whether the processes represented by the chemical mechanisms are in line with those indicated by the relative species concentrations in the observed data. Conclusions regarding model performance for longer-term averages versus daily and hourly variations are also compared. The high-temporal-resolution SEARCH data provide a basis for a detailed evaluation of the modeling results.

Results for REMSAD for the two episode periods suggest good representation of PM2.5 but somewhat mixed representation of the various component species. Organic aerosols tend to be underestimated. For one simulation period, ozone is well simulated while, for the other, ozone is generally overestimated. As of the writing of this abstract, the evaluation of UAM-VPM is not complete.

[P11-04] SIMULATION OF THE ATMOSPHERIC AEROSOL SIZE/COMPOSITION DISTRIBUTION IN A THREE-DIMENSIONAL CHEMICAL TRANSPORT MODEL.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 11: Air Quality Modeling (8:30 PM-9:30 PM) Grand Ballroom 2-4

Atmospheric pollutants have been implicated in the development of adverse effects on human health, the formation of acid rain and acid fogs, visibility reduction, and influence on the energy balance of the planet. Models that accurately describe the physical and chemical atmospheric transformations of these pollutants are necessary to determine how changing emissions will affect downwind airborne concentrations and how to best go about controlling air pollution.

Improvements and additions have been made to the chemical transport model CAMx to create a new transport model PMCAMx. These improvements focus on aerosol and aqueous-phase treatment. The first addition was a hybrid mass transfer approach to determine partitioning between the gas and aerosol phase for volatile inorganic species. Here bulk equilibrium is assumed for fine particles and mass transfer equations are solved for larger particles. To simulate the behavior of secondary organic aerosol (SOA) components and their interactions with inorganics, an SOA model was also integrated into PMCAMx. Finally, in an effort to describe cloud and fog processing of pollutants, a variable size resolution aqueous-phase chemistry module also was incorporated into the model.

We will present an overview of our additions to PMCAMx and explore the accuracy and efficiency of these additions.

[P11-05] DEVELOPMENT AND APPLICATION OF THE PMCAMx MODEL TO TREAT FINE PARTICULATE AND VISIBILITY ISSUES.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 11: Air Quality Modeling (8:30 PM-9:30 PM) Grand Ballroom 2-4

The Comprehensive Air-quality Model with extensions (CAMx) is a photochemical grid model that was developed in the late 1990s to treat urban and regional ozone issues under a one atmosphere concept. CAMx was first applied to address ozone issues as part of the Ozone Transport Assessment Group (OTAG), but has undergone continuous development and refinement. Because CAMx consists of all new computer coding in a modular framework, it is ideally suited for extension to other air quality issues beyond ozone and the platform has become a host fotr several "probing tools" including Ozone Source Apportionment Technology (OSAT), Decoupled Direct Method (DDM), and Process Analysis. This paper discussed the extension of the CAMx to treat particulate matter (PM) and visibility issues through the inclusion of state-of-science aerosol modules. A sectional approach has been adopted in PMCAMx to treat size resolved PM. Aerosol thermodynamics are treated using either a full dynamic module or the ISORROPIA equilibrium module. A multi-sectional aqueous-phase chemistry algorithm has also been implemented. Secondary organic aerosol is being treated using a reversible semi-volatile scheme. New dry and wet deposition schemes have been developed. A PM Source Apportionment Technology (PSAT) is also being developed and implemented into PMCAMx that allows source attribution of primary and secondary PM to user selected geographic source regions and source categories.. This paper presents the technical formulation of the PMCAMx treatment of aerosols, the application and evaluation of the model to western and eastern US cities, and the formulation and performance of the PSAT PM source apportionment scheme.

[P03-16] ATOFMS CHARACTERIZATION OF AMBIENT FINE AND ULTRAFINE PARTICLES FROM A VERSATILE AEROSOL CONCENTRATION ENRICHMENT SYSTEM (VACES).

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:30 PM-9:30 PM) Grand Ballroom 2-4

Recently ambient particle concentrators have been developed to investigate exposures to real ambient aerosols because ambient aerosol concentrations are generally too low to induce measurable acute toxic effects. Besides particle number concentration and size, particles with different chemical composition generate different toxic effects. By using a particle concentrator in health effects studies, the number concentrations of ambient particles can be significantly enriched. However, the chemical composition of the enriched ambient particles may also vary because particles undergo a series of pumping, saturation, and desolvation processes when passing through the concentrator. In this poster, an aerodynamic lens aerosol time-of-flight mass spectrometer (ATOFMS) was used to characterize fine and ultrafine ambient particles sampled from the outlet of a versatile aerosol concentration enrichment system (VACES) in Rochester, NY. Major particle types observed for the enriched particles and the temporal variations of these types observed over the course of the study are presented and compared with those obtained during direct (i.e. non-concentrated) ambient sampling. Based on the data analysis results, influences of the concentrator on the particle composition will be evaluated and discussed.

Acknowledgements

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[P11-07] AN EVALUATION OF THE MODELS-3 CMAQ AEROSOL MODULE.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 11: Air Quality Modeling (8:30 PM-9:30 PM) Grand Ballroom 2-4

Ambient air concentrations of particulate matter (PM) continue to be a major concern for the U.S. Environmental Protection Agency. High concentrations of fine particles have been linked to detrimental health effects and visibility degradation. Accordingly, the Clean Air Act and its Amendments require EPA to establish National Ambient Air Quality Standards (NAAQS) for PM and to assess current and future air quality regulations designed to protect human health and welfare. One of the most reliable tools for performing these assessments are air quality models, such as the Models-3 Community Multiscale Air Quality (CMAQ) model, which simulates air concentrations and deposition of various pollutants, including PM. These simulations, which can be conducted on numerous spatial and temporal scales, support both regulatory assessment by EPA Program Offices, as well as scientific studies by research institutions.

The aerosol module within CMAQ is designed to simulate the complex processes involving both PM2.5 and PM10, which are not single entities, but consist of varying mixtures of chemical species, each having its own emission, transport and deposition characteristics. Aerosol species considered within CMAQ are sulfate, nitrate, ammonium, water, secondary organic aerosols from both anthropogenic and biogenic sources, primary organic aerosols, elemental carbon, and unspecified primary aerosol material. These species are contained in the fine particle size range (PM2.5, which are represented by two interacting lognormal distributions, the Aitken and accumulation modes. Particles with diameters larger than 2.5μm are represented by a third lognormal distribution that does not interact with those representing PM2.5. The coarse mode chemical species are represented by two categories, soil-derived particles and chemically unspecified particles.

In order to determine its value to the regulatory communities, CMAQ, like all models, must be evaluated using observational data. Accordingly, this research compares PM simulated by CMAQ during a three month simulation (June through August, 2001) with PM data collected by two networks: 1) the Interagency Monitoring of PROtected Visual Environments (IMPROVE) network; and 2) the Clean Air Status and Trends Network (CASTNet). A suite of metrics will be used in the evaluation, including summary statistics, numerous measures of bias (mean, mean normalized, mean fractional, normalized mean) and error (root mean square, normaized mean, mean absolute gross and mean normalized gross).

[P03-15] DEVELOPMENT AND EVALUATION OF A COMPACT FACILITY FOR EXPOSING HUMANS TO CONCENTRATED ULTRAFINE AMBINET PARTICLES.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:30 PM-9:30 PM) Grand Ballroom 2-4

Abstract: This paper presents development and evaluation of a very compact facility for exposing humans to concentrated ambient ultrafine particles The development of the facility has been based on an already developed and published versatile aerosol concentration enrichment system (VACES) to concentrate ambient ultrafine particles. The human ultrafine concentrator operates at versatile intake flow rate of up to 1300 liters per minute (LPM). The concentrator is preceded by an ultrafine impactor which collects the accumulation mode particles under a very low pressure drop (0.015 kPa), a feature that is essential in enabling us to conduct inhalation studies to ultrafine CAP. The ultrafine concentrator was characterized in field experiments, in which the total flow was 600 LPM. Tests were done to determine the enrichment of ultrafine particles in terms of their number and mass concentration as well as chemical composition including elemental carbon (EC), inorganic ions (sulfate an nitrate) and polycyclic aromatic hydrocarbons (PAHs) at minor flow rates of 10, 15, 20, 25 and 30 LPM. Results showed a near-ideal increase in number concentrations (corresponding to the ratio of total-to-minor flow rate) of ultrafine particles after enrichment. Measurements were done using a Scanning Mobility Particle Sizer (SMPS) for the following size bins: 180-140, 140-100, 100-70, 70-40 and 40-15 nm. Results also indicated a uniform concentration enrichment across all the size bins. For the minor flow of 10 LPM, a 50-fold increase could be obtained with just a single virtual impaction stage. Similar results were obtained for EC and PAHs concentrations (measured by an Aethalometer), for which the maximum obtainable concentration enrichment was by a factor of 50, corresponding to a minor flow of 10 LPM. Furthermore, tests were also conducted to characterize the system for mass concentrations, including ions such as sulfate and nitrate at a minor flow of 30 LPM (corresponding to an ideal enrichment factor of 20). The mass, sulfate and nitrate concentrations were compared after collecting ultrafine particulate matter (PM) on 47 mm Teflon filters before and after enrichment. For all the observations, the average ratio of enrichment factor was found to be 18.9, 20.6 and 17.8 for ultrafine PM mass, sulfate and nitrate, respectively, thus very close to the ideal values indicating perfect collecting efficiency with minimal particle losses. The ultrafine concentrator will be used to expose humans to ultrafine CAP beginning in the spring of 2003.

[P07-23] OPTICAL AND CHEMICAL LIGHT SCATTERING DETERMINATION IN THE SOUTHEAST: EXAMPLES FROM THE SEARCH NETWORK.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

The Southeastern Aerosol Research and Characterization network consists of eight aerosol monitoring stations -- 4 urban/rural pairs -- that are operating continuously in four states in the Southeast from 1998 to 2005. The chemical composition of fine and coarse particulate matter fractions is determined from 24-hr filter samples and, in some locations, also from semi-continuous measurements. Integrating nephelometers are used to make measurements of light scattering in ambient air samples that have been desiccated with Nafion diffusion dryers.

This paper provides a first, exploratory analysis of the nephelometer measurements and aerosol composition at some of the SEARCH sites. Conditions at urban and rural sites are compared and causes for differences are illuminated. Chemical light scattering (an estimate of light scattering from products of mass concentrations of chemical species and their scattering efficiencies) is compared with the direct measurements of light scattering by the nephelometers, using the formula that has been developed for Class I areas by IMPROVE. The appropriateness of using the IMPROVE light scattering efficiencies for representing chemical light scattering in Southeastern rural and urban area is explored. Benefits to the understanding of chemical light scattering that are provided by rapidly-improving semi-continuous chemical measurements are also addressed.

The SEARCH nephelometer measurements have recently been extended to all eight locations and have been enhanced to improve data quality, so this exploratory analysis will be used to guide more comprehensive analyses of the full regional data set after another year of data collection.

[P07-24] A NEW INTEGRATING NEPHELOMETER FOR VISIBILITY STUDIES.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

Visibility impairment is mostly caused by particle scattering with important contributions from both fine particles (e.g., sulfate, carbonaceous particles) and coarse particles (e.g., entrained mineral dust). Scattering by fine particles can be characterized with good accuracy by commercial nephelometers. This is in contrast to scattering by coarse particles, which includes a large near-forward scattering component due to diffraction that is not easily included in the integrated measurement of particle scattering. Most existing nephelometers have a forward truncation angle of 7° or above, resulting in truncation losses of more than 25% for particles with a diameter larger than 2.5 μm. In locations where large particles contribute substantially to atmospheric scattering, such nephelometers are not adequate for characterizing the scattering component of visibility impairment.

The Integrating Sphere Integrating Nephelometer (ISIN) is a novel and unique reciprocal nephelometer that uses an integrating sphere with attached truncation-reduction tubes to contain the sample volume and to integrate the scattered light. Its main advantage over current integrating nephelometers is the seven-fold reduction in truncation angle to about 1° that reduces errors in measuring scattering from large particles. Truncation losses of more than 25% occur for the ISIN at particle diameters of larger than 16 μm. Additional features include the improved ability to sample large particles and the well-defined operating wavelength. Initial comparisons of the ISIN with two commercial nephelometers using sub-micron particles revealed excellent correlation and agreement within a few percent. Comparisons with one of the two commercial nephelometers during a study of dust entrainment by military off-road vehicles from an unpaved roadway, showed good agreement for ambient fine particles (no entrainment) while the ISIN readings were up to four-times higher than those of the commercial instrument for freshly entrained coarse particulate matter. This large discrepancy is attributed to the reduced truncation error (up to a factor of two) and the improved large particle sampling of the DRI-ISIN.

[P07-25] ANALYSIS OF AEROSOL LIGHT ABSORPTION MEASUREMENT CAPABILITIES: THE RENO AEROSOL OPTICS EXPERIMENT.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

Aerosol light absorption measurements are important for health, climate, and visibility applications. The Reno Aerosol Optics Experiment was conducted in June of 2002 with the main purpose of evaluating our capability to accurately measure aerosol light absorption. Most of the measurements were accomplished using well-characterized external mixtures of laboratory-generated ammonium sulfate and kerosene soot aerosol. A primary standard for measurement accuracy was provided by the difference of extinction and scattering measurements. Photoacoustic measurements of aerosol light absorption agreed well with the primary standard measurements.

Aerosol light absorption measurements have typically been accomplished using filter-based samplers. Here the attenuation of light across the filter is measured as a proxy for light absorption. This approach purposely overestimates the in-situ aerosol light absorption because these filters are multiple scattering substrates that amplify absorption as a means of improving instrument sensitivity. Various empirical approaches have been used to calibrate these instruments. For example, the calibration model used for the Particle Soot Absorption Photometer requires additional measurements of aerosol scattering to reduce the artifact it produces on the absorption measurements. It will be shown that the PSAP and 7 wavelength aethalometer data can be parameterized to provide reasonably good correlations with the photoacoustic instrument for time-averaged data. Comparisons of the time series data from the photoacoustic instrument and aethalometer for white and dark aerosol limiting cases reveal insight on filter-based artifacts. A theoretical analysis of the reduced aethalometer response upon filter loading by dark aerosol is presented based on the reduction of filter multiple scattering as it darkens.

[P07-26] MEASUREMENT OF ATMOSPHERIC VISIBILITY WITH A HIGH-QUALITY CAVITY.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

Visibility can be characterized by measurement of optical extinction through the Koschmieder relationship. Atmospheric extinction can be as low as a few Mm^{-1}, requiring large optical path lengths for its measurement. With the development of relatively inexpensive mirrors with ultra-low reflection losses, tens of kilometers of optical path length can be realized in practical, compact (1-m length) optical cavities. At the Desert Research Institute such cavities are being used for extinction measurements with sensitivities down to 0.1 Mm^{-1}.

Two pulsed laser techniques have been employed simultaneously to obtain highly sensitive extinction measurements with large dynamic range. The Cavity Ring Down (CRD) technique yields very sensitive detection, largely independent of laser power fluctuations, with a dynamic range from 0.1 Mm^{-1} to 1,000 Mm^{-1}. Cavity Enhanced Detection (CED) has a simpler experimental setup and data analysis algorithm than CRD, while yielding a dynamic range from 1 Mm^{-1} to about 5 10^6 Mm^{-1}. The CED sensitivity limit is due to power fluctuations of the pulsed laser and could be further improved by measuring and accounting for these fluctuations.

Capabilities of CRD and CED techniques including sensitivity, dynamic range, calibration, and complexity are further discussed and compared through simultaneous measurements.

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[P07-27] CORRELATION OF VISIBILITY AND PM2.5 MASS CONCENTRATION AND RELATED PRECURSORS IN THE ADIRONDACK REGION OF UPSTATE NEW YORK DURING THE PMTACS-NY SUMMER INTENSIVE OF 2002.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

The physical and chemical characterization of fine particulate matter in ambient air is a major objective of the PMTACS-NY Supersite Program. As part of this program, a summer field intensive campaign operated from the ASRC's Whiteface Mountain base station (44° 22' N, 73° 54' W) located in the northern Adirondack region of upstate New York. The sampling site is within the canopy of a transition zone forest comprised mostly of white and yellow birch, sugar maple, beach and some red spruce and balsam fir. Routine gas and particulate matter measurements at this site include: NO, NO2, NOy, SO2, O3, air toxics, PM mass, and PM chemical speciation, and semi-continuous PM carbon. During the 2002 field campaign, additional instruments were deployed to measure semi-continuous PM mass, sulfate, nitrate, ammonium, and organics, gaseous formaldehyde, HONO, HNO3, and OH/HO2. In addition, a commercial nephelometer (OPTEC, NGN-3) was deployed at the start of the summer campaign. The nephelometer and R&P 8400S and 8400N semi-continuous PM sulfate and nitrate monitors, introduced during the summer 2002 campaign, were integrated into the routine measurement operation at the site. This presentation reports on preliminary analyses relating B_{scat} measurements and PM mass and chemical composition.

High correlations were observed between the PM2.5 particulate mass concentration measurements and the scattering coefficients (b_{scat}), with an r^2 value of 0.793 for the entire campaign. Several episodic pollution events as well as periodic influences of transported smoke across the northern US-Canada border from intense forest fires in southern Quebec were also observed during the campaign. During two such episodic events (07/09/02 and 07/21/02-07/24/02), PM mass and b_{scat} correlations reported r^2 values of 0.988 and 0.883 respectively. The effects of the forest fires were also observed in the PM organic carbon concentrations, which were as much as twenty times higher than typical mean concentrations during the smoke events.

The correlation of PM2.5 mass concentration and ozone mixing ratio data for the entire campaign was rather weak, with an r^2 value of 0.317. During the episodic period 07/21/02 - 07/24/02 a somewhat stronger correlation was indicated, with an r^2 value of 0.576. The chemical features of this episode are presented and the relationship of gaseous precursor species and PM2.5 mass concentrations explored.

[P07-28] WATER CONTENT OF AMBIENT AEROSOL DURING PITTSBURGH AIR QUALITY STUDY.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

The ability of atmospheric particles to absorb water affects their lifetime, their light scattering properties, their interactions with semi-volatile compounds, and probably their deposition efficiency in the respiratory tract. Due to the hysteresis effect of the hygroscopic growth, the physical state (dry or wet) of particles in the troposphere is uncertain below about 80% RH, leading to uncertainties in their optical and chemical properties. Aerosol size distributions, dried and at ambient RH conditions, have been monitored within the Pittsburgh Air Quality Study (PAQS), for several months starting with July 2001. The measurements were made using the Dry and Ambient Aerosol Size Spectrometer (DAASS) (Stanier et al. 2002).

A comparison of "dry" and "wet" size distributions revealed that during summer and autumn the ambient aerosol in Pittsburgh always contained water, even at RH as low as 30%. During the winter, however, several periods were observed when particles were dry up to 65% RH. This behavior is consistent with the chemical composition of the aerosol and our understanding of its hygroscopic properties. During the summer, particles in the area are often acidic. The dominant component, ammonium bisulfate does not crystallize down to about 10% RH. During the winter months the inorganic aerosol in Pittsburgh is dominated by ammonium sulfate and ammonium nitrate and crystallizes at higher RH. The observed aerosol growth factors are compared with the thermodynamic equilibrium model GFEMN (Ansari, Pandis, 1999) prediction. This comparison indicates that the aerosol on some occasions may be composed of a mixture of crystallized and wet particles. The difference in the physical state maybe the result of either different chemical composition (externally mixed aerosol) or different histories of the air parcels (particles may have experienced different RH).

An important implication of the aerosol being wet during acidic conditions is that the PM mass measurements may suffer a positive artifact due to the retained water on the aerosol during the weighing.

Ansari, A.S.; Pandis, S.N. (1999) Prediction of multicomponent inorganic atmospheric aerosol behavior. Atmos. Environ. 33, 745-757

Stanier C.O., Chan W.R., Khlystov A., Mandiro M., Pandis S.N. (2002) Semi-continuous measurements of the aerosol size distribution and liquid water content in Pittsburgh, PA using the Dry/Ambient Size Spectrometer System (DAASS). To be submitted to Aerosol Sci. & Technol.

[P03-02] EXPERIMENTAL EXPOSURES OF ASTHMATIC AND HEALTHY VOLUNTEERS TO CONCENTRATED AMBIENT COARSE PARTICLES IN LOS ANGELES.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:30 PM-9:30 PM) Grand Ballroom 2-4

Twelve asthmatic and 4 healthy adults were exposed to filtered air (FA) and to concentrated ambient coarse particles (CCP) using 15 parallel virtual impactors interfaced to a whole-body exposure chamber. Exposures lasted 2 hr with intermittent exercise. Mean CCP concentration was 157 (range 56-218) $\mu g/m^3$ by continuous monitoring with a tapered-element oscillating microbalance (TEOM); on average, 85% was coarse (2.5-10 μm aerodynamic diameter) and the rest <2.5 μm. No clinically important symptoms were observed during/after CCP, relative to FA, and CCP did not significantly alter spirometry, arterial O_2 saturation, or airway inflammation as judged from total cell counts of induced sputum. After CCP, small increases in heart rate and decreases in several measures of heart rate variabililty were statistically significant ($P < .05$) or suggestive ($P < .1$). Conclusion: Exposures to ambient coarse particles had no obvious pulmonary effects but appeared to alter autonomic nervous system influence on the heart.

[P11-06] AIR QUALITY MODELING OF AN EXTREME PM10 EPISODE AT SANTIAGO, CHILE.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 11: Air Quality Modeling (8:30 PM-9:30 PM) Grand Ballroom 2-4

The city of Santiago, Chile is subject to strong anticyclonic, subsidence-based thermal inversions reinforced by low coastal troughs on the Pacific Ocean (110 km to the west). In such episodes, ambient concentrations of pollutants start to rise as the episode worsens.

We are using the Comprehensive Air Quality Model with Extetensions (CAMx) to study one episode that happened from May 14 through May 19, 1998. The atmospheric conditions were such that the PM10 hourly levels reached dangerously high levels (see Table), and 24h moving average values rose as high as 350 (μg/m^3).

In addition, the air temperature difference between 2 and 8 m above ground was near 4 K at all those hours, signaling a strongly stable surface boundary layer, with Richardson numbers exceeding the critical value of 0.25 at those hours. The episode enden on Monday, May 18th, when authorities shut down 50% of the stationary sources and banned near 60% of the older vehicles in the city, curbing down pollution levels.

The modeling exercise was carried out applying CAMx to a region extending 120 km E-W and 80 km N-S, completely covering the greater metro area of Santiago (30 by 35 km in size) with a 2 by 2 km grid resolution.

The meteorological information was obtained by applying the CALMET preprocessing scheme to the following configuration of data:

a) A dense surface network, consisting of 30 surface meterological stations b) The output of the HIRLAM regional scale meteorological model, at 0.1 degrees of resolution, covering central Chile.

The model outcome was assessed using the ambient air quality monitoring performed routinely by the local authorities at 8 monitoring sites apread across the city, covering most of the urban zone.

The results of the model performance are assessed in graphical and statistical ways, showing the capabilities of the CAMx modeling system to simulate the transport and chemistry over such a complex terrain flow.

Summary of PM10 episode, May 1998

Day	LST at peak PM10	PM10 (μ/m^3)	Ri (5m)
Friday, 15th	22-23	600	0.20
Saturday, 16th	21-22	818	0.37
Sunday, 17th	21-22	495	1.86
Monday, 18th	22-23	198	2.45

[P11-16] ATMOSPHERIC BOUNDARY LAYER CHARACTERIZATION AND THE AEROSOL EXTINCTION COEFFICIENT DURING THE BALTIMORE PM SUPERSITE - JULY 2002.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 11: Air Quality Modeling (8:30 PM-9:30 PM) Grand Ballroom 2-4

During the Baltimore PM Supersite July 2002 intensive field campaign, a set of instruments were deployed to measure and derive Atmospheric Boundary Layer (ABL) properties, particularly aerosol extinction coefficient and mixing layer height.
In this presentation we will present analysis of aerosol backscatter data obtained with the Johns Hopkins University elastic backscatter lidar system. In addition we make use of micrometeorological instruments, a nephelometer, an APS (Aerodynamic Particle Sizer), and a SMPS (Scanning Mobility Particle Sizer). The data obtained with these instruments are used in Mie theory computations to get aerosol scattering / extinction / backscattering coefficients. The aerosol extinction coefficient determined for λ =1.064 μm is used as boundary condition in the lidar equation to obtain the vertical profile of aerosol extinction coefficient.

[P02-02] KEY ATTRIBUTES OF AMBIENT AIR QUALITY DATASETS FOR ASSESSING SHORT-TERM HEALTH EFFECTS: AN EPIDEMIOLOGIC PERSPECTIVE.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:30 PM-9:30 PM) Grand Ballroom 2-4

For epidemiologic time-series studies assessing the short-term health effects of ambient air pollution, desirable attributes of air quality databases depend on the specific study questions, but several features are generally useful. It is important that the ambient pollutant monitor(s) be appropriately sited to maximize spatial representativeness for the geographic area under study; knowledge of the extent of spatial heterogeneity of each pollutant of interest is crucial for the interpretation of epidemiologic study results. An assessment of the influence of local sources immediately surrounding the monitoring station(s) is helpful. Because the relationships of specific pollutants with adverse health outcomes have yet to be fully understood, information on an extensive suite of analytes may be useful (including criteria gases, mass of different size fractions of particulate matter (PM), physicochemical characteristics of PM, gas-phase hydrocarbons, and meteorological parameters); however, strong correlations among pollutants, due to common sources and meteorological phenomena, may limit the epidemiologic utility of such data. To evaluate the association between health outcomes and ambient pollution concentrations at a daily, or sub-daily, level, the temporal resolution should be as fine as is feasible, to allow for flexibility in choosing the level of aggregation needed. Measurements should, of course, be made with the highest level of validity and precision. It should be kept in mind that the primary goal in time-series studies is to capture true day-to-day variation in air quality measures, rather than absolute levels, in order to evaluate the relationship between daily fluctuations in ambient pollution levels with daily fluctuations in health outcome measures. The amount of missing data during the monitoring period should be minimized, a factor that is particularly important when evaluating the health effects of pollutants using multiple-day lag structures. Instrument uncertainty, determined from colocation or previously conducted reliability studies, should be estimated. The ambient air quality data should also be accompanied by thorough documentation of the measurement methods and quality control procedures. The attributes of the ambient air quality database generated by Aerosol Research and Inhalation Epidemiology Study (ARIES) at the Jefferson Street monitoring station in Atlanta, Georgia, from August 1, 1998, to August 31, 2000, will be used to illustrate the extent to which an existing database has met the needs of epidemiologists.

[P02-01] METANALYSIS OF THE IMPACT OF PM10 ON PREMATURE MORTALITY.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:30 PM-9:30 PM) Grand Ballroom 2-4

Many analyses have been conducted worldwide to estimate the health benefits from air pollution abatement. A key issue in the estimation of these benefits is the unit risk of the concentration-response function. Among all effects, premature mortality is with no doubt the most important. When local studies (i.e. studies conducted in the same region or city in which the benefits of abatement are being calculated) are available, they are usually used directly in benefit estimation. When no local studies are available, the current practice is to extrapolate results from a similar locality, or to take an average (sometimes weighted) of a given set of studies. However, these methods do no consider the difference in conditions of the target place from the original study place.

In this work we present a meta-analysis of studies of the short term impacts of particulate matter (PM10) impacts on premature mortality, considering explicitly the factors that may influence it. Through a weighted regression model, a meta-analysis of the PM unit risk for a sample of 85 cities around the world was performed, considering as explanatory variables the average concentrations of air pollutants, the monitoring sites density, the mean temperature, the city's surface, the population density, the percentage of population over 65 years old, the average annual mortality rate, and gross income per capita.

Population density, average concentration of PM10, and mean temperature had the greater explanatory power. The effect of PM10 concentrations on unit risk was negative, with the slope decreasing 0.000035 for each 10 μg/m3 of PM10. The effects of temperature and population density were both positive. The proposed model allows to better predicting the effect of particulate matter on mortality for any city on the base of its environmental and demographic attributes.

[P02-12] A PILOT STUDY OF TRAFFIC EXPOSURES AND THEIR HEALTH EFFECTS AMONG SOUTH BRONX CHILDREN WITH ASTHMA.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:30 PM-9:30 PM) Grand Ballroom 2-4

Traffic-related pollution has been associated with adverse respiratory health effects using distance from roadways as an exposure index, rather than direct personal monitoring. Therefore, our goal was to assess the feasibility of a program to measure personal traffic-related PM exposures (using Elemental Carbon, EC, as an index) among inner-city elementary school children with asthma, and to relate these exposures to nearby truck traffic and to health.

A group of ten 5th grade children with asthma from a South Bronx elementary school located adjacent to the Major Deegan Highway were followed for 3 weeks in April-May, 2002. For each child, continuous fine PM concentrations (MIE Data RAM) and 24-hour average fine EC (via reflectance), and daily NO2 (using Super-Palmes) were determined via personal monitoring. Daily filter PM2.5 personal samples were analyzed for EC using reflectance. The subjects' data on personal respiratory symptoms, asthma medications, lung function, and activity pattern data were also collected. PM2.5, EC, NO2, CO, SO2, and O3 were also monitored at the NYU PM Center mobile air monitoring lab, located beside the school. Daily diaries of asthma symptoms and medications were filled out, and spirometry collected, at the start and end of the school day, and each evening. Counts of trucks and cars were made using automated counters during one week of the study.

Measurements were successfully completed, with collection rates usually above 90%. Personal PM2.5 levels were weakly correlated with, and usually higher than, central site PM2.5, suggesting indoor sources dominated PM2.5 exposures. Personal PM2.5 concentrations were higher for the most ETS exposed children. Peak outdoor EC concentrations at the central van were correlated with peak truck traffic periods. Personal EC levels were also variable, but more strongly correlated with (r^2=0.72), and usually lower than, central EC, suggesting outdoor sources dominated personal EC exposures. Unlike PM2.5, EC exposures were similar for ETS vs. non-ETS affected subjects. Peak flow lung function was negatively associated with both average EC and PM2.5 levels ($p<.05$). Presence of shortness of breath and wheezing symptoms were significantly associated with EC levels, but not with PM2.5. This suggests that traffic-related EC is more strongly associated with adverse asthma symptoms than PM2.5 in general.

Research Supported by: The Health Effects Institute (RA 02-4), the NYU Center for Urban and Global Health, and by Center Grants from the NIEHS (ES-00260) and the EPA (R827351).

[P11-21] APPLICATION OF PMCAMX TO THE SOUTH COAST AIR BASIN AND THE EASTERN UNITED STATES.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 11: Air Quality Modeling (8:30 PM-9:30 PM) Grand Ballroom 2-4

Three-dimensional chemical transport models are essential tools used by policy makers in determining effective strategies to address air pollution problems. To be effective, models must be versatile enough to accurately predict observed atmospheric conditions in multiple regions, which can have differing local air quality problems. Here we apply the chemical transport model of PMCAMx to two regions, California's South Coast Air Basin (SCAB) and the Eastern United States.

In the case of the SCAB, we have simulated a two-day PM episode from October 1995. The episode exhibits meteorological conditions (e.g., extensive fog cover) typical of fall PM episodes in the SCAB. Also important was the existence of data to evaluate model performance. There were five sampling sites for measurement comparisons during this period, located at Los Angeles, Anaheim, Diamond Bar, Riverside, and Fontana.

The Eastern United States case is validated with more recent measurements taken during the intensive sampling periods at Pittsburgh and other supersites. High PM in the Pittsburgh region is characterized by high sulfate and organic material, in contrast to the SCAB, where high PM contains high concentrations of nitrate and ammonia, particularly east of Anaheim and Diamond Bar.

The performance of PMCAMx in both of these regions is evaluated. PMCAMx and other chemical transport models have previously been shown to perform relatively well in the SCAB, but few studies have been done in the eastern United States to date. The preliminary results for PMCAMx in this region will be given to show how the different atmospheric conditions affect the performance of the transport model. PMCAMx allows the use of different aerosol and cloud modules, and some of the differences between these approaches will also be shown.

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[P11-20] CHARACTERIZATION OF PM AND METEOROLOGY TO SUPPORT SELECTION OF MODELING EPISODES.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 11: Air Quality Modeling (8:30 PM-9:30 PM) Grand Ballroom 2-4

Data available from the ongoing SouthEastern Aerosols Research and CHaracterization Study (SEARCH) and concurrent monitoring programs provide a basis for examining the relationships between aerosols and other geographical and meteorological factors that influence the phenomenon of regional haze in the southeastern U.S. Daily measurements of particles, trace gasses, and meteorological parameters from the SEARCH monitoring network are available for eight monitoring sites located throughout the Southeast (in urban, suburban, and rural locations).

This poster describes the use of the SEARCH data to explore the relationships between aerosol formation, composition, and transport and meteorology. The findings are then used to guide the development of recommendations for selecting modeling episode periods for air quality modeling applications, with consideration of the frequency and magnitude of measured PM2.5 events, observed variations in the relative importance of the PM constituents, important PM-related processes, and the geographical scales encompassed by both urban-health and regional-haze issues. The emphasis of the analysis is PM2.5 and regional haze.

In this study, we used the Classification and Regression Tree (CART) statistical analysis software to extract information about the physical relationships among the variables and to classify the days according to species concentrations and meteorological parameters. Specifically the CART analysis technique was used to determine the types of conditions that lead to high PM concentrations and poor (and good) visibility, and distinguish among different types of PM and visibility events.

CART was applied for each SEARCH site and for PM2.5 concentration, PM constituents, and calculated visibility. The results of the CART analysis have provided interesting insights into the relationships among the input parameters. These relationships vary among the different locations and between the urban, suburban/rural monitors. The CART results indicate that different meteorological conditions lead to differences in concentration as well as constituency.

Objective episode selection procedures were then used to construct a set of episode days for regional-scale modeling of the Southeast. An optimization procedure was applied to the selection of multi-day episodes for optimal achievement of specified selection criteria for various combinations of geographical areas and PM/visibility metrics. The episodes are expected to represent the characteristics (and ultimately the response to emission reductions) of PM2.5 air quality relative to the annual NAAQS for PM, and visibility relative to the regional haze goals.

[P11-19] PRIMARY AND SECONDARY ORGANIC AEROSOLS OVER THE UNITED STATES: ESTIMATES ON THE BASIS OF OBSERVATIONS AND MODELED PRIMARY OC/EC RATIOS.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 11: Air Quality Modeling (8:30 PM-9:30 PM) Grand Ballroom 2-4

The temporal and spatial distributions of primary (OC_{pri}) and secondary (OC_{sec}) organic aerosols over the US were estimated with observational data from the IMPROVE and SEARCH networks, coupled with the modeled primary OC/EC ratios from EPA's Models-3/CMAQ during the two month summer periods (period 1: June 15 to July 17 and period 2: August 3 to August 31) in 1999. For the results of period 1, the mean OC_{pri} concentrations over the Northeast, Southeast, Central, West and California regions were 0.5, 1.5, 0.6, 1.0, 1.4, and 1.4 μ g C m^{-3}, respectively, while the mean OC_{sec} concentrations were 1.1, 1.2, 0.7, 0.5, 0.7, and 1.1 μg C m^{-3}, respectively. The contribution of OC_{sec} to the measured OC ranged from 34% over the West to 69% over the Northeast. The mean values of modeled primary OC/EC ratios ranged from 1.18 over the Northeast to 3.71 over the West. The similar conclusions for the period 2 can be obtained. The daily temporal variations at SEARCH sites indicate that the daily mean values of primary OC/EC ratios can change from 0.84 to 2.99 at Yorkville and the contributions of secondary OC to OC can change from 0% to 66% at North Birmingham during the period 1. The hourly results at Cornelia Fort, Nashville (TN) and Atlanta, GA, show great variations of contributions of secondary OC to OC. These results indicate the difficulties in estimating the relative contributions of primary and secondary OC at a site. There is large uncertainty in the estimation of the relative contributions of primary and secondary OC based on the assumption of a constant representative ratio of primary OC/EC at a location. The analysis also reveals that there was some association between the secondary OC, K and Zn (correlation coefficients> 0.45), indicating that biogenic origin may contribute to the formation of secondary OC significantly since K and Zn are abundant in plant tissues.

[P11-18] JET OF STRETCHING DURING THE PARTIAL COALESCENCE.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 11: Air Quality Modeling (8:30 PM-9:30 PM) Grand Ballroom 2-4

During the falling in free atmosphere of drops of various sizes their collision happens. The result of this process can be rebound, coalescence and partial coalescence which is transition process.

The result of interaction of drops is determined by process of displacement of gas interlayer between drops. If the interlayer between drops will stay then the rebound happens. If during the approachment the interlayer will be displaced then the coalescence happens. In case of partial coalescence the interlayer of gas is broken though locally. For partial coalescence it is necessary that the break off of an interlayer of gas has taken place at the stage of rebound. In this case the drop has a sufficient kinetic energy to break off the arisen necking. This necking brakes a flying away drop that results in stretching it (the drop) in a jet. During the certain ratio of parameters the jet acquires the cylindrical form. The process of partial coalescence was in detail investigated in Kolpakov (1983). In experiments the generator of monodisperse drops of "vibrating needle" type, impulse light source synchronized with the generator of drops through the generator of delay of a light pulse was used. The characteristic time of drop appearance was about 10^{-2} sec and characteristic time of interaction was 10^{-4}-10^{-5} sec. At the save time the using of the mentioned above generators has allowed to visualize the process of collision of drops and to study all three kinds of interaction in detail.

It turns out that the ratio of a radius of a jet *a* in the moment when it takes a cylindrical form to an initial radius of a drop *R* which is stretching in a jet is in a range from 0.9 to 0.56.

The solution of such problem was represented in Aslanov (1999). The process of separation of a drop forming on the latter cycle of beaking off of the jet were the hydrodynamic instability of the latter achieves its maximum significance is considered.

Including such process regular we apply to this control volume the equation of balance of mass and energy.

The solution of this equation gives the significance $\eta = a/R \approx 0.53$.

If we compare this significance with the result obtained experimentally (0.56) we can see a good agreement between the result of the experiment and theoretical account.

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[P03-17] METHODS FOR EXPOSING RODENTS AND CELLS TO CONCENTRATED AMBIENT PM USING VACES.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:30 PM-9:30 PM) Grand Ballroom 2-4

We have assembled, tested, and validated the Versatile Aerosol Concentration Enrichment System (VACES) developed by Sioutas et al in preparation for a subchronic experiment that will involve exposure of mice in vivo and respiratory epithelial cells in vitro to concentrated ambient particles (CAP). Since the labor-intensive nose-only exposure regimen is not an option in a long-term experiment, a whole-body exposure mouse chamber was designed specifically for use with the VACES. The exposure system consists of a 5-gallon (20 inches X 12 inches X 6 inches) stainless steel (SS) tub with 32 cubicles (1 mouse per cubicle) separated by perforated SS sheets. The tops of these cubicles are covered with perforated plastic sheets to allow telemetry monitoring during the exposure. In each exposure chamber, six SS tubes (each 22 cm in length) with 15 0.25 mm holes 13.5 mm apart, are used to distribute CAPs evenly throughout the exposure chamber. The exhaust consists of 4 SS tubes (each 40 cm in length), each with 28 0.5 mm holes, covered with a semi-circular urine shield. In addition, a major modification was made to the original design of the VACES to facilitate the operation of the system in a subchronic study: the salt-ice slurry used in the condensation process was replaced by a refrigerated circulator (chiller). Mass flow controllers are used to maintain a constant flow rate through these exposure chambers. For a sham control experiment, the identical system is used, except that a HEPA filter at the inlet to the VACES removes ambient particles. The entire system allows for simultaneous exposure of 64 mice to CAPs, with an equal number of sham- exposed mice as controls. Telemetry receivers have been modified so that 16 mice per group with ECG transmitters can be monitored during exposure. Furthermore, a Biosampler is used to collect CAPs (one sample per day) for the in vitro exposures. A respiratory epithelial cell line (BEAS- 2B) stably transfected with NF-kB-luciferase reporter plasmid is used to assess daily biological activity of ambient PM. We will present the assessment of flow and particle distribution of the exposure chamber as well as preliminary data of in vivo and in vitro responses to CAP. Research supported by: The NYU-EPA Particulate Matter Health Research Center (R827351) and The NIEHS Center Grant (ES00260).

[P03-14] DEVELOPMENT OF A SYSTEM TO ASSESS THE TOXICITY OF SECONDARY COAL COMBUSTION EMISSIONS: THE TERESA STUDY.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:30 PM-9:30 PM) Grand Ballroom 2-4

The Toxicological Evaluation of Realistic Emissions of Source Aerosols (TERESA) study is a comprehensive effort to evaluate the formation and toxicity of secondary particles from coal combustion. To date, the toxicity of coal combustion emissions has been examined only in terms of primary particles, but these emissions may not reflect population exposures because of atmospheric chemistry. TERESA involves on-site sampling of emissions at multiple coal-fired power plants across the U.S., followed by simulation of atmospheric chemistry in a reaction chamber, and exposure of normal and compromised rats. In preparation for fieldwork at the first TERESA study plant in Wisconsin, the sampling apparatus and reaction chamber are currently being developed and tested. Stack samples will be diluted with dry air and introduced into the chamber, where hydroxyl radicals are added to convert SO_2 to sulfate. Light, $NH_{3\ (gas)}$, VOCs, and inert particles are also added. Target mass concentration output from the chamber will be in the range of 200-300 $\mu g/m^3$. Prior to fieldwork, the composition of appropriate mixtures of added chemical species will be estimated using kinetic models and existing plant emission profiles. These models will allow for variation of the mixtures to simulate a range of atmospheric conditions and to predict both gaseous pollutant and particle concentrations. Results of the photochemical modeling and chamber testing will be presented at the PM2003 meeting. Extensive characterization of emissions will be carried out, including gases (CO, CO_2, NO_x, SO_2, O_3, NH_3, hydrocarbons), particle number, size distribution, mass, and composition (including SO_4, NO_3, NH_4, strong acidity, metals, EC, OC, and organics). Aged emissions will enter an exposure chamber in a mobile toxicological laboratory. Normal rats and a susceptible rat model (myocardial infarction) will be exposed to emissions and multiple toxicological endpoints will be evaluated. Particle formation, composition, and toxicity will be compared for different atmospheric conditions and dilution scenarios, providing information on the effects of atmospheric chemistry on the formation of secondary particles and their health effects. The ultimate goal of TERESA is to compare the toxicity of secondary coal combustion and mobile source emissions to better understand the components of PM responsible for adverse health effects. The TERESA study is the first to investigate the toxicity of actual power plant emissions using mobile laboratories, and the first to incorporate secondary atmospheric chemistry.

[P02-03] BEYOND THE HARVESTING EFFECT: MEASURING THE EFFECT OF LONG TERM TSP EXPOSURE ON LIFE EXPECTANCY.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:30 PM-9:30 PM) Grand Ballroom 2-4

In a recent paper, Murray and Nelson (JAWMA, 2000) attempt to quantify the effect of exposure to tsp on life expectancy. Using daily Philadelphia data from 1974 through 1988, they estimate the unobserved atrisk population, and conclude that short term exposure to tsp has a small effect on life expectancy. The main result that exposure to tsp reduced life expectancy by at most 2 days is consistent with what has been termed the harvesting hypothesis.

One weakness of the Murray and Nelson model is that it does not allow entry into the atrisk pool to be affected by longer term exposure to pollution. In this study, we extend the model of Murray and Nelson to allow for the possibility that longer term exposure to tsp influences entry into the pool of atrisk individuals. We postulate the existence of an unobserved atrisk population, and an unobserved process via which individuals are allowed to enter the atrisk population after being exposed to longer term pollution. We use moving averages of tsp to proxy for long run pollution. The model is cast into state space form, and the Kalman filter is used to estimate atrisk population, entry into the atrisk population, and life expectancy.

Our main result is that while longer term exposure to tsp does indeed increase the pool of atrisk individuals, this effect is quite small. Therefore, while the data appear to be inconsistent with the "harvesting only" hypothesis, the effect of longer term exposure to tsp appears to be much smaller than has been indicated elsewhere in the literature.

[P11-15] GAS-PHASE NITRIC ACID AND SULFURIC ACID FORMATION: RESULTS FROM PMTACS-NY SUMMER 2001 CAMPAIGN.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 11: Air Quality Modeling (8:30 PM-9:30 PM) Grand Ballroom 2-4

Hydroxyl (OH) radical, other trace gases such as SO_2, NO_2, nitric acid (HNO_3), and aerosol composition (including nitrate and sulfate) were measured during the PMTACS-NY summer 2001 field campaign at Queens in New York City. These observations provide an opportunity to study the formation rates of gas-phase HNO_3 and sulfuric acid (H_2SO_4) and the relationship between formation rates and concentrations. For gas-phase HNO_3, its concentration followed very well the production from OH reaction with NO_2 for both composite diurnal variation and individual days. This agreement indicates that the reaction of OH with NO_2 was the main gas-phase HNO_3 source and that the HNO_3 deposition rate was very fast in this area. Based on the measured OH, NO_2 and SO_2, the maximum production rates of HNO_3 and H_2SO_4 were about 10 $\mu g\ m^{-3}\ hr^{-1}$ and 0.5 $\mu g\ m^{-3}\ hr^{-1}$, respectively, at midday. On average, the daily cumulative HNO_3 and H_2SO_4 production rates were 135 $\mu g\ m^{-3}\ d^{-1}$ and 5.2 $\mu g\ m^{-3}\ d^{-1}$, respectively. Comparisons with the results from Whiteface Mountain field site (representing a relatively clean environment) show that HNO_3 and H_2SO_4 production rates in New York City were higher by factors of 24 and 13, respectively. Results also show that the nitrate concentrations (in $\mu g\ m^{-3}$) in the particles were lower than the calculated HNO_3 production rates (in $\mu g\ m^{-3}\ hr^{-1}$) by a factor of 10 on average. On the contrary, the sulfate concentrations (in $\mu g\ m^{-3}$) in the particles were higher by a factor of about 15 than calculated gas-phase H_2SO_4 production rates (in $\mu g\ m^{-3}\ hr^{-1}$). This very different relationship between the gas phase production and particle phase concentration of sulfate and nitrate provides useful information about sources and sinks of these important species.

[P11-14] EVALUATION OF NITROGEN DIOXIDE PHOTOLYSIS RATES IN SAO PAULO (BRAZIL).

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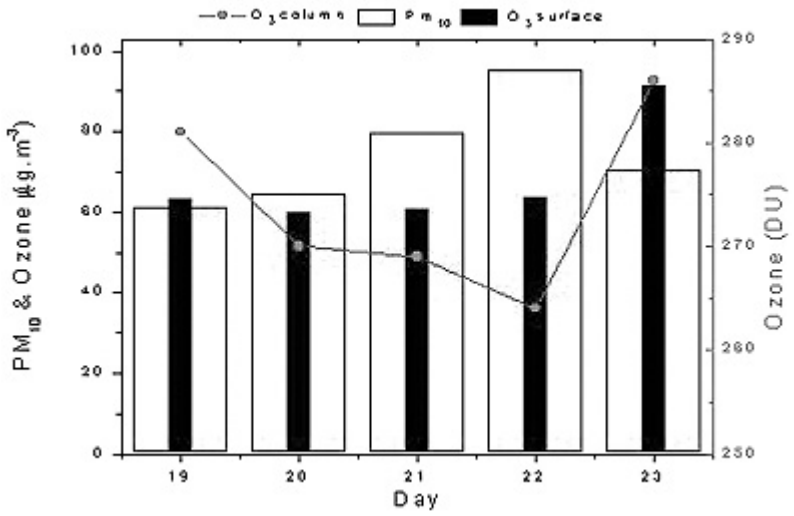
Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 11: Air Quality Modeling (8:30 PM-9:30 PM) Grand Ballroom 2-4

The São Paulo Metropolitan Area with 16 million inhabitants and more than 5 million vehicles has several problems concerning air pollution. A problem which is worrying the community is the ozone concentration, whose values are increasing in spite that other pollutants concentrations are decreasing.

This study is involved in the analysis of NO_2, O_3 and particulate matter relations. Since NO_2 is an O_3 precursor, photolysis rates of this gas were predicted for São Paulo during a specific week in August, 2002, using the Tropospheric Ultraviolet-Visible (TUV) radiation transfer model (NCAR 2000, http://acd.ucar.edu/models). The results correlated particulate, NO_2, O_3 concentrations and meteorological parameters. Optical properties were obtained from Aeronet (Remote Sens. Environ., 66:1-16, 1998) for São Paulo. Urban aerosol concentrations seemed to influence the rates, which decrease when occurs an increase in particles concentrations. In Figure 1 are presented the O_3 and PM_{10} at surface (data from CETESB, the São Paulo State Environmental Agency) O_3 column (data from TOMS) for August, 19 to 23. Aerosol optical depth (AOD), single scattering albedo and the Angstrom parameter alpha are showed in Figure 2. It was observed that urban aerosol can decrease the rates due to the absorption fraction of the particles, and then the decrease of the actinic flux. The single scattering albedo behavior shows also a decrease. The rates decreased through the week and then the O_3 concentrations, as expected. (Click to see figure 1) Figure 1. Ozone and PM_{10} concentrations for August, 19-23 (2002) (Click to see figure 2) Figure 2. Aerosol optical depth (AOD), single scattering albedo and alpha for August, 19-23 (2002)



Figure

[P11-14] EVALUATION OF NITROGEN DIOXIDE PHOTOLYSIS RATES IN SAO PAULO (BRAZIL).
(continued)

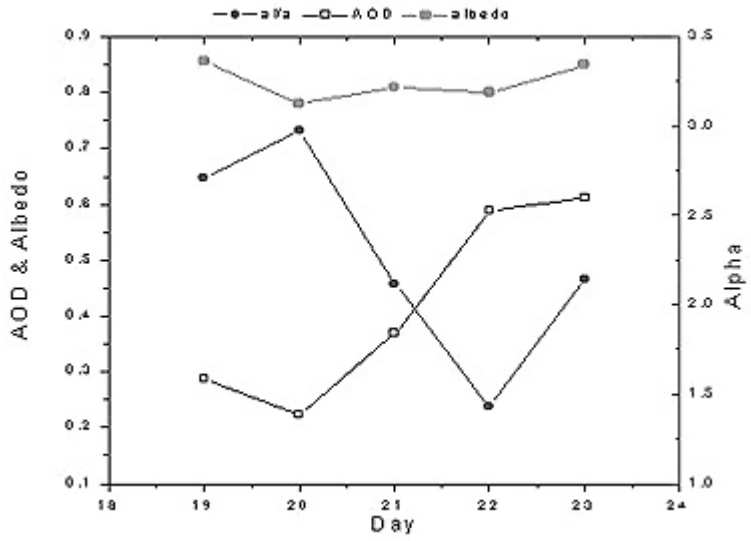


Figure 1

[P11-13] ESTIMATED SCAVENGING COEFFICIENTS OF SOLUBLE AEROSOL FROM OBSERVATIONS IN THE EASTERN UNITED STATES.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 11: Air Quality Modeling (8:30 PM-9:30 PM) Grand Ballroom 2-4

The scavenging of atmospheric aerosol by falling precipitation is a major removal mechanism of airborne particles. This process involves complex interactions between aerosols and hydrometeors and is dependent on precipitation and aerosol properties. Atmospheric aerosol models employ wet scavenging coefficients (WSC) to describe the fate of various aerosol species under precipitation conditions. Given the complexity of precipitation process and the variability in the physical and chemical characteristics of ambient aerosols, the representation of wet removal processes in numerical models requires detailed comparisons with observations. In this work we present: (1) a conceptual microphysical model to estimate the WSC of soluble aerosol by rain; (2) an independent method to estimate average WSC of soluble aerosol (sulfate) based on available data from Eastern United States locations. The paper shows that model calculations of WSC are well supported by the independent estimates from observations and discusses the sources of uncertainties. The study indicates the needed measurements to validate microphysical models of WSC for conditions of interest in atmospheric aerosol modeling.

[P11-12] A PARTICULATE MATTER AIR QUALITY FORECAST MODELING SYSTEM FOR THE NORTHEAST U.S. - COMPARISONS WITH SUMMER 2001 EPA SUPERSITE FIELD INTENSIVE DATA.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 11: Air Quality Modeling (8:30 PM-9:30 PM) Grand Ballroom 2-4

An air quality forecast modeling system (AQFMS), which has run reliable18-hr oxidant air quality forecasts for the Northeast United States for over a year, has been further developed to consider the prediction of PM air quality in the region. The AQFMS was designed to operate with forecasted meteorological fields from either of two mesoscale meteorological models, the Penn State/NCAR Mesoscale Model MM5 or the University of Athens' ETA-SKIRON meteorological model. The meteorological fields are used to drive the Comprehensive Air Quality Model with Extensions (CAMx), a photochemical air quality simulation model.

This prototype system has recently been upgraded to incorporate emissions of SO2, NH3, and primary particulate matter and a rudimentary secondary formation mechanism for sulfate, nitrate and organic particulate matter. Archived meteorological forecasts, generated as part of the PMTACS-NY Supersite Summer 2001 Field Intensive, have been used to re-run the forecasts with updated emissions generated by the SMOKE emission model and the modified chemical mechanism within the CAMx model.

Preliminary assessment of the PM air quality forecast modeling system is presented and forecasted PM model results for the northeast and New York metropolitan areas are compared with measurements performed during the EPA Summer 2001 Supersite intensive field campaign.

[P11-11] SIMULATION OF PARTICULATE MATTER IN SOUTHERN TAIWAN BY MODELS-3/CMAQ.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 11: Air Quality Modeling (8:30 PM-9:30 PM) Grand Ballroom 2-4

Particulate matter is one of major pollutants causing the ambient air quality standard to be exceeded in southern Taiwan, especially during November to February in the following year. The results from field measurements showed that the abundant species in PM2.5 were sulfate, nitrate, ammonia, organic carbon and elemental carbon. In this study, Models-3/CMAQ was used to simulate the particulate matter in southern Taiwan from the 21st to 27th, November 1996 and the simulated results were then compared with field measured data. The meteorological data were provided by MM5 with FDDA and the emission data were from Taiwan Emission Data System version 4.2 (TEDS 4.2) by using SMOKE for stationary, mobile and area sources. The VOCs emitted from biogenic sources were estimated by BEIS2. Four layers of nested grids with the finest grid of 4 km by 4 km, 15 vertical sigma layers, RADM2 and RPM mechanisms were used in the simulation. In southern Taiwan, measured data showed that sulfate concentrations were about 1.5 times greater than those of nitrate. However, the simulated results revealed that nitrate concentrations were about 2 times greater than those of sulfate. But the simulated nitrate concentrations were similar to the observed data and sulfate concentrations were significantly underestimated. Note that the average ratios of measured to simulated NOx and SO2 were 1.4 and 1.1, respectively. That is, both were in good agreement for SO2 and the simulated NOx were slightly underestimated. Therefore, the formation of sulfate was underestimated by RPM in Models-3/CMAQ. The underestimation of ammonia may due to the underestimation of sulfate, because ammonia sulfate was the major compound in secondary aerosol. Based on measured results, carbonaceous species accounted for about 20% of PM2.5 in Kaohsiung City. Thus, the simulated concentrations of organic carbon (OC) and elemental carbon (EC) were underestimated, too. However, the differences between simulated and measured NMHC concentrations were even greater. Therefore, the underestimation of VOCs emission may cause the lower simulated concentrations of OC/EC. Diurnal variation patterns of NO3--N and HNO3-N were similar between simulation and observation data: greater HNO3 concentrations occurred in daytime and the opposite pattern was observed for nitrate. However, the peak concentrations of HNO3 and NO3- were not in the same ranges between simulated and observed data. Additionally, ammonia was highly correlated with sulfate in measured data, but in simulated results, ammonia was strongly correlated with nitrate.

[P11-10] MODELING PARTICULATE MATTER WITH THE COMMUNITY MULTISCALE AIR QUALITY (CMAQ) MODELING SYSTEM DURING THE PACIFIC NORTHWEST 2001 (PNW2001) FIELD CAMPAIGN.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 11: Air Quality Modeling (8:30 PM-9:30 PM) Grand Ballroom 2-4

The Community Multiscale Air Quality (CMAQ) modeling system is examined for its ability to predict particulate material (PM) concentrations in the Pacific Northwest. Particulate matter pollution in the Pacific Northwest is unique due to few large pollution point sources and to the large contribution of biomass burning. The worst particulate pollution occurs on cold, stable, stagnant days when wood stoves are heavily used. Strong inversions trap PM close to the surface and often concentrate it in narrow valleys around the Puget Sound. Summertime PM production impacts visibility in the numerous Class I areas in the region. Transport is important from other urban areas such as Portland, OR and Vancouver, BC as well as from forest fires east of the Cascade mountain crest.

To understand PM and gaseous pollution in this region, Pacific Northwest National Laboratories (PNNL) and others conducted the Pacific Northwest 2001 (PNW2001) campaign in August, 2001. This was done in concert with Pacific 2001, a Canadian study of pollution in the Lower Fraser Valley of British Columbia and northwest Washington. Air pollutants, gaseous precursors, and meteorological variables were measured from the ground and by aircraft within the boundary layer. CMAQ simulations were performed using 12 km and 4 km gridded domains for August 20th, 26th, and 27th, the days when the most intensive observations were conducted. The states of Washington, Oregon, and Idaho as well as Environment Canada provided a ground-up emissions database for this study. MM5 produced meteorological fields using a combination of analysis nudging at the coarse resolution and observation nudging to winds at the fine scale. Sensitivity to analysis and observational nudging and to boundary layer parameterizations is investigated by comparison to observations from surface profilers, PNNL aircraft, and more than one hundred surface sites. The results indicate nudging to a gridded analysis improves meteorological fields throughout the simulation. In addition, the MRF boundary layer parameterization produced more realistic profiles and PBL heights than the Asymmetric Convection Model PBL scheme. The CMAQ modeling results are compared to aircraft and ground measurements of PM size, mass, species, and optical properties.

[P11-08] RELATIVE CONTRIBUTIONS OF PRIMARY AND SECONDARY (BIOGENIC AND ANTHROPOGENIC) ORGANIC AEROSOLS AT NASHVILLE: COMPARISONS OF OBSERVATIONS AND MODELING RESULTS.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 11: Air Quality Modeling (8:30 PM-9:30 PM) Grand Ballroom 2-4

The performance of EPA's Models-3/CMAQ (2002 release) on relative contribution of primary and secondary (biogenic and anthropogenic) organic aerosols was examined and evaluated, paired in time, against observational data from the SOS/Nashville'99 Experiment (June 15 to July 15, 1999). The 12-hour mean ratios of $^{14}C/^{13}C$ measured by radiocarbon analysis were used to determine the fractions of biogenic total carbon (BTC). Organic carbon (OC), elemental carbon (EC) and total carbon (TC) concentrations were measured by a thermo-optical transmission analyzer. The results show that the model captured the temporal variations of observed TC (correlation coefficient (r) =0.90) with slightly higher mean modeled TC concentration (5.4 $\mu g\ C\ m^{-3}$) than the observed TC (4.8 $\mu g\ C\ m^{-3}$). The model slightly overpredicted nighttime observed TC but underpredicted daytime observed TC. The modeled mean fraction of BTC (0.36) was ~44% lower than the observation (0.64). This is due to the fact that the modeled mean BTC concentration (2.0 $\mu g\ C\ m^{-3}$) was 39% lower than the observation (3.2 $\mu g\ C\ m^{-3}$). One of the reasons for the underprediction of BTC by the model is that the model did not include the contribution from the primary BTC. A close inspection of daytime and nighttime cases indicates that the model overpredicted the nighttime OC but underpredicted daytime OC.

[P11-17] COMPUTATIONAL METHODS FOR MULTI-PHASE MULTI-REACTION EQUILIBRIUM PROBLEM - MODELING URBAN AND REGIONAL AEROSOLS.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 11: Air Quality Modeling (8:30 PM-9:30 PM) Grand Ballroom 2-4

Atmospheric particulate matter (PM) models are effective tools to quantify the relationship between sources of air pollutants and their health and environmental impacts. An ubiquitous component of the PM models is the thermodynamic module that simulates the partitioning of chemical species among the gas, aqueous, and solid phases and predicts the total mass and chemical composition of PM. When the temperature and pressure are both constant, the number of phases and the amount and composition of each phase which occurs at equilibrium in nature - the true composition - corresponds to the global minimum of the Gibbs free energy of the system. It is often the case that there are multiple local minima in the minimization approach and multiple solutions the equation solving approach. In this talk, we discuss the issues and challenges associated with multiple local minima and numerical scaling, and approaches to reducing the likelihood of methods giving the wrong solution. We present a new avenue to appropriately predict the phase transition between the aqueous and solid PM phases, based on the reformulation of the optimality system as a nonlinear system of variational inequality type. Consequently, active set based Newton method is developed to obtain robust and stably convergent numerical solutions of multi-phase multi-reaction equilibrium problem. We conclude with numerical experiments, showing that the method is efficient, computationally suitable for its use in 3D Eulerian urban air-shed models.

[P07-01] EVALUATION OF PM10 EMISSIONS FROM AGRICULTURAL OPERATIONS IN SAN JOAQUIN VALLEY, CALIFORNIA.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

In California's San Joaquin Valley (SJV), agricultural operations are a highly complex but potentially significant source of PM10. In late summer and fall a large fraction of PM10 is attributed to soil dust (Chow et al., 1992) becoming airborne due to agricultural activities.

We have used point sampler arrays to evaluate PM concentrations (vertical point sampler profiles) and calculate point sampler emission factors. However, because of many limitations associated with point sampler techniques, especially limited spatial resolution in the vertical direction, the results may significantly underestimate the plume concentration and result in underestimates of emission factors (Holmén et al., 2001).

Application of lidar (Light Detection and Ranging) to PM measurements will be presented. Data collected with point samplers and CNL lidar (simultaneously) during a variety of agricultural operations in the summer and in the fall of 2000 will be reported. Analytical methods developed in our laboratory will show lidar contribution to clarify if the shapes of plumes measured as three-point PM vertical profiles are representative of the average plumes recorded during the sampling period and help to determine the dust plume height which should be considered for integrating the modeled PM10 concentrations.

The relationship between the amount of PM10 generated from the soil during agricultural practices and the soil texture measured by clay, silt and sand content (Carvacho et al., 2002) will be establish for these series of experiments.

Results will be presented showing comparisons between three-point PM vertical profiles (for selected tests), averaged vertical profiles obtained from the lidar two dimensional (2D) scans and PM10 index values calculated for corresponding soils. Further, soil moisture content measured during summer and fall studies will be presented and correlated with emission factors calculated based on PM models and verified with lidar (Holmén et al., 2001).

[P01-13] SOUTHEASTERN AEROSOL RESEARCH AND CHARACTERIZATION (SEARCH) STUDY: KEY FINDINGS FOR POLICY MAKERS.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 1: The NARSTO North American PM Assessment (8:30 PM-9:30 PM) Grand Ballroom 2-4

The Southeastern Aerosol Research and Characterization (SEARCH) study began in mid-1998 and is supported through 2005. The SEARCH network consists of 8 research sites in 4 urban-rural or urban-suburban pairs, each of which is routinely measuring an extensive set of gases, particuate matter (mass and composition in fine and coarse mode), meteorology and extinction. In addition to 24-hr integrated samples for PM, many measurements, including major components of PM, are made at temporal resolution of one-hour or less. Among it's many objectives, SEARCH is aimed at providing information for policy makers as they decide how to address the air quality issues they face, (e.g., the PM and ozone NAAQS, and regional haze).

This poster will illustrate and summarize key messages that the SEARCH data support. These messages include:

· Carbonaceous material (elemental carbon plus organic carbon *1.4) makes up the largest fraction of fine PM; sulfate is the second major component.

· Organic carbon and sulfate are largely regional in nature. However, organic and elemental carbon account for almost all of the difference between urban and rural fine PM, thus providing evidence of important local contributions to EC and OC.

· Wood smoke from various sources is an important component of organic carbon across the southeast, especially in winter and spring.

· Coarse particulate matter has substantial carbonaceous material. These should be included in any future speciation plans.

· There are many ways to display the composition of particulate matter. The perceived message can be dramatically different depending on which method is used. Therefore, definitions and assumptions should be provided by the author and demanded by the reader.

· SEARCH uses two approaches to illustrate relative composition. The first of these seeks to explain mass reported on FRM filters. The second seeks to explain mass as it exists in the real atmosphere; that is, independent of biases imposed by the FRM sampling methodology.

· All SEARCH sites are in attainment relative to the daily and annual NAAQS for fine mass, except those near downtown Birmingham, AL (N. BHM) and Atlanta, GA (JST), both of which exceed the annual standard only.

· Saharan dust and sea salt represent intermitten sources of fine mass with annual contributions of roughly 0.5 - 0.75 μg/m3.

· FRM Biases can have an important effect on attainment status as well as spatial interpretation of fine mass data. Two important biases identified to date include: 1) failure to blank correct data: and 2) differences between vendors of FRM samplers.

[P01-12] DIURNAL CYCLES AND SPORADIC EVENTS IN THE SAINT LOUIS AEROSOL.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 1: The NARSTO North American PM Assessment (8:30 PM-9:30 PM) Grand Ballroom 2-4

The Saint Louis - Midwest Supersite is generating long (year+) time series of high-quality hourly concentration data for a variety of gas and particle species. The resulting data streams are novel in their combined temporal and chemical resolution, and present correspondingly novel challenges and opportunities for analysis. From the emissions-management perspective, patterns of temporal behavior and meteorological associations carry information that can help to distinguish pollutants from different source categories. As examples, diurnal cycles of surface concentration reflect differing mixes of tail-pipe and tall stack emissions during nocturnal inversions and daytime convection; concentrations of local emissions are more sensitive than those of distant emissions to variations in local wind speed; emissions from some point sources may be confined to certain wind sectors. From the health perspective, long time series make it possible to assess whether routine 24-hour samples provide an adequate measure of community exposures. In particular, it is only through such series that the potential for threshold effects from non-periodic and short-lived concentration excursions can be examined.

This presentation examines the first year of data for PM-2.5 mass, sulfate, black carbon, elemental and organic carbon, and aerosol number together with the standard criteria gases and surface meteorological variables. Two-dimensional distributions of mean concentration vs. the peak/mean multiple illustrate how simple screening plots can reveal differing patterns of intra-day variation and highlight unusual days. Diurnal cycles, averaged over all observations and over subsets exhibiting selected conditions of concentration or meteorology, can reveal source fingerprints that are obscured in 24-hour data.

[P01-11] A SPATIO-TEMPORAL AEROSOL CLIMATOLOGIC CONTEXT FOR THE SAINT LOUIS-MIDWEST SUPERSITE.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 1: The NARSTO North American PM Assessment (8:30 PM-9:30 PM) Grand Ballroom 2-4

Conceptual models that capture key features of an airshed's emissions and meteorological characteristics can illuminate observed patterns of ambient aerosol behavior. Such models can be developed by analyzing aerosol characteristics in terms of local surface meteorologic parameters and broader spatio-temporal patterns in weather and aerosol climatology. Numerous tools are now available to support such investigations. This presentation will demonstrate the application of selected tools/strategies for the St. Louis - Midwest Supersite data.

One strategy focuses on the integration of synoptic scale weather patterns into the particulate matter chemical composition data set. The great multiplicity of parameters potentially relevant to synoptic scale weather motivates the search for classification schemes that reduce synoptic weather patterns to relatively few distinct types. Examples of such schemes include clustered air mass back trajectories (e.g., S.R. Dorling et al., *Atmos. Environ., 26A*: 2575-2581 (1992)) and hybrid manual/automatic synoptic-weather typing (e.g., S.C. Sheridan, *Int. J. Climatol., 22*: 51-68 (2002)). This presentation will present and interpret frequency distributions for aerosol mass and selected aerosol chemical components as stratified by the synoptic scale weather classes.

A second strategy combines visual representations from multiple sources into a single "picture" of the aerosols' multi-dimensional characteristics, such as distribution in space and time (x,y,z,t), with respect to particle size, and chemical composition. Two classes of tools for conducting multivariate pattern and trend analyses will be presented. A 'virtual wall' has been developed to replace taped-up plots in hallways for data visualization. Consisting of side-by-side views of different data, it provides an effective method for capturing and assessing relationships among aerosol parameters. The 'wall' is particularly effective for temporal analysis in the form of animations. An example 'wall' configuration includes pollutant concentrations, times series, weather maps, trajectory plots, satellite imagery and web cams. A second class of tools fuses multiple data into a single map or time view to identify similarities or reconcile differences in spatio-temporal patterns. A common set of fusion tools are geographic information systems (GIS) that overlay data for spatial analysis.

[P01-10] OVERVIEW OF THE SAINT LOUIS - MIDWEST SUPERSITE.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 1: The NARSTO North American PM Assessment (8:30 PM-9:30 PM) Grand Ballroom 2-4

The Saint Louis - Midwest Supersite is a comprehensive research effort to provide physical and chemical measurements of ambient particulate matter in a setting broadly representative of the urban Midwest. One of the eight EPA-funded Supersites, the Saint Louis - Midwest Supersite is a public/private partnership that features significant leveraging of resources. The regional characteristics of St. Louis and its historical prominence as one of the original 'Six-Cities Study' sites has provided an ideal opportunity for the confluence of a number of air pollution health and epidemiology studies with this Supersite. This presentation will summarize the project's overarching objectives and measurement strategy; as such, it serves as a roadmap for the emerging data streams and other work products. In particular, this presentation will highlight: characteristics of the Saint Louis area that influence the measurement observations (e.g., climatology, emission sources), synergies with exposure and health effects studies and particulate matter model evaluation studies, and efforts to characterize and improve a battery of research-grade, prototype and commercially-available instruments subjected to sustained operation for a two-year period.

[P01-09] LINKAGES ACROSS PM POLICY AND RESEARCH: EXAMINING THE POLICY RELEVANT FINDINGS FROM THE PM2.5 SUPERSITES PROGRAM.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 1: The NARSTO North American PM Assessment (8:30 PM-9:30 PM) Grand Ballroom 2-4

The PM2.5 Supersites program was designed to complement routinely operating PM2.5 networks by providing enhanced temporal and chemical/physical composition data in addressing three overarching objectives: supporting health effects and exposure research, advanced monitoring methods development and testing, and increased air quality characterization in support of national and State emission reduction strategies. As the Supersites are in the final stages of an intensive measurement campaign in eight cities across the United States that commenced in 1999, the program is expected provide relevant information for the technical assessments underlying development of national and State implementation plans (SIPs) that currently are underway and expected to continue over the next five years. The objective of this paper is to illustrate the program design attributes and highlight selected preliminary findings from the Supersites, and related PM research efforts, that should support these planning efforts.

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[P07-13] THE COMPARISON BETWEEN THERMAL OPTICAL TRANSMITTANCE ELEMENTA CARBON AND AETHALOMETER BLACK CARBON MEASURED AT MULTIPLE MONITORING SITES.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

As a part of the University of Rochester Particulate Matter (PM) Center study and the Philadelphia summer intensive PM program, a semi-continuous organic carbon / elemental carbon (OC/EC) analyzer (Sunset Lab) and a two-wavelength Aethalometer (AE-2, Megee Scientific Company) were operated simultaneously. The OC/EC analyzer was operated every two-hour resolution using both optical transmittance (λ= 680 nm) and thermal/optical transmittance. The Aethalometer measured black carbon (BC) and polycyclic aromatic hydrocarbon PM (UVPM) using their light absorption (λ= 880 and 350 nm, respectively). In addition, daily integrated filter samples were collected to measure the integrated OC/EC carbon fractions using the convential laboratory system.

During the Rochester intensive program conducted between June 6 and 18, 2002, BC and UVPM were approximately same and highly correlated (r^2 = 0.98, slope = 0.91). Thermal EC and optical EC were highly correlated and the thermal EC was about 11 % higher than the optical EC. BC was more correlated with optical EC (r^2 = 0.78) than thermal EC (r^2 = 0.72). However, BC was much higher than the optical EC. During the Philadelphia summer intensive PM program measured between July 10 and August 3, 2002, UVPM was approximately 18% higher than Rochester UVPM. The correlation coefficient between optical EC and BC (r^2 = 0.78) was consistent with the correlation coefficient of Rochester study. Also, BC was 30% higher than the optical EC indicating inclusion of light-absorbing OC in Aethalometer BC.

[P07-12] A REMOTE SENSOR FOR VEHICLE EXHAUST PARTICULATE MATTER.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

There is a need to establish vehicle emission inventories. A recent promising approach is to measure the emissions from many on-road vehicles. The major gaseous pollutants in vehicle exhaust - hydrocarbons, carbon monoxide, and nitrogen oxide - have been measured via roadside remote sensing for a number of years. Technology for the measurement of particulate matter (PM) in vehicle exhaust is less well developed. Opacity measurements of vehicle exhaust plumes have been made, but the technique generally suffers from a lack of sensitivity and opacity is only a measure of elemental carbon, but not of PM mass.

We describe a PM measurement system using a pulsed ultraviolet (266 nm) laser that utilizes a light detection and ranging (LIDAR) system to measure the PM-sensitive backscattered light in addition to the extinction of the transmitted beam (opacity). Light from a laser pulse is partially scattered back toward the system by particles in the exhaust plume. The backscattered light is used as a sensitive measure of PM mass density. This is complemented by a transmission measurement resulting in a UV opacity that quantifies PM mass density for very dense plumes. Therefore, PM mass densities can be measured over a broad range of sparse and dense vehicle exhaust plumes. Simultaneous with the PM measurement, an infrared source is used to quantify the carbon dioxide content of a similar column. The ratio of PM to carbon dioxide gives a fuel-based PM emission rate (units of milligrams of PM per kg of fuel). Ambient PM background is measured before the vehicle passes by the system and subtracted from the total PM concentration measured after the vehicle, yielding the vehicle's PM emission.

Inversion of the road-side measurements requires a laboratory calibration as well as a number of assumptions about the PM. Assumptions about the particulate characteristics are necessary to calculate the single-particle backscatter and extinction cross sections needed to predict the received power that will be measured by the system. Backscatter and extinction cross sections are calculated for solid spheres of organic carbon to represent the exhaust particles from spark-ignition vehicles and for layered spheres consisting of a core of elemental carbon surrounded by a shell of organic carbon to represent the exhaust particles from diesel-powered vehicles. A log-normal size distribution with a specific particle mass median diameter is assumed. On-road PM measurements from nearly 150,000 vehicles are analyzed in a companion poster.

[P01-14] THE STATISTICAL ANALYSIS OF PM 2.5 IN ATLANTA: AN APPLICATION TO THE CONTROL STRATEGY.

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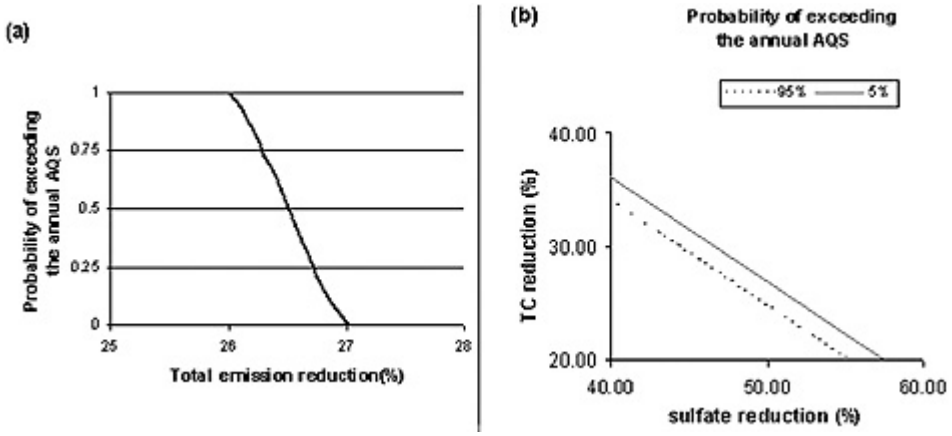
Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 1: The NARSTO North American PM Assessment (8:30 PM-9:30 PM) Grand Ballroom 2-4

Speciated, daily PM2.5 levels for Atlanta, GA are analyzed to develop the underlying distributions. Using these distributions, the levels of control needed to meet the NAAQS, and the of success, were assessed for varying levels of reductions in sulfate and organic carbon, the two dominant species found in Atlanta's fine particulate matter. In this case, data from three sites in Atlanta were used: Fort McPherson., South Dekalb and Tucker, with data available from 1999 to 2002. The measured annual PM2.5 mass concentrations in Atlanta are generally higher than the 15 μg/m3 standard: 19.1 μg/m3 at the Fort McPherson site, 17.0 μg/m3 at South Dekalb and 20.2 μg/m3 at Tucker. While occasional values were above the 65 μg/m3 daily standard, the 98th percentiles of daily concentrations were not: 39.4 μg/m3, 38.5 μg/m3 and 46.5 μg/m3, at Fort McPherson, South Dekalb and Tucker, respectively. Using the probability distributions found for sulfate and carbon at each site, and assuming a linear reduction in each pollutant in response to controls (which is open to question), the necessary reductions in each pollutant, and their combinations, were calculated. However, because of the limited number of the observed annual mean concentrations, instead of calculating the required reduction of the total emission sources directly, as the total emission sources were reduced, the probability to exceed the annual AQS was calculated. Fig.1 shows the probability of exceeding the annual NAAQS in Tucker for varying levels of emission reductions. Fig. 1also shows the probability to exceed the annual NAAQS when either TC or sulfate or combinations are reduced. In this case, it was found that the distributions lead to a relatively tight response, i.e., the difference of 1% reduction in levels corresponds to either a nearly 100% chance or negligible chance of meeting the NAAQS. The reasons for this finding are explored, along with the reasonableness. (Click to see figure 1) Fig.1. The probability of exceeding the annual AQS. (a) is as the total emission sources are reduced. (b) is when the TC and the sulfate are reduced.



Figure

[P07-10] NEW INSIGHTS INTO THE DYNAMICS OF SOURCES OF FINE PARTICULATE MATTER USING SEMI-CONTINOUS CHEMICAL SPECIATION SAMPLERS.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

Much of the current understanding of the dynamics of the sources of atmospheric fine particulate matter is derived from laboratory based chemical analyses that are performed on 24-hour averaged samples. As new instruments have come available to measure the chemical composition of fine particulate matter on a semi-continuous basis, new opportunities have arisen to better understand the dynamics of fine particulate matter sources. Such instruments, including semi-continuous fine particle mass, organic and elemental carbon (ECOC), sulfate ion, nitrate ion, and trace metals have been operated at the St. Louis- Midwest Supersite since the spring of 2001 and will continue to operate until the spring of 2003. Examination of the hourly averaged data from these instruments over this extended sampling period provides information of the frequency and duration of source impacts including high concentrations of organic carbon and trace metals that are sustained for periods in the range of a few hours. Likewise, the temporal patterns of secondary ion including sulfate and nitrate ion show significant differences among different days. It is of great importance that these events are virtually impossible to detect using 24-hour averaged fine particle concentration data. Furthermore, they can be masked in the summary statistics (e.g., seasonal mean diurnal profiles) commonly used to characterize aerosol climatology for higher time resolution data. Examples will be presented for specific days that have similar daily average fine particle compositions but drastically different peak concentrations and temporal patterns. As efforts continue to better understand the relationship between atmospheric fine particle concentrations and public health, there is a need to better understand impact of the dynamics of the components of atmospheric fine particulate matter.

[P07-05] DIURNAL PATTERNS IN $PM_{2.5}$ MASS AND COMPOSITION AT A BACKGROUND, COMPLEX TERRAIN SITE.

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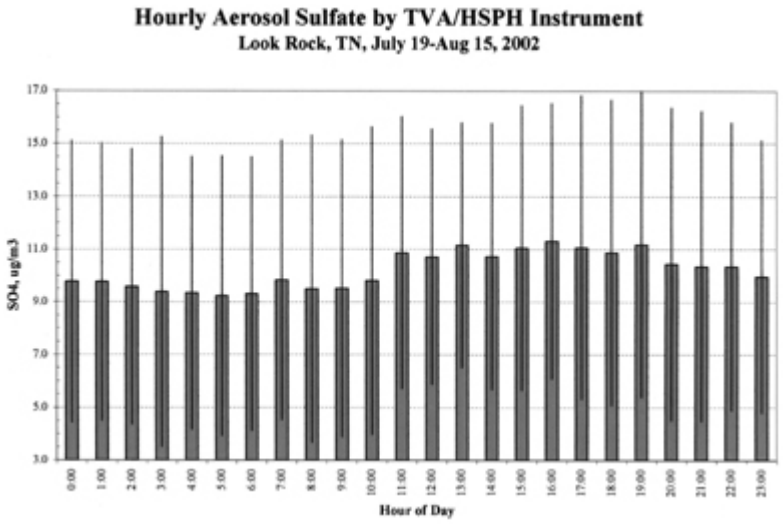
Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

Current fine particle NAAQS specify 24-h integrated mass measurements as the compliance metric. The value of continuous short-time resolution (1h or less) sampling is, however, recognized and being including in US EPA monitoring strategies. An extensive body of mass concentration data has been acquired using continuous $PM_{2.5}$ TEOM monitoring at Look Rock, TN, along with trace gas measurements. This data set has now been augmented by continuous sampling for sulfate (2 methods) and black carbon during enhanced monitoring periods at the site. We compare the 12- and 24-h averaged values with mass and compostion data from integrated samplers, then report the diurnal variations in concentrations from continuous monitoring for 3 summers (see Figure for summer, 2002, sulfate data) and for more limited periods throughout the year. The role of upslope-downslope circulation and daytime production processes on the observed diurnal variability are discussed. These factors appear to largely control the observed diurnal patterns, and do influence the time variability of concentrations leading to pollutant exposure in the complex terrain environment of the Great Smoky Mountains National Park. (Click to see figure 1)



Figure

[P07-09] LASER-INDUCED BREAKDOWN SPECTROSOPY (LIBS) FOR ELEMENTAL ANALYSIS OF AMBIENT PARTICLES: DATA FROM THE PITTSBURGH SUPERSITE.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

Laser-induced breakdown spectroscopy (LIBS) is increasingly under consideration as a method for rapid elemental analysis applied to multiple media. Applications of LIBS typically employ a pulsed laser with a high peak power to form a spark (breakdown) in the medium to be examined. In gases, the temperature of the resulting plasma at short times (< 10 microseconds) is in the range of 10,000 - 15,000 K, hot enough to dissociate molecules into their constituent atoms, and to excite the electrons in the neutral atoms and ions formed in the plasma out of the ground state and into excited electronic states. As the plasma cools, excited electrons and ions relax back into their ground states, emitting light at characteristic atomic frequencies. Identification of the atoms present in the sample volume occurs using well-known atomic emission lines, and quantification of the elemental species concentration occurs via quantification of the intensity of the emission lines.

LIBS has been used for elemental analysis of ambient particles at the Pittsburgh Supersite. Individual particles are interrogated to determine elemental distributions. Data from a week-long measurement campaign revealed a predominence of Na, Mg and Ca in the sampled particles, with smaller numbers of Cr, Mn, Fe, and Cu-containing particles. Several multi-element particles were observed. Detection limits for the method are on the order of 20 - 100 fg, depending on the element. This paper will focus on the application and potential of the method, data processing, the implications for monitoring, and the potential for source / receptor measurements.

[P07-08] QUALITY CONTROL OF CONTINUOUSLY SIZE-FRACTIONATED FINE AND ULTRAFINE PARTICLE DATA.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

Aerosol technology has recently advanced to detect fine and ultrafine particles in semi-continuously size-fractioned data for short time-intervals, such as those generated by Scanning Mobility Particle Sizer (SMPS) and Aerodynamic Particle Sizer (APS). Aside from applauding tremendous amount of data available, investigators encounter a new challenge of quality control issue of such data. In addition to assure that the instruments are operating in proper procedures and conditions, potential outliers may occur from inherent and unknown mechanisms, which could heavily influence estimation of summary statistics. In this report, a two-stage approach is presented to identify potential outliers so that the integrity of good data is maintained without distortion by the outliers and the potential mechanisms of generating such outliers can be investigated. The first stage considered the entire spectrum of size-fractionated data by date-time as a whole. Total concentration, representing the overall magnitude of the group, and the coefficient of variation (CV), representing the relative strength of group variability, were used to partition the data into four distinct sub-groups. In each sub-group, the second stage of potential outlier screening was employed, by taking into accounts the relative spike and a modified Z-score of each observation, to identify potential outliers. Based on the results from the first stage analyses, we found normal (mass and good) data of particle number concentrations generated by SMPS were contaminated with data of four distinct outlier patterns, one was known due to instrument error and the other three were probably due to inherent and unknown mechanisms of SMPS. The second stage effectively identified potential outliers (high sensitivity and specificity) and revealed the pattern of outliers was consistent within each distinct group. Unlike those of SMPS, APS data were rarely contaminated with potential outliers. In conclusion, the proposed new approach is a useful quality control tool to identify potential outliers in semi-continuously size-fractioned data.

[P07-07] PARTICULATE MATTER MASS CONCENTRATION MEASUREMENTS AT THE SAINT LOUIS - MIDWEST SUPERSITE.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

The St. Louis - Midwest Supersite features an extensive array of equipment designed to measure ambient particulate matter mass concentrations. As of November 2002, eighteen months of data have been collected at the East St. Louis (IL) core site. Daily filter-based mass measurements at this site include 24-hour integrated PM-1 by sharp cut cyclone and 24-hour integrated PM-2.5 and PM-10 by Harvard Impactors. Hourly PM-2.5 mass concentrations are obtained using two semi-continuous colocated Andersen CAMMS. In addition to these sustained daily measurements, a medium-volume dichotomous sampler (PM-2.5 and PM-10 cuts) samples on alternating days. To complement these measurements, in March 2002, the Supersite deployed a Rupprecht and Patashnick PM-2.5 TEOM (operating at 50°C). Adjacent to the site, the Illinois Environmental Protection Agency operates a MetOne PM-2.5 Beta Attenuation Monitor, Andersen PM-2.5 FRM (1-in-3 day schedule), Andersen SA1200 PM-10 sampler (1-in-6 day schedule), and GMW/Andersen 2310 TSP sampler (1-in-12 day schedule). This measurement matrix provides not only a robust data stream for aerosol climatologic assessment but also an extensive data set for evaluating the intercomparability of the various measurement methods.

This presentation will summarize our experience with the aforementioned mass concentration monitors at the St. Louis - Midwest Supersite. Emphasis will be placed on the following issues: measurement precision for the Andersen CAMMS; comparisons of the CAMMS data to 24-hour average filter-based mass concentration and hourly-average TEOM mass concentrations; analyses of meteorology and aerosol composition to explain the variations in CAMMS mass and TEOM mass compared to filter mass; and a comparison of the PM-2.5 FRM to other PM-2.5 mass data streams.

[P07-06] CONTINUOUS ULTRAFINE PM MEASUREMENTS IN SOURCE AND RECEPTOR SITES OF THE LOS ANGELES BASIN AND RELATION TO PM2.5 MASS, CHEMICAL COMPOSITION AND SOURCES.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

Population exposure to ambient particulate matter (PM) has received considerable attention due to the association between ambient particulate concentrations and mortality. Recent toxicological studies and controlled human and animal exposures suggest that ultrafine fractions of PM may be responsible for observed health effects. Recently, technologies for continuously measuring coarse and fine PM mass concentrations have been developed and/or improved. A device to continuously measure ultrafine PM mass concentrations based on beta attenuation has now been developed and characterized as part of the activities of the Southern California PM Center and Supersite in Los Angeles, CA.

In this study, two different Beta Attenuation Monitors (BAMs) are employed to measure ultrafine and PM2.5 mass concentrations. The BAM for measuring ultrafine PM is preceded by a 150 nm cut point low pressure drop impactor. Both the BAMs are operated for 2-hour cycles at a typical urban site near a freeway. Among the other instruments co-located with the BAMs are an SMPS (Scanning Mobility Particle Sizer), an APS (Aerodynamic Particle Sizer), an ESP differential TEOM and an Aethalometer.

The main objectives of this study are to document diurnal variation in the ambient ultrafine PM and PM2.5 mass concentrations and to compare the BAM measurements with time-integrated impactor measurements as well as continuous data from the SMPS, APS, and TEOM in source and receptor areas of the Los Angeles Basin (LAB). These data will be presented in context with wind speed and direction and traffic density. The degree of temporal correlation between the ultrafine and fine PM modes is of particular interest because it yields insight into the contributions of particular sources to each mode.

Results in the receptor areas of the LAB show low correlation between ultrafine and PM2.5 mass concentrations, demonstrating that continuous PM2.5 measurements cannot predict UF mass. By contrast, much higher associations between PM2.5 and ultrafine mass concentrations, as well as total particle counts and EC concentrations, are observed in source (urban) sites of the LAB, leading to the conclusion that vehicular sources are the main contributor to PM concentrations at these sites. Our comparison shows that there are significant differences in the diurnal pattern of the ultrafines at the source and the receptor site. Data on the chemical composition of ultrafine PM between these two locations will also be presented.

[P07-04] THE RELATIONSHIP BETWEEN BOTH REAL-TIME AND TIME-INTEGRATED COARSE AND FINE PARTICULATE MATTER AT AN URBAN SITE IN LOS ANGELES.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

Population exposure to ambient particulate matter (PM) has received considerable attention due to the association between ambient particulate concentrations and mortality. Current toxicological studies and controlled human and animal exposures suggest that all size fractions of PM may be responsible for observed health effects. Recently, technologies for continuously measuring coarse and fine PM mass concentrations have been developed and/or improved.

In this study, coarse (PM_{10}-$PM_{2.5}$) and fine ($PM_{2.5}$) PM mass concentrations near a typical urban site are measured with both continuous sampling devices and a time-integrated sampler. The collocated continuous monitors include: a Beta Attenuation Monitor (BAM) to measure $PM_{2.5}$, an ESP differential Tapered Element Oscillating Microbalance (TEOM) to measure $PM_{2.5}$, a Scanning Mobility Particle Sizer (SMPS) and Aerodynamic Particle Sizer (APS) to measure both coarse and fine PM, and a Continuous Coarse Monitor (CCM) to measure coarse PM. This device consists of a 2.5 μm cutpoint virtual impactor placed upstream of a Tapered Element Oscillating Microbalance (TEOM). Time-integrated samples are taken every sixth day with a Micro-Orifice Uniform Deposit Impactor (MOUDI).

The main objective of this study is to document both short-term and diurnal variation in ambient fine and coarse particulate mass concentrations with respect to each other while considering the effects of sources, weather, wind speed and wind direction. Of particular interest will be how well each size fraction tracks the other, for this will yield insight on the contributions of particular sources to each mode during various conditions.

[P07-02] A NEW INSTRUMENT FOR MONITORING NUMBER AND MASS OF AMBIENT PARTICLES: LABORATORY AND FIELD EVALUATIONS.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

Current air quality standards are based on particle mass concentration and consequently various instruments are available for mass measurement. However, there are other metrics, such as number concentration, which, according to recent studies, may be more closely related to health effects resulting from atmospheric particulate matter than just mass (measured for example as PM10). For such metrics there is currently a lack of suitable instrumentation for monitoring purposes. Since it is not yet clear which of these metrics best correlates with the health effects, simultaneous monitoring of both particle mass and number would be useful especially in urban areas.

A novel real-time particle-counting instrument has been developed in an attempt to achieve this aim. It is capable of counting particles with diameters from approximately 10 nm to 10 μm in several size ranges. The instrument uses a parallel combination of optical counting for larger particles plus condensation nucleus counting for the smallest sizes. Gravimetric sampling of PM10 or PM2.5 provides the possibility of comparing the measured number concentrations with widely used mass concentration standards and with mass measurements from other instruments.

The new instrument was calibrated in the laboratory using standard PSL aerosol and sodium chloride particles and comparing its performance with that of a condensation particle counter (CPC) from TSI (model 3010). The performance was then further evaluated in field trials at various sites including a monitoring station in Birmingham (UK) city centre, a site mainly influenced by traffic emissions from major roads. Results are reported from this site, at which the instrument was collocated with a CPC (TSI model 3022A) and a TEOM. Very good correlation was observed between the ultrafine particle concentration indicated by the new instrument and the total number concentration measured by the CPC. Mass concentration calculated from the particle numbers in the various size fractions correlated well with the values measured by TEOM, implying that the number-to-mass conversion method could be used for near real-time monitoring of PM10 as well. The correlations between the new instrument and the TEOM and CPC data as function of particle size are also discussed. The number and mass concentrations from this field trial have been further analysed in relation to source distribution in and around the sampling site and various meteorological parameters.

[P07-20] CONTINUOUS MEASUREMENTS OF PM2.5 SULFATE, NITRATE AND AMMONIUM IN SEARCH.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

Filter-based measurements of fine particulate mass and composition are valuable for understanding bulk characteristics of atmospheric aerosols. They are, by definition, the basis for determining attainment status relative to National Ambent Air Quality Standards for PM2.5. Filter methods are also useful for calculating mass balance and extinction budgets, and for evaluation of spatial patterns and secular trends. On the other hand, long integration times for filter measurements (typically 12 to 24 hours on a sustained basis) limit insight into particle dynamics. Processes that govern particle concentration and composition do not take place over discrete 24-hour periods; rather, they occur over periods of minutes to hours to days. Continuous or semi-continuous methods are required to observe short-term processes and to challenge our understanding of particle formation and transformation, deposition, transport and accumulation. The SEARCH study uses continuous techniques to measure PM2.5 mass and composition at 8 sites in the southeastern U.S., on time scales ranging from 5-minutes to 1-hour. PM2.5 mass is measured with an R&P model 1400a/b TEOM maintained at 30C and equipped with a nafion drier. Carbon (organic, elemental, total) is measured with an R&P Model 5400 particulate carbon monitor and an Andersen aethelometer (elemental only). Sulfate is measured with a modified Harvard School of Public Health (HSPH) continuous sulfate analyzer. The HSPH technique involves reduction of sulfate to sulfur dioxide on a hot (875C, or higher) stainless steel converter, followed by pulsed UV-fluorescence detection of sulfur dioxide. Interfering species, sulfur dioxide and reduced sulfur gases, are scrubbed upstream of the converter. Ammonium and nitrate are measured using a multi-channel analyzer designed by ARA. In this approach, ammonium and nitrate are selectively converted to NO and detected via ozone chemiluminescence. This poster will present results of field measurements using the above continuous analyzers. Data will be compared with filter-based measurements for a several SEARCH sites and overall operating characteristics will be described. Observations for a number of settings (e.g., rural, urban and coastal) will be described and contrasted.

[P03-01] RATIONALE AND DESIGN OF THE CARDIOVASCULAR LINKAGE BETWEEN ENDOTHELIAL DYSFUNCTION AND AIR POLLUTION (CLEAN AIR) STUDY.

Robert D Brook, Jeffrey R Brook, J Tim Dvonch, Sanjay Rajagopalan, Jack R Harkema, Bruch Urch, Renaud Vincent, Frances Silverman, Gerald J Keeler Internal Medicine, University of Michigan, Ann Arbor, MI; University of Toronto, Toronto, ON, Canada; School of Public Health, University of Michigan, Ann Arbor, MI; Michigan State University, East Lansing, MI; Health Canada, Ottawa, ON, Canada

Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:30 PM-9:30 PM) Grand Ballroom 2-4

Objective: The aim of this abstract is to introduce the rationale and design of the CLEANAIR study, a series of human clinical experiments to be jointly performed at the Universities of Michigan and Toronto.

Background: Short-term inhalation of concentrated ambient fine particles (CAP) plus ozone causes acute arterial vasoconstriction in healthy adults. Vascular endothelial dysfunction and arterial vasoconstriction may be important biological linkages between air pollution exposure and increased cardiovascular morbidity. However, the biological mechanisms responsible are unclear.

Hypotheses: The chief hypothesis of this research is that alterations in vascular reactivity following exposure to CAP and ozone are key mechanisms linking air pollution exposure with cardiovascular events. We hypothesize that the previously observed vascular dysfunction results from systemic inflammation (pro-inflammatory cytokine release) and oxidative stress that triggers enhanced vascular expression of endothelins and reduces endogenous vasodilator production. Secondary hypotheses are that the vascular dysfunction significantly impacts systemic hemodynamics, increases blood pressure, and reduces blood flow. We also intend to identify the specific air pollution components responsible for the detrimental impact on human vascular function.

Design: CLEANAIR consists of two separate double-blind, cross-over studies using controlled human exposures to CAP + ozone. A new mobile human exposure facility (AirCARE 1) will be employed at the University of Michigan to focus on the underlying biological mechanisms. AirCARE 1 is the result of a joint collaboration between the University of Michigan and Michigan State University. The effects of pre-exposure treatments with anti-oxidants and endothelin receptor blockade on the vascular responses to air pollution exposure will be investigated compared to placebo. The exposure facility located at the University of Toronto will be used to investigate the importance of CAP versus ozone, as well as specific particle constituents, in the etiology of the vascular dysfunction following air pollution exposure.

Conclusion: The CLEANAIR study will provide important information regarding the biological mechanisms linking air pollution with increased cardiovascular morbidity and mortality.

[P07-11] MEASUREMENTS OF PARTICLE INORGANIC AND ORGANIC CHEMICAL COMPOSITION WITH THE PARTICLE-INTO-LIQUID SAMPLER (PILS).

Rodney J Weber, Doug Orsini, Amy Sullivan, Yilin Ma, Kari Meier Earth and Atmospheric Sciences, Georgia Tech, Atlanta, GA

Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

We describe the latest developments of a new instrument for near real-time quantitative measurements of bulk aerosol particle chemical composition. The device continuously captures particles into a small flow of purified water. This flow may then be analyzed by existing analytical chemical techniques for measurements of the dissolved aerosol particle chemical composition. Coupled to a dual channel ion chromatograph (IC), the instrument is capable of measuring a suite of aerosol ionic constituents at sensitivities down to approximately 10 ng per cubic meter of air with a duty cycle of roughly 4 minutes. Coupled directly to a total organic carbon analyzer the organic carbon (OC) aerosol component is measured online, or alternatively, by placing a liquid filter inline, the water-soluble carbonaceous component of atmospheric aerosol particles can be determined. The detection limit of either measurement is to approximately 0.1 ugC per cubic meter at a duty cycle of 2 to 6 minutes. Both PILS IC and PILS OC devices has been deployed for surface and airborne measurements in studies whose focus has ranged from urban air quality to characterization of Asian outflow. Current work is focused on speciation of the water-soluble organic carbon component and the extension of the technique to solvents other than water. Examples from various field studies will be presented.

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[P02-17] THE EFFECT OF ANTHROPOGENIC POLLUTION OF THE ATMOSPHERE ON HUMAN HEALTH ON THE TERRITORY OF GEORGIA.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:30 PM-9:30 PM) Grand Ballroom 2-4

The effect of air-polluting substances on mortality of population has been studied on the basis of real statistical and hydro meteorological materials for 1980-1999. There have been revealed those harmful ingredients, which stimulate the development of the most widespread diseases causing mortality. Correlation links between some ingredients entering in communal boilers and fumes from the traffic and increased frequency of such diseases as cardiovascular system, blood organs, respiratory organs and appearance of new diseases.

On the basis of the obtained results, we can conclude that during the last decade on the whole territory of Georgia the main source of anthropogenic pollution of atmosphere is auto transport and substandard petrol, and one of the main factors of the morbidity and mortality of population can be considered harmful components of exhausted fumes of auto transport.

[P03-19] EFFECTS OF PHYSICO-CHEMICAL PROPERTIES OF ULTRAFINE PARTICLES ON THE PERFORMANCE OF AN ULTRAFINE PARTICLE CONCENTRATOR.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (8:30 PM-9:30 PM) Grand Ballroom 2-4

Ultrafine particle concentrators are used to conduct in-vivo animal and human inhalation exposures. Ultrafine particles grow in supersaturation conditions to supermicron sizes and get concentrated via a virtual impactor. Excess water from the grown droplets is removed to return the particles to their original size. Various studies have explored the ability of ultrafine particles, with different chemistry, to act as cloud condensation nuclei. Based on our understanding from these studies, we explored the hypothesis of differential concentration enrichment of ultrafine particles due to their hygroscopicity. Initial experiments were conducted, with indoor air, using a recently developed ultrafine particle concentrator. Varying the temperature in the saturator and condenser units attained different supersaturation conditions. Ultrafine particles must grow to droplet sizes above the cut-point of the virtual impactor. Results from this experiment showed an increase in concentration factor with increasing supersaturation ratio. Theoretically, targeted supersaturation ratio should be in the range of 2.5-3.0 in order to activate particles as small as 10nm. To assess our hypothesis that above result also indicate the underlying heterogeneous composition of indoor air, we challenged the particle concentrator with artificially generated single-component ultrafine aerosols. A fixed supersaturation ratio of 3.0 was maintained. Ultrafine particle size-distributions were measured, using SMPS, both upstream and downstream of the particle concentrator. Table 1 summarizes the results from these experiments. These results suggest that physico-chemical properties of ultrafine particles considerably affects the final droplet size to which particles grow and hence the overall concentration enrichment factors. Considering the fact that about 50-70% of atmospheric ultrafine mass consists of carbonaceous materials, these results provide us with insight in terms of what supersaturation ratios should be maintained in such an ultrafine particle concentrator.

Table 1: Aerosol characteristics for condensational growth experiments.

Aerosol	Property	Median dia (nm)	Up conc (#/cc)	Down conc (#/cc)	CF
Amm. sulphate	Hygroscopic	58.2	3170	220000	69
NaCl	Hygroscopic	91.9	6940	371000	54
Indoor air	Variable	98.1	3310	127000	38
PSL	Hydrophobic	81.8	324	10200	32

[P07-03] INFERRING THE SOURCES OF FINE AND ULTRAFINE PARTICULATE MATTER AT DOWNWIND RECEPTOR SITES IN THE LOS ANGELES BASIN USING MULTIPLE CONTINUOUS MEASUREMENTS.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

Recent studies that have found increased health effects of atmospheric ultrafine particulate matter (PM) have refocused attention on particle number rather than particle mass concentrations as a relevant measurement of PM pollution. As part of the Southern California Supersite program, ambient particle characteristics were measured over 13 months at three different sites in the eastern portion of the Los Angeles Basin: Riverside, Rubidoux and Claremont, CA. The sites represent receptor locations that are influenced by local particle sources as well as advection from the more intense particle sources upwind closer to Downtown Los Angeles. An SMPS/APS tandem system was employed to collect continuous particle size distributions, from which particle number and mass concentrations were calculated. An aethalometer provided continuous particulate elemental carbon (EC) concentrations. Results so show no meaningful correlation between particle number and mass, indicating that fine particle standards may not be effective in controlling ultrafine concentrations. Diurnal patterns show a morning traffic peak indicated by increases in particle mass, number, and EC. Afternoon periods in the warmer months are characterized by high number counts while mass and EC remain low, suggesting the formation of new particle by photochemistry. Particle mode diameters range from 30 nm up to above 100 nm, a result not seen in most other studies of particle size distributions in other urban or rural areas where mode diameters are generally less than 50 nm. Evidence is presented that the observed ultrafine particle concentrations and size distributions are influenced by long range advection and photochemical processes as well as vehicular emissions, which have been previously assumed to dominate day to day ultrafine particle levels.

[P01-15] SOUTH BRONX ENVIRONMENTAL STUDIES PROJECT: COMPARISON OF GROUND-LEVEL AIR QUALITY DATA WITH NEW YORK STATE DEPARTMENT OF CONSERVATION MONITORING STATIONS DATA.

Carlos E Restrepo Wagner Graduate School of Public Service, New York University, New York, NY

Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 1: The NARSTO North American PM Assessment (8:30 PM-9:30 PM) Grand Ballroom 2-4

The South Bronx is a low-income, minority community in New York City. It has one of the highest asthma rates in the country, which community residents feel is related to poor air quality. Community residents also feel that the air quality data provided by the New York State Department of Environmental Conservation (DEC) through their network of monitoring stations do not reflect the poor quality of the air they breathe. This is due to the fact that these monitoring stations are usually located about 15 meters above ground. In the years 2001 and 2002 this project collected air quality data at various locations in the study area. They were collected at ground level by a mobile laboratory placed in a van. On average, the van collected hourly data at each location for periods of three to four weeks. This poster compares those data with data collected by DEC's monitoring stations in Bronx County during the same periods. Although there is good agreement in the data among DEC stations there are some important differences between ground level measurements and DEC data. For PM2.5, during the period November 7-29, 2001, the average daily concentration recorded by the van was 16.70 μg/m3. The average values for three DEC monitoring stations in the area ranged between 15.39 and 15.54 μg/m3. In the case of ozone, the concentrations recorded at ground level were generally lower than those recorded by DEC stations. During that same period, the average daily concentration of O3 recorded by the van was 0.0035 ppm. Two DEC stations in the area recorded daily averages of 0.0059 ppm and 0.0062 ppm. For the other pollutants the concentrations measured by the project are substantially higher than those recorded by DEC's monitoring stations. For NO2 the concentrations recorded at ground level are over twice as high as those recorded by DEC. In the case of SO2, ground level measurements are also substantially higher, being about 40% greater than DEC's values. Similarly, CO concentrations measured at ground level tend to be 60-90% higher than those recorded by DEC monitoring stations. Such differences between ground level and monitoring station measurements have important implications for policy development.

Supported by EPA Agreement X-982152. The co-Principal investigators on the project are Rae Zimmerman, Ph.D (New York University's Wagner Graduate School of Public Service, Institute for Civil Infrastructure Systems) and Lung Chi Chen, Ph.D (New York University School of Medicine, Nelson Institute of Environmental Medicine).

[P02-15] ASSOCIATIONS BETWEEN PARTICULATE AIR POLLUTION AND ACUTE CARDIO-RESPIRATORY VISITS IN AN AMBULATORY CARE SETTING.

Amber H Sinclair, Dennis D Tolsma Research Department, Kaiser Permanente Georgia, Atlanta, GA

Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:30 PM-9:30 PM) Grand Ballroom 2-4

Existing studies of particulate matter (PM) and cardiorespiratory outcomes have mainly concerned emergency department visits, mortality, and individual symptoms and pulmonary function measurements, and do not investigate characteristics of PM. Kaiser Permanente (KP), a not-for-profit health maintenance organization with over 270,000 members in the Georgia Region, is collaborating with the Electric Power Research Institute (EPRI) on the Atlanta superstation component of the Study of Particulate Health in Atlanta (SOPHIA). Atlanta is an air quality-monitoring site for ARIES, which provides detailed information on the physical and chemical characteristics of PM. The KP study is a time series investigation of the possible associations between daily levels of suspended particulate matter and ambulatory care acute visit rates during the 25-month period, August 1, 1998 to August 31, 2000. Acute visits were identified as those visits with a same day appointment or urgent visit type code. Acute visits to the nine Atlanta KP health facilities with a respiratory diagnosis of asthma, COPD, or upper or lower respiratory infections were identified through electronic visit data. Air quality variables of *a priori* interest for our study were: 24 hour average measurements of PM2.5, coarse PM (2.5-10 μm), PM10, PM2.5 components (acidity, sulfates, OC, alkenes, aromatics and elemental carbon), 10-100 nm PM count and area (ultra-fines), pollen, mold, polar VOCs (OHC), ozone, NO2, CO, HNO3, and SO2. Visit counts for diagnosis case groupings were modeled by selected air quality metrics using Poisson general linear modeling controlling for temporal trends and meteorologic variables. Moving averages of the 0 to 2 day, 3 to 5 day and 6 to 8 day lagged air quality variables were investigated. Preliminary statistically significant findings show that the strongest associations by case group were 1.11 for OHC for child asthma for the 0 to 2 day lag; 1.14 for pollen for the 6 to 8 day lag; and 1.13 for OHC for the 6 to 8 day lag. For LRI, the most important lag was the 3 to 5 day (4 out of 6 findings), while the most important lag for URI was the 0 to 2 day (6 out of 10 findings). We will present final results from the 25-month data set for the respiratory illnesses, as well as initial findings for cardiac outcomes. This study provides a unique assessment of air quality and health effects by investigating characteristics of particulate matter in an ambulatory care setting, and complements the mortality and emergency department studies in Atlanta under ARIES.

[P02-16] THE LEVEL OF PM10/PM2.5 IN INDOOR AIR AND RESPIRATORY HEALTH OF THE PEOPLES IN BEIJING, CHINA: A COMMUNITY-BASED PILOT STUDY.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:30 PM-9:30 PM) Grand Ballroom 2-4

Background and objective: Lots of studies around the world indicated that indoor air pollutants play an important role on the human health. But few such studies were conducted in china and the relationship between indoor air pollution and the human health is not very clear. In this study, we attempt to investigate the level of indoor air pollution and to assess its effects on the residents' health in Beijing. Methods: 270 houses were selected randomly in three municipal districts (90/per district) as the subjects for indoor air monitoring and represented respectively industrial, old urban and cultural/educational areas of Beijing. The concentrations of indoor air pollutants, including particulate matter ≤ 10/2.5 micro in aerodynamic diameter (PM10/PM2.5) and SO2, were measured in the bedrooms and the kitchens of the subjects. At the same time, more than 1,500 residents living in these houses were investigated with the questionnaire for their respiratory health and other confounding factors. Results: The levels of indoor air PM10/PM2.5 were quite vary(22μg/m3 for bedroom~1469μg/m3 for kitchen)in winter of Beijing. The concentrations of indoor air PM10 and PM2.5 in the houses with coal stove for heating were much higher than that in houses with central heating system (P<0.01), but not for SO2. From the graphs of 24-hours real time monitoring, we have found that the peaks of the curves for indoor air PM10/PM2.5 emerged often in the cooking time. It suggested that the coal stove using for heating or cooking is major source of indoor air pollution in winter of Beijing. Conclusions: More attention should be paid to the indoor air pollution and residents' health in Beijing and the work in this area should be continued.

The Indoor Air PM2.5 Level among Three Districts in Beijing(mg/m3)

district	Dongchen		Shijingshan		Haidian	
	bedroom	kitchen	bedroom	kitchen	bedroom	kitchen
count	75	72	80	78	81	80
average	0.535	0.539	0.447	0.508	0.519	0.550
S.D	0.341	0.310	0.218	0.577	0.451	0.654
Min.	0.147	0.144	0.037	0.041	0.066	0.061
Max.	2.630	2.13	1.03	6.09	5.13	7.92

[P02-18] WITHDRAWN

Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (8:30 PM-9:30 PM) Grand Ballroom 2-4
WITHDRAWN

[P07-21] SEMI-CONTINUOUS $PM_{2.5}$ SULFATE AND NITRATE MEASUREMENTS IN NEW YORK CITY.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

Ambient $PM_{2.5}$ comprises various constituents including sulfate, nitrate, ammonium, organic and elemental carbon and various trace elements. Filter based methods are being used in EPA's national networks to provide measurements of average daily $PM_{2.5}$ mass and chemical composition. However, due to the sampling times employed, these methods cannot track concentration changes that occur on time scales of hours or less. In order to better understand the various source contributions, and to quantitatively track short-term variations in $PM_{2.5}$ mass and composition, semi-continuous methods for chemical composition have recently been developed and are currently being used in various field studies.

As part of the New York $PM_{2.5}$ Supersites Study semi-continuous $PM_{2.5}$ Sulfate and Nitrate Rupprecht and Patashnick instruments (R&P 8400S and 8400N) have been deployed in a site in the South Bronx, New York City. The instruments collect $PM_{2.5}$ particulate matter on a metal strip by a humidification and impaction process followed by flash vaporization and detection of the evolved gases. These instruments have provided 10 minute particulate sulfate and nitrate data since April 2002. Time resolved data shows that $PM_{2.5}$ can exhibit a large degree of variability over a period of a few hours with particulate sulfate typically varying by a factor of two to three and nitrate up to a factor of ten. In general sulfate concentrations are significantly higher than nitrate. To date the maximum hourly sulfate concentration has been 29.9 $\mu g/m^3$ which occurred on August 13, 2002 compared to a maximum hourly nitrate concentration of 10.5 $\mu g/m^3$ observed on June 20, 2002. On these days the 24-hr average sulfate and nitrate concentrations were 15.3 $\mu g/m^3$ and 3.39 $\mu g/m^3$ respectively, clearly indicating that 24 hr filter measurements can significantly underestimate maximum concentrations. Peak nitrate concentrations tended to occur in the early morning hours between 5 and 11 am coinciding with morning rush hour followed by a decrease in the afternoon and a gradual increase in the late evening around 8 pm. In contrast no diurnal trend was observed for particulate sulfate with peak concentrations occurring at various hours throughout any given day. Maximum sulfate occurred from June to August consistent with the period of highest SO_2 oxidation.

Other instruments at the site include an R&P 2300 Speciation Sampler, R&P 2025, R&P TEOMs $PM_{2.5}$ and PM_{10} and gas measurement SO_2, NO_x and O_3 instruments. Data from the semi-continuous Sulfate and Nitrate particulate instruments will be presented and compared with other collocated instruments.

[P01-08] CONCEPTUAL MODEL OF PM IN THE WINDSOR-QUEBEC CITY CORRIDOR.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 1: The NARSTO North American PM Assessment (8:30 PM-9:30 PM) Grand Ballroom 2-4

The Windsor-Quebec City Corridor, a long narrow area stretching from Windsor/Detroit in the southwest to Montreal and Quebec City in the northeast, is the most heavily populated region of Canada. As part of the 2003 NARSTO North American PM Assessment, we have synthesized available information on emissions, meteorology, and ambient PM levels in the Windsor-Quebec City Corridor to produce a region-specific conceptual model for PM. This poster summarizes this regional conceptual model, including the nature of the PM problem in the Windsor-Quebec City Corridor, contributing sources and processes, and implications for air-quality management.

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[P07-19] USE OF CONTINUOUS SO2 AND SULFATE MEASUREMENTS TO ESTIMATE SO2 OXIDATION RATES IN POWER PLANT PLUMES.

Eric S Edgerton, Callie J Waid, Benjamin E Hartsell, D A Hansen, John J Jansen HQ, Atmospheric Research & Analysis, Inc., Cary, NC; Data Management, Atmospheric Research & Analysis, Inc., Plano, TX; EPRI, Palo Alto, CA; Southern Company, Birmingham, AL

Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

This paper presents a novel approach for estimating SO2 oxidation rates in power plant plumes. The approach is based on continuous and simultaneous measurement of SO2, NOy and fine particulate sulfate at a surface site, under conditions when the site is impacted by a plume from a known point source. The research site, located approximately 55 km WNW of Atlanta, GA is instrumented with a high sensitivity pulsed UV-fluorescence SO2 analyzer, a high-sensitivity ozone-chemiluminescence NOy analyzer, a modified Harvard School of Public Health (HSPH) continuous sulfate analyzer, plus an array of instruments for continuous measurement of fine particulate matter, trace gases and surface meteorology. The measurement principle and overall performance of the HSPH sulfate analyzer, as deployed in the SEARCH network, are discussed in a companion paper. In practice, the ambient SO2 signal is used to determine if the site is influenced by one of five coal fired power plants (CFPPs) within an approximate 100 km radius. For this study, we arbitrarily define an event as one with a peak 1-minute SO2 concentration of at least 15 parts per billion. Once an event has been detected, the source contributing to that event is identified by two methods: 1) air mass trajectory analysis using the NOAA-HySplit model; and 2) comparison of the ambient SO2:NOy ratio with in-stack data from continuous emission monitors (CEMs). Events are assigned to a particular souce only if trajectory data indicate flow along a line (+/- 15 degrees) from the plant to the site, and if the ambient SO2:NOy agree with CEM data +/- 10 percent. Roughly 2 dozen events are successfully classified for the periods December 2001-March 2002 (winter) and June-September 2002 (summer). Linear regression of sulfate to SO2 is then used to estimate the fraction of oxidized sulfur in each plume event, and trajectory data are used to estimate time of flight (reaction time) from source to site. Fraction of oxidized sulfur divided by transit time represents the average oxidation rate during plume transit. Results show a wide range of apparent oxidation rates. Winter events exhibit oxidation rates on the order of 0.0 to 0.2 percent per hour, and, in general, little sulfate above estimated primary sulfate emissions. Summer events exhibit oxidation rates between 0.1 and 2.1 percent per hour. Nighttime events, both summer and winter, show virtually no oxidation. The population of events will be discussed and results will be compared with available oxidation rates from the literature.

[P07-18] ULTRAFINE PARTICLE EVENTS ASSOCIATED WITH NITRATE CHEMISTRY OBSERVED BY SINGLE PARTICLE MASS SPECTROMETRY.

Michael P Tolocka, Murray V Johnston, Derek A Lake, Anthony S Wexler Chemistry and Biochemistry, University of Delaware, Newark, DE; Mechanical and Aeronautical Engineering, Civil and Environmental Engineering, Land, Air and Water Resources, University of California, Davis, Davis, CA

Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

Single particle measurements in Baltimore from March to December 2002 were performed with the real-time single particle mass spectrometer RSMS III. Spectra were collected in both positive and negative ion modes over a particle size range of 40-1250 nm in diameter. For nitrate analysis, positive ion spectra were initially selected at m/z 30 on the basis of an above threshold signal. The spectra were further analyzed by the fast adaptive neural network algorithm Art-2a to confirm the presence of nitrate in these particles. From this analysis, nominally "pure" nitrate particles (defined as having a signal intensity at m/z 30 greater than 75% of the total ion signal) were identified. Examination of these data revealed numerous ultrafine particle events in which the number of "pure" nitrate particles in the 50-90 nm size range would quickly increase and then decrease. The increase in the number of "pure" nitrate particles during these events would either precede or coincide with an increase in particulate nitrate mass (measured coincidentally with an R&P 8400N ambient particulate nitrate monitor); the number concentration would then decrease as the particulate nitrate mass decreased. In a few instances, nitrate particles in the 50-90 nm size range were found to grow into larger 110-220 nm size particles over time. Correlations of these events with both meteorological variables and continuous particulate nitrate mass measurements have been explored. Mass concentrations calculated from "pure" nitrate particles identified with RSMS III agree well with particulate nitrate mass measurements. The occurrence of ultrafine nitrate particle events correlated well with high relative humidity and low temperature as expected by equilibrium considerations.

[P01-20] URBAN AIR QUALITY MODELING IN THE NETHERLANDS AND THE IMPACT OF (EUROPEAN) ABATEMENT PROTOCOLS.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 1: The NARSTO North American PM Assessment (8:30 PM-9:30 PM) Grand Ballroom 2-4

Reducing the adverse impact on human health is the focus of national as well as European regional and urban air quality management. Ground-level ozone, NO2, and PM10 and some related PM fractions seem to be major air pollution components in this respect and their ambient levels appear to be associated with a variety of adverse health effects ranging from respiratory symptoms and complaints to enhanced morbidity and premature mortality with cardiac and respiratory causes. Both short-term and long-term exposures to these pollutants appear to be important.

Very recently, the European Union (EU) has initiated the Clean Air For Europe (CAFE) programme with the objective 1. to review existing limit values, emission ceilings, and abatement protocols (as set out in the current legislation, including the position of the EU as Party to the UN-ECE Convention on long-range Transboundary Air Pollution (LRTAP)) and 2. to develop an cost-effective clean air strategy. Thereby efforts are being made to focus not only on the impact on a regional scale but also on an urban scale, where large groups of the population are exposed. Urban air pollution is also of particular concern because of the more complex air pollution mixture, the local sources contributing to air quality, including those of motor vehicle exhaust emissions. In addition, there is an interest to evaluate whether specific reduction measures on local emissions could add to the more regional and EU-transboundary influence on ambient air pollution abatement, as set the LRTAP protocols. Data on how the typical urban air pollution situation differs from that in regional areas requires, however, a more fine-scale modeling approach then usually applied.

This study has therefore focused on the impact of abatement protocols for acidification and ground-level ozone reduction using fine-scale modelling in The Netherlands. Emissions, concentrations, and human exposure of a number of major air pollutants has been modeled and estimated on a typical fine scale and the outcome for urban areas have been be compared with those for regional areas. The modelling has focussed on ozone, NO2, and the various PM fractions (different particle size and composition) and the first results will be presented. The data suggest that air quality management may have positive effects on both regional and urban air quality. Possible consequences for human health will be qualitatively discussed awaiting further exposure and risk assessment studies.

[P01-18] AEROSOL CHEMICAL COMPOSTION UPDATE: CAN WE ACHIEVE THE ANNUAL PM2.5 NAAQS BY CONTROLLING ORGANIC CARBON?

Roger L Tanner, William J Parkhurst Air, Land and Water Sciences, Tennessee Valley Authority, Muscle Shoals, AL

Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 1: The NARSTO North American PM Assessment (8:30 PM-9:30 PM) Grand Ballroom 2-4

Extensive new monitoring data now confirm that organic carbonaceous materials and sulfates are the major contituents of fine particulate matter in Eastern North America. Reduction of particulate sulfates by reducing precursor gaseous SO_2 has been the target of multiple control strategies since the 1970s. Control of organic aerosols could be considered, but it is complicated by several factors: the complexity of organic aerosols, the paucity of knowlege concerning their many sources, and the mix of natural biogenic and anthropogenic sources. The fraction of modern carbon derived from ^{14}C measurements using the two source assumption can be used to derive the relative magnitude of biogenic (modern) and fossil-derived carbonaceous aerosols. An extensive body of data (reported herein) from a background site near the Great Smoky Mountains National Park show that, with the exception of one late summer period, only 10-40% of the carbonaceous aerosol is of fossil origin. The biogenic fraction of aerosol carbon may, however, derive from natural sources such as gas-to-particle conversion of biogenic hydrocarbon and other biogenic emissions, or from anthropogenic activities in which biogenic materials are combusted (burning of wood and agricultural waste). Efforts to determine the fraction that man-made combustion sources contribute to modern carbon in ambient aerosols have been limited, especially in urban areas. From the limited data, however, we conclude that about 50% of aerosol carbon (of the order of 15-20% of observed fine mass) derives from fossil combustion sources or from human combustion of wood fuels and other biogenic materials. In most areas, controls on those combustion sources could be used to bring average fine mass levels below the annual $PM_{2.5}$ NAAQS.

[P07-17] SULFATE DETECTION IN INDIVIDUAL FINE AND ULTRAFINE AMBIENT PARTICLES AT THE BALTIMORE SUPERSITE.

Murray V Johnston, Derek A Lake, Michael P Tolocka, Anthony S Wexler Chemistry and Biochemistry, University of Delaware, Newark, DE; Mechanical and Aeronautical Engineering, Civil and Environmental Engineering, Land, Air and Water Resources, University of California, Davis, Davis, CA

Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

Single particle measurements in Baltimore from March to December 2002 were performed with the real-time single particle mass spectrometer RSMS III. During this time period, spectra were obtained for over 350,000 particles across a size range of 40-1250 nm in diameter. Unlike previous versions of the instrument, RSMS III contains a dual drift tube configuration that permits both positive and negative ion spectra to be simultaneously recorded for each particle. Since sulfate is preferentially detected in negative ion spectra, this instrument offers for the first time the opportunity to study the distribution of sulfate in fine/ultrafine particles. Over 75% of the particles above 400 nm were found to contain sulfate. Many of these particles gave strong negative ion signals (from sulfate) with virtually no positive ion signal detected. These particles are thought to arise from nominally "pure" ammonium sulfate particles, most likely produced by cloud processing of CCN. If particles in the 50 to 100 nm range act as CCN, then by the time they have grown to 400 nm or larger, the initial core only comprises a very small faction of the total particle mass (i.e., a 50 nm CCN only comprises 1/1000 of the mass of a 500 nm particle). The low mass fraction, coupled with the difficulty in vaporizing an entire particle of this size, inhibits detection of the CCN core. "Pure" ammonium sulfate particles smaller than 200 nm in diameter are rarely detected, in part because negative ions are more difficult to produce from small particles and in part because the initial CCN can be detected since it is a larger fraction of the total particle mass. Mixed composition particles containing sulfate are observed in the smaller size ranges and constitute 10-50% of the total particles detected.

[P01-17] ADVANCED FACTOR ANALYSIS OF SPATIAL DISTRIBUTIONS OF PM2.5 IN THE EASTERN UNITED STATES.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 1: The NARSTO North American PM Assessment (8:30 PM-9:30 PM) Grand Ballroom 2-4

This work analyzes PM2.5 24-h average concentrations measured every third day at over 300 sites in Eastern U.S. during 2000. The non-negative factor analytic model, Positive Matrix Factorization, has been enhanced by modeling the dependence of PM2.5 concentrations on temperature, humidity, pressure, ozone concentration, and wind velocity vector. The model comprises 12 general factors, augmented by 5 urban-only factors intended to represent excess concentration present in urban sites only. The computed factor components or concentration fields are displayed as concentration maps, one for each factor, showing how much each factor contributes to the average concentration at each site. The factors are also displayed as flux maps that illustrate the spatial movement of PM2.5 aerosol, thus enabling one to pinpoint potential source areas of PM2.5. The quality of the results was investigated by examining how well the different alternative models reproduce especially high concentrations of PM2.5 on specific days at specific sites. Delimiting the spatial extent of all such factors that exhibit a clear regional maximum surrounded by an almost-zero outer domain lowered the uncertainty in the computed results.

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[P01-19] AMMONIA ABATMENT AND SECONDARY PM REDUCTIONS.

Jan Willem Erisman Clean Fossil Fuels, Energy Research Centre of the Netherlands, ECN, Petten, Netherlands

Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 1: The NARSTO North American PM Assessment (8:30 PM-9:30 PM) Grand Ballroom 2-4

The major components of the atmospheric aerosol are carbonaceous components, inorganic ionic compounds, crustal components and water. These components are thus the main contributors to PM2.5 and PM10 and are important concerning compliance with legal standards. Secondary formed particles contribute to a large extent to the PM2.5 fraction. In large parts of Europe the contribution is between 60 and 80%. In order to reduce PM concentrations it is therefore necessary to decrease precursor emissions. Up to know emissions of SO2 have decreased with more than 60%, but particle concentrations have not decreased that much. In this paper the role of ammonia in particle formation is addressed. It is shown that the secondary PM concentrations can only be reduced if, apart from SO2 and NOx, also ammonia emissions are equally decreased.

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[P01-16] DEVELOPMENT OF A DATABASE AND ANALYTICAL TOOLS FOR THE MANAGEMENT OF DATA DERIVED FROM U S-DOE (NETL)-FUNDED FINE PARTICULATE ($PM_{2.5}$) RESEARCH.

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Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 1: The NARSTO North American PM Assessment (8:30 PM-9:30 PM) Grand Ballroom 2-4

Large amounts of data have been collected through several research projects funded by the U.S. Department of Energy (NETL). These data collection efforts have focused on the characterization of fine particulate ($PM_{2.5}$) matter present in ambient air along the Upper Ohio River Valley (UORV) corridor, and the data resides in disparate datasets, with no capabilities for analyzing or processing the different datasets simultaneously. NETL has contracted Advanced Technology Systems, Inc. (***ATS***) to provide these capabilities to the project sponsors, interested stakeholders, and the general public through a web interface and a server-based database application.

Project Goals and Objectives: The purpose of this project is to develop a comprehensive solution to integrate the ambient air quality data being collected under multiple monitoring programs in the UORV corridor and other NETL-funded projects. The project's end product will be one tool with two separate interfaces; one designed with the sponsors and stakeholders in mind and the other open to the general public.

Application Infrastructure: The underlying data and application infrastructure are key to any computerized data analysis tool. ***ATS*** has assembled a network of hardware, software, and technical personnel to build the underlying infrastructure for this data management and analysis tool.

Development Tools: The project team has selected Microsoft's .NET platform of development tools contained in Visual Studio.NET. The .NET development tools provide direct access to the database server and incorporate very useful debugging tools into the development suite, thus reducing the overall development time required to complete this project.

Development and Testing Schedules: The entire project is expected to last until October 2004. By this time, the project will have moved from the conception phase, to design and development phases, and finally to completion and implementation. The first year's tasks involve the design and development activities that occur at the server level, while the second year's tasks will involve developing the two user interfaces for access to the data via an Internet connection.

[P01-21] REDUCED FORM MODEL TO ESTIMATE AIR POLLUTION IMPACTS.

Luis Cifuentes, Hector Jorquera, Fabian Gaioli, Nelson Gouveia, Devra Davis School of Engineering, P. Universidad Catolica de Chile, Santiago, Chile; Secretaría de Ambiente y Desarrollo Sustentable, Ministerio de Desarrollo Social, Buenos Aires, Argentina; Faculdade de Medicina, Universidade de Sao Paulo., Sao Paulo, Brazil; The H. John Heinz III School of Public Policy and Management, Carnegie Mellon University, Pittsburgh, PA

Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 1: The NARSTO North American PM Assessment (8:30 PM-9:30 PM) Grand Ballroom 2-4

Although many Latin American countries are already suffering the direct and indirect consequences of global climate change, climate mitigation policies are usually not ranked high in their political agenda. Such policies when exist are mostly driven by local air pollution abatement and this is likely to remain so in the near future.

The main objective of this work is to devise clear, quantifiable, replicable indicators that can be used by policy makers, to estimate the local and regional health damages induced by local human activities and the benefits from reducing air pollution associated with GHG and air pollution mitigation measures and changes in social habits, based on the results of co-benefit analysis from 3 SA cities (Santiago, Chile; Buenos Aires, Argentina; and São Paulo, Brazil).

Based on analysis and comparison of case studies already being developed in Argentina, Brazil and Chile, we have developed an approximate way of computing health benefits for different policy options, along with their associated carbon reductions. As part of the work, we have also determined the common issues that dominate the estimation of effects as well as the differences, to determine the factors that settle the health benefits: atmospheric conditions, population characteristics, economic conditions.

The final objective of this work is to propose a reduced-form model that can be used to estimate the health benefits, the GHG abatement, and their relative importance in different SA cities. The information produced by this work will be very useful for decision-makers in most south American cities, at the moment of considering different policy options. We thus hope to effectively effect policy making regarding global change and air pollution abatement in the Americas.

[P07-14] MEASUREMENT OF REAL-TIME $PM_{2.5}$ MASS AND FINE CHEMICAL COMPOSITIONS AT NORTHWEST PHILADELPHIA.

Doh-Won Lee, Cheol-Heon Jeong, Eugene Kim, Philip K Hopke Civil and Environmental Engineering, Clarkson University, Potsdam, NY; Chemical Engineering, Clarkson University, Potsdam, NY

Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

As a part of the North East Oxidant and Particle Study (NE-OPS) program, a summer intensive particulate matter (PM) measurement was conducted during July 10 to August 3, 2002. Real-time $PM_{2.5}$, particulate sulfate, semi-continuous thermal/optical organic carbon (OC) and elemental carbon (EC) concentrations were measured at NE-OPS site in Philadelphia. In addition, 24-hour integrated filter samples were obtained to measure OC, EC, and sulfate concentrations. The source contributions to fine PM were determined on two-hour basis. $PM_{2.5}$ mass concentration measured by a 30 °C TEOM system with a Sample Equilibration System dryer was approximately 22 $\mu g/m^3$ (max.= 63 $\mu g/m^3$, min.= 6 $\mu g/m^3$). The 5-min. averaged sulfate concentration measured by a continuous sulfate analyzer (Harvard School of Public Health design) ranged from 2 to 32 $\mu g/m^3$. The continuous sulfate analyzer showed excellent agreement with daily filter-based analysis by Ion Chromatography with correlation coefficients of 0.98. However, the continuous analyzer measured approximately 40% less sulfate than the filter samples. The average continuous sulfate concentrations were strongly correlated with 1-hour averaged $PM_{2.5}$ mass (r^2 = 0.89). The correlation coefficient between $PM_{2.5}$ and OC was 0.64. However, $PM_{2.5}$ mass was poorly correlated with EC. The predominant chemical components of $PM_{2.5}$ mass at the monitoring site were sulfate and OC. On average, OC and EC measured using a semi-continuous OC/EC analyzer accounted for 21 % and 2 % of total $PM_{2.5}$, respectively. The sulfate mass was measured to comprise 39 % of total $PM_{2.5}$ mass concentration.

[P07-15] CHARACTERIZATION OF CHEMICAL COMPOSITIONS IN FINE PARTICULATE MATTER DURING THE ROCHESTER PARTICULATE MATTER STUDY.

Cheol-Heon Jeong, Doh-Won Lee, Eugene Kim, Philip K. Hopke, Robert Gelein Civil and Environmental Engineering, Clarkson University, Potsdam, NY; Chemical Engineering, Clarkson University, Potsdam, NY; EPA PM center, University of Rochester, Rochester, NY

Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

As a part of the summer intensive Rochester particulate matter (PM) study, highly time resolved measurements of $PM_{2.5}$ mass, organic carbon (OC), elemental carbon (EC), black carbon (BC), and particulate sulfate were conducted near University of Rochester PM Center at Rochester, NY. The continuous, semi-continuous, and daily filter-based methods were used during June 3 to 18, 2002 to characterize the composition of fine PM in urban ambient air. In order to minimize the loss of semi-volatile compounds in fine PM and condensation of water, TEOM system (R&P) was operated at a fixed temperature 30 °C with a Sample Equilibration System dryer. A Semi-continuous OC/EC analyzer (Sunset Lab) measured 2-hour averaged OC and EC mass concentrations of fine PM with an upstream OC denuder to prevent the positive artifacts of semi-volatile organic compounds. High resolution particulate sulfate concentrations were measured by a continuous sulfate analyzer (Harvard School of Public Health design). In addition, collocated daily filter samples were collected for filter-based OC, EC, and sulfate analysis. During the measurement period, the comparison of particulate sulfate concentration between the semi-continuous analyzer and filter-based ion chromatography analysis shows good agreement with a correlation coefficient of 0.85. While the continuous sulfate concentrations were highly correlated with TEOM $PM_{2.5}$ mass ($r^2 = 0.88$), the sulfate concentration was only 26 % of total $PM_{2.5}$ concentration. The average thermal OC and EC measured by a semi-continuous analyzer were approximately 6.6 $\mu g/m^3$ and 0.4 $\mu g/m^3$, respectively. The average TEOM $PM_{2.5}$ mass was 15.9 $\mu g/m^3$. The semi-continuous OC/EC measurements were lower than undenuded daily filter sample OC/EC. The average concentrations of semi-continuous total carbon (OC + EC) and the filter-based total carbon were approximately 43% and 63% of the TEOM $PM_{2.5}$ mass concentration, respectively.

-Supported by EPA PM Center grant R827354

[P07-16] COMPARISON OF FILTER-BASED AND SEMI-CONTINUOUS CARBON AEROSOL MEASUREMENTS AT RESEARCH TRIANGLE PARK, NORTH CAROLINA.

Joann Rice OAQPS, EMAD, U.S. Environmental Protection Agency, Research Triangle Park, NC

Wednesday, April 2, 2003, 8:30 PM, Poster Session 3: Workshop 7: Semi-Continuous Methods for Measuring PM (8:30 PM-9:30 PM) Grand Ballroom 2-4

Particulate carbon is a major constituent of fine particulate matter (PM2.5) mass in many parts of the United States. Carbon has been found to account for as much as 50% of the total fine particle mass in the atmosphere. The carbon fraction of PM2.5 consists of elemental carbon (EC) and organic carbon (OC). Particulate elemental carbon is a primary emission from incomplete combustion of fossil fuels and biomass burning and serves as a tracer for combustion-derived particles. Particulate organic carbon has both primary and secondary emission sources. Primary emissions originate from combustion, chemical, geological (fossil fuels), and biogenic sources, whereas organic carbon is secondarily formed from gas-to-particle transfer of anthropogenic and biogenic precursor gases. Both EC and OC have significance in relation to atmospheric visibility, EC as a light absorbing material and OC as a light scattering material, and control strategies for PM2.5. The goal of this paper is to provide results from the intercomparison of measurements made by the Rupprecht & Patashnick series 5400 carbon analyzer, the Magee Scientific Aethalometer and a filter-based Andersen Chemical Speciation sampler in Research Triangle Park, NC. In addition, observations regarding temporal patterns, diurnal patterns and seasonality of the semi-continuous measurements are provided.

[P04-26] SEMI-VOLATILE PM2.5 MATERIAL ALONG THE WASATCH FRONT.

Norman L Eatough, Russell W Long, Delber J Eatough, William E Wilson Chemistry & Biochemistry, Brigham Young University, Provo, UT; US EPA, Research Triangle Park, NC

Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

Ammonium nitrate and semi-volatile organic compounds (SVOC) are significant components of fine particles in urban atmospheres. These components, however, are not properly determined with current U.S. EPA accepted methods such as the PM2.5 FRM or other single filter samplers due to significant losses of semi-volatile material (SVM) from particles collected on the filter during sampling. Continuous PM2.5, mass measurements are attempted using methods such as the R&P TEOM monitor. This method, however, heats the sample to remove particle-bound water resulting in evaporation and loss of semi-volatile material. Research at Brigham Young University has resulted in samplers for both the integrated and continuous measurement of total PM2.5 including the semi-volatile material. The PC-BOSS (Particle Concentrator-Brigham Young University Organic Sampling System) is a charcoal diffusion denuder based sampler for the determination of fine particulate chemical composition including the semi-volatile organic material. The RAMS (Real-time Ambient Mass Sampler) is a modified TEOM monitor which includes diffusion denuders and Nafion dryers to remove gas-phase material which can be absorbed by a charcoal sorbent filter. The RAMS uses a "sandwich filter" consisting of a conventional particle collecting Teflon coated TX40 filter, followed by an activated charcoal sorbent filter which retains any semi-volatile ammonium nitrate or organic material lost from the particles collected on the Teflon coated filter, thus allowing for determination of total PM2.5 mass including the semi-volatile material. The semi-volatile component of PM2.5 has been measured over a two-year period from winter 1999 through winter 2001 at three locations along the Wasatch front in Utah using RAMS and PC-BOSS. Data were collected at the Hawthorne EMPACT sampling site in Salt Lake City, Utah and at STAR sampling sites in Bountiful, and Lindon, Utah. Data will be presented for three short intensive periods during that sampling program; two winter periods with high PM2.5 concentrations due to winter inversions, and a summer period when the Salt Lake City site was impacted by smoke from wildfires in the Wasatch Mountains. PM2.5 was dominated by organic material and ammonium nitrate in the winter and by organic material in the summer. In all cases, substantial amounts of semi-volatile material, SVM, was present which was not measured by a TEOM monitor or by EPA PM2.5 FRM sampler but was detected by the RAMS and PC-BOSS. The EPA PM2.5 FRM sampler could be modified using the techniques presented here to allow for the correct determination of semi-volatile particulate matter.

[P04-32] EFFECT OF NITRATE VOLATILIZATION ON MEASURED GRAVIMETRIC MASS IN CALIFORNIA AND IN THE IMPROVE NETWORK.

Lowell L Ashbaugh, Robert A Eldred Crocker Nuclear Laboratory, University of California, Davis, CA

Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

Volatilization of particle nitrate from Teflon sampling filters during sampling can represent a significant loss of $PM_{2.5}$ or PM_{10} mass (Table 1). The highest $PM_{2.5}$ mass loss found in the California Acid Deposition Monitoring Program (CADMP) occurred during summer daytime in southern California, amounting to 30-40% of the gravimetric $PM_{2.5}$ mass. Mass losses of 5-15% were observed in national parks in the Sierra Nevada, with higher losses in the winter than in summer. Although the measurements necessary to calculate the actual nitrate mass loss are not available for remote sites in the IMPROVE network (Interagency Monitoring or Protected Visual Environments), the potential mass loss was consistent with the measured loss observed in the CADMP network.

The extent of mass loss is geographically and seasonally dependent. Not only is the mass measurement affected, but also the results of speciation analysis and source apportionment modeling could be misleading if the nitrate is not measured accurately. There is no straightforward method to correct for the mass loss using routine monitoring data.

Although there is loss of volatile nitrate from Teflon filters during sampling, the nitrate remaining after collection appears to be quite stable. There was little, if any, loss of nitrate from Teflon filters collected in the IMPROVE program after as much as two hours under vacuum and one minute of heating by a cyclotron proton beam.

Fraction of $PM_{2.5}$ mass volatilized as ammonium nitrate by site, season, and time of day for CADMP measurements.

Site	Summer Daytime	Summer Nighttime	Winter Daytime	Winter Nighttime
Azusa	0.33	0.12	0..21	0.12
Bakersfield	0.15	0.06	0.09	0.02
Fremont	0.16	0.09	0.16	0.07
Gasquet	0.09	0.08	0.07	0.04
Los Angeles	0.40	0.12	0.16	0.07
Long Beach	0.17	0.10	0.15	0.06
Sacramento	0.10	0.08	0.10	0.06
Santa Barbara	0.12	0.11	0.14	0.08
Sequoia National Park	0.08	0.05	0.15	0.11
Yosemite National Park	0.05	0.05	0.10	0.08

Summer - June through September, Winter - October through February

[P04-39] AEROSOL ANALYSIS BY ICP-MS: PROBLEMS, SOLUTIONS, AND APPLICATIONS.

Martin M Shafer, James J Schauer Environmental Chemistry & Technology, University of Wisconsin-Madison, Madison, WI

Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

Inductively-coupled plasma mass spectrometry (ICPMS) approaches can provide distinct advantages over traditional methods of aerosol chemical characterization. These advancements include; significantly enhanced detection limits, improved accuracy, and the capability for isotopic resolution. Also, importantly, the ICPMS approach can readily be integrated with techniques which supply phase and chemical speciation information. For example, selective chemical extractions can provide critical data on the association of metals with major phase-components and oxidation state of certain metals. Extractions with physiological relevant fluids can address the bioavailable species. Valuable information on metal-ligand stability can be obtained when electrochemical techniques, such as cathodic stripping voltammetry, are applied to these same extracts.

However, realization of these unique advantages for the broad spectrum of aerosol components depends upon careful implementation of a comprehensive set of chemical and instrumental protocols which address contamination, solubilization, and interferences. This paper will outline, with the use of specific examples, various strategies to address these problems, recognizing that laboratory facilities may vary and multiple solutions are possible. Efficient, validated, solubilization methods are crucial and a range of options adapted for specific groups of elements, as well as generational capabilities of ICPMS instrumentation, will be presented. Matrix and plasma-sourced polyatomic interferences can severely compromise detection levels for many key elements. However, several strategies for minimization of these interferences are practical and these will be discussed in context with specific digestion methods and ICPMS tools.

We will also present data from our recent research that clearly illustrate the advanced capabilities and broad applications of these new methods. Examples will include: (1) detailed size-resolved trace element analysis of aerosols, (2) comprehensive elemental characterization of extremely small samples from personal samplers, (3) assessment of the potentially bioavailable fraction of metals in aerosols through extractions with physiological relevant fluids, and (4) the use of metal stable isotopes in source reconciliation.

[P04-38] NICKEL SPECIATION OF URBAN PARTICULATE MATTER.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

A mixture of $NiSO_4$, Ni_3S_2, Ni°, and NiO and NIST urban PM standard reference material (SRM 1648) were analyzed in duplicate using a Ni sequential extraction method designed to quantify soluble, sulfidic, elemental, and oxidic forms of Ni that may occur in PM. Leachates from these extractions were analyzed for their Ni contents. Extraction residues are being analyzed using two definitive speciation techniques, x-ray absorption spectroscopy (XAS) and x-ray diffraction.

In cooperation with the Broward County Department of Planning and Environmental Protection, ambient PM, PM_{10}, and $PM_{2.5}$ were sampled continuously during August 26-31, 2002, from an urban SLAMS site in Fort Lauderdale, FL. Relatively large amounts (0.2 gram) of bulk PM and much smaller amounts ([Ite]2 mg) of PM_{10} and $PM_{2.5}$ were collected. These samples are being analyzed using scanning electron microscopy, sequential Ni extraction, and XAS. Forthcoming analysis results will be used to evaluate the Ni species selectivity of the extraction method and identify the chemical forms of Ni present in urban PM, PM_{10}, and $PM_{2.5}$.

[P04-37] THE EXPERIMENTAL INVESTIGATION OF AEROSOL PARTICLES IN THE DYNAMIC THERMAL DIFFUSION CHAMBER.

Paul Mirgorod, Gennady Lipatov Physical Department, Mechnikov Odessa National University, Odessa, Ukraine; Physical Department, Mechnikov Odessa National University, Odessa, Ukraine

Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

A full filtration of gases from aerosol particles, which in the definite fields of industry - semi-conductor technique, medicine, different biotechnologies is even practically impossible for the most existing aerosol filters. Since the requirements to the degree of filtration are steadily increasing, the search of methods and creation of filtration systems are conducted, which would meet the following requirements: the sedimentation of aerosol particles shouldn't depend on their sizes, should provide continuity of filtration process and mustn't require the regeneration of a filter.

One of the possible variants of filters of this sort is examined. Well-known physical processes such as: the condensational growth of aerosol particles in the diffusive field of super-saturated water vapor and their movement in laminar flow under gravity force are put into the basis of the suggested elaboration.

The experimental investigation of movement of the diluting aerosol NaCl in the mixture "air-aqueous vapor" was carried out. The sizes of aerosol particles were (0.2-0.7) micron, and their concentration wasn't more then 1000 in cubic centimeter. The investigation was carried out on the basis of the dynamic slit horizontal thermal diffusion chamber. The method of measuring consisted in the fixation of zero sudden change of aerosol particles when thermal conduction is given and the measuring of volumetric gas consumption, which are called "critical", is simultaneous.

The investigations showed the possibility of full sedimentation of aerosol particles. So when the temperature is changing in the range (10-25) °C between heating and condenser of the thermal diffusion chamber expenditures are in the range (0.02-0.8) liter per minute and then the full sedimentation of aerosol particles occurred.

[P04-36] MEASUREMENT UNCERTAINTY IN THE DETERMINATION OF FINE PARTICLE MASS AND MASS CONCENTRATIONS OF SULFATE AND TRANSITION METALS.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

Measurements of fine particle mass concentrations and speciated mass concentrations carry significant consequences from both regulatory and health effects perspectives. Data of known precision and accuracy needs to be the starting point for pollution mapping, air quality models, regulatory decisions, and scientific and health effects research. For a number of reasons, measurements of airborne particulate matter, and specifically fine particulate matter (or $PM_{2.5}$) place extraordinary demands on measurement technologies.

Indicators of data uncertainty and reliability will be explored in this paper. In the absence of NIST standards (or the equivalent) for particulate matter and its component species, comparisons of co-located measurements provide useful estimates of measurement uncertainties. Two case studies will be examined; 1) measurements of bulk mass concentration using FRM filter samplers and two versions of the continuously measuring TEOM® mass monitor; and 2) measurements of sulfate, lead, and transition metals from three co-located filter samplers. For the second case the three samplers consist of an IMPROVE sampler, a R&P 2300 sampler as part of the EPA Speciation Trends Network (STN), and an ACCU® sampler attached to a TEOM monitor. Sulfate is measured via Ion Chromatography for all samples, but samples are collected and handled differently and the analysis occurs at two different laboratories. Elements are measured by X-Ray Fluorescence (XRF) at two independent laboratories and by Inductively Coupled Plasma - Mass Spectrometry (ICP-MS) at the third laboratory. These multiplicities of methodologies and laboratories will allow a better estimation of measurement uncertainties.

[P04-25] POLICY IMPLICATIONS OF $PM_{2.5}$ FEDERAL REFERENCE METHOD PERFORMANCE RELATIVE TO MASS BALANCE CLOSURE.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

The National Ambient Air Quality Standards (NAAQS) for ambient air concentrations of $PM_{2.5}$include regulatory standards defining $PM_{2.5}$ as the mass measured by the Federal Reference Method (FRM). Many urban and metropolitan areas in the US are projected to exceed the annual average $PM_{2.5}$ NAAQS of 15 $\mu g/m^3$.

Comparing FRM mass measurements to the mass of the sum of the aerosol chemical components provides a means of evaluating FRM performance against atmospheric conditions. Daily ambient aerosol samples were taken in Pittsburgh, Pennsylvania from the summer 2001 through winter 2002 as part of the Pittsburgh Air Quality Study (PAQS) to measure $PM_{2.5}$ mass by the FRM and the aerosol chemical composition. Monthly average $PM_{2.5}$ concentrations for July and August were 20 and 28 $\mu g/m^3$. During this time, the FRM measurement periodically exceeded the mass of the sum of the aerosol chemical components by almost 30%, with monthly average discrepancies of 13 and 20%. In the winter months, monthly average $PM_{2.5}$ concentrations were approximately 12 $\mu g/m^3$, with the FRM-measured mass at or slightly below the sum of the mass of the aerosol chemical components.

The observed mass balance discrepancy may be explained by a combination of factors, including retention of aerosol water, loss of organic material and nitrates, and uncertainty regarding the conversion of organic carbon data to total organic material. Days with significant positive mass discrepancy can be explained by estimates of aerosol water content. The negative discrepancy observed on days dominated by organic aerosol or winter days with relatively high nitrate concentration appears to correlate with estimated volatilization losses.

The finding that the mass discrepancy observed appears to be a function of aerosol chemical composition has implications for national air quality policy for several reasons. First, aerosol composition varies considerably across the US, suggesting that the mass discrepancy may vary on a regional basis. Second, if indeed the FRM discrepancy is attributable to aerosol composition, basing $PM_{2.5}$ compliance on FRM data may lead to control strategies that target species disproportionately in comparison to their relative health effects. Comparing FRM and aerosol composition data across the country allows further delineation and quantification of the policy impacts of the FRM discrepancy effect.

[P04-35] INFORMATION FROM IONS IN EXTRACTS FROM ACIDIC GAS DENUDERS USED IN THE PM2.5 CHEMICAL SPECIATION SAMPLING NETWORK.

Walter C. Eaton, Eva D. Hardison, Constance V. Wall EG, RTI, RTP, NC

Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

Each of the four designs of PM2.5 chemical speciation collectors employs magnesium oxide (MgO) or sodium carbonate (Na2CO3) coated denuders prior to the nylon filters that collect PM for ion analysis. The denuders remove acidic gases, such as nitric acid vapor, from the air stream and prevent them from reaching the filter surface. MgO denuders remain in use for up to 30 sampling days; Na2CO3 denuders are in use for one sampling day. Exploratory work to determine the "catch" of the MgO denuders has been undertaken. Topics to be covered include:

Extraction methods and recovery estimates - A method for aqueous and buffered extraction of ions (representative of acidic species) from the denuder surfaces is described. Ions at concentrations representative of ambient air acidic gas concentrations are spiked into the MgO slurry that is subsequently applied to denuder surfaces. Recoveries are reasonable and range from 107 to 116 percent. The capacity of the denuder for absorption of acidic gases is reviewed.

Comparison of acidic gas concentrations across PM2.5 sites - Concentrations of acidic gases such as nitric acid vapor (expressed as micrograms of species per cubic meter of air sampled) are determined via ion chromatographic analysis of denuder extracts for nitrate and other anions. Average values (for three months'sampling at a frequency of every third day) of acidic gas concentrations are compared for several sites in the U.S. that differ in PM2.5 composition. Relationships between acidic gas concentrations and the ionic components of the PM2.5 collected during the same time period are sought and discussed. Acid gas concentrations are also compared to values reported in the literature.

[P04-23] USING ULTRAFINE CONCENTRATORS TO INCREASE THE HIT RATE OF SINGLE PARTICLE MASS SPECTROMETERS.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

A rapid single particle mass spectrometer, RSMS-3, developed at the University of California, Davis and the University of Delaware was installed at the EPA Supersite in Pittsburgh to measure ultra-fine single particles in the atmosphere. This instrument is used to analyze both sizes and chemical components of ultra-fine particles simultaneously, but is limited by its hit rate to more polluted conditions. To extend its application to cleaner areas, several methods are under consideration to increase its hit rate. One of them is to introduce an ultra-fine particle concentrator to the sampling inlet of the mass spectrometer.

An ultra-fine particle concentrator, VACES, developed at the University of Southern California has been deployed in many field experiments. In its optimum configuration, VACES concentrates ultra-fine particles by factors of 15-25, depending on the minor-to-total flow ratio of the virtual impactor. Previous experimental results showed that the concentrator does not distort the size distribution of the original ultra-fine aerosols.

A test of VACES coupled to the RSMS-3 mass spectrometer was conducted at the Pittsburgh EPA Supersite in April 2002 to determine the hit rate increase and elucidate particle composition changes induced by the concentrator. The hit rate increased by 5-20 times. Statistical analysis shows that there was no change in particle composition due to concentration. At the same time, a number of lessons were learned pertaining to details of the use of these systems together. Problems and their possible solutions are discussed.

[P04-33] SPECIATION OF AEROSOL PARTICULATE MATTER BY SEPARATING AND QUANTIFYING THE VOLATILE AND INVOLATILE AS WELL AS THE SOLUBLE AND WATER-INSOLUBLE FRACTIONS.

Klaus Wittmaack, Lothar Keck, Norbert Menzel Institute of Radiation Protection, GSF-National Research Center, Neuherberg, Germany; Institute of Radiation Protection, GSF-National Research Center, Neuherberg, Germany; Institute of Radiation Protection, GSF-National Research Center, Neuherberg, Germany

Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

We report results obtained in course of an ongoing study that aims at understanding sampling artifacts on filters and in impactors as well as providing detailed information about the composition of PM under different meteorological conditions. Mass closure is one of the ultimate goals. Ambient aerosol matter is sampled in the form of PM2.5, PM10 and TSP on membrane, quartz fiber and glass fiber filters (teflon filter to be added soon) as well as in low-pressure impactors (Berner, Moudi). To identify the contribution of adsorbed NOx, SO2 and other gases, sampling is also carried out with and without denuders and by implementing impregnated filter packs. Six essentially identical aerosol deposits on 37-mm diameter filter can be produced using two PM2.5 (or PM10) samplers in parallel, each containing three monitors. Great effort was devoted to producing high-purity filters by extracting soluble impurities in ultra-pure water, followed by backing up to high or the maximum tolerable temperatures. The aerosol covered filters as well as the back-up filters are initially characterized in terms of the total mass, the ion mass, the acidity and the elemental composition, the latter being measured by proton induced X-ray emission spectrometry, PIXE. Thereafter samples of the same composition are passed through various treatments like controlled removal of volatile components at temperatures up to 400°C and/or separation of the water soluble and insoluble fractions. Owing to the reproducible filter pretreatment it is possible to quantify both the dissolved and the insoluble mass. The soluble mass can be separated into the ionic and the non-ionic fraction. Quite generally we find that the aerosol matter collected on different types of filters or in impactors, but under otherwise the same conditions, exhibits distinct differences in composition. Whereas, for example, the SO4 concentration derived from membrane and fiber filter measurements is the same, the (apparent) NH4 and NO3 concentrations are lower for fiber filters by up to factors of 2 and 9 (!), respectively. Moreover, the (apparent) mass concentration calculated from samples collected on fiber filters may be up to a factor of 2 lower than for membrane filters. This could be due, at least in part, to a higher water content of samples collected on membrane filters. The water soluble component amounts to between 50 and 70% of the total PM and the ionic fraction comprises about 80% of the soluble matter.

[P04-31] WITHDRAWN

Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4
WITHDRAWN

[P04-30] PRELIMINARY RESULTS OF EPA\\'S PERFORMANCE EVALUATION OF FEDERAL REFERENCE METHODS AND FEDERAL EQUIVALENT METHODS FOR COARSE PARTICULATE MATTER.

Paul Solomon, Tom Ellestat, Teri Conner, Roy Zweidinger, Mary Harmon, Robert Vanderpool, Bob Murdoch, Sanjay Natarajan, Chris Noble, Tim Hanley, Lee Byrd, Richard Scheffe Office of Research and Development, US EPA, Las Vegas, NV; Office of Research and Development, US EPA, RTP, NC; Research Triangle Institute, US EPA, Raleigh, NC; Office of Air Quality Planning and Standards, US EPA, Raleigh, NC

Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

The main objective of this study is to evaluate the performance of sampling methods for potential use as a Federal Reference Method (FRM) capable of providing an estimate of coarse particle (PMc: particulate matter with an aerodynamic diameter between 2.5 μm and 10 μm) mass concentrations in ambient air. Three sampling approaches are being evaluated. These approaches include a discrete method for measuring coarse particles directly using a sequential sampler; a discrete difference method, which uses two samplers, one to measure PM2.5 the other PM10 with the difference, PM10-PM2.5, representing an estimate of PMc; and two continuous coarse particle samplers that measure PMc directly with a time resolution of less than 1 hour. The direct sequential and continuous methods use the dichotomous virtual impactor for separating fine and coarse particles. The samplers will be evaluated in three locations that provide diverse challenges to the samplers, including high PMc to PM10, high PM2.5 to PM10, and an intermittent site (impacted by a source to see high and low values) under cold conditions. This presentation will provide preliminary results from the first location with a high PM2.5 to PM10 ratio.

[P04-24] THE DEVELOPMENT AND TESTING OF A SEQUENTIAL PMc (COARSE) AMBIENT PARTICULATE SAMPLER.

T. Merrifield, G. Ruffolo , BGI Instruments, Waltham, MA; TCR Tecora, Milano, Italy

Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

A new sequential gravimetric sampler by which ambient air particulate is segregated into PM Coarse (PM_c); that being the collection of ambient particulate between 10 and 2.5 micrometers AED, utilizes the $1m_3$/hr classical Virtual Impactor. The U.S. EPA is considering future changes in the National Air Quality Standards (NAAQS) to include a national network for PM Coarse. The classical Dichotomous Sampler utilizing the Virtual Impactor operates with the flow rate at 16.67alpm collecting the ambient particulate onto two filters, one being PM_c Coarse and other $PM_{2.5}$ Fine. A project was undertaken to develop a candidate PM_c Reference Method sampler utilizing a set of sequential filters for one week of daily sampling onto two 47mm PTFE membrane filters. The platform sampler is essentially a modified EPA Reference Method sampler for $PM_{2.5}$ utilizing the Virtual Impactor beneath the PM_{10} FRM Inlet. The sequential sampler uses two sets of filters, mechanically and pneumatically moved through the sampler each 24 hour sample event. A review of the historical literature from the 1970's to present, and field testing of the Virtual Impactor are revisited. Recent field and laboratory tests of the new Sequential PM_c sampler demonstrate the sample gave a cut point of $PM_{2.5}$ to 0, and $PM_{2.5}$ to 10. Field tests concluded a precision and accuracy within the EPA requirements.

[P04-48] INTERLABORATORY COMPARISON STUDIES FOR CHARACTERIZATION OF ORGANIC COMPOUNDS IN PARTICUALTE MATTER.

Michele M Schantz, Stephen A Wise, Joellen Lewtas Analytical Chemistry Division, NIST, Gaithersburg, MD; NERL, Manchester Lab, US EPA, Port Orchard, WA

Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

A working group of investigators, who are characterizing and quantifying the organic compounds in particulate matter (PM) as part of the US EPA\\'s PM 2.5 research program and related studies, was established three years ago to advance the quality and comparability of data on the organic composition of PM. This group has just completed their second interlaboratory comparison study. The first study used a subset of SRM 1649a (Urban Dust, sieved to <123 mm) that had been sieved to <63 mm (Air Particulate I) as an unknown PM sample. In addition to Air Particulate I, the participants received a dichloromethane extract of Air Particulate I as a second unknown sample and a sample of SRM 1649a for use as a control material. For the second study, initiated in March 2002, the participants received a sample of PM2.5 collected recently in Baltimore, MD along with a sample of SRM 1649a. It is a requirement that all participants return data on Air Particulate I and SRM 1649a prior to receiving the Baltimore PM2.5 material, so at this point there are participants at different stages of the two studies. The target analytes, organic source tracers and toxic species, include polycyclic aromatic hydrocarbons (PAHs), nitrated PAHs, alkanes (including hopanes and cholestanes), sterols, carbonyl compounds (ketones and aldehydes), acids (alkanoic and resin), phenols, and sugars. Because this is a performance-based study, laboratories are encouraged to use the methods that they are routinely using in their laboratories to analyze similar samples. Laboratories are requested to return data from three analyses (subsamples) of each sample provided along with a summary of the methods used. The data received from the participating laboratories, following outlier testing, are then used to assign a consensus value to each analyte in the unknown samples. Results are used in the consensus value assignment for the unknown PM sample only if the laboratory\\'s results for SRM 1649a are within 30% of the uncertainty limits of the certified values. The consensus values, accuracy and precision assessments, and the methods used by each laboratory are summarized in a report provided to the participants. In this report, laboratories are numerically identified with only the laboratory and the study coordinators knowing this numerical identification. The results from the two interlaboratory studies will be presented along with plans for future interlaboratory trials, standard reference materials, and calibration standards. This work has been funded by the U S Environmental Protection Agency. It has been subjected to Agency review and approved for publication.

[P04-22] DATA VALIDATION AND QUALITY ASSURANCE FOR THE CHEMICAL SPECIATION TRENDS NETWORK.

James B. Flanagan, Jessie A. Deal, James A. O'Rourke, Edward E. Rickman EICD, RTI, RTP, NC

Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

The PM2.5 Chemical Speciation program has very tight data turnaround requirements -- fully-validated data are currently being uploaded to AIRS in an average of <120 days after sampling for all 59 analytical values that are reported for each sampling event. Data for 225 field monitoring sites (approximately 1800 separate monitoring events per month) are validated and reported at monthly intervals to the state and local air monitoring agencies which operate the samplers. An efficient system for data validation has contributed to RTI's ability to meet EPA's stringent requirements. This presentation will provide an overview of the steps used to validate the data and the different kinds of data comparisons used to identify questionable data. Some of the routine validation steps include checks of exposure dates and range checks on various parameters; and verification of mass balance, anion/cation charge balance, and sulfur/sulfate balance.

The high degree of integration with the laboratory database has enabled many data entry, validation, and reporting functions to be automated, and also allows human data reviewers to assess overall trends easily. The monthly validation procedures sometimes help to identify problems with individual samplers in the field (such as a leaking flow channel), which can then be brought to the attention of the agency that operates the field site.

Data quality assessment reports are prepared by RTI on a semi-annual basis. Much of the information in these reports is based on results of validation screening, as well as from laboratory QC procedures, and from data processing. Data quality results from the most recent semiannual QA report will be presented.

[P04-34] DEVELOPMENT AND EVALUATION OF AN ELECTROSTATIC COLLECTOR FOR SEMI-VOLATILE PM2.5.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

The objective of this research is to evaluate the potential of electrostatic precipitation to minimize sampling artifacts associated with semi-volatile components of PM-2.5. A device is being developed which is intended to collect a sample of atmospheric particulate matter without shifting its gas/particle phase partitioning. This work builds upon previous research at UNC which demonstrated the usefulness of a personal ESP sampler for collecting oil mist samples. The personal ESP reduced both positive and negative artifacts when tested using a laboratory-generated semi-volatile aerosol. The new sample collector will be tested using PM-2.5 Federal Reference Method samplers, with the electrostatic collector used in place of the Teflon filter.

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[P04-47] SEMI-VOLATILE ORGANIC SPECIES DURING THE TEXAS AIR QUALITY STUDY -2000: PARTICULATE CARBON AND GAS/PARTICLE PARTITIONING OF HYDROCARBONS.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

During the late summer of 2000 (8/15 - 9/15/00), the Texas Air Quality Study - 2000 was conducted to improve understanding of the factors that control the formation and transport of air pollutants along the Gulf Coast of southeastern Texas. A variety of real-time and integrated samplers were deployed at three sites to characterize ambient aerosols, including semi-volatile organic compounds. The LaPorte Airport site was upwind of nearby petrochemical refineries. The Houston Regional Monitoring Site-3 was on the shipping channel between Galveston Bay and central Houston, and Aldine represented a suburban site.

Semi-volatile species were collected with Integrated Organic Gas and Particle (IOGAP) samplers that incorporates XAD-4 coated annular diffusion denuders upstream of a filter and back-up sorbent substrate. This diffusion-based measurement technology minimizes artifacts that are associated with sampling semi-volatile organic species (SVOC). During sampling, the gas phase SVOC were trapped on the XAD-4 coated denuders. Particles were collected on the filter. The post-filter sorbents (XAD-4 impregnated filters) trapped any SVOC that volatilized from the collected particles. Extracts of the denuder, filter and sorbent were analyzed separately for gas-particle partitioning.

This presentation shows gas/particle partitioning data for PAH and alkanes, as well as particulate mass concentrations. Organic and elemental carbon and PAH concentrations were compared for particles collected with the IOGAP and conventional samplers. Three specific periods were selected for analysis: A high ozone (>150 ppb) episode, a wood-smoke event and a cleaner period for comparison. Over 60 organic compounds have been analyzed. Noticeable increases in the more volatile compounds were observed in the morning of the high ozone event and several key wood-smoke markers (retene, leveglucosan) during the wood-smoke event. However, the organic speciation data, as well as the PM mass measurements, suggest there was not much variability between the three sampling sites. This observation is supported by the unique circular wind patterns observed around the Greater Houston Area.

[P10-13] SIZE RESOLVED MASS BALANCE OF AEROSOL PARTICLES OVER THE METROPOLITAN REGION OF SAO PAULO, BRAZIL.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

The mass size distribution of atmospheric aerosol particles in the heavily polluted metropolitan region of Sao Paulo, Brazil, was determined by means of a micro-orifice uniform deposit impactor (MOUDI) during the period of 3-11 of August, 1999. The particles collected on the 5 lower stages of the impactor (stages 9A, 7A, 6A, 5A and 4A with d_{50} of: 0.09, 0.38, 0.59, 1.0 and 1.8 μm, respectively) were analyzed by particle induce X-ray emission technique (PIXE) for up to 20 trace elements. These 5 stages plus the After Filter were analyzed also for mass, black carbon (BC) and by ion chromatography (inorganic ions: Na^+, NH_4^+, K^+, Mg^{2+}, Ca^+, Cl^-, NO_3^- and SO_4^{2-}). Real time carbon monitor provided organic and elemental carbon concentration for PM10.

Considering that there is enough ammonia in the urban atmosphere, it was assumed that all sulfate was in the form of ammonium sulfate. For the 5 stages, the ammonium sulfate concentration was estimated by the sulfur concentration obtained by PIXE analysis assuming a conversion factor of 4.125; and the crustal material was estimated by the sum of the main oxides and carbonates: Al_2O_3, SiO, $CaCO_3$, K_2CO_3, Fe_2O_3 and ZnO.

The liquid water adsorbed by the inorganic aerosol was also taken into account by using the ISORROPIA model (Nenes et al., 1998), using as input the concentrations obtained by ion chromatography.

The averaged mass balance analysis for each stage showed that BC is concentrated in the After Filter, being present as particles with very low diameters. The ammonium sulfate and the liquid water content have simple unimodal size distributions, with a maximum value at stage 6A (d=0.59μm). The crustal material contribution is greater at stages with greater cut-off diameters. More than half of the fine particulate matter is not resolved. Part of this difference should be explained by the organic carbon (OC) and water absorbed by these small organic particles, which were not considered. Assuming that all the OC measured by the carbon monitor is in the fine mode, it would explain almost 60% of the missing mass.

On the basis of these results and assumptions it can be concluded that carbon (OC+BC) may have higher contributions than ammonium sulfate, and that the three of them are responsible for the major composition of the fine particulate in the metropolitan region of Sao Paulo.

Reference:

Nenes, A.; SN Pandis and C Pilinis, 1998: A new thermodynamic equilibrium model for multiphase multicomponent inorganic aerosols. *Aquatic Geochem.*, **4**, 123-152.

[P04-21] ESTIMATING ANALYTICAL MEASUREMENT UNCERTAINTY FOR THE PM2.5 CHEMICAL SPECIATION PROGRAM.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

The PM2.5 Chemical Speciation program uses four separate analytical methods -- anions and cations by ion chromatography (IC), trace elements by X-ray fluorescence (XRF), gravimetric mass, and organic/elemental carbon (OC/EC). A total of 59 separate analytical values are reported. Each method differs in the factors that affect the total analytical uncertainty.

Many of the factors that contribute to total uncertainty are difficult to assess using conventional laboratory quality control (QC) samples such as calibration standards, laboratory blanks, spikes, and replicates. Some examples that will be presented include the following:

Assessment of filter lot contamination - Each new filter lot from the manufacturer must be checked before it is used for environmental sampling. Filter lots that do not pass the acceptance levels must either be sent back to the manufacturer, or the laboratory must clean each filter from that lot. Residual levels of contamination can be estimated based on laboratory blank results.

Estimation of Artifact Carbon - The OC/EC method uses quartz filters, which have been fired at 900°C, to collect particulate matter for carbon analysis. There is a clear time dependency in the organic fraction that may be due to uptake of volatile and semi-volatile organic compounds (VOCs and SVOCs) from the atmosphere. This phenomenon affects the bias and precision of the OC measurements, but usually has little effect on EC results.

XRF "Uncertainty" Values - The XRF instruments that are used to measure 48 elements provide "uncertainty" figures paired with each analytical result as part of the software's output. These uncertainties are based, in part, on raw counting statistics. A current challenge is to reconcile these reported uncertainty values with other determinations of precision such as statistical evaluation of replicate analysis results.

[P04-54] CHLORDANES IN THE INDOOR AND OUTDOOR AIR OF THREE US CITIES.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

The indoor and outdoor concentrations of six Chlordane species (trans-chlordane, cis-chlordane, trans-nonachlor, cis-nonachlor, oxychlordane and MC5) were measured at 157 non-smoking residences in three urban areas during June 1999-May 2000. The data represent a subset of samples collected within the Relationship of Indoor, Outdoor, and Personal Air study (RIOPA). The study collected 48 hour integrated samples from homes in Los Angeles County, CA, Houston, TX, and Elizabeth, NJ. Both particle bound (PM2.5; quartz fiber filter) and vapor phase (PUF adsorbant) Chlordane concentrations were separately measured by GC / EI MS after solvent extraction.

Technical Chlordane (a mixture of ~140 poly-chlorinated norboranes) was used as a broad-spectrum pesticide from the 1940s through the 1960s, and was regulated in 1979, restricting most above aground and agricultural uses. By 1983 the only remaining application in the US was as a termiticide, primarily in new building construction, and by 1988 the termitcide registration was cancelled ending the sale and use of Chlordane in the United States. However, due to the physio-chemical properties of these compounds, they are widespread, being found in both biotic and abiotic matricies from the arctic, to mid latitudes, and tend to bioaccumulate and biomagnify.

The outdoor (gas + particle) total Chlordane (trans-chlordane + cis-chlordane + trans-nonachlor + cis-nonachlor) concentrations ranged from 36 to 4270 pg m-3 in Los Angeles, from 8 to 11000 pg m-3 in Elizabeth, and from 62 to 1770 pg m-3 in Houston. The corresponding indoor total Chlordane concentrations ranged from 37 to 111500 pg m-3 in Los Angeles, from 260 to 31800 pg m-3 in Elizabeth, and 410 to 38900 pg m-3 in Houston. Geometric mean concentrations were higher in indoor air than outdoor air (1980 vs.580 pg m-3 in CA; 1300 vs. 170 pg m-3 in NJ; 4180 vs. 280 pg m-3 in TX), which suggests that there are significant indoor sources of Chlordane species in a subset of homes in each of the three cities. Chlordane isomer ratios as well as individual indoor to outdoor concentration ratios will be presented.

[P04-53] THE DISTRIBUTION OF PARTICULATE POLYCYCLIC AROMATIC HYDROCARBONS (PAHS) IN THE ATLANTIC AND INDIAN OCEAN ATMOSPHERES.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

Polycyclic aromatic hydrocarbons (PAH) are ubiquitous products of fossil fuel and biomass combustion. Some PAHs are carcinogenic and mutagenic. There are no direct local sources of PAHs to remote regions of the world's oceans, and the fate of PAHs is driven by atmospheric transport. Assessing the global distribution of these contaminants is difficult due to the lack of current data in the remote oceanic atmosphere. Two field campaigns, AEROSOL99 and The Indian Ocean Experiment (INDOEX) were completed in the winter of 1999. As part of these studies, the Research Vessel Ronald H. Brown sailed from Norfolk, VA to Cape Town, South Africa and then northeast through the Indian Ocean. The main objective of AEROSOL99 and INDOEX was to elucidate the aerosol and trace gas chemistry in the Atlantic and Indian Oceans' marine boundary layer. INDOEX demonstrated that a massive pall of smoke from biomass and fossil fuel combustion covers most of the Northern Indian Ocean throughout the Indian dry season, February to April. Aerosol samples obtained from an area spanning the Northern and Southern Hemispheres of the Atlantic and Indian Oceans as well as the Bay of Bengal and the Arabian Sea were analyzed for PAHs.

The samples were grouped in characteristic air regimes (5 Atlantic Ocean and 7 Indian Ocean) through back-trajectory calculations via HYSPLIT to characterize particle PAH burdens from similar continental and marine source locations. The Northern Hemisphere Indian Ocean atmosphere contained approximately an order of magnitude greater aerosol PAH concentrations and more than 90% of most of the PAH were detected. This increased anthropogenic PAH signal correlates with ancillary atmospheric measurements such as elemental and organic carbon (Bates et al., in press; Ball et al., 2002; Dickerson et al., 2002). Benzo[a]pyrene, the best known mutagenic PAH, in the highly impacted Northern Hemisphere Indian Ocean air regime (>400 km off shore) was only a factor of 4 lower than values recently measured in Baltimore, MD (45 + 14 and 190 + 110 pg/m3, respectively) indicating a strong Indian anthropogenic signal extending well into the Indian Ocean atmosphere. Source specific PAH signatures in concert with ancillary measurements, such as black carbon, were used to qualitatively identify the major sources of PAHs to the coastal Indian Ocean atmosphere. This study presents the most recent estimate of remote oceanic aerosol PAHs and an assessment of the impact and sources of anthropogenic emissions from the Indian sub-continent on the Indian Ocean atmosphere.

[P04-52] SIZE DISTRIBUTION OF NITRO-PAHS IN THE BALTIMORE, MD ATMOSPHERE.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

Adverse health effect of ambient urban aerosol is well established. The presence of nitro-substituted polycyclic aromatic hydrocarbons (nitro-PAH) have been linked to the direct mutagenicity of these urban aerosols. Specific nitro-PAHs are formed by primary emissions (diesel exhaust) and through secondary gas-phase transformation reactions of parent PAHs via O3 or NO3 oxidation. The size distribution of nitro-PAHs from primary and secondary reactions provides valuable information on the potential mutagenicity of various particle sizes and populations. In conjunction with the Baltimore PM 2.5 Supersite, 12 and 24h bulk and size resolved aerosol were collected in April 2002 using a modified Anderson Hi-Vol and Berner low-pressure impactor. The homologue distribution was used to estimate the size distribution of diesel-derived soot and to further resolve primary and secondary sources of the various nitro-PAHs congeners in the Baltimore, MD atmosphere. To our knowledge this is the first size resolved nitro -PAH data reported and explored as a potential diesel soot marker in the Eastern United States.

[P04-51] FAST ANALYSIS OF SVOC IN THE PM2.5 FRACTION OF AMBIENT AEROSOL FOR USE IN EPIDEMIOLOGICAL STUDIES.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

Several epidemiological studies have investigated the influence of the particles on health effects. The association of individual specific organic pollutants or groups of pollutants with health effects, occurring in the fine dust, was not examined in epidemiological studies yet. As a new analytical approach recently the thermal desorption has been employed for extracting semi volatile compounds from ambient particulate matter. The direct thermal desorption - gas chromatography - mass spectrometry (DTD-GC-MS). technique enables fast, simple, and cheap analysis of semi volatile organic compounds e.g. in the PM2.5 fraction of ambient aerosol.

In our study besides determination of particle mass (TEOM) and number concentration (CPC) particulate matter is sampled with a PM2.5 sequential sampler on quartz fiber filters at a flow of 1 m^3 h-1. The sampling period for each sample is 24 h. The samples are analyzed for SVOC by DTD-GC-TOFMS. The DTD interface introduced in this study is a novel approach making it possible to use the liner of the GC injection interface as a sample container for the filter aliquots. Putting the liner in the injector is automated, and the analytes are thermally desorbed from the liner directly onto the capillary GC column. For analysis the filters are cut into pieces, each representing 1 m^3 of sampled air. One to four of these pieces are placed into a GC-liner. Isotope labeled reference compounds are added for quantification. For desorption the temperature is kept at 450°C for 10 Minutes. During desorption the SVOC are focused on a retention gap at 40°C oven temperature.

The measurements showed, that a filter aliquot representing 1 m^3 of sampled air is sufficient for a single analysis. Thus repeated analyses of one filter can be carried out.

In the samples among others (n-)alkanes, fatty acids, terpenes, hopanes, PAH, oxy-PAH and heterocyclic aromatic compounds have been identified and quantified. Further effort identifying unknown compounds using comprehensive GCxGC/TOFMS and peak deconvolution technique is on the way. For use in the epidemiological study the concentrations of individual compounds (e.g. n-alkanes, acids, PAH, PAH-quinones etc.)are summarized. Additionally the amount of the unresolved carbonaceous matter (UCM) is calculated for each sample. Statistical analysis is carried out using the concentrations of the single compounds as well as the summarized concentrations.

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[P04-46] PARTICULATE CARBON AND GAS/PARTICLE PARTITIONING OF HYDROCARBONS IN SEATTLE.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

This presentation focuses on clarifying the influence of semi-volatile organic species on exposure assessment for airborne particulate matter. For this purpose we deployed conventional and diffusion-based sampling technology at a central monitoring site and both indoors and outdoors at several residential sites, during part of the extensive exposure assessment efforts of the Northwest Center for the Study of the Health Effects of Particulate Matter (Seattle, 1999-2001). Organic and elemental carbon and polycylic aromatic hydrocarbons (PAH) concentrations were compared for particles collected with several types of samplers. The role of semi-volatile species both indoors and outdoors can be clarified by comparing gas/particle partitioning data for PAH to particulate carbon and particulate mass concentrations.

Semi-volatile species were collected with Integrated Organic Gas and Particle Samplers that incorporate XAD-4 coated annular diffusion denuders upstream of a filter and back-up sorbent substrate. This diffusion-based measurement technology minimizes artifacts that are associated with sampling semi-volatile organic species (SVOC). During sampling the gas phase SVOC were trapped on the XAD-4 coated denuders. Particles were collected on the filter. The post-filter sorbents (XAD-4 impregnated filters) trapped any SVOC that volatilized from the collected particles. Extracts of the denuder, filter and sorbent were analyzed separately for PAH. Particulate organic (OC) and elemental carbon (EC) were determined from sections of quartz filters by thermal optical transmission.

The results from May 2001 suggest that indoor particulate PAH and EC track each other and infiltrate from outdoors when no cooking or combustion sources are present indoors. However, indoor particulate PAH and OC do not track each other unless diffusion denuders are used to prevent indoor gas-phase OC from adding to the apparent particulate OC.

[P04-49] ANALYSIS OF POLAR ATMOSPHERIC ORGANIC COMPOUNDS USING LIQUID CHROMATOGRAPHY/ MASS SPECTROMETRY ATMOSPHERIC PRESSURE PHOTOIONIZATION (LC/MS APPI).

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

Nearly 50% of the organic carbon mass collected as fine particles cannot be analyzed using current molecular level mass spectrometric analytical methods (e.g., gas chromatography/mass spectrometry, GC/MS) due to low volatility in the gas chromatographic system. The presence of one or more polar functional groups, high molecular weight (> 450 amu), and/or thermal instability are principal factors preventing successful analysis by GC/MS. Consequently, little chemical information is available on a substantial fraction of the organic carbon fine particle mass, the "polar" organic fraction. The presence of functional groups within molecules contained in this fraction can impart acidic or basic character to fine particles, increase solubility in aqueous media, govern fate and transport of fine particles in the atmosphere, and influence uptake by biological systems, including absorption within the human respiratory tract.

Reverse phase high pressure liquid chromatography (HPLC) is an analytical method that can be applied to highly polar, water-soluble organic compounds. Unlike GC/MS, compounds can be nonvolatile, have high molecular weight (up to 100,000 amu), and be partially to fully water-soluble. Polar organic compounds of atmospheric significance were examined using Liquid Chromatography/Mass Spectrometry combined with Atmospheric Pressure Photoionization (LC/MS APPI) and mass-to-charge (m/z) detection by an ion trap mass spectrometer. Injections of standard solutions in methanol were conducted using analyte concentrations of 2 ppm, 20 ppm and 200 ppm, and corresponding to total injected masses of 20 ng, 200 ng and 2000 ng, respectively. The standard suite was composed of basic organic compounds (nitrogen heterocycles), sulfur heterocycles (benzothiphenes), acidic aromatic compounds (benzoic acid, nitrobenzoic acid), and an aliphatic dicarboxylic acid (azelaic acid). Basic and acidic organic compounds were analyzed selectively by operating the APPI ionization source under positive mode (organic bases) or negative mode (organic acids). All standard compounds produced ions that could be detected as either [M+H]+, [M]+, or [M-H]- and exhibited good ion abundances for even the lowest standard concentrations (20 ng injected mass).

The linear response for standards and low detection limits in the ng/microliter range demonstrate the usefulness of LC/MS APPI as a new molecular level analytical tool for identifying a large range of polar organic compounds. In addition, the technique is selective for acidic and basic organic molecular constituents in fine particles.

[P04-27] NUMBER CONCENTRATIONS OF PARTICLES CONTAINING SPECIFIC CHEMICAL COMPONENTS.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

Single particle mass spectrometers are ideally suited to count ambient particles as a function of size and chemical composition. In the past, single particle data has been used to determine the fraction of particles for a given particle size that contain a specific chemical composition and to estimate the time-dependent mass concentration of these components. Number concentrations of particles containing specific chemical components have not been reported, despite growing evidence that both number concentration and chemical composition correlate strongly with adverse health effects.

The lack of composition-dependent number concentration measurements can be traced to the performance of most single particle mass spectrometers - they do not efficiently analyze particles in the fine/ultrafine size range where number concentrations are greatest. We have deployed single particle mass spectrometers at the Baltimore and Pittsburgh supersites that efficiently analyze particles between about 50 nm and 1000 nm in diameter. With these instruments, the absolute number concentrations of particles containing specific chemical components can be determined from the rate at which particles are detected and analyzed.

In this poster, the methodology for composition, size and time dependent number concentration measurements will be presented, and results will be shown for the specific example of transition and heavy metals in particles. At the Baltimore supersite, over 10% of the particles analyzed contain one or more of these metals. Number concentrations of particles containing specific metals enable emission source characterization, receptor modeling and exposure studies that are based on number rather than mass concentration.

[P04-45] THE DEVELOPMENT AND EVALUATION OF POROUS FOAM AS A DENUDER FOR A PERSONAL ORGANIC PARTICULATE MATTER SAMPLER.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

Epidemiological studies show a strong correlation between elevated particulate matter (PM) and a range of adverse health effects(1). The need for accurate measurement of personal exposure to PM and chemical components of PM has been identified by the National Research Council as a research priority of particulate matter (2). By using activated carbon impregnated foam as a denuder in a personal sampler, gas phase interferences in the measurement of semi-volatile organic compounds collect on a filter are avoided. The foam denuder is followed by a pre-fired quartz filter followed by a charcoal impregnated glass fiber filter to determine fine particulate carbonaceous material and nitrate, including semi-volatile species lost from the particles during sampling. Samples, collected at Brigham Young University, are evaluated for collection efficiency, and the data is compared with PC-Boss date (3) collected in tandem.

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[P04-44] EXAMINING THE ASSUMPTIONS BEHIND ELEMENTAL CARBON MEASUREMENTS USING THE THERMAL-OPTICAL TRANSMITTANCE TECHNIQUE.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

Diesel particulate matter is one of the major national air toxics as per the 1996 EPA National Air Toxics Assessment. Elemental carbon (EC) is often used as a tracer for the contribution of diesel soot to ambient particulate matter. The most common way to measure elemental carbon is by analyzing an aerosol sample collected on a quartz filter with a thermal-optical method such as IMPROVE or NIOSH. Previous work has shown that measurements of elemental carbon from these different methods do not agree.

This poster examines the organic carbon-elemental carbon (OC/EC) split using a conventional Sunset Labs Thermal-Optical Transmittance (TOT) analyzer. The OC/EC split is difficult to determine because some of the organic carbon pyrolyzes during the analysis. The TOT method corrects for the pyrolysis by measuring the transmittance of the filter. The ambient EC is taken as the mass of carbon that evolves after the transmittance returns to its original, pre-analysis value. The underlying assumption of the method is that either (a) the pyrolyzed carbon (PC) and ambient EC have similar optical properties, or (b) the PC comes off completely before the EC.

Experiments were performed to examine these two assumptions. The first experiment involves washing ambient samples with organic solvents (to reduce OC and minimize pyrolysis) followed by OC/EC analysis. Comparing the washed and unwashed filters shows that PC evolves at the same time as ambient EC, and further, that the optical transmittance of these two types of carbon are different. Therefore changes in the relative rate that PC and EC evolve alter the OC/EC split.

Refractory doped filters using sucrose and ambient aerosol were also analyzed to examine the effect of refractory loading on the PC and EC evolution. Higher refractory content appears to increase pyrolysis of the OC; also, the refractory causes light absorbing carbon (PC and EC) to come off earlier (at lower temperatures) in the analysis cycle. The net effect of the refractory is to alter the relative rate at which PC and EC evolve from the filter, changing the OC/EC split assigned by the TOT technique.

An additional factor affecting the carbon evolution is the maximum temperature used in the initial, Helium mode of the NIOSH protocol. Results will also be presented showing that a higher temperature of 870 °C leads to more rapid loss of EC relative to PC, compared to using a peak temperature of 700 °C; this results in lower estimates of ambient EC with the protocols using the higher temperature.

[P04-42] NIST PROGRAM FOR FORMATION AND CHARACTERIZATION OF ENGINEERED AEROSOL PARTICULATES: ADDRESSING NEEDS FOR GLOBAL CLIMATE CHANGE.

Cary Presser, Joseph Conny, George Klouda, R. Michael Verkouteren Chemical Science and Technology Laboratory, National Institute of Standards and Technology, Gaithersburg, MD

Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

An essential element in advancing the atmospheric science of aerosol particles is the ability to make unequivocal on-site measurements of the physical and chemical properties of the atmospheric particulate matter (PM). To allow measurement traceability to standards and improve interlaboratory reproducibility, three types of reference materials of increasing complexity are relevant:
1) pedigree PM (i.e., engineered PM with traceability to a stated reference),
2) simulated PM (i.e., mixtures of pedigree PM and other well-characterized substances with properties similar to real PM), and
3) real PM (serving as measurement benchmarks).
For pedigree PM, commercially available materials such as carbon black are less suitable for two reasons: 1) a specialized system is needed to provide control over the synthesis of pedigree and simulated PM; and 2) an open, unequivocal, and well-documented source is needed to be universally accepted by PM measurement communities. Thus, the capability is needed to produce carbon particles to meet the requirements of traceability and serve as an accepted standard reference material.
NIST is developing a program for PM measurement traceability to a stated reference. The Liquid Injection Test bed for Aerosol Research (LITAR) is a unique, highly controlled and characterized benchmark industrial-like facility, which can serve to generate reproducibly pedigree and simulated PM reference materials. This facility can reproduce a range of combustion conditions related to a variety of industrial sources, is well diagnosed, and it provides the opportunity to correlate well-characterized chemistries with PM. Parametric experimental investigation of PM characteristics in this facility can provide fundamental information for input and validation of climate change models.
We will also describe a new tool, the laser-driven thermal reactor (LDTR), to provide a well-controlled environment for determination of thermal physical and chemical kinetics properties of PM. Due in part to its rapid thermal response, it is expected that the LDTR studies will lead to an improved fundamental understanding of the thermal physical and chemical kinetics properties of different types of carbon in species-rich PM, and as a result provide a mechanistic \\'road map\\' toward development of a new measurement process for aerosol black carbon.

[P04-41] HOW DOES THERMAL-OPTICAL ANALYSIS FOR BLACK CARBON IN PM BEHAVE OPTICALLY?

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

Thermal-optical measurement methods for black carbon (BC) in PM rely on changes in the optical behavior of PM carbon to indicate when organic carbon (OC) mass is analytically separate from BC mass during thermal desorption and the subsequent detection of carbon by flame ionization. The major advantage of thermal-optical analysis (TOA) is that while mass measurement is directly related to the optical behavior of PM carbon, no prior knowledge of PM absorptivity or the specific attenuation cross section is required, as with purely optical methods such as aethelometry. Nevertheless, TOA relies on three assumptions based on the constancy of optical absorptivity during analysis. First, absorptivity of PM remains constant prior to OC pyrolysis, i.e., no substantive change in the particle refractive index occurs with heating that would affect absorptivity. Second, absorptivity of instrument-produced OC char does not change during heating in either the inert (helium) environment or oxidizing (O2-He) environment. Third, OC char has the same absorptivity as BC that is native to the sample.

In this work, we tested these assumptions by determining the variation in TOA absorptivity vs. stage of analysis in three types of samples: urban dust, indoor air particles, and forest fire emissions. The apparent absorptivity was calculated from carbon mass remaining on filters and laser transmission (670 nm) as a function of analysis time. An important factor in the calculation is the spurious variation in laser response with heat, as heat induced changes in light scattering of the filter substrate fibers or the non-carbonaceous PM components imbedded in the filter.

[P04-40] EQUIVALENCE OF CARBON FRACTIONS FROM DIFFERENT THERMAL EVOLUTION METHODS AT THE FRESNO SUPERSITE.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

Twelve PM2.5 samples from ~410 cm2 quartz fiber filters acquired every third day at the Fresno Supersite from September 2002 through January 2003 were submitted to the following thermal/optical analysis protocols applied with the same instrument, procedures, and standardization: 1) Oregon Graduate Institute thermal optical reflectance (TOR); 2) IMPROVE TOR and thermal optical transmittance (TOT); 3) NIOSH TOR and TOT; 4) Speciation Trends Network (STN) TOR and TOT; 5) ACE-ASIA TOR and TOT; 6) Lawrence Berkeley Laboratory continuous temperature ramp; 7) German VDI extraction/combustion; 8) French pure oxygen combustion Japanese two temperature, 9) Brookhaven National Laboratory two temperature; 10) General Motors Research Laboratory two temperature; and 11) R&P two temperature.

These methods differ from each other with respect to: 1) combustion atmospheres; 2) temperature ramping rates; 3) temperature plateaus; 4) residence time at each plateau; 5) optical monitoring configuration and wavelength; 6) standardization; 7) sample aliquot and size; 8) evolved carbon detection method; 9) carrier gas flow through or across the sample; and 10) location of the temperature monitor relative to the sample. These differences are not completely documented in the published descriptions, although they may make a difference in the comparability of the measured carbon fractions.

[P04-29] CONTINUOUS PM 2.5 MASS BY THE DIFFERENTIAL TEOM® MONITOR AND A CONTINUOUS SIZE SEGREGATED NITRATE MONITOR IN CLAREMONT CALIFORNIA: EVALUATION OF THE DYNAMICS OF NITRATE VOLATILIZATION.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

As part of the Los Angeles based U.S. EPA sponsored Southern California Particle Center and Supersite (SCPCS), semi-continuous (10-minute) particulate matter less than 2.5 micrometers (PM2.5), and semi-continuous (10-minute) size segregated particulate nitrate (2.5-1.0 μm, 1.0-0.5 μm, & 0.5~0.1 μm) were measured using the Differential TEOM ® monitor (Patashnick, et al., 2000; Jaques, et al., 2002), and a cascaded Integrated Collection and Vaporization Cells (ICVC) (Stolzenburg, et al., 2002; Fine, et al., 2002), respectively. The Differential TEOM monitor employs an electrostatic precipitator to resolve artifactual changes in filter mass change related to semi-volatile PM. The electrostatic precipitator (ESP) is activated in alternating 5-min periods to remove particles from the sample air stream. The mass change of the filter with the ESP activated is subtracted from the mass change during the normal collection (with the ESP off) to provide an artifact-corrected mass.

In this paper we compare the mass lost during the "ESP-on" cycle to ambient particulate nitrate concentrations measured by the ICVC. For measurements at Claremont, episodes of PM2.5 are often highly associated with ammonium nitrate, and they generally correspond with high daytime temperatures, peaking during mid-afternoons. For days of high PM2.5 nitrate, the artifactual mass loss from the TEOM filter measured with the "ESP on" is correlated (R-squared = 0.76) with the ammonium nitrate concentrations measured by the ICVC. The correlation increases to R- squared = 0.79 when a lag of between 30 to 40 minutes is applied to the ammonium nitrate data. This suggests there is a delay between the time of particle collection and it’s volatilization from the filter. The data suggest that the rate of volatilization is non-linear, especially following high periods of PM2.5 ammonium nitrate. It appears that the volatilization of nitrate occurs more rapidly when freshly loaded onto the filter.

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[P04-28] A MULTI-SITE INTERCOMPARISON OF SEMI-CONTINUOUS CARBON, NITRATE AND SULFATE MONITORS.

Jim Homolya, Steve Taylor-Jr, Jewell Smiley, Darcy Anderson, Mark Bohlin, Jim Frost, Ed Michel, Stan Pausel
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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

A 12-month study (July 2002-2003) is being conducted to evaluate the operational performance and intercomparison of the R&P 5400C, 8400N, and 8400S carbon, nitrate and sulfate monitors at five National Air Monitoring Sites located across the country. The monitors are sampling $PM_{2.5}$ aerosols and the monitoring results are being compared to corresponding results obtained from filter-based 24-hour samples collected by the EPA Chemical Speciation Network samplers. This experimental study included the development of standardized operating procedures and the design and implementation of an independent field auditing scheme for the sulfate and nitrate monitors. In addition to the inter- and intra-site comparisons of measured values, data and information are being collected to assess the operational stability, level of maintenance, and overall costs associated with long term routine use of such semi-continuous technologies by state and local agencies. The results from this work will help guide the EPA and state/local agencies on the appropriate addition of semi-continuous monitors into the existing 54-site Chemical Speciation Trends Network for the primary purposes of providing higher temporal resolution of speciation data for health studies and near real-time public information.

An approach to achieve the latter data application is being assessed in the current pilot study by evaluating the installation and use of point data collection systems at each of the five sites. These systems, developed by Information Processing Systems of California, Inc., provide automated collection and processing of air quality data and also perform automated calibration of sensors, provide significant QC of received data, offer complete GUI for user data validation, save data in EPA AIRS format, and apply the entire set of MeteoStar® LEADS visualization tools to real-time or averaged data. In such manner, monitor operational control and data output can be accessed through direct satellite uplink and made readily-available for state agency/EPA review and quickly communicated to the general public in appropriate formats.

[P04-50] ANALYSIS OF OXYGENATED ORGANICS WITH HIGH PERFORMANCE LIQUID CHROMATOGRAPHY/ION TRAP MASS SPECTROMETRY.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

Interest in the measurement of oxygenated organic species in source emissions is increasing due to the role that these molecules play in ozone and secondary organic aerosol (SOA) formation. The traditional approach to measure these compounds is derivatization in concert with gas chromatography/mass spectrometry. Previous efforts in our laboratory established the utility of O-(2,3,4,5,6)-pentafluorobenzylhydroxylamine (PFBHA) derivatization in concert with gas chromatography/ion trap mass spectrometry (GC/ITMS) for the measurement of carbonyl, hydroxy-carbonyl and dicarbonyl species present at part-per-trillion (pptv) levels in biogenic and anthropogenic emissions. With respect to anthropogenic emission however, this approach may lack the analytical range necessary for all oxygenated species present. Of particular concern are oxygenated polycyclic aromatic hydrocarbons (oxy-PAHs), due to their carcinogenic and mutagenic potential. For the analysis of these compounds, we are exploring atmospheric pressure chemical ionization (APCI) along with high performance liquid chromatography/ion trap mass spectrometry (HPLC/ITMS) as a complimentary technique to GC/ITMS. Specifically, we are evaluating the utilization of APCI/HPLC/ITMS for the analysis of underivatized and PFBHA derivatives of model aromatic aldehydes, ketones and dicarbonyls (quinones). Our results suggest equivalent or greater sensitivity for the pentafluorobenzyl (PFB) oximes when utilizing positive ion detection. Since the mass spectra of these derivatives are dominated by the pseudo molecular ion $[M+H]^+$, the APCI positive ion mass spectra can aid in the identification of unknown species. Application of negative ion detection produced at least 5x greater sensitivity for most of the PFB oximes investigated. The mass spectra base peak is typically a fragmentation ion arising from cleavage of the pentafluorobenzyl group ($[M-C_7H_2F_5]^-$), with a few exceptions exhibited by the smaller analytes. Our data suggest that APCI/HPLC/ITMS is a powerful tool to compliment existing methodologies for the analysis of oxygenated organic species present in source emissions.

[P10-20] MASS AND CHEMICALLY RESOLVED SIZE COMPOSITIONS OF FINE PARTICULATE MATTER AT THE PITTSBURGH SUPERSITE.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

Multi orifice impactor samplers (MOUDI) were used to collect aerosol samples in eight size bins from 0.056 to 2.5 micrometers in particle diameter. Samples were collected in aluminum foils for analysis of carbonaceous material and Teflon filters for analysis of particle mass and inorganic ions. 24-hour samples were collected during the summer intensive (July 2001) and winter intensive (January 2002). Aerosol mass distributions were measured daily during the whole Pittsburgh Air Quality Study (PAQS), form July 2001 to July 2002.

MOUDI performance was compared against other integrated mass samplers (TEOM, FRM, Dichot). The inter-comparison results show that the MOUDI tends to overestimate the PM2.5 mass by 15%. Size distributions obtained from the MOUDI are compared to an SMPS system to validate measurements from both instruments.

Stage mass concentrations are inverted and lognormal distributions are obtained for total mass collected on the impactors. Separate inversions are performed for the organic and inorganic speciation MOUDI data and lognormal distributions are obtained.

The number of modes and their peak diameters are used to provide insights about the age of the aerosol and the processes that affected it (e.g. cloud processing). The ratio of organic to inorganic concentrations is used to estimate the hygroscopic properties of these particles as a function of their size.

[P04-02] CHARACTERISATION AND DETERMINATION OF POLLUTANT EMISSIONS (HYDROCARBONS AND HEAVY METALS) FROM ROAD TRAFFIC IN AN URBAN AREA.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (8:00 AM-9:00 AM) Grand Ballroom 2-4

In urban areas, road traffic is recognised as an important source of particles and both organic and inorganic pollutants. Road traffic involves numerous potential sources of hydrocarbons and metals, e.g., combustion products from fuel and oil, wear products from tires, brake linings, bearings, coach and road construction materials, and resuspension of soil and road dust. Therefore, emission measurements in conventional dynamometric tests alone are not sufficient to fully address this problem. In order to do so, studies need to be performed under realistic driving conditions in environments where the contribution from other emission sources is eliminated. Measurements in two heavily trafficked tunnels in Paris conurbation have been used successfully to quantify emissions of a large number of particulate pollutants. At least, five runs were made in each tunnel, generally extending over several hours, during which air concentrations of pollutants in the middle of the tunnel were determined. In this research program, hydrocarbon (aliphatic hydrocarbons and 16 PAHs selected from the priority list of the US Environmental Protection Agency) and heavy metal pollutants were measured from road traffic. The results showed the characteristic distribution of road traffic for both organic and inorganic pollutants. With respect to organic pollutants, the PAH profiles of air samples from the tunnel were determined with the predominance of phenantrene, fluoranthene and pyrene. About inorganic pollutants, antimony, cadmium, copper, lead and zinc were highlighted as mainly representative of road traffic. Moreover, study of the pollutants fingerprints, using specific ratios, suggested the significance of combustion sources (predominance of heavy weight PAHs (4 to 6 rings)) and the presence of brake-lining derived particles (Cu/Sb ratio).

[P04-67] SPATIAL AND SEASONAL VARIATION, SIZE FRACTIONATION, AND CHEMICAL CHARACTERIZATION OF PARTICULATE MATTER IN DETROIT, MICHIGAN.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (8:00 AM-9:00 AM) Grand Ballroom 2-4

As part of a community-based participatory research project, the effects of air pollutants and the role they play in exacerbating childhood asthma are being assessed in Detroit, Michigan. One specific aim of the project is to identify sources of air pollutants through chemical characterization of particulate matter (PM), primarily $PM_{2.5}$ and PM_{10}, to which the children are exposed. In addition to daily filter collection during seasonal intensive measurement campaigns (each two weeks in duration) at two ambient monitoring locations, continuous measurements of ozone and $PM_{2.5}$ (TEOM) are made at each location.

Results from the 11 seasonal campaigns (10/99 to 5/02) indicate daily $PM_{2.5}$ levels averaged 17.6 ± 11.1 $\mu g/m^3$ and 16.1 ± 10.3 $\mu g/m^3$ at two Detroit communities (southwest Detroit and east Detroit, respectively) sampled concurrently. Daily measures of PM_{10} for the same measurement periods resulted in 28.7 ± 15.4 $\mu g/m^3$ and 23.8 ± 12.9 $\mu g/m^3$ at the two sites. Levels of both $PM_{2.5}$ and PM_{10} are significantly higher at the southwest Detroit site relative to east Detroit. In addition, while levels of organic carbon (OC) in both $PM_{2.5}$ and PM_{10} appear similar between sites, levels of elemental carbon (EC) in both particle size fractions are increased at the southwest Detroit site, with levels of coarse fraction (PM2.5-10) EC being more than 2 times higher than the east Detroit site. The increased levels of PM and EC at the southwest Detroit site, where the coarse particle fraction makes up nearly 40% of the total PM_{10}, are likely due to the close proximity of heavy industrial sources (coal combustion, refining, incineration, etc.) and interstate motorways which impact this community.

Ongoing comprehensive trace metal characterization (Sr, Mo, Cd, Sb, Pb, Mg, S, V, Cr, Mn, Fe, Ni, Cu, Zn, As, etc.) of all filter samples collected over the 11-season period (10/99 to 5/02) will provide a more complete assessment of the PM components. When combined with other project measures including concurrent twice-daily peak expiratory flow and FEV_1 spirometry and daily asthma symptom and medication diaries for 300 asthmatic children living in the two Detroit communities, and daily characterization of PM personal exposure and PM indoor home exposure for a subset of 20 of the children, these data will allow not only investigations into the sources of PM in the Detroit airshed in regard to PM exposure assessment, but also the role of air pollutants in exacerbation of childhood asthma.

[P10-14] PARTICLE FORMATION AND GROWTH IN SO_2- AND VOC-RICH PLUMES NEAR HOUSTON, TEXAS.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

Gas-phase particle precursors and tracer species and particle size distributions were measured aboard an aircraft downwind from industrial and urban sources in the vicinity of Houston, Texas during the daytime in late August and early September, 2000. The plumes originating from several sources, including a gas- and coal-fired power plant, the petrochemical industries along the Houston ship channel, and the urban center of Houston, were studied. On the days selected for analysis, the nearly constant southerly wind allowed the plumes to advect in parallel to the north of Houston with minimal mixing between the plumes. These meteorological conditions allowed comparison of the evolution in particle properties within the plumes from the discrete sources as a function of plume age and oxidation.

The industries and electrical utilities at the periphery of the city were the primary sources of particulate mass flux from the Houston metropolitan area. Particle volume was observed to increase with increasing plume oxidation (age) in those plumes that were rich in SO_2, but which did not contain elevated concentrations of volatile organic compounds (VOCs), at a rate consistent with condensation and neutralization of the gas-phase oxidation products of SO_2. In contrast, in plumes from petrochemical industries that were rich in both SO_2 and VOCs, observed particle growth greatly exceeded that expected from SO_2 oxidation alone, indicating the formation of organic particulate mass. In those plumes which had enhanced concentrations of VOCs but which did not contain much SO_2, and in the plume of the Houston urban center, no particle volume growth with increasing plume oxidation was detected. Since substantial particle volume growth was associated only with SO_2-rich plumes, and not with those with enhanced concentrations of VOCs alone, these results suggest that photochemical oxidation of SO_2 is the key process regulating particle mass growth in all the studied plumes in this region over time scales of several hours. However, the uptake of organic matter--perhaps enhanced by acid-catalyzed reactions on the surfaces of the particles--probably contributes substantially to particle mass in petrochemical plumes rich in both SO_2 and VOCs. We recommend further quantitative studies of particle formation and growth in photochemical systems containing nitrogen oxides (NO_x=NO+NO_2), VOCs and SO_2 to extend those previously made in NO_x-VOC systems.

[P10-15] SIZE-RESOLVED AEROSOL CHEMICAL COMPOSITION MEASUREMENTS DURING THE NEW ENGLAND AIR QUALITY STUDY WITH AN AEROSOL MASS SPECTROMETER ABOARD THE *RONALD H. BROWN*.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

The New England Air Quality Study is a multi-institutional research project to improve understanding of the atmospheric processes that control the production and distribution of air pollutants in the New England region. During July-August, 2002 a large, collaborative, intensive period of atmospheric measurement and model comparisons took place. As part of this study, an Aerosol Mass Spectrometer (AMS) was deployed aboard the NOAA ship *Ronald H. Brown* in the Gulf of Maine and collected 2-minute averaged particle mass spectra as well as organic, sulfate, and nitrate mass distributions. The AMS measures non-refractory components of aerosol particles with aerodynamic diameters between roughly 40 and 1500 nm. Because sodium chloride, sodium sulfate, and sodium nitrate are relatively non-volatile at the AMS heater temperature used during this study, these species were not detected with the AMS.

A wide variety of air masses were sampled during the intensive period, including clean marine, clean continental, and polluted continental air masses. In general, the non-refractory particle composition was mostly organic and sulfate with significantly lesser amounts of nitrate and particle mass loadings typically peaked around 400-600 nm in aerodynamic diameter. Several events with high aerosol organic, sulfate, and/or nitrate mass loadings were observed and the atmospheric processes that caused them will be discussed.

[P10-16] CHEMICAL CHARACTERIZATION OF FINE AND ULTRAFINE AEROSOLS DURING THE ROCHESTER, NY SUMMER INTENSIVE, 2002.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

Some toxicological studies in animals have shown more significant adverse effects due to inhalation of ultrafine aerosol (diameter less than 0.10 μm) than fine aerosol (diameter less than 2.5 μm). Chemical characterization of fine and ultrafine aerosol concentrations were obtained in Rochester, NY, June 3 to 19, 2002 as part of ongoing work by the University of Rochester EPA Ultrafine PM Center to characterize ultrafine aerosols in U.S. urban areas.

Two modified MOUDI/Nano-MOUDI (MSP Model 110 and 115) samplers were used in parallel to obtain inorganic ion, elemental and organic carbon and trace metal concentrations of particles from 10 to 180 nm. The MOUDI/Nano-MOUDI samplers collected aerosol for eight consecutive days in order to obtain sufficient sample for analysis. Two precautions were taken to minimize the possibility of particle bounce from the upper stages to the ultafine particle stages. The MOUDIs were modified to reduce the flow to 10 lpm while maintaining the particle size cut-points by carefully masking two-thirds of the jets on each stage in the MOUDI. The reduced flowrate decreases the velocity that the particles move through the system, decreasing the likelihood of particle bounce. In addition, greased substrates (dioctyl phathalate) were used on MOUDI stages above 180 nm to capture the larger particles. The greased substrates were changed every 48 hours to maintain good capture efficiency. Results of a preliminary study done to determine a grease with minimal transfer to lower stages will be presented.

In addition to the ultrafine particle collection, four 48-hour samples were collected with three MOUDIs and a PM1.8 sampler to obtain chemical speciated, size segregated fine aerosol concentrations. The MOUDIs were operated with a cyclone at the inlet to restrict collected particles to the range 0.056 - 1.8 μm. Speciated concentrations of fine and ultrafine aerosol will be compared and MOUDI/Nano-MOUDI size distributions will be presented.

A Nano-SMPS (scanning mobility particle sizer TSI Model 3936N25), a Long-SMPS (TSI Model 3936L22) and an APS (Aerosol Particle Sizer, TSI Model 3320) were run continuously during the eight days of filter sampling to obtain size distributions of particles ranging from 0.004 um to 10 um. This data will be used to further characterize the fine and ultrafine ambient aerosol. Particular attention will be paid to size distributions obtained while a diesel truck idled near the sampling site.

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[P10-17] CHARACTERIZATION OF CONCENTRATED ULTRAFINE AEROSOLS.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

Ultrafine aerosols (diameters less than 100 nm) are suspected of causing adverse health effects in humans. Ultrafine particles composed of trace metals and acidic apecies have been suggested as causes of the observed health effects. The Prototype Harvard Ultrafine Particle Concentrator, located at the University of Rochester Medical Center, is targeted for use in toxicological studies in animals and for controlled clinical studies in humans related to ultrafine aerosols. These studies are part of the research objectives of the EPA Ultrafine PM Center at the University of Rochester. The study presented in this poster, along with a companion poster by researchers at University of California, San Diego, was undertaken to characterize the ultrafine aerosols obtained from the Concentrator.

Two modified MOUDI/Nano-MOUDI samplers (MSP Model 110 and Model 115) were used in parallel to obtain trace metal, inorganic ion and elemental and organic carbon composition of particles with diameters ranging from 10 to 180 nm. Eight-hour samples were collected on each day from June 3 - 8, 2002, at the University of Rochester. Sample collection typically began between 8 and 9 am and concluded by mid-afternoon. Weather conditions over the six days ranged from rainy and cool to sunny and warm.

The MOUDI/Nano-MOUDI sampler consists of a standard MOUDI operating at 30 lpm and a Nano-MOUDI operating at 10 lpm. The MOUDIs were modified to reduce the flow to 10 lpm while maintaining the particle size cut-points by carefully masking two-thirds of the jets on each stage in the MOUDI. The decreased flow rate through the two samplers allowed simultaneous sampling from the Concentrator which has a nominal flowrate of 20 lpm. Greased substrates (dioctylpthlate) were used on MOUDI stages larger than 180 nm to minimize particle bounce but were not analyzed for chemical composition.

In order to further characterize the aerosol from the concentrator, ambient and concentrated size distributions were measured simultaneously. A Nano-SMPS (scanning mobility particle sizer TSI Model 3936N25) and a Long-SMPS (TSI Model 3936L22) were used to obtain size distributions of concentrated aerosol and a Long-SMPS (TSI Model 3936L22) was used to obtain size distributions of ambient ultrafine aerosol. Size resolved chemical composition of the concentrated aerosol will be presented along with ambient and concentrated size distributions.

Supported by EPA PM Center grant R827354

[P04-55] COMPARISON OF SEMI-VOLATILE ORGANIC COMPOUNDS FROM WILDFIRE EMISSION DOMINATED AMBIENT SAMPLES TO RESIDENTIAL AND AGRICULTURAL WOOD COMBUSTION SOURCE SAMPLES.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

Several wildfire emission dominated ambient samples were collected in Reno, NV during the wildfire seasons of 2000 and 2001. Wildfires were approximately 50-150 miles from collection point and ranged in size. These samples are compared to residential and agricultural wood combustion source emissions collected from a direct exhaust stack prior to release to the atmosphere. All samples were collected using teflon impregnated glass filters (TIGF) followed by polyurethane foam (PUF) and XAD-4 resin sandwich cartridges. Samples were analyzed by GC/MS methods for semi-volatile organic compounds including polycyclic aromatic hydrocarbons (PAH), higher molecular weight hydrocarbons, methoxy phenol derivatives, organic acids, cholesterol, sitosterol, and levoglucosan. Results of this comparison of semi-volatile organic compounds of wildfire emission dominated ambient samples and wood combustion source emissions will be presented.

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[P10-19] SIZE AND CHEMICAL CHARACTERIZATION OF URBAN ULTRAFINE AND FINE PARTICULATE MATTER IN THE EASTERN UNITED STATES.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

Recently, ultrafine particles, particles with aerodynamic diameters less than 100 nm, have gained increasing attention because of their hypothesized adverse health effects and potential to act as cloud condensation nuclei. Size, chemical composition, and temporal variations of ultrafine particles at the single particle level are essential for assessing their impact on air pollution, global climate change, and human health. A dual polarity aerosol time-of-flight mass spectrometer (ATOFMS) with an aerodynamic lens inlet system[1,2], was developed for on-line characterization of individual fine and ultrafine particles. In the summer of 2002, this ATOFMS was deployed for atmospheric measurements in two urban areas in the Eastern United States (Rochester, NY and Atlanta, GA) to characterize fine and ultrafine urban particulate matter. The observed particles consisted of organic carbon (OC), elemental carbon (EC), and EC/OC. EC and EC/OC were found to be the major ultrafine particle types, whereas OC and OC/EC were dominant for particles between 100 nm and 300 nm. The mass spectral signatures will be compared to ion markers identified in ATOFMS source characterization studies to determine the emission sources. These major particle types and their associations with inorganic species (i.e. ammonium, sulfate, nitrate, and heavy metals) as well as the temporal variations during the two studies will be presented.

Acknowledgements

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[P04-03] SEASONAL, SPATIAL, AND DIURNAL VARIATIONS OF INDIVIDUAL ORGANIC COMPOUND CONSTITUENTS OF ULTRAFINE PM AND PM2.5 IN THE LOS ANGELES BASIN.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (8:00 AM-9:00 AM) Grand Ballroom 2-4

Recent studies have used individual organic compounds as tracers for primary sources of ambient particulate matter in chemical mass balance or other source apportionment techniques. Most of these studies have focused on total PM2.5 and on sampling periods encompassing entire days or longer. A newly developed high-flow rate, low pressure-drop ultrafine particle separator enables collection of sufficient mass for organic speciation in two particle size fractions over relatively short periods of time. At a nominal flow rate of 500 liters per minute, particles between 0.18 and 2.5 μm in diameter are collected on an impaction substrate and ultrafine particles below 0.18 μm are collected on a downstream high-volume filter. Four daily time period samples (morning, midday, evening, and overnight) were collected over five weekdays to form a weekly average composite for each diurnal period. Sampling was conducted at two sites over two seasons; summer (August) and winter (January) samples were collected at both an urban site near downtown Los Angeles and a downwind inland site in Riverside, California. Examples of individual organic compounds that are tracers for primary emissions are hopanes and steranes from motor vehicles and levoglucosan from wood combustion. The results show how these and other organic PM species vary from season to season, between upwind and downwind sites, and over the course of the day. The collection and analysis of two distinct size fractions (accumulation and ultrafine modes) provide information on how these compounds are distributed with respect to particle size. Finally, observations of seasonal, diurnal, and geographical patterns allow for the identification of potential organic markers for photochemical secondary organic aerosol formation.

[P10-21] ASPIRATION AND TRANSFER EFFICIENCIES OF THE TSP AND DICHOTOMOUS PM SAMPLING INLETS.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

An experimental system has been developed for the rapid measurement of the aspiration/transfer efficiency of aerosol samplers in a wind tunnel. The system was used in an EU-funded project to study the application of scaling principles to sampler aspiration efficiency. As part of this work, we measured the aspiration and transfer characteristics of two inlets commonly used for sampling airborne PM: the 'Total Suspended Particulate' or TSP inlet, and the low-volume dichotomous sampler inlet typically used in sampling PM10 or PM2.5.

Each test inlet type was constructed on three scales: full-scale, half-scale and double-scale in the case of the TSP inlets, and full-scale, half-scale and third-scale in the case of the dichot inlet. Tests were carried out using an aerosol of polydisperse solid glass spheres, with the APS used to compare aerosol concentrations sampled alternately through the inlets and through isokinetic reference probes. Confirmatory tests were carried out using monodisperse aerosols of sodium fluorescein, and narrow-fraction aerosls of fused alumina.

The main results of interest concern the fraction of the external aerosol that enters the inlet and is transferred through it, hence is available for collection by a filter, or further size fractionation into PM10 or PM2.5. This is referred to here as the sampling efficiency, being the product of the inlet aspiration efficiency and the inlet transfer efficiency. Our results show that the sampling efficiency of the low-volume dichot inlet has D50 $\approx$15 μm in calm air; the D50 increases with increasing external wind speed. The TSP sampling efficiency is similar to the dichot in calm air, but it decreases with increasing external wind. At external winds higher than ~8 km/h the D50 of the TSP sampler falls below ~10μm.

An interesting question is whether one can scale the inlets to operate at either higher or lower flow rates, while preserving the same sampling characteristics as the current full-scale, 16.67 l/min versions. In the case of the dichot inlet our results indicate that scaling to lower flow rates presents no problem. In scaling the inlet to operate at higher flow rates, the fall-off in efficiency at low external winds might present practical limitations. For the TSP sampler, scale-invariance was not observed and the double-scale inlet displayed lower sampling efficiency than expected on the basis of scaling principles.

The conclusions drawn from this work are:

The low-volume dichot inlet has satisfactory sampling efficiency that increases as the external wind increases. Under all conditions expected in practical use the inlet aspirates sufficient PM to allow either PM10 or PM2.5 to be selected downstream. The inlet can be scaled to operate at different flow rates.

The TSP inlet does not select a constant fraction of the external PM at all wind speeds. It is likely to undersample the coarse end of the PM10 fraction at moderate and high external winds. The inlet cannot be scaled to operate at higher flow rates as this further degrades its aspiration efficiency

[P10-22] THE DEVELOPMENT AND DESIGNATION TESTING OF A NEW EPA APPROVED FINE PARTICLE INLET A STUDY OF THE U.S. EPA DESIGNATION PROCESS.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

The process by which ambient air sampling instruments are designated for use under the U.S. EPA Reference and Equivalency Program is a rigorous and demanding routine involving design, laboratory and field testing. The process for Equivalency PM-2.5 Class II and III designation has been coined as nearly impossible to achieve. A project was undertaken to develop an Equivalent Method to the EPA WINS PM-2.5 Impactor as a Class II Equivalent Method for the FRM sampler. The project built upon the authors' previous development of design models for cyclones, together with practical experience suggesting that cyclones are capable of superior field performance under loading when compared with impactor systems. Empirical cyclone models were used to develop a new generation of very sharp cut cyclones (VSCC). In laboratory tests, the VSCC demonstrated a precise 2.5 μm D_{50} cut point and sharpness superior to the WINS. A formal application was then undertaken to achieve EPA Class II Equivalency designation. The process included aerosol laboratory loading trials with results showing no change in cut point after up to 90 days between cleaning cycles. Several FRM field trials to compare the WINS FRM to the VSCC were performed in western and eastern airsheds to demonstrate the precision and accuracy of the candidate VSCC FRM. Results showed the VSCC used in the FRM gave a cut point of 2.5 micrometers and the field tests concluded a precision and accuracy within EPA requirements.

[P10-23] CORRECTION OF DROPLET DISTORTION EFFECTS IN AERODYNAMIC PARTICLE SIZING INSTRUMENTS.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

Aerodynamic particle sizers (models APS and Aerosizer; TSI, Inc.) are widely used to measure diameter distributions of aerosols. Droplets have been observed to distort into oblate spheroids in the acceleration field of the APS, resulting in underestimation of particle aerodynamic diameter. The Aerosizer accelerates particles at a higher rate than the APS and produces a larger degree of diameter underestimation.

Droplet aerodynamic diameter underestimation was measured for several liquids (several polymethylsiloxanes, triethanolamine, and oleic acid) with a range of viscosities (η = 0.052 to 0.59 N·s/m^2) and surface tensions (σ = 0.020 to 0.032 N/m). Droplets were generated over a range of sizes between about 4 to 15 μm using a vibrating orifice generator and their aerodynamic diameters were calculated from the observed droplet settling velocities. The droplets were measured using an APS 3310, an APS 3320, an Aerosizer LD, and an Aerosizer DSP, though not all instruments were used at the same time. The measurements were grouped by instrument type (APS, n = 56 and Aerosizer, n = 50) and a relatively simple function was found to fit all the data within experimental error, after excluding three outliers. The function consisted of the size shift $\Delta = - a \times d^b / (\sigma^c \times \eta^e)$, with d in μm. Fits to the data using a range of values for a, b, c and e were investigated. The mean square error (MSE), upon which the regression depended, did not increase more than 20% for a relatively broad range of the four fitting parameters. It was decided that the simplest equation consistent with theoretical information available would be used. The value of b was taken to be 2, since this appeared to be approximately correct from published APS calculations. The resulting constants were different for the APS ($a = 8.84 \times 10^{-5}$; c = e = 0.688) and the Aerosizer ($a = 4.45 \times 10^{-4}$; c = 0.934; e = 0.253). The MSE for the APS was 0.0371 (1 outlier removed) and for the Aerosizer was 0.122 (2 outliers removed). The outliers occurred for the largest droplets, perhaps from residual solvent affecting the viscosity and surface tension. There appeared to be no significant difference between the response of different models of the APS or of the Aerosizer. The equations fitted the experimental data reasonably well and may be useful to estimate the acceleration effect for similar liquids. However, caution in their use is advised in that these are only empirical fits to the data and there is little theoretical justification for the chosen equation, especially when extrapolating outside the range of parameters used in these experiments. For example, water droplet distortion appears to be overestimated.

[P10-24] SPATIAL AND TEMPORAL VARIATIONS IN PM2.5 MORPHOLOGY.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

Extensive studies are currently underway at characterizing the ambient aerosol by measuring its size distribution and chemical composition. Relatively few studies have examined the morphology of these particles (1,2). Though there are only a few studies, there is a general observation that the finer sized particles are more aggregated or have lower fractal dimensions. In this study, an electrostatic sampling system in conjunction with the TEOM was used to collect PM 2.5 particles onto electron microscope grids. The method allows for the collection of particles without potentially altering the aggregate structures. A Scanning Electron Microscope was then used to examine the morphology of ambient aerosols in the Greater Cincinnati air shed and at the St. Louis Supersite. A computer algorithm was developed and used to calculate the mass-fractal dimension based on the cumulative-intersection method. Spatial and temporal variations of the variations of the morphology of the ambient particles will be reported.

Preliminary results show that the percentage of agglomerate particles varied over a day of sampling. The percentages started high (14%) during the morning rush hour and steadily decreased to 1% in the evening. The total number of agglomerates followed the same pattern. The total number of particles (agglomerate and non-agglomerate) started high in the morning, decreased during the day, but increased in the evening. Fractal Dimensions for agglomerates varied from 1.4 to 2, with an average of 1.80 (SD=0.12, n=18). The same analysis is being done for other days, from locations in St. Louis and in Cincinnati, and the results will be presented.

1. Xiong, C., and Friedlander, S.K. (2001) Morphological Properties of Atmospheric Aerosol Aggregates. Proceedings of the National Academy of Sciences, 98, 11851-11856.

2. Katrinak, K.A., Rez, P., Perkes, P.R. and Buseck, P.R. (1993) Fractal geometry of carbonaceous aggregates from an urban aerosol. Environmental Science and Technology 27, 239-547. (Click to see figure 1)

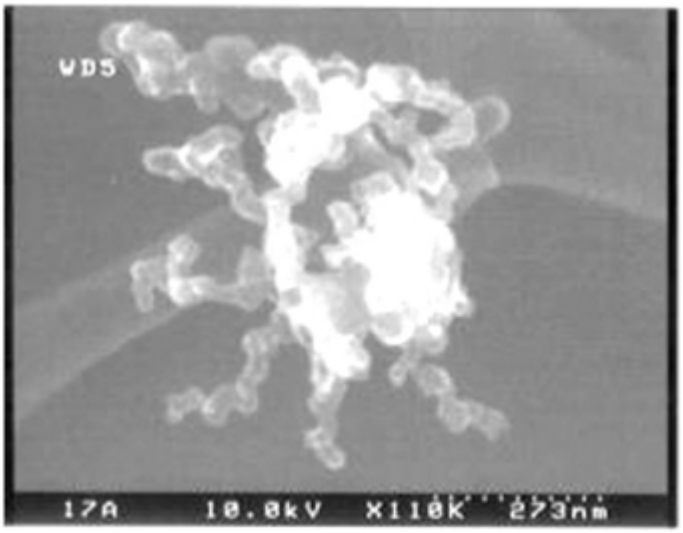

Figure 1. Sample agglomerate captured during sampling D1=1.76

Figure

[P10-25] THE NATURE OF SIZE-RESOLVED INDIVIDUAL ASIAN DUST STORM PARTICLES COLLECTED AT GROUND-BASED SITE ON WEST COAST OF JAPAN.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

It is widely recognized that Asian dust storm is a serious and growing environmental problem in East Asia as well as the Pacific Basin. To determine the nature of Asian dust storm particles as single particles, the intensive field measurement was carried out on west coast of Japan (Yasaka, Tango Peninsula, 35.62°N; 135.07°E) during dense Asian dust storm event on March 2002. Due to the size dependence of the chemical composition of aerosol particles, the size-segregated aerosol particles were collected using low pressure Andersen impactor sampler. Also, in order to understand the many distinct types of single particles observed in the receptor area, soil samples collected at four desert areas in China were analyzed. For the quantification analysis of the ultra trace elements in the individual coarse particles (>1.17 μm), X-ray microprobe system equipped at Super Photon ring-8 GeV (SPring-8) BL-39XU was applied. By using this SPring-8 system, we could successfully carry out the reconstruction of elemental map and quantification analysis for multiple elements in individual particles with ~ pico gram level sensitivity. As one of the representative soil components, aluminum masses of individual particles at stage-2 (Dp: 5.07 μm) and stage-5 (Dp: 1.17 μm) are in the range of $6.40X10^{-2}$ pg to $5.78X10^{-1}$ pg with average $2.09X10^{-1}$ pg and in the range of $1.19X10^{-1}$pg to $1.44X10^{-1}$pg with average $1.30X10^{-1}$ pg, respectively. The mass ratios of [Σsoil components] to [Σ total element] are 0.82 at stage-2 and 0.75 at stage-5, respectively. This implies that the effect of soil components on total elements mass is significant. While on the other hand, the several anthropogenic elements like vanadium, chromium, manganese, cobalt, nickel, copper, and zinc are poor at both stages. To estimate the chemical mixing state of individual Asian dust storm particles with sea salt and other artificial components, elemental maps were drawn. Particles were categorized into two groups, namely internally mixed particles and externally mixed particles. The fine structure in the immediate vicinity of the X-ray absorption edge is sensitive to the valence of the absorber atom and the site geometry. From this near-edge feature referred to as X-ray absorption near edge structure (XANES), the chemical forms of iron (Fe^{2+}, Fe^{3+}) in individual particles could be clearly characterized.

[P10-26] CALIBRATION OF THE NANO-MOUDI II CASCADE IMPACTOR.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

Cascade impactors normally have lower cut sizes of about 0.5 um. To go to smaller sizes of about 0.5 um, two techniques have been used: low pressure or small nozzles. To go to even lower cut sizes, a combination of low pressure and small nozzles must be used. This is the technique that has been used in Nano-MOUDI cascade impactor by MSP Corporation, where three nano stages have been added to the basic MOUDI. The success of this unit has led to a new impactor, the Nano-MOUDI II. Unlike the original Nano-MOUDI, which was three stages added to the standard MOUDI, the Nano-MOUDI II is an entirely new design. The Nano-MOUDI and the newly developed Nano-MOUDI II cascade impactors (MSP Corporation, Minneapolis, Minnesota) have been calibrated to define the particle collection efficiency curves. The design of the Nano-MOUDI started with a standard MOUDI, operating at 30 L/min, and then three nano-cut stages operated at 10 L/min was added at the exit, to provide for cut sizes of 18, 10, 5.6, 3.2, 1.8, 1.0, 0.56, 0.32 0.18, 0.10, 0.056, 0.032, 0.018, and 0.01 um. The newly designed Nano-MOUDI II starts with three nano-cut stages, and adds seven stages at the inlet to provide for cut sizes of 2.5, 1.0, 0.56, 0.32, 0.18, 0.10, 0.056, 0.032, 0.018 and 0.01 um, all at 10 L/min. In addition to the calibrations, the number and size of the nozzles in the upper stages of the Nano-MOUDI II were modified so as to reduce the pressure drop through all stages to as low a value as possible. The advantage of low pressure drops through the upper stages is to keep the absolute pressure at the nano-cut stages to as large a value as possible, reducing affects of mass loss due to volatile particles.

[P10-12] STATISTICAL SUMMARY AND OBSERVATIONS OF SEMICONTINUOUS PARTICLE SIZE DISTRIBUTIONS MEASURED AT THE BALTIMORE SUPERSITE.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

Size distributions of aerosol particles wre measured in the range 9.3 to 20,535 nm from February through November, 2002 using an SMPS (9.3 nm to 437 nm, Model 3080) and an APS (0.486 to 20.535 mm, Model 3321) installed in a specially equipped trailer at Ponca Street, Baltimore, MD, as a part of the Baltimore Supersite program. A statistical summary of these data, showing the frequencies of occurance of nucleation, aerosol accumulation, and course particle peaks are presented, as well as their seasonal trends. Further analysis of the combined SMPS and APS spectra coupled with meteorological, traffic, NO/NO2, EC/OC, and nitrate data are used to classify these spectral features in terms of nucleation (10 to 30 nm range) events, primary and secondary sources, including transient particle producing events. Interesting features associated with a Canadian smoke influence and dust events are described. Complete SMPS/APS data sets will be available on the Eastern Supersites Program Relational Database.

[P10-18] SEASONAL EFFECTS ON THE SIZE DISTRIBUTION OF PAH, EC AND OC IN CLAREMONT, LOCATED DOWNWIND OF CENTRAL LOS ANGELES.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

The size distribution of air particles determine their dry and wet deposition, atmospheric residence time and efficiency of deposition in the human respiratory system. Changes in size distributions may result from chemical and physical processes, and from changes in meteorological conditions. To better understand these effects, we measured the size distributions of 12 priority polycyclic aromatic hydrocarbons (PAH), elemental (EC) and organic carbon (OC), from October 2001 to July 2002 in Claremont, located ~ 40 km downwind of central Los Angeles. Samples were collected once a week for 24-hr with MOUDI impactors, and composited into monthly periods in 3 aerodynamic dia. intervals: 0-0.18 um (ultrafine UF), 0.18-2.5 um (accumulation AC), and 2.5-10 um (coarse CR). Temp., RH, WD and WS were also measured. The distributions of the PAH group that includes the more volatile species (PHE-FLT) are similar to the group containing the less volatile PAH (BAA-IND). However, the distribution shapes varied markedly over the year. From Oct. to Jan., the distributions contained no CR modes. Beginning in Feb., most of the distributions showed a prominent CR mode, especially for the less volatile group. PAH concentration in the less volatile group closely tracked ambient temp., but not so well for the more volatile group. For both groups, the Oct.-Jan. mass conc. did not vary much in all 3 modes, with the largest mass found in the AC mode. After a spike observed in Feb., the total concentrations significantly increased in the more volatile group, and decreased in the less volatile group, and, for both groups, the largest fraction of the mass moved towards the CR mode. High positive correlations of temp. with PHE and ANT suggest increased contribution from diesels, and partitioning from the vapor-phase during transport. Negative correlations of temp. with the less volatile PAH in UF and AC modes suggest desorption from the particle-phase (as temp. increases) and partitioning from the vapor to the particle-phase (as temp. decreases). During the year, EC distributions showed prominent UF and AC modes, but no CR modes. Significant AC modes were seen for OC in all samples, and a smaller UF mode for most samples. A strong effect of temp. on the conc. of EC and OC was seen.

[P04-11] PARTICLE SIZE DISTRIBUTIONS OF UNRESOLVED COMPLEX MIXTURE FROM RESIDENTIAL WOOD COMBUSTION AS DETERMINED BY DIRECT THERMAL DESORPTION-GC/MS.

Michael D Hays, Norman D Smith, John Kinsey, Yuanji Dong National Risk Management Research Laboratory, United States Environmental Protection Agency, Research Triangle Park, NC; ARCADIS, Geraghty, and Miller, Research Triangle Park, NC

Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (8:00 AM-9:00 AM) Grand Ballroom 2-4

Unresolved complex mixture (UCM) is a facet of organic chemical analysis of combustion source related fine particulate matter ([PM2.5]; particles with aerodynamic diameters [da]≤2.5 microns). It is observed in GC/MS total ion chromatogram (TIC) traces as a prominent hump, positioned beneath resolved components, over a broad retention time range and partly comprises aliphatic and aromatic hydrocarbons. For aerosols of carbon-based emission sources, the chromatographic area ascribed to UCM typically exceeds that which is resolved, establishing it as abundant on a mass basis. Also, UCM mass is conserved to some degree in ambient PM2.5. With considerable epidemiological support, ambient PM2.5 mass is linked to human morbidity and mortality. Further, particle deposition efficiency in the lung and biological toxicity are size dependent; thus, improved comprehension of the chemical composition of potentially toxic UCM in emissions by particle size is critical. This work generates and examines particle size distributions of UCM chemical fractions from residential wood combustion appliances (wood stove and fireplace, which seasonally emit substantial quantities of PM2.5 mass). Chemical analysis was achieved with direct thermal desorption (TD)-GC/MS of collection substrates from a Dakati electrical low-pressure impactor (ELPI). Tested fuels were oak and Douglas fir. Single ions of aliphatic, mono-, di-, and tri-aromatic steroid, alkylbenzene, alkylnaphthalene, and alkylphenathrene constituents of UCM from size segregated fine particles of wood combustion aerosols were mathematically extracted from the TIC matrix. It is estimated that the alkylbenzene constituent of UCM is most abundant, followed by aliphatic, monoaromatic steroid, and alkylphenathrene components. Generally, higher estimated total UCM concentrations are associated with smaller particle diameters. Improved classification of UCM from additional sources of carbonaceous aerosol emissions is now possible. With these data widely available, the health effects mechanisms, and regulatory and air quality modeling issues of PM2.5 can be advanced.

[P04-19] MEASURE OF IONS IN PM2.5 FILTERS.

Eva D. Hardison, David L. Hardison, Christine C. Van Hise EG, RTI, RTP, NC

Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

Ion chromatography (IC) is used for the measurement of two anions, sulfate and nitrate, and three cations, sodium, potassium, and ammonium, collected on nylon and Teflonâ filters in the U.S. Environmental Protection Agency's PM2.5 Speciation Program. The measurement method is selective and sensitive, allowing measurement to below 0.05 ppm in the filters extracts. Duplicate injections show a relative percent difference of better than 5% above about 0.05 μg/mL. Analysis of quality control check samples show a recovery of better than 95%. In this work, four different Dionex, dual-column IC instruments are being used. Several different issues have been addressed in the process of generating the best possible analytical data. First, the nylon filters used for the collection of particulate material analyzed for ion content must be cleaned prior to use. Several approaches were taken in response to variability with level of contamination; the final method involves five sequential extractions in deionized water. Another issue is the method of ion extraction. Since one filter must be analyzed for both the cations and anions, deionized water was the only solvent of choice. Research has shown that water only extracts about 90% of the nitrate on the nylon.
Sodium carbonate buffer, normally used for anion extraction, could not be used because of the need to measure sodium in the particulate; another approach cutting the filter in half and extracting one-half for cations using water and the other half for anions using carbonate buffer, is thus far, considered impractical.

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[P04-18] COMPLEXITY IN FILTER HANDLING AND SHIPPING IN PM2.5 CHEMICAL SPECIATION NETWORK OPERATIONS.

Jessie A. Deal, James A. O'Rourke EG, RTI, RTP, NC

Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

The Sample Handling and Archiving Laboratory (SHAL) at RTI provides technical support to the U.S. Environmental Protection Agency's PM2.5 Speciation Trends Network (STN). The STN is a component of the National PM2.5 Monitoring Network. Two-hundred and twenty five samplers participate in the STN are located across the U. S., including one sampler in Puerto Rico. The objectives of the STN are to determine annual and seasonal spatial characterization of aerosols, air quality trends analysis, and development of emission control strategies. The SHAL supplies clean filters to the network field sampling sites and receives the filters back from the sites following sampling of ambient air. Sampled filters are removed from their housings and distributed to analytical laboratories. The fine particulates collected on the filters are analyzed for 59 chemical species.

Field sites in the STN network operate on one of three different schedules. The fine particulates are collected by the field samplers on three different types of filters. There are currently five different types of samplers deployed in the STN network.

A detailed description of the SHAL operations and a discussion of the problems involved when using multiple types of samplers and sampling on different schedules will be presented. The growth in the STN since its inception in February 2000 and some of the quality assurance issues of SHAL operations will also be described.

[P04-17] DETECTION AND QUANTIFICATION CAPABILITIES OF MEASUREMENT SYSTEMS.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

To address the growing need for meaningful and common communication of measurement capabilities and measurement results in the international metrological community, the International Union of Pure and Applied Chemistry [IUPAC; Ref. 1] and the International Organization for Standardization [ISO; Ref. 2, 3] have prepared guidelines for the reporting of experimental data and specification of detection and quantification capabilities of measurement processes. In this presentation we (1) summarize the recommendations of IUPAC and ISO regarding basic concepts, terminology, and numerical evaluation; and (2) present some rudimentary illustrations for measurement problems relevant to the NARSTO program. A central element of the guidelines is the distinction between the MEASUREMENT PROCESS [MP], with its underlying capabilities (LD, Detection Limit; and LQ, Quantification Limit), and MEASUREMENT RESULTS [MR], with their estimated values, uncertainties, and detection decisions (LC, Critical Value). Note that LC is defined in terms of the probability of a false positive (α); LD, in terms of the probability of a false negative (β), given LC; and LQ, in terms of the relative standard deviation (rsdQ) at the Quantification Limit. Default values for α and β are 0.05 each; for rsdQ, 0.10. Under simplifying assumptions (normal random error with constant sd): LC = 1.645 σo, LD = 3.29 σo, and LQ = 10 σo, where σo is the standard deviation of the estimated net result.

For the MP, the key issues are the use of LD and LQ for planning, or to assess the adequacy of the MP for the measurement problem. For the MR, key issues are the application of LC for deciding whether results are significantly greater than the blank, and to avoid information loss and non-detect substitution bias ["virtual reality"], by always reporting the numerical value obtained (even if it is negative) and its total uncertainty [uc: combined standard uncertainty; 3].

1.IUPAC Recommendations, 1995: Nomenclature in Evaluation of Analytical Methods, including Detection and Quantification Capabilities, Pure & Appl Chem, 67 (1995) 1699-1723.

2ISO Standard 11843-1,2 Capability of Detection, Part 1 (1997), Part-2 (1998).

3.Guide to the expression of uncertainty in measurement [ISO-GUM], issued by BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, and OIML (ISO, Geneva) 1993.

[P04-16] AIRBORNE AND DEPOSITIED BACTERIA NEAR A WASTE WATER TREATMENT PLANT.

Ashish K Sahu, Thomas Holsen, Stefan Grimberg Civil and Environmental Engineering, Clarkson University, Potsdam, NY

Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (8:00 AM-9:00 AM) Grand Ballroom 2-4

Bacteria samples from air upwind and downind of a wastewater treatment plant and from the roof of the Science Center at Clarkson University were collected. Airborne samplers were collected by drawing air through a filter and depositions samples were collected with water on a surrogate surface. Bacterial counts were determined using the BAC_Light test to calculate concentration and flux at the sites. Onsite wind information was collected during sampling to evaluate the upwind and the downwind readings. Results obtained indicated higher concentrations and fluxes of bacteria downwind of the treatment plant. DNA of the bacteria was extracted to determine what type of bacteria were collected. The results obtained is helpful for bioaerosol risk evaluation.

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[P04-15] CHARACTERIZATION OF PARTICULATE EMISSIONS FROM A COMBUSTION BOILER WITH DUAL FUEL CAPACITY.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (8:00 AM-9:00 AM) Grand Ballroom 2-4

ABSTRACT

In 1997, the United States Environmental Protection Agency (EPA) promulgated new ambient air standards for particulate matter with aerodynamic diameter smaller than 2.5 micrometers (PM2.5). There are few existing data regarding emissions and characteristics of fine aerosols from petroleum industry combustion sources, and the information that is available is old. A dilution sampler was deployed to characterize PM2.5 emission from an industrial boiler unit with duel fuel capacity of burning natural gas and heating oil. The diluted exhausted was diluted at 20 air ratio and aged for 80 seconds prior than sample collection, including PM mass, metal (XRF), EC/OC (TOR), sulfate, nitrate, and gaseous PM2.5 precursors such as VOC, SVOC, and carbonyls. It is found that organic carbon the most abundant species and accounts for more than 80% of PM2.5. In addition, a modified Micro-Orifice Uniform Deposit Impactor is used to characterize distribution of metal species in the range of <0.1, 0.1-0.32, 0.32-1.0 and 1.0-2.5mm. The results indicate particles less than 0.32mm are 60-80% of the mass in PM2.5. Number concentrations of particle less than 0.32mm measured by Measurement of SMPS number concentrations indicated that the particle size mode of 20-40nm for natural gas combustion and 80-100 nm for heating oil combustion and the transformation due to particle condensation/coagulation process occurs in the order of a few seconds. Further more, the results of the chemical composition profile from this study can provide an insight of PM2.5 emission from stationary sources for source apportionment and receptor modelings.

[P04-14] AGGLOMERATION AND ADSORPTION OF FINE CARBONACEOUS PARTICLES ONTO ASIAN DUST PARTICLES.

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Asian Dust particles are composed mainly of mineral dust that originated from the major desert-sources in the northern and northwestern China. Severe visibility impairment during the Asian Dust storm periods is resulted from the enormous amount of coarse particles. Extensive aerosol optical and chemical monitoring were seasonally carried out in order to investigate the physico-chemical properties of Asian Dust particles from 1999 to 2001 in the urban area of Kwangju (35°10′N, 126°54′E, 70.5 m A.S.L.), Korea. Mass fractions of chemical components of fine and coarse particles were analyzed to identify the seasonal variation of visibility characteristics in the urban atmosphere of Kwangju from the result of 1999 to 2000. Fine mass fraction of carbonaceous particles (EC/OC) during Asian Dust storm periods of 2000 was observed less than those during other seasons. Therefore the extensive monitoring was partially modified to investigate the chemical components of coarse particles during ACE-Asia (Aerosol Characterization Experiments) international cooperative observation, 26th March to 6th May, 2001. There were three Asian Dust storms in Korean peninsula, on 22nd March, 11th April, 25th April. Black carbon for the coarse regime was analyzed using the switching method of aethalometer with PM2.5 and PM10 inlet additionally. Single particle analysis was carried out on the fine and coarse particles using SEM/EDX (scanning electron microscope/energy dispersive x-ray analysis). The differences of their chemical compositions and physical characteristics between the fine and coarse regime were investigated among three Asian Dust storm events. In particular, it was revealed that the great loading of Asian Dust particles resulted in the agglomeration and adsorption of fine carbonaceous particles. Agglomeration rate ($[BC_{coarse}]/[BC_{PM10}]$) of mass concentration of black carbon was calculated to be 0.41, 0.50, and 0.24 during the three Asian dust events, respectively. Mass concentration of black carbon was observed to be highest value of 3.96 $\mu g/m^3$ for the coarse regime due to the agglomeration of them by Asian dust particles.

[P04-01] ELEMENTAL CONCENTRATIONS AND PARTICLE SIZE DISTRIBUTIONS OF AMBIENT AEROSOL IN METROPOLITAN AREA WITH INTENSE HIGHWAY TRAFFIC: GREATER CINCINNATI STUDY.

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Respiratory problems and other health effects have been associated with the finer fractions of the PM2.5 aerosol. This motivated an extensive study on factors affecting the PM2.5 concentration levels and elemental composition of ambient aerosols in the Greater Cincinnati metropolitan area, which is characterized by intense highway traffic and thus considerable emissions of diesel exhaust particulate matter. The study was conducted during four seasons (winter, spring, summer and fall) and included 8 monitoring cycles. The measurements were conducted at 11 locations around the city at different distances from highways (ranging from 200 m to 4.2 km). In each monitoring cycle, 24-hour ambient aerosol sampling was performed simultaneously at four sites for about two weeks. The samples were collected with Harvard impactors during working days in order to obtain consistent concentration levels with respect to the traffic. Teflon filters were utilized for subsequent elemental analysis, and quartz filters were used for the elemental and organic carbon analysis. The particle size distributions were measured by a MOUDI impactor. The spatial and temporal variation of the PM2.5 total mass and elemental concentrations were determined. Meteorological conditions, traffic density, configuration of interstate highways and industrial air pollution were incorporated in the analysis. The average PM2.5 concentration ranged from 10 to 29 $\mu g/m^3$ and was evenly distributed through the city area, independent of the distance from the highway. The weekly variation of PM2.5 was not significant, while there was a noticeable seasonal variation. The PM2.5 concentration increased from winter to summer. Three inner city stations, located in downtown, close to the major highway, clearly showed elevated levels of metal concentrations, e.g., Fe (73-585 ng/m^3), Pb (2-71ng/m^3), Zn (10-80ng/m^3) and elemental carbon concentration, C_{El} (0.21-0.44 $\mu g/m^3$) possibly suggesting a greater diesel engine exhaust contribution in comparison to other sites. All other stations showed significantly lower levels of these elements and lower elemental-to-total carbon ratios. Further analysis to establish this on a more precise, quantitative manner is being performed. The particle size distributions revealed that significant mass fraction of the PM2.5 is represented by the submicrometer particle size range.

[P04-12] INFLUENCE OF CANADIAN FOREST FIRE ON MEASUREMENTS OF CARBONACEOUS COMPOUNDS IN FINE PARTICULATE MATTER DURING THE 2002 PHILADELPHIA SUMMER INTENSIVE PARTICULATE MATTER PROGRAM.

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During July 2002, the North East Oxidant and Particle Study intensive program was conducted in northeastern Philadelphia, PA. On July 2, 2002, a Canadian forest fire started and severe smoke was transported to the monitoring site from July 6 to 9, 2002. The smoke plume radically altered the local air quality conditions around Philadelphia for a few days. In this study, $PM_{2.5}$ mass, organic carbon (OC), elemental carbon (EC), black carbon (BC), ultraviolet absorbing particulate matter (UVPM), and sulfate aerosol were continuous measured using a 30°C TEOM with a SES (Sample Equilibration System) dryer, a semi-continuous OC/EC analyzer (Sunset Lab), a two-wavelength Aethalometer (AE-2, Magee Scientific Company), and a continuous sulfate analyzer (Harvard School of Public Health design). In addition, daily integrated filter samples were collected and analyzed using a Sunset Lab. thermal / optical OC/EC analyzer and an Ion chromatography (Dionex-500). During the measurement period, an abrupt increase of $PM_{2.5}$ was observed on the afternoon of July 6. The highest $PM_{2.5}$ mass concentration was greater than 160 $\mu g\ m^{-3}$ late in the evening of July 7. Peaks in the measured semi-continuous thermal and optical EC were observed on same day. The thermal EC was three time higher than the optical EC. In addition, UVPM was much higher than BC during the Canadian forest fire. It strongly suggests that there was substantial amounts of aromatic organic compounds in $PM_{2.5}$ during the forest fire. Also, the difference between optical EC, thermal EC, BC, and UVPM indicate that these measurement methods are strongly dependent on the chemical composition of $PM_{2.5}$. During July 7 to 8, sulfate aerosol concentration increased from 4 to 7 $\mu g\ m^{-3}$ while thermal OC and EC dramatically increased from 0.3 and 5.0 to 3.1 $\mu g\ m^{-3}$ and 43.0 $\mu g\ m^{-3}$, respectively.

[P04-20] ASSURING COMPARABILITY BETWEEN MULTIPLE X-RAY FLUORESCENCE INSTRUMENTS USED IN THE PM2.5 CHEMICAL SPECIATION PROGRAM.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4b: Sampling and Analyzing PM - Sampling and Analysis Networks and Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

X-ray fluorescence (XRF) is used for the measurement of 48 elements collected on Teflonâ filters in the U.S. Environmental Protection Agency’s PM2.5 Chemical Speciation Program. This technique provides a high level of sensitivity for many of the elements of interest, provides linear response to concentration over several orders of magnitude, and is relatively fast and interference free. The Chemical Speciation Program began with one XRF operated by Chester LabNet and now includes three instruments at Chester LabNet, one at Cooper Environmental Services, and two at RTI.

To ensure comparability of the results obtained from these different instruments, the equivalency of each XRF was initially tested as it was brought on-line. Each instrument was first shown to meet basic QC requirements for precision and accuracy based on measurements with commercial and NIST SRM standards. Then, real-world filters selected from the Chemical Speciation Program's filter archive were analyzed in order to show that results, which were statistically equivalent to the results obtained by the original Chester LabNet instrument, could be obtained. The filters for the instrument equivalency tests were specifically chosen to provide a wide range of concentrations for the major, commonly found elements. An ongoing round-robin intercomparison program coordinated by RTI helps to ensure that the instruments continue to agree on the real-world filter results. Correlations of the round-robin results between instruments are generally good, but average ratios for individual elements outside the desirable 90% to 110% range are not unusual, particularly for elements that have poor measurement precision. The ongoing comparisons have resulted in identification of several minor problems including a calibration drift on one instrument, and high background values for three elements on another instrument that turned out to be an instrument artifact.

[P04-10] CHEMICAL SPECIATION OF PM-2.5 COLLECTED DURING PRESCRIBED FIRES OF THE COCONINO NATIONAL FOREST IN FLAGSTAFF AZ.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (8:00 AM-9:00 AM) Grand Ballroom 2-4

The fire-suppression policy of the past century has left forests overgrown with heavy duff and litter layers, increasing the likelihood of catastrophic fire. Prescribed fire, in combination with mechanical thinning, is a preferred method to reduce this fuel load; hence, the use of prescribed fire is expected to increase in the next decade. Fine particulate (PM-2.5) is produced in forest fires, both natural and prescribed. In this work, we examine the chemical composition of PM-2.5 generated during prescribed fires of the Coconino National Forest during October 2001 and October 2002. All fires studied are broadcast burns (as opposed to pile or slash burns) in areas with a 9-12 year accumulation of duff and litter.

Particulate is collected using a battery-operated chemical speciation PM-2.5 monitor (MetOne SuperSASS). Smoke is sampled during the ignition, combustion, or smoldering phase of the prescribed fire, as well as during laboratory burns of litter, duff, and soil taken from the prescribed fire site. PM-2.5 in the wood smoke is collected simultaneously on four filters. Three of the filters (PTFE, nylon + MgO denuder, and quartz) are analyzed at Research Triangle International for total mass and 48 elements (sodium through lead); ions (anions and cations); and total, organic, and elemental carbon, respectively. Preliminary efforts are underway to analyze the fourth filter (quartz) at Northern Arizona University for mutagenic activity and selected polyaromatic hydrocarbon concentrations (benz(a)anthracene, benzo(b)fluoranthene, chrysene, fluoranthene, and pyrene). A description of the sampling method, analysis procedures, and results will be presented.

[P04-09] AMBIENT PM2.5 DURING A HEAVY POLLUTED EPISODE IN HEATING SEASON IN BEIJING, CHINA.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (8:00 AM-9:00 AM) Grand Ballroom 2-4

Coal is primary energy in Beijing and about 23% burned for residential heating in heating season starting on each November 15 and ending on March 15 the next year, leading to more frequent days with heavy air pollution than in non-heating season. One-week integrated PM2.5 samples were collected continuously with a low-flow rate sampler at a downtown site (Chegongzhuang, CGZ) and a residential site (Tsinghua University, THU) in Beijing between since July 1999. Average concentration of TSP was 833 μg.m-3 at CGZ in the week of 11/18-11/25/99, just after the beginning of heating season. PM2.5 mass in this week rocketed to 330 μg.m-3 from 195 μg.m-3 in the last week, then decreased to 93.4 μg.m-3 in the next week, exhibiting large weekly fluctuation. In this stagnation week (SW), daily average wind velocity was less than 1.5 m/s except on November 25, and relative humidity (RH) ranged between 65-91% during four continuous days between 11/20-11/23, leading to much increased air pollutants due to space heating to accumulate near ground surface. For example, daily PM10 concentrations were between 413-632 μg.m-3 for these four days. PM2.5 constituted 87% of PM10 and 40% of TSP in SW, much higher than the values of 55% and 29% on an annual average basis.

All the species except crustal elements in PM2.5 had their maximum weekly concentrations in SW. Average concentrations of SO42-, NO3-, NH4+, OC, and elemental carbon (EC) alone were 61.6, 54.0, 22.1, 58.9, and 25.4 μg.m-3, which were 2.9, 3.1, 1.7, 1.0, and 1.4 times higher than their seasonal mean, respectively. Much more abundant ions in SW suggests that meteorology (for example, RH, stagnation) has very important impact on gas to particle transformation in Beijing. Meanwhile, crustal species (consisting of oxides of aluminum, silicon, calcium, magnesium, and iron, and 25% of that of potassium) only accounted for 6.4% of the PM2.5 mass, much less than the annual value of 11.1%. The enrichments of most trace elements in SW were much higher than their annual mean, and an order of magnitude higher than that of a typical week with serious dust storm in the spring of 2000, suggesting that anthropogenic contribution was substantially enhanced then. The mass ratio of bromine to lead (Br/Pb, 0.048) in this week was much less than that in fall (0.078) and spring (0.086), which could not explained by emission from motor vehicle alone. High correlation of lead with selenium and EC suggested coal burning was probably another major source of lead.

[P04-08] SOURCE RESOLUTION OF SULFATE AND TRACE ELEMENTS IN PM2.5 IN NEW YORK, NEW YORK.

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As a part of the New York Supersite Program 24 hour PM2.5 aerosols were collected on 47mm Zefluorú filters at three sites in New York State. The sampling sites were located at Queens, Whiteface Mountain and Pinnacle State Park. The sampling site located in Queens Public School 219 (PS219) was our urban site and the other two were rural sites. The filters were extracted in 7 ml of double deionized distilled water at 70° C for 1.5 hours. A 1 ml portion of the extract was analyzed by ion chromatography for SO_4^{2-} and another 1 ml aliquot for water-soluble trace elements by inductively coupled plasma mass spectroscopy (ICPMS). The remaining 5 ml plus the filter was microwave digested in a mixture of 2 ml nitric acid, 4 ml hydrogen peroxide and 0.5 ml hydrofluoric acid and analyzed for total trace metals by ICPMS. The data is being used to: (1) characterize the chemical composition of PM2.5 aerosols; (2) estimate contributions form regional emissions to the observed concentrations in New York City; and (3) determine the sources of chemical species using chemical mass balance method, and potential source contribution function.

In this paper, we present the efficiency of water extraction for selected trace metals. Our results indicate that the measured trace metals fall under three groups, those which are highly soluble Mg, V, Mn, Zn, As, Se Sb and Pb with water extraction efficiencies between 75 - 95 %; those which are moderately soluble Ca, Fe, Co, Ni, with water extraction efficiencies between 58 and 44 % and the elements Al, Cr and Cd, which have the lowest solubility, with efficiencies in the range 10 - 12%. Generally the observed quarterly and annual mean concentration of SO_4^{2-}, and the measured trace metals are highest at PS219 followed by Pinnacle State Park (PSP) and Whiteface Mountain (WFM). At all three sites the SO_4^{2-} concentration is highest in the third quarter (July to Sept). At PS219 the mean trace metals concentrations are highest in the fourth quarter (Oct - Dec). The annual SO_4^{2-}/Se ratio at all three sites are around 4000 indicating a regional component. These ratios are indicative of "aged" aerosols transported from distances of several hundreds of km. In fresh aerosols the typical SO_4^{2-}/Se ratios are ~1500. High concentration of Zn, Cd, Sb and Pb were observed at Queens on September 13,2001. Comparison of pre and post September 11, 2001 data and air trajectories indicate that these peaks are a result of air mass passing over the World Trade Center sites before reaching our receptor.

[P04-07] MEASUREMENTS OF PM2.5 CARBONACEOUS SPECIES IN RURAL AND URBAN AREAS OF SOUTHERN CALIFORNIA.

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Elemental carbon (EC) and organic carbon (OC) particles represent an important fraction of the atmospheric PM2.5 mass and play a major role in aerosol toxicity and climate radiation forcing. While both EC, OC, and toxic components such as polycyclic aromatic hydrocarbons (PAHs) are emitted by combustion processes, there are additional non-combustion OC sources (e.g. biogenic and secondary organic aerosol, SOA) that contribute to the atmospheric carbonaceous particle burden.

EC, OC and PAH concentrations were measured in six sites of Southern California from May 2001 to July 2002. Two are located in rural areas (Atascadero and Lompoc) and four in receptor areas downwind of central Los Angeles (San Dimas, Riverside, Upland and Mira Loma). PM2.5 samples were collected every eighth day for 24 hrs. at ~113 lpm. EC and OC were measured using a thermo-optical transmission analyzer, and PAHs by HPLC-Fluorescence.

OC to EC ratios have been used by several researchers to estimate, separately, the contributions of primary (anthropogenic and biogenic) and secondary OC to the total OC burden. The measured OC/EC ratios were higher in the rural areas (4.6-9.8) with a maximum seen in Lompoc during the spring. In urban areas, the OC/EC ratios were always higher during the hot season (2.8-4.1), decreasing to ~2.0 as the temperatures decreased. For all areas during the warmer months, the OC/EC ratios were larger than 2.0, indicating additional contributions of biogenic and SOA. The observed PAH concentrations followed the general EC and OC trends. PAH concentrations increased as the air temperature decreased, an indication of absorption from the vapor-phase, lower inversion layers and reactivity. Significant concentrations of benzo[ghi]perylene and indeno[1,2,3-cd]pyrene were found in both the urban and rural areas, suggesting important contributions from vehicular exhaust emissions.

[P04-06] SECONDARY ORGANIC AEROSOL CONTRIBUTION TO CARBONACEOUS PM2.5 CONCENTRATIONS IN PITTSBURGH.

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A major component of PM2.5 in the Eastern US is carbonaceous material. This organic particulate matter results from both direct emissions from sources such as automobiles, trucks and industries (primary), and from the oxidation of organic gases (secondary). Data from the Pittsburgh Air Quality Study are used to examine the contribution of secondary organic aerosol to the total organic aerosol loading measured in the city during 2001 and 2002.

The contribution of secondary organic aerosol is estimated by using elemental carbon as a tracer for primary emissions of organic particulate matter (OC to EC ratio approach). A systematic method for the determination of the primary ratio has been developed based on the correlation of measurements of OC and EC to gaseous tracers of photochemical activity (O3) and primary emissions (CO, NOx). Sampling methods of carbonaceous aerosols have been a big area of discussion because of the different issues associated with the different samplers characteristics and analysis methods. In this work, the proposed algorithm to determine the primary and secondary contribution of OC is applied to different sets of organic aerosols measurements (using an undenuded sampler, a denuded sampler and an in-situ carbon analyzer) for carbonaceous concentrations. Consistent results for the SOA fraction are obtained when the method is applied to the different sets of measurements for OC and EC. This approach indicates that between 20 and 40% of the organic particulate matter in Pittsburgh during the summer months is secondary in origin, negligible contributions of SOA are estimated for the winter of 2001-02, and from 5 to 25% secondary material contributions are estimated for the fall of 2001.

[P04-05] ESTIMATION OF SECONDARY ORGANIC AEROSOL.

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The secondary organic aerosol (SOA) is generally estimated as SOA = OC - EC*(OC/EC)pri, where OC and EC are organic and elemental carbon, respectively and (OC/EC)pri is the ratio for primary sources. Generally the minimum measured (OC/EC) is used as the (OC/EC)pri. However, the contributions from various primary sources may changes from time to time and the (OC/EC)pri should also vary. In this study, three different methods are used to estimate the (OC/EC)pri. In addition to the minimum measured (OC/EC), the (OC/EC)pri were estimated using the results from receptor model analysis (chemical mass balance) and emission inventory. First, the ratios of (OC/EC) were measured for each individual sources. The (OC/EC)pri was then computed as the ratio of [summation]OCi*Fi to [summation]ECi*Fi, where OCi and ECi are the fractions of organic and elemental carbon in particles from primary sources and Fi is the contribution of each types of primary sources to the ambient particles. Two different methods were used to estimate the value of Fi: chemical mass balance receptor model and emission inventory. The results showed that the (OC/EC)pri is 1.27, 2.37, and 2.52 for the minimum measured method, chemical mass balance method, and emission inventory method, respectively. Therefore, the estimated concentrations of secondary organic aerosol from three methods are different by a factor of about 2. That is, due to the variation of contribution from primary sources, the minimum measured method may overestimate the SOA by a factor of two.

[P04-04] THE PRESENCE AND POTENTIAL SOURCES OF ALKYLNITRONAPHTHALENES IN AMBIENT AIR AT LOCATIONS IN SOUTHERN CALIFORNIA.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (8:00 AM-9:00 AM) Grand Ballroom 2-4

Alkylnaphthalenes are semi-volatile polycyclic aromatic hydrocarbons (PAHs) emitted into the atmosphere from a variety of sources including diesel exhaust. The methylnaphthalenes (MNs), ethylnaphthalenes (ENs) and 9 of the 10 isomers of dimethylnaphthalenes (DMNs) have been measured in ambient air (1,8-DMN is not observed in ambient air nor in diesel fuel). At ambient temperatures, these alkylnaphthalenes exist primarily in the gas-phase and their major atmospheric loss process is by daytime gas-phase reaction with the hydroxyl (OH) radical.

Simulated atmospheric reactions of volatilized diesel fuel with OH radicals or with NO_3 radicals were carried out in a 7000 L all-Teflon environmental chamber. Additionally, ambient measurements were conducted in August 2002 to analyze for alkylnitronaphthalenes which had been identified as atmospheric transformation products in our environmental chamber reactions. Four time intervals per day (07:00-10:30, 11:00-14:30, 15:00-18:30 and 19:00-06:30) were sampled for one week in urban Los Angeles (12-16 August 2002) and at Riverside (26-30 August 2002), a downwind receptor site.

Our ambient measurements showed the presence of methylnitronaphthalenes (MNNs), dimethylnitronaphthalenes (DMNNs) and ethylnitronaphthalenes (ENNs). The profiles of the alkylnitronaphthalenes from the OH radical chamber reactions of volatilized diesel fuel are very similar to the profiles of the alkylnitronaphthalenes observed in ambient air, suggesting that alkylnaphthalenes from unburned diesel fuel undergo atmospheric reactions to form mutagenic nitro-derivatives. Consistent with laboratory studies of the photolysis of the MNNs, certain alkylnitronaphthalenes were observed to decrease in the midday samples, suggesting that photolysis is an important loss process for the alkylnitronaphthalenes.

To our knowledge, this is the first report of DMNNs in ambient air. To date, we have only identified the nitro-derivatives of 2,6-DMNN. Although the DMNs were observed at 5-10% of the naphthalene concentration, their nitro-derivatives appeared relatively more abundant and may have toxicological significance.

[P04-13] POST HARVEST BIOMASS BURNING AEROSOLS AND THEIR IMPACT ON AIR QUALITY IN GWANGJU, KOREA.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4a: Sampling and Analyzing PM - Source Characterization and Attribution (8:00 AM-9:00 AM) Grand Ballroom 2-4

Open field burning after harvest greatly impact the regional air quality in Gwangju, Korea. In order to investigate the chemical characteristics of those biomass burning aerosols, intensive 12-hr particulate matter sampling had been conducted 4~15 June 2001 in Gwangju. A rotating shadowband radiometer (RSR) was used to monitor atmospheric optical depth during the same period. The biomass burning aerosols were collected using PM10 and PM2.5 URG cyclone samplers to analyze mass, ionic and carbonaceous species. The ionic species were analyzed using ion chromatography and the carbonaceous species were analyzed using a selective thermal manganese dioxide oxidation (TMO) method. The mean PM10 and PM2.5 concentrations for the entire intensive sampling period were 153.8 and 129.6μg/m3, respectively. Exceptionally high level of PM2.5 concentration exceeding in the National Ambient Air Quality Standards (NAAQS) was observed, which was compared to 35.8μg/m3 observed during normal days. The average organic carbon and elemental carbon concentrations were 19.61μg/m3, 2.68μg/m3, respectively with OC/EC ratios 5.9~9.1 during the intensive period. The mean aerosol optical depth (AOD) derived from RSR measurement was 0.74 during the biomass burning events and 0.32 during normal days. Enrichment in the fine particles was remarkable and these increased aerosols which were originated from biomass burning after harvest brought about visibility reduction and increase of AOD also may affect the human health.

Mean value of criteria particulate matter released from biomass burning during intensive period in Gwangju, Korea.

	PM10(μg/m3)	PM2.5(μg/m3)	NO3-(μg/m3)	SO42-(μg/m3)	OC(μg/m3)	EC(μg/m3)	AOD
Mean±std.	153.8± 27.2	129.6± 24.6	17.46± 10.42	23.31± 12.91	19.61± 9.36	2.68± 0.91	0.64± 0.23

[P08-29] GENE EXPRESSION PROFILES IN HUMAN AND RAT VASCULAR ENDOTHELIAL CELLS EXPOSED TO RESIDUAL OIL FLY ASH (ROFA) OR VANADIUM (V).

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

Epidemiological studies have reported increased mortality and morbidity in cardiopulmonary patients with increased levels of particulate matter (PM) in the environment. The mechanisms of action for PM and the constituents responsible for the observed health effects are not known. Recent studies implicating cardiovascular and clotting systems in PM response suggest that the vascular endothelium may be targeted. To test this hypothesis and understand the possible role of endothelial dysfunction in PM cardiovascular toxicity, we initiated studies with primary vascular endothelial cell cultures using a model PM, ROFA, and one of its toxic metal constituents, V. Assessing the temporal differential expression of genes on acute exposure to ROFA or V could reveal the transcriptional regulation involved in the initiation and progression of acute injury. Primary cultures of human umbilical vein endothelial cells (HUVEC) and rat pulmonary micro-vessel endothelial cells (RLMVEC) (VEC Technologies, Inc., New York, NY) were exposed to saline, ROFA (1μg/ml) or V (1μM) for 25 minutes to investigate the immediate injury and or stress response. Global gene expression profiles were generated using human (8k) and rat (4k) plastic microarray (Clontech, Palo Alto, CA). Analysis of the gene expression data (GeneSpring, Silicon Genetics, Redwood City, CA) indicated exposure and species-specific differential gene expression and altered genes can be grouped into genes common to both the treatments as well as unique to ROFA and V exposure. Classification of altered genes based on biological processes, cellular components and molecular function indicated species-specific differences in ROFA and V toxicity. Despite species differences, the differential gene expression profiles observed here suggest direct toxic effects of ROFA and V on endothelial cells and their possible involvement in cardiovascular effects of PM. (This abstract does not reflect US EPA policy).

[P08-22] CHEMICAL AND *IN-VITRO* TOXICOLOGICAL CHARACTERIZATION OF WINTER AND SPRING $PM_{2.5}$ IN HELSINKI.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

Urban air fine particulate ($PM_{2.5}$) concentrations are consistently associated with changes in cardiorespiratory functions among susceptible population groups. In Finland, there are large contrasts in sources of PM pollution between winter (high regional + long-distance transport + local automotive engine emissions) and spring (high resuspension of road dust). The objective of our present study was to compare the chemical and *in-vitro* toxicological characteristics of $PM_{2.5}$ from these seasons.

A field study was conducted at a traffic site in Helsinki between 13 January and 20 April 2000. A total of 28 samplings of ambient air $PM_{2.5}$ were made in 3 and 4-day periods using a High-Volume Low cutoff Impactor (HVLI) at 68 m3/h. The extracted PM masses from the winter and spring periods were pooled separately on the basis of the $PM_{2.5}$:PM_{10} concentration ratio (continuous beta attenuation data) to form larger samples representing contrasting urban air PM pollution situations:

1) Winter-$PM_{2.5}$ during high $PM_{2.5}$:PM_{10} ratio (0.58; low resuspension)

2) Spring-$PM_{2.5}$ during low $PM_{2.5}$:PM_{10} ratio (0.28; high resuspension)

Spring-$PM_{2.5}$ had clearly higher watersoluble soil metal contents (Al, Fe, Ca) and lower anionic contents (SO_4^{2-}, NO_3^-) than Winter-$PM_{2.5}$. The PM samples from both periods induced dose-dependent NO production in murine RAW 264.7 macrophages without a major seasonal difference in potency. In contrast, Winter-$PM_{2.5}$ was a significantly less potent inducer of TNF-α production than Spring-$PM_{2.5}$. Moreover, Winter-$PM_{2.5}$ caused practically no IL-6 production, whereas Spring-$PM_{2.5}$ produced a partially dose-dependent response. The PM samples from both periods induced dose-dependent reductions in cell viability without major seasonal difference. With regard to cell viability, and especially cytokine productions, the insoluble fractions of Winter-$PM_{2.5}$ and Spring-$PM_{2.5}$ seemed to be responsible for nearly the whole responses. Polymyxin B (antagonist of endotoxin) abolished the IL-6 production induced by Spring-$PM_{2.5}$ and significantly reduced the TNF-α productions induced by both Winter-$PM_{2.5}$ and Spring-$PM_{2.5}$. Deferoxamine (somewhat cytotoxic iron chelator) did not modify these responses. Neither polymyxin B nor deferoxamine modified the PM-induced reductions in cell viability.

In conclusion, Winter-$PM_{2.5}$ and Spring-$PM_{2.5}$ had different proinflammatory profiles in a standard murine macrophage cell line. This activity was strongly associated with the insoluble PM fraction involving partly endotoxin.

[P08-23] CHEMOTAXIN RELEASE BY TYPE II EPITHELIAL CELLS FOLLOWING TREATMENT WITH FINE AND ULTRAFINE PARTICLES.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

In rat inhalation studies it is well documented that ultrafine particles induce more pulmonary inflammation than fine particles at the same lung mass burden. We hypothesise that this acute inflammatory response following deposition of ultrafines is a result of chemotaxin production by epithelial cells following exposure to ultrafine particles. More specifically we hypothesise that, in vivo, ultrafine particles can induce type II epithelial cells to secrete chemotactic agents which can alter the normal pattern of particle clearance from the lungs. Retention of macrophages and their particle loads in the lung periphery could cause build-up of particle dose resulting in increased toxicity via mechanisms such as oxidative stress.

We have therefore used a modified 96-well chemotaxis assay chamber to assess the macrophage chemotactic potential of the type II cell secretions. Utilizing Zymosan Activated Serum (ZAS), a well documented source of the chemotactic complement protein C5a, we have examined both time and dose- related macrophage migration and measured the chemotactic activity in conditioned medium obtained from epithelial cells dosed with fine & ultrafine particles. We found that sub-toxic doses (125 μg/ml) of carbon black in its ultrafine form, induced chemotaxis to a greater extent than equivalent mass doses of either fine carbon black or both forms of titanium dioxide. (0.587 ± 0.076 compared to 0.427 ± 0.045 for fine TiO_2; 0.412 ± 0.045 for ultrafine TiO_2 and 0.484 ± 0.068 for fine carbon black. All data given is the mean of 3 experiments plus or minus SEM).

Preliminary experiments to determine the degree of the chemotactic activity using molecular weight cut-off filters have shown the chemotactic agents to be located above 5 kDa molecular weight (0.467 ± 0.031 for the 5 kDa - 10 kDa fraction and 0.470 ± 0.027 for the >10 kDa fraction compared to 0.403 ± 0.002 for the <5 kDa fraction).

Future investigations will concentrate on further identifying the chemotactic agent secreted by the type II pneumocytes with the objective of obtaining a clearer picture of the events surrounding the enhanced pathogenicity of ultrafine particles in the lung.

[P08-24] ADVERSE HEALTH EFFECTS DUE TO INHALED CARBON NANOPARTICLES?

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

Many epidemiological studies, but not all, have identified associations between the frequency of adverse health outcomes in man and the mass concentration of particulate matter (PM) in ambient air. However, plausible mechanistic models capable of interpreting the epidemiological findings are not available at present. This unsatisfactory situation is clearly related to the fact that the mass concentration of aerosol particles is a very gross parameter that does not describe the concentration of inflammatory or toxic components of PM reasonably well. Most of the previous studies have not even made a distinction between the soluble and the insoluble fraction of PM. In this contribution possible adverse health effect due to incorporation of carbon nanoparticles (NPs) in the human lung are assessed. Recent work in this laboratory (K. Wittmaack, Atmospheric Environment 36 (2000) 3963; K. Wittmaack et al., Atmospheric Environment, in press) has provided evidence that carbon NPs constitute the core of a significant fraction of larger fine particles which have grown in the atmosphere by condensation of sulfates, nitrates and organic carbonaceous compounds. All particle-type carbon matter identified by scanning electron microscopy (SEM) had sizes between 20 and 40 nm, irrespective of the final size of the air borne particles. The results are in very good agreement with other recently reported investigations using other techniques. With information on the size distribution at hand, the mass concentrations of carbon NPs in ambient air can be calculated from measured number concentrations. It turns out that, averaged over 24 h, the contribution of carbon NPs to PM2.5 is well below 1%, i.e. only on the order of 100 ng/m^3. Animal studies, on the other hand, are usually performed at carbon NP mass concentrations that are more than three orders of magnitude higher. In spite of these very high doses, the observed effects were small.Considering these results it is not very likely that carbon NPs, a major component of the insoluble fraction of fine (and ultrafine) PM in urban aerosols, constitute an important risk factor for human health. Hence attention should focus on the much larger soluble fraction of aerosol matter.

[P08-25] CYTOKINE RESPONSES ELICITED BY $PM_{2.5}$ SEAS SAMPLES COLLECTED AT THE BALTIMORE SUPERSITE DURING A 2002 INTENSIVE STUDY.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

Exposure to fine particulate matter, $PM_{2.5}$, has been associated with adverse health effects, including increased human morbidity and mortality. These particles contain a complex mixture of organic and inorganic compounds, elemental carbon, trace elements and biological components including endotoxin. A major goal of the Baltimore PM Supersite is to relate chemical and biological endpoints of $PM_{2.5}$ with local and/or geographically distinct sources. We hypothesized that continuously collected ambient air samples have biological activity that reflect specific components of the particles. Particles collected at 30-minute intervals using a semi-continuous aerosol sampler (SEAS) during a summer "intensive" sampling period at the Baltimore Supersite (Ponca St.) were analyzed for their ability to elicit the release of pro-inflammatory cytokines from RAW 264.7 cells, and chemokines from A549 cells. Alveolar type II epithelial cells (A549) released IL-8 and MCP-1 at levels that varied with collection time. Similarly, different levels of TNF-α and IL-6 were released by macrophage-like cells (RAW 264.7) depending on the time of day the samples were collected. Endotoxin was also present in many of the samples; but cytokine and chemokine release did not correlate directly with these levels. Our data suggest a role for other components of $PM_{2.5}$, such as metals, in the cellular response to the particles and that adverse health effects may be attributable to these component-specific effects.

Supported by the Baltimore Supersite Program grant R82806301

[P08-26] COMPARISON OF THE BIOLOGICAL ACTIVITY OF NIST INTERIM REFERENCE MATERIAL FOR $PM_{2.5}$ WITH NIST STANDARD REFERENCE MATERIAL® 1648 FOR URBAN PARTICULATE MATTER.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

For the past 25 years, the only sources of industrialized urban air particulate matter (PM) legitimated by the National Institute of Standards and Technology (NIST) have been standard reference material® (SRM) 1648 and SRM® 1649a ("urban dust" certified for organic compounds only). While well characterized with respect to its inorganic speciation, SRM® 1648 is poorly characterized with regard to the size of its constituent particles. Because epidemiological evidence suggests that human morbidity and mortality are associated with exposure to particulate matter of size 2.5μm or less ($PM_{2.5}$; fine fraction), the NIST and the USEPA have jointly developed an interim reference material for urban particulate matter specifically of this size. In order to test the hypothesis that the interim reference material for $PM_{2.5}$ is biologically active, we exposed the human alveolar type II (ATII) cell line, A549, to NIST fine particulate matter (0.62 mg/ml-1.0 mg/ml) for 24 hrs. A549 cells elicited the chemokines IL-8 and MCP-1 at levels above medium control and in a $PM_{2.5}$ dose-dependent manner. IL-8 release was similar in separate experiments for ATII cells exposed either to 500 μg/ml interim NIST $PM_{2.5}$ or to 100 μg/ml $ZnCl_2$, suggesting that metals may play a role in the biological activity of NIST $PM_{2.5}$. We then compared the interim NIST sample against SRM® 1648 in the same *in vitro* system and at identical concentrations (0.62 mg/ml-1.0 mg/ml). The IL-8 response after treatment with the interim reference material was similar to that of SRM® 1648 at all concentrations except 250 μg/ml, at which the interim SRM was six times more active than SRM® 1648. Similarly, interim reference material was 1.2-1.5 times more active in the production of MCP-1 by A549 cells at concentrations of 125-500 μg/ml than were the same concentrations of SRM® 1648. Interestingly, increasing concentrations of ZnCl2 (25-400 μM) led to decreasing MCP-1 release by A549 cells without a significant decrease in cell viability. In conclusion, our data support the hypothesis that the biological activity of PM is due not only to speciation, but also to particle size, and that during exposure to $PM_{2.5}$, ATII cells may signal two completely different cell types into the alveolar space, depending on the content of the particulate matter inhaled into the distal lung.

[P08-27] CHARACTERIZATION OF ORGANIC AEROSOL (WOOD SMOKE AND DIESEL EXHAUST PARTICULATE) USING SUBCRITICAL WATER FRACTIONATION AND IN VITRO TOXICITY TESTS.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

In contrast to inorganic aerosols, which are often well characterized, only ca. 15%-50% of the organic carbonaceous (OC) particulate mass has been characterized. The limited knowledge of OC fractions is due to the use of organic solvents, which are able to extract only nonpolar or slightly polar organics. In addition, polar compounds cannot usually be analyzed via gas chromatography with a mass spectrometer (GC/MS). Recently, subcritical water (defined as hot water under sufficient pressure to maintain the liquid state) has been used to extract organics with a wide range of polarities. The advantage of water extraction is in the ability of water to change polarity when the temperature is changed. At lower temperatures (e.g., 25°-100°C), water can extract polar compounds; with increasing temperature (e.g., to 250°C), the polarity of water decreases and becomes comparable to the polarity of organic solvents, allowing nonpolar compounds to be extracted.

In this study, subcritical water was used for the extraction and fractionation of organic atmospheric particulate. Two common carbonaceous aerosols, diesel exhaust particulate (relatively nonpolar matrix) and wood smoke particulate (polar matrix), were sequentially extracted using a range of subcritical water temperatures from 25° to 300°C. The toxicological importance of individual fractions was studied on four separate systems, bacterial and mammalian cell respiration, mammalian cell cytotoxicity, and bacterial genotoxicity. The data obtained were related to the composition of extracts, which was determined on the basis of carbon, hydrogen, nitrogen, and sulfur analysis; total organic carbon; GC/MS analysis; and for diesel exhaust particulate, the analysis of metals.

In general, cytotoxicity was highest for the polar fractions from wood smoke particulate and the non-polar fractions from diesel exhaust particulate. In addition, the most polar fraction of diesel exhaust showed significant cytotoxicity. This might be attributed to the increased concentration of sulfur, Fe, Zn, Mg, and Mn (possibly present in the form of soluble sulfates). The detailed toxicity and analytical results will be presented. In summary, the results indicate that standard methods employing organic solvents neglect characterizing the polar fractions of aerosol particulate, which are important from a toxicological point of view.

Acknowledgment

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[P08-36] FREE RADICALS ON COAL COMBUSTION EMISSION PARTICLES AND THE LUNG CANCER RISK.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

Combustion-generated particles can contain large quantities of persistent radicals. These radicals were reported to have stabilities and Electron Paramagnetic Resonance (EPR) parameters that are consistent with semiquinone radicals. In a previous study on Xuanwei, a rural Chinese county which has the highest lung cancer rates in China, it was shown that free radical concentrations in coal emission particles were correlated with lung cancer mortality rates better than the BaP concentrations; the radical concentrations on some coal emission particles were much higher than those on cigarette smoke particles. The lung cancer rates vary by two orders of magnitude among communes located in the same general area inside the county. The different coals are believed to be associated with different lung cancer mortality rates of the residents who burn them for heating and cooking. In the present study, samples of 15 different coals used by the rural households in Xuanwei, China are burned in the laboratory simulating the burning style of the households. Emission particles are subjected to EPR analysis. Preliminary measurements over the emissions from one US coal, as the control group, and several coals from Xuanwei, indicate that free radicals are present in substantially high concentrations, in the order of 10^{17} spins per gram of particulate matter. The intensity of the radicals on particles varies by a factor of 6 among the samples measured so far. (Click to see figure 1)

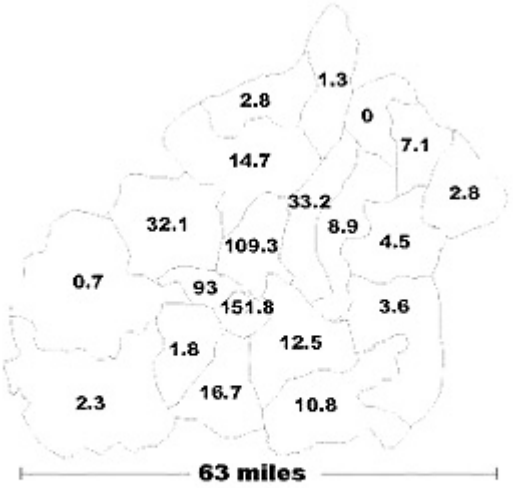

Figure 1. Map of Xuanwei County, showing commune boundaries, each commune's annual lung cancer mortality rate per 100,000 (1973-75). The rates vary by two orders of magnitude among communes in the county.

Figure

[P08-28] IN VITRO TOXICITY OF AMBIENT PM10 AND PM 2.5 COLLECTED FOR HEPMEAP PROJECT.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

Despite the many epidemiological studies correlating exposure to ambient PM10 levels with respiratory diseases and cardiopulmonary mortality, there is a need to establish biologic plausibility of these health effects. Here we present the preliminary comparison of eight coarse (PM10) and fine (PM2.5) samples collected at two different locations across Europe for the HEPMEAP project (QLRT-1999-01582). The identity of the locations (A; B) and time of collection is still unknown. We used the cell line RAW 264.7 (mouse monocytes/macrophages) and the same concentrations for all particles of 20μg/cm2 and 60μg/cm2. RAW 264.7 cells when stimulated with lipopolysaccharide (LPS) release large amounts of inflammatory mediators including the cytokine interleukin-6 (IL6) and the precursor of prostaglandins arachidonic acid (AA); in order to control the activation of our cells we have included LPS (1 μg/ml) in our experiments. Cytotoxicity was measured by the release of LDH. LPS induced a moderate release of 1.26±0.29% while all tested samples had no effect on cell viability apart one coarse fraction. The inflammatory mediators released by macrophages or epithelial cells in vitro play major roles in pulmonary inflammation related to particle exposure. Both fine and coarse particles collected in location A, dose dependently increased AA release as compared to control cells. However, AA release was only slightly induced in two samples, with no difference between the two fractions, while in the other two samples coarse particles were more effective than fine particles. In fact coarse particles of the latter samples induced at 60 μg/cm2 a highly significant ($p<0.001$) AA release of 226 ± 21.95% and 236± 24.74% similar to the LPS-induced which was 237± 22.62%. The coarse fraction with the lowest AA release was the only one of location A which induced ($p<0.0005$) at both concentrations the production of IL6. In two samples of location B the coarse fractions were more effective than fine fractions in releasing AA, and at 60 μg/cm2 the release was similar to the LPS-induced level. In the other two samples fine fractions were more effective than coarse fractions, but without attaining the level of LPS. It seems that there is no correlation between the increase of AA release and the increase in IL6 production. Among all tested samples only one of location B increased both AA release and IL6 production. As the two end points are linked to two different cell signalling pathways these results can be expected. Our results suggest that there is the possibility with our model system to show contrasts and discriminate between samples with different composition.

[P08-19] INFLAMMATORY EFFECTS INDUCED BY PM_{10} SAMPLES OF DIFFERING COMPOSITION.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

Numerous studies have demonstrated toxicological effects of ambient particulate (PM_{10}), but have been unable to identify the physical or compositional elements responsible. In this study PM_{10} was collected from six locations in the UK which vary in predominant source and composition of particulate. PM_{10} samples were collected for 24 hour periods onto Teflon filters for one year. The concentrations of primary, secondary and course particulate comprising each PM_{10} sample were analysed by mathematical modelling (Stedman *et al*., 1998). The inflammation induced by each sample was determined using a rat lung instillation model. Particulate was recovered into 1ml saline of which 500μl was intra-tracheally instilled into female Wistar rat lungs. Within each experiment, the PM_{10} samples instilled were all sampled on the same date. Control animals were instilled with saline alone. Eighteen hours after instillation broncho-alveolar lavage (BAL) was conducted to assess the inflammatory cell population and biochemical markers of inflammation. There was a significant increase in neutrophils ($p<0.001$) and MIP-2 ($p<0.05$) in BAL from lungs exposed to roadside PM_{10} collected from Marylebone Road, London compared to the control but inflammation induced by urban, rural and industrial PM_{10} was not significant.

Preliminary statistical analysis indicates that mass dose of PM_{10} instilled is the greatest factor influencing neutrophil influx into the lung. However, the primary particulate content of PM_{10} is also a strong factor in inducing inflammation. In contrast, the secondary and coarse fractions of the PM_{10} were relatively weak in this respect. This preliminary data would suggest that the primary component of PM_{10} is more important than the secondary or coarse component in driving the inflammatory effects induced by PM_{10} in the rat lung.

[P08-30] INFLUENCE OF EXTRACTION TECHNIQUE AND COLLECTION SUBSTRATE ON THE OXIDATIVE ACTIVITY OF ENVIRONMENTAL PARTICULATE MATTER (PM).

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Toxicological assessment of PM is dependent on the samples being representative of those within the environment. Whilst this is often assumed there are many potential pitfalls related to sampling and extraction procedures that may result in artifactual distortions of particle activity. In this study we examined three potential sources of error in obtaining representative environmental PM: the impact of particle sonication, the nature of the collection matrix; and the type of extraction fluid. Study 1: Diesel exhaust particles (100μg/ml) underwent various periods of sonication (1-20 min.), prior to separation into whole, supernatant and washed particle fractions. The activity of these fractions was then assessed by measuring their capacity to deplete ascorbate (AA-200μM, pH7.4). Extended periods of sonication resulted in increased particle activity. One minute of sonication (S1) resulted in a 76% loss of AA, compared with a fall of 49% in the un-sonicated sample (V0). This loss increased to 82% after 20 min of sonication (S20). A similar pattern was observed in the particle supernatants: V0, 25%; S1, 40%; S20, 66%. In contrast, although 1 min sonication greatly increased washed particle activity: 4% (V0) vs. 66% (S1), further sonication resulted in a loss of activity up to S20 (34%) as the activity was displaced from the particle surface. Study 2: The activity of particles collected directly into ultra-pure water (BioSampler ®) was compared against samples extracted from Teflon filters (Partisol) and polyurethane foam (High Volume Cascade Impactor) matrices. Particles extracted from the Teflon filter and polyurethane foam had significantly greater activity than particles collected directly into water resulting in AA losses of 40±6% (BioSampler ®) vs. 100 ± 0% (filter) vs. 73±3% (foam). Study 3: The activity of coarse and fine PM was compared following extraction from foams into water or methanol. We observed little difference in the capacity of coarse or fine PM to deplete AA when they were extracted into water or methanol: 55±6 % vs. 45±11% (coarse) and 67±6% vs. 63±3% (fine) respectively. Conclusion: These data illustrate that both the sampling matrix and extraction procedure can have profound effects on PM activity. As the BioSampler ® collection results in the lowest level of particle interference we believe this probably gives the most accurate representation of environmental PM. These results highlight the need for caution when relating the activity of PM measured in in vivo and in vitro models to that breathed environmentally.

[P08-31] METAL COMPONENTS OF AIR POLLUTION PARTICLES AFFECT THE FUNCTION OF CULTURED CARDIAC MYOCYTES.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

Epidemiological studies have reported increases in cardiovascular morbidity and mortality following peak episodes of acute air pollution exposure. In addition, toxicological studies have shown that dysrhythmias, changes in repolarization, and increases in internal defibrillator discharges correlate with air pollution particulate matter (PM) exposure. Previous studies have shown that PM and its components (e.g. transition metals) are capable of leaving the lung and entering the vascular system. This study addresses the hypothesis that zinc (Zn) directly interacts with myocardial cells to cause electrophysiological changes that may underlie the cardiac dysfunction reported in epidemiology and toxicology studies. Ventricular myocytes isolated from 1-day old rats were cultured as confluent monolayers for 11-13 days. Myocytes were then exposed to different concentrations of Zn for various times and spontaneous myocyte beat rate, a surrogate measure of heart rate, was measured. Compared to baseline, exposure to Zn significantly decreased beat rate at 4 hours by 17%. Since beat rate is affected by impulse propagation and cell-to-cell communication, the effect of Zn on cellular coupling was assessed using fluorescent recovery after photobleaching (FRAP, a physiologic measure of cell-to-cell communication and gap junction permeability). Zn decreased the FRAP rate at 4 hours by 76% suggesting that Zn may decrease heart rate by disrupting cell-to-cell communication. Changes in gene expression of gap junction proteins that facilitate cell-to-cell communication and impulse propagation were measured next. Zn increased gene expression of connexin 43, the major gap junction protein expressed in the heart, by 76% but had no effect on a second gap junction protein, connexin 40. Potassium and calcium channels can also influence spontaneous beat rate by affecting repolarization of the myocytes. Compared to control, exposure to Zn increased mRNA accumulation of voltage-gated potassium channel proteins Kv4.2 and KvLQT1 and the alpha 1 subunit of the L-type calcium channel. No evidence of cytotoxicity was observed at the concentrations of Zn used in this study. These data suggest that soluble metals found in air pollution particles can affect the spontaneous beating of cardiac myocytes, possibly by disruption of cell-to-cell communication or by affecting the complex repolarization system, thereby potentially contributing to PM-associated cardiac morbidity and mortality. This abstract does not necessarily reflect EPA policy.

[P08-32] DNA DAMAGE ASSAY AS A QUANTITATIVE MEASURE OF FREE RADICAL FORMATION BY SIZE-FRACTIONATED COAL COMBUSTION-DERIVED ASH PARTICLES.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

Respirable particulate materials in the air have been of interest in recent years because of a number of research studies correlating particulate exposure with health risks. However, the nature, origin, and mechanism of the pathology associated with these risks require further study. Respiratory and cardiovascular consequences of exposure to airborne particulates may arise as the result of formation of reactive oxygen species (ROS) at the particle interface or from water-soluble transition metal ions arising from the particulates. Rapid quantitative assessment of ROS formation by particulates from various sources and of different sizes and compositions would provide insights regarding the relative toxicological importance of these aspects of particulate materials. Performing this assessment in the context of a natural biomolecule such as DNA is more meaningful biologically. Therefore, we employed a ROS-dependent DNA damage assay using supercoiled circular DNA from the bacteriophage ΦX174 as the test substrate. Free radical damage creates nicks in the superhelical coiled structure, resulting in relaxed DNA forms that migrate differently under electrophoresis. The technique was tested on ash particulate samples of different sizes collected using differential filtration of materials originating from combustion of a lignite coal. Time- and dose-dependent assays were conducted, and comparisons of the DNA damage originating from exposure to particulates from different sources and of various sizes were performed in fully crossed analysis panels with and without ascorbate, desferoxamine, citrate, and mannitol. Free radical-dependent DNA damage was measured by comparing relative quantities of supercoiled vs. nicked DNA visualized with ethidium bromide following separation by electrophoretic migration through a 0.6% agarose gel. Particulates catalyzed formation of ROS products, but distinct differences were noted between ROS formation mediated by particulates of differing sizes. DNA damage in samples exposed to particulate materials was apparently through iron-dependent formation of hydroxide radicals. The DNA breakage assay for measuring ROS production by particulate materials is sensitive, rapid, and quantitative. Results of this in vitro assay appear likely to reflect expected in vivo toxicity. Meaningful comparisons of particulate toxicities are rapidly attainable with this technique. Application of this technique to compare particulate materials may be informative regarding the health hazards likely to be associated with human exposure.

[P08-33] EXPOSURE TO PARTICULATE MATTER IN AIR POLLUTION LEADS TO INFLAMMATORY RESPONSES IN THE MOUSE BRAIN.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

The etiology of neurodegenerative disorders is at present unknown. Although a small percentage of these disorders are familial cases linked to specific genetic defects, most are idiopathic. Thus environmental factors are thought to play an important role in the onset and progression of neurodegeneration. In the present study, we determined the effect of an exposure (4 hours, 5 days per week for 2 weeks) to concentrated airborne particulate matter on brain inflammatory indices in cortical tissue of ovalbumin-sensitized BALB/C mice. Animals were divided into three exposure groups; filtered air (control) ultrafine particles (UF) or fine plus ultrafine particles (F + UF). The levels of proinflammatory cytokines interleukin-1 alpha (IL-1α) and tumor necrosis factor alpha (TNFα) in the cytoplasmic fraction of brain homogenates were significantly increased in mice exposed to F + UF. While IL-1α was also increased in the brain of mice exposed to UF alone, TNFα levels were not substantially different in this group compared to the control. These data indicate that components of inhaled fine particulate matter may enter the brain and trigger a proinflammatory response. Levels of the immune-related transcription factor NF-κB were also found to be substantially elevated in the nuclear fraction of brain homogenates in both exposed groups compared to the control. Since there is evidence that inflammatory events may contribute to the pathogenesis of neurodegenerative disorders, the results suggest that environmental exposure to particulate matter may enhance events in the central nervous system connected to disease processes. More study on the effects of inhaled particulate matter on the brain is warranted before concluding that these observations may cause adverse human health effects.

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[P08-34] IMMEDIATE EFFECTS OF PARTICULATE AIR POLLUTANTS ON CARDIAC AND RESPIRATORY FUNCTION IN YOUNG, OLD, AND HYPERTENSIVE RATS.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

Understanding how quickly ambient particulate matter air pollution (PM) causes health effects can provide important clues about the biological mechanisms involved in PM-related morbidity and mortality. Times-series studies have shown that the lag time between elevated PM and increases in cardiopulmonary-related hospital admissions and death is one day or less. If PM does cause serious health effects shortly after exposure, one would expect to see some physiological change during exposure. We have examined the effects of various PM air pollutants on rats with implanted ECG and blood pressure (BP) transmitters to determine whether PM causes immediate effects. Spontaneously hypertensive rats (SHR) with BP transmitters (which measure BP, heart rate and respiratory rate) were exposed to concentrated ambient PM (CAPS) for 4 hrs. The SHR were also exposed to fine and ultrafine sulfuric acid aerosols because acid is one of the components of PM that could potentially activate irritant receptors and cause effects during exposure. Young and old (20 months) Sprague Dawley (SD) rats with ECG transmitters (which measure heart rate and core temperature) were exposed to fine and ultrafine acid aerosols and to resuspended carbon black. Inhalation of CAPS by the SHR caused a striking decrease in respiratory rate that was apparent soon after the start of exposure and that stopped when exposure to CAPS ceased. The decrease in respiratory rate was accompanied by a decrease in heart rate. Exposure of the same SHR to fine acid aerosol also caused a significant decrease in respiratory rate similar to the effects of CAPS. Ultrafine acid had the opposite effect on respiratory rate in SHR as CAPS. In both old and young SD rats, inhalation of fine acid aerosol caused an immediate increase in temperature (compared to air-exposed rats) that ceased when exposure stopped. Ultrafine acid caused an immediate decrease in heart rate and temperature during exposure in young SD rats and no significant effect on old SD rats. Carbon black inhalation had no significant effect on heart rate or temperature during exposure in either old or young rats. This study showed that inhalation of PM and acid aerosols have immediate effects on cardiopulmonary function during exposure. The pattern of the response to inhaled PM is consistent with activation of irritant receptors in the respiratory tract. Supported by grants from NIEHS (ES00260) and EPA (R 82735101).

[P04-65] AN ANALYSIS OF URBAN SPECIES DATA - A TALE OF TWO CITIES.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (8:00 AM-9:00 AM) Grand Ballroom 2-4

Urban speciated fine particulate data of the STN monitoring network from January 2001 to February 2002 were studied in both eastern and western locations of the U.S. Seasonal variability of PM2.5 mass, organic carbon, elemental carbon, sulfate ion, nitrate ion, and ammonium cation concentrations were analyzed. Their relationships with ozone and meteorology were examined. Preliminary results suggest that differences in meteorology (in particular, relative humidity) and emissions may have a significant impact on the observed seasonality in species concentrations in Fresno and Atlanta. Based on an analysis of other cities, this influence appears to be more general and may typify the difference between eastern and western cities in the United States. In Atlanta, ozone, sulfate and ammonium were high in the summer when temperature and humidity were high, whereas organic carbon concentrations were relatively flat year round. In Fresno, however, sulfate concentrations were very low even in the summer. PM2.5 concentrations were much higher in the winter and dominated by organic carbon. Organic carbon, nitrate and ammonium ion were observed to be the highest in late fall and winter when relative humidity was the highest (above ~60%). Much lower mixing height and stagnation were also the major factors for the observed high concentrations of various species. The dominance of organic carbon concentration in Fresno in winter may be closely related to its relatively mild winter temperature, high humidity, and plenty ammonium nitrate particles.

[P08-03] ON-ROAD EXPOSURE TO HIGHWAY AEROSOLS. 3. EXPOSURES OF AGED AND COMPROMISED RATS.

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Ambient particulate pollution is associated with adverse health effects in epidemiological studies in the elderly with cardiopulmonary diseases. We hypothesize that ultrafine particles (UFP) contribute to these effects, especially when they are freshly generated and occur at high number concentrations. Studies to determine adverse effects have been performed using laboratory-generated surrogates, diluted exhaust from stationary engines, or concentrated ambient UFPs. Methodological difficulties exist with such experiments and questions remain about how well these particles model those found in ambient air. Freshly-generated UFPs are present at high concentrations on highways and vehicle passengers are directly exposed to them. We wished to expose rats to these UFPs to test their potential to cause effects. Since such exposures have not been done before, our objectives were to: (i) demonstrate the feasibility of an on-road exposure study; (ii) determine if there are significant effects in aged rats; and (iii) determine effects after priming of the respiratory tract. Old rats (21 mo. F-344) were exposed directly on highways to either the aerosol (<1μm)/gas phase, gas phase only, or filtered air using an on-road exposure system. Some rats were pretreated with a low dose of inhaled endotoxin or with instilled influenza virus to induce lung inflammation. The exposures in compartmentalized whole-body chambers consisted of 6 hr driving periods on I-90 between Rochester and Buffalo once or 3 days in a row. Endpoints related to lung inflammation, inflammatory cell activation, and acute phase responses were measured after exposure. In addition, spontaneously hypertensive (SH) rats (7-9 mos) with implanted radiotelemetry devices were pretreated with inhaled or ip-injected endotoxin prior to on-road exposures to monitor effects on heart rate, blood pressure, and heart rate variability. The on-road exposure system did not affect measured endpoints in filtered air-exposed rats, indicating that it was well tolerated by them. Exposure dependent effects were observed in the inflammatory response, as assessed by the percentage of lavage neutrophils, and in lavage cell oxidant release. Evaluations of the contribution of priming agents and exposure atmosphere to these effects are ongoing. Sponsored by EPA PM Center grant R827354 and EPA STAR grants R828046 and R82678.

[P08-12] ADJUVANT ACTIVITY OF VARIOUS DIESEL EXHAUST AND AMBIENT PARTICLES IN TWO ALLERGIC MODELS.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

In the framework of an EU study entitled "Respiratory Allergy and Inflammation due to Ambient Particles (RAIAP)" various particulate matter samples have been tested for their adjuvant potency in two animal models for allergy. A pollen allergy model in the Brown Norway (BN) rat and an ovalbumin model in the Balb/c mouse were used in this study to compare the discriminatory value of these two models. Two different sources of diesel exhaust particles (DEPI supplied by Dr Mauderly; DEPII is purchased from National Institute of Standards and Technology: SRM2975), a residual oil fly ash source (ROFA) and two sources of ambient borne particles (Ottawa dust: EHC-93 and road tunnel dust (RTD)). Rats were sensitised intratracheally with Timothy grass pollen (Phleum pratense, 200 μl, 10 mg/ml) on day 0, challenged on day 21 and examined on day 25. Mice were sensitised intranasally at day 0 and 14, challenged intranasally at day 35, 38, 41, (0.5μl, 0.4 mg Ovalbumin/ml) and examined at day 42. Particulate matter (PM) was administered either during the sensitisation phase or during the sensitisation and challenge phases (for mice only) or during the challenge phase only.

In the pollen model, only DEPI stimulated the effect on the IgE and IgG1 response to pollen allergens. In the BAL of BN rats exposed to a combination of pollen and PM the percentage eosinophilic granulocytes had decreased compared to the BAL of BN rats immunised with pollen only. No other biomarkers in lung or BAL revealed adjuvant activity in the pollen model.

The IgE levels were increased in mice after co-exposure to ovalbumin and PM in the sensitisation phase but not after co-exposure during the challenge phase only. The inflammatory response was stronger in the lung, predominantly by the influx of eosinophilic granulocytes, as was observed by both histopathological examinations and bronchoalveolar lavage (BAL) analysis. In addition, BAL levels of inflammatory interleukines IL-4 and IL-5 were increased. Based on the IgE antibody response to ovalbumin, the ovalbumin model ranked the adjuvant capacity of the particles in the following order: RTD> ROFA>EHC-93> DEPI> DEPII.

In conclusion, adjuvant activity of air borne particles was shown in an ovalbumin allergy model in mice, whereas this could not be reproduced in a pollen induced allergy model in rats.

[P08-04] MOLECULAR ADSORPTION AT PARTICLE SURFACES: A PM TOXICITY MEDIATION MECHANISM.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

Fine atmospheric particles depositing in the lung present a large adsorbent surface for the adsorption of broncho-alveolar lining fluid (BALF) components, including lung surfactant and its associated proteins. Such adsorption at invading particle surfaces is known to be important in biological particle clearance, and the immunological and toxicological fate of these particles. In experiments reported here, it was hypothesized that this is also true for particles of non-biological origin, and that fine particles with large surface areas could adsorb opsonising components of BALF. It may be further hypothesized that physiological alterations in the levels of these defensive surfactant components - through absence or depletion - may lead to reduced host defense performance on PM inhalation.

Elemental carbon (EC) is a ubiquitous component of fine particulate matter (PM2.5). EC originates largely from fossil fuel combustion, and vehicles in particular contribute a significant proportion of PM2.5 EC mass. Since the size distribution of EC is sub-micron, industrially produced carbon blacks in the 25-100 nm size range were used as a surrogate for urban EC, in terms of surface area and chemistry. Sub-micron and micron polystyrene particles with different surface functionalities were used as surrogates for other atmospheric particle types.

Particles were first washed and re-suspended in physiological saline three times to remove surfactant coatings added during manufacture. Colloidal suspensions of particles with estimated surface areas and specific chemistries were generated. Isolated components of BALF (albumin, fibrinogen, DPPC and surfactant proteins) were added at concentrations spanning physiological concentrations, as measured in human lung lavage.

Particles visibly accumulated within hours when placed in increasing concentrations of two BALF components. Marked changes in the size distribution of the immersed particles were observed, compared to a saline control. Differences in particle agglomeration were also observed in the particles with different surface chemistries, including carbon blacks. Marked reductions in the zeta potential of some particle types were detected when specific BALF components were added, indicating surface adsorption was responsible for the observed agglomeration. These coated particles introduced to cell lines also provoked different responses to uncoated particles. These differences may be attributed to changes in the surface chemistry and the reduced surface areas of the introduced particles. Molecular adsorption at PM surfaces in BALF may therefore mediate the toxicity of PM via one or both of these mechanisms.

[P08-05] ASSESSING THE OXIDATIVE CAPACITY OF ENVIRONMENTAL AND MODEL PARTICULATE MATTER (PM) IN SYNTHETIC RESPIRATORY TRACT LINING FLUID (RTLF).

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Introduction: Transition metals released from the surface of inhaled PM have been proposed to contribute to their pulmonary toxicity by catalyzing the formation of free radicals at the air-lung interface.

Methods: We investigated the capacity of a range of environmental (8-10 daily collections of PM2.5 and PM10) and model (10 residual oil fly ash samples of differing composition) particulates to oxidatively consume antioxidants in a synthetic RTLF model (200μM ascorbate, urate, and reduced glutathione, pH 7.4) as an index of their oxidative capacity. Particles were incubated in RTLF at a dose of 50μg/mL for 4h after which reactions were stopped by acidification and the particles removed by centrifugation. Antioxidant concentrations were determined using HPLC and spectrophotometric methods. Concentrations of water leachable Fe, V, Ni, Cu, Pb and As were determined by ICP-MS.

Results: Incubation with environmental PM resulted in a significant loss of ascorbate from the synthetic RTLF. Fine and coarse PM appeared comparatively reactive, with losses observed in the daily samples ranging from: -47.5±1.6 to -90.1±0.4% (fine) and -68.4±7.3 to -95.2±0.6% (coarse). The magnitude of these losses were comparable to those observed with the 10 ROFA samples: -36.0±2.8 to -97.5±0.3%. Significant losses of glutathione were also observed with all fine and coarse samples. These responses were strongly correlated in both fractions with the extent of ascorbate depletion: $r=0.7$, $p<0.01$ (fine&coarse), though quantitatively smaller: maximal depletion, -25.5±6.6 (fine) and -29.0±0.5% (coarse). In the environmental PM samples the extent of ascorbate depletion was significantly associated with the soluble Fe and Cu concentrations ($r=0.45$, $p<0.05$ and $r=0.41$, $p<0.05$, respectively), whilst GSH depletion only showed a significant correlation with Cu ($r=0.54$, $p<0.01$). In contrast no such associations were noted in the ROFA samples where significant losses of both ascorbate and reduced glutathione were observed in particles with low or unmeasurable Fe and Cu concentrations. Notably, these samples had high concentrations of soluble vanadium.

Conclusions:These data demonstrate that environmental PM are highly reactive toward RTLF antioxidants and that this oxidant activity is related to their soluble Fe and Cu composition. However, the ROFA data illustrated that other metals, specifically vanadium can also drive the oxidation of RTLF antioxidants and contribute to the overall avtivity of PM.

[P08-06] RESPONSE OF HUMAN ALVEOLAR MACROPHAGES TO ULTRAFINE, FINE AND COARSE URBAN AIR POLLUTION PARTICLES.

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In the lower airways, macrophages are important regulators of inflammation and indispensable in their antimicrobial activities. Thus, air pollution particles, which modulate airway macrophage host defenses may, in susceptible individuals increase severity of inflammatory and infectious disease. In the present study, size fractionated, ultrafine (UF), fine (PM0.1-2.5) and coarse (PM2.5-10) particles were collected from two urban sites in the Netherlands, and were compared for effects on human alveolar macrophages (AM). Inflammatory cytokine production, phagocytosis, and expression of phagocyte receptor CD11b were assessed in particle-exposed AM. IL-6 levels induced by PM2.5-10 (20411 pg/ml) were >10- fold higher than induced by PM0.1-2.5 (1781 pg/ml). Levels induced by PM0.1-2.5 were 2-3 fold higher than induced by UF (770 pg/ml) when cells were exposed to the same particle mass. Cytokine induction by the PM was inhibited by antibody to CD14 and required the presence of serum for optimal stimulation, implying that bacterial products or endotoxin were a stimulatory moieties in both coarse and fine particulate matter. Phagocytosis of opsonized yeast was inhibited by coarse PM> fine, as was yeast-induced oxidative burst. Coarse particles decreased CD11b expression > fine PM. The UF did not affect these functions.Taken together these results suggest that PM recognition by human alveolar macrophages involves receptors evolved to recognize microbial cell structures, and that microbial products preferentially found in the coarse particle fraction of PM may be involved in inflammatory events and decreased pulmonary defenses associated with exposure to pollution particles.

[P08-07] EXPRESSION OF C-REACTIVE PROTEIN AND HEAT SHOCK PROTEIN 70 IN THE LUNG EPITHELIAL CELL LINE A549, IN RESPONSE TO PM10 TREATMENT.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

Increased levels of C-reactive protein (CRP) and heat shock protein 70 (HSP70) in plasma are known to be associated with an increased risk of cardiovascular disease. In this study the effect of environmental air pollution particles (PM10) on the expression of CRP and HSP70 in the lung epithelial cell line A549 cells was investigated. After PM10 treatment the expression of both CRP and HSP70 in A549 cells was significantly increased. Using ELISA and Western blot techniques it was also found that both CRP and HSP70 were secreted from the cells after PM10 treatment. Proteins produced in the lung can rapidly enter the systemic circulation. These results show that these two proteins can be induced by PM10 treatment of A549 lung epithelial cells and this may be important to an understanding of how air pollution episodes contribute to an increased risk of cardiovascular disease.

[P08-08] DEFINING THE RELATIONSHIP BETWEEN PARTICLE SIZE, NUMBER, METAL COMPOSITION AND OXIDANT ACTIVITY IN AMBIENT PARTICULATE MATTER.

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There is a need to identify the properties of particulate matter (PM) responsible for its adverse health effects. Studies with ambient and model PM have revealed that a range of metals (Fe, Cu, V) can participate in Fenton chemistry and other biologically relevant oxidation reactions. We compared the oxidative activity of PM using a range of complementary methodologies: (1) ESR, using the spintrap 5,5-dimethyl-1-pyrroline-N-oxide (DMPO) to quantify H2O2-dependent formation of hydroxyl-radicals by PM; (2) DNA oxidation in cell-free (calf thymus) and cultured A549 cells using oxidative DNA damage (8-OHdG) and single strand breaks; as well as, (3) the capacity of PM to deplete antioxidants (ascorbate, urate and reduced glutathione) in a synthetic respiratory tract lining fluid model. These endpoints were related to water leachable transition metals, determined by ICP-MS. Using parallel daily ambient samples of PM10, PM2.5 and PM1 collected in Duisburg, Germany we have demonstrated that all PM fractions have the ability to induce OH-radical formation in the presence of H2O2, as well as to consume both ascorbate and reduced glutathione in the absence of exogenous oxidants. In each of these endpoints the greatest activity was observed in the PM1 fraction. The DMPO-OH generation by PM fractions correlated well with their capacity to degrade both ascorbate and GSH (r2=0.73). In both PM10 and PM2.5, a significant correlation was also observed between ESR-activity and formation of 8-OHdG in nude DNA, confirming that OH-radical generation was driving oxidative DNA damage. In A549 cells, both PM10 and PM2.5 induced 8-OHdG and DNA single strand breaks. In all fractions, the DMPO-OH formation correlated well with metal content and with parallel total particle counts, although the latter was strongest in the PM2.5 fraction. Daily variation in particle oxidant activity was examined by analysis of coarse and fine PM collected from 3 sites over half a year time frame. In summary, oxidant activity of PM, assessed by cellular and acellular methods, can be quantified and related to both metal content and particle number. We propose to supplement such an integrative measure of activity to the current mass metric in interpreting the potential health impacts of ambient PM.

[P08-09] EXPOSURE OF SPONTANEOUS HYPERTENSIVE RATS TO AMBIENT PARTICULATE MATTER AFFECTS CARDIOVASCULAR PERFORMANCE IN A LANGENDORFF MODEL.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

Exposure to ambient particulate matter (PM) is associated with increased mortality and morbidity among those subjects with cardiovascular impairment. Since the spontaneous hypertensive rat (SHR) resembles genetically the disease state of mature cardiovascular diseases, we hypothesized that treatment of SHR with PM, would affect its cardiovascular performance after coronary occlusion and reperfusion.

Four different groups of SHR were exposed by intratracheal instillation with I) Saline control, II) 10 mg road tunnel dust (RTD)/kg body weight, III) 10 mg EHC-93/kg body weight and IV) LPS 350 endotoxin units/animal. At 4 or 24 hrs post-exposure, hearts were isolated and retrograde perfused in the Langendorff mode. The experimental protocol included 30 minutes stabilization, a 35 minutes coronary occlusion (LAD) followed by 120 minutes reperfusion. Coronary flow (CF), pressure in left ventricle (LVDP), systolic pressure, diastolic pressure and heart rate (HR) were measured and hearts were either fixed for histology or frozen for protein analyses. Effluent was also collected for determination of lactate dehydrogenase (LDH). Results: No significant differences in baseline CF, HR and LDH were found at 4 or 24 hours after exposure to either RTD, EHC-93 or LPS. However, baseline LVDP was significantly decreased ($P<0.035$) compared to group I at 4 but not 24 hours after instillation. A decrease in LDVP was noted in all hearts after occlusion followed by a rapid recovery upon reperfusion. In RTD-exposed animals the recovery of LDVP was much slower. This delayed recovery led to a significantly decreased LDVP at two hours of reperfusion ($P<0.01$). An increase in coronary flow (CF) was noted in all hearts after occlusion, but the recovery of CF to baseline differed amoung the exposure groups. In PM-exposed animals (group II and III), CF was significantly increased upon reperfusion compared to saline-exposed rats (ANOVA, Post-hoc testing) The level of statistical significance varied between 0.04 and 0.09 dependent on specific time-point (60 or 120 min) after reperfusion and PM sample (RTD vs EHC-93). Both effects on LDVP and CF were acute since they were only seen at 4 hrs post-exposure, and not at 24 hrs. Conclusion: This study demonstrates that exposure to ambient PM has an acute effect on several cardiovascular parameters measured in the Langendorff model. The effect is transient and since LPS did show effects we suggest that apart from inflammation driven systemic effects ambient PM can exert direct changes on cardiac function.

[P08-21] FINE DUST PARTICULATE MATTER INDUCES CYTOKINE RELEASE THROUGH TRPV1 ACTIVATION IN LUNG CELLS.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

Inflammation is an important initial event in PM lung toxicity that may mediate the subsequent development of whole body responses including cardiovascular and respiratory symptoms. Recent in vitro cell culture studies involving treatment of cultured cells with well characterized combustion and soil derived fine particles are summarized in the poster.

Fine particulate samples d<2.5 mm (PM 2.5) were examined for production of interleukin-6 (IL-6) in the human epithelial lung cell line BEAS-2B. A Utah desert dust sample induced significantly greater IL-6 production than a coal fly ash particulate sample even though previous work * showed that coal ash has higher bioavailable iron than soil dusts. Particulate matter may mediate lung cell toxicity through interactions with the vanilloid receptor TRPV1. To further test this supposition, cytokine production by PM 2.5 in a BEAS-2B cell line engineered to over-express TRPV1 was measured. This engineered cell line exhibited a significantly greater PM 2.5-induced IL-6 response, corroborating the importance of TRPV1 in particulate matter-lung cell interactions. In addition, PM 2.5-exposed BEAS-2B cells treated with capsazepine (CPZ), an antagonist of TRPV1, exhibited a marked decrease in IL-6 production. These data suggest that soil dust particles expected to be benign are in fact surprisingly pro-inflammatory, and that particulate matter likely elicits lung cell toxicity through interactions with TRPV1.

* Ball, B. Ryan, Kevin R. Smith, John M. Veranth, Ann E. Aust, Inhalation Toxicology 12:209-225 (2000)

[P08-11] TIME COURSE STUDY OF PULMONARY AND CARDIOVASCULAR EFFECTS OF AMBIENT PARTICULATE MATTER IN SPONTANEOUS HYPERTENSIVE RATS.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

Particulate air pollution may be responsible for serious respiratory and cardiovascular health effects or even premature mortality especially among susceptible subpopulations. To get insight in the time course of ambient particulate matter (PM)-induced toxicity we have examined the response in 12 week old spontaneous hypertensive rats (SHR) at different time points (4, 24 and 48 hours) after PM exposure. SHR received a single dose by intratracheal instillation (0.3, 1, 3 or 10 mg PM/kg body weight) of a mixture of coarse and fine PM sampled at a Dutch freeway tunnel. In addition, EHC-93 (Ottawa dust, 10 mg/kg body weight) was used as a reference and LPS (350 EU/rat) as a positive control for inflammation. Exposure-related effects were investigated using histopathology (pathological changes, cell proliferation), bronchoalveolar lavage fluid (BAL) and blood analysis (cytokines, lactate dehydrogenase (LDH), alkaline phosphatase (ALP), protein, cell differentials, endothelins, fibrinogen, Clara cell protein). Both tunnel PM and EHC-93 induced significantly increased LDH levels in BAL at 24 and 48 hours but only at the highest dose and the LDH levels increased with time. Instillation of EHC-93 resulted in elevated ALP levels at all post-exposure times whereas the tunnel sample induced increased ALP levels only at 48 hours at the two highest levels. No changes in LDH or ALP levels were observed after LPS exposure and also the instillation procedure itself did not influence the LDH or ALP levels in BAL. A dose-effect relationship was observed for the viability in BAL at 24 hours after exposure to high ambient PM levels and the increased viability seems to diminish at 48 hours. These preliminary results indicate that a relatively high dose of ambient PM is needed to cause pronounced pulmonary toxicity and that these effects occur at least 24 hours after the exposure, via instillation. This study was performed within the scope of two EU projects: Health effects of particles from motor engine exhaust and ambient air pollution (HEPMEAP; http://www.hepmeap.org) and Chemical and biological characterisation of ambient air coarse, fine, and ultrafine particles for human health risk assessment in Europe (PAMCHAR; http://www.pamchar.org)

[P08-20] SMOG CHAMBER EXPERIMENTS OF URBAN MIXTURES ENHANCE INFLAMMATORY RESPONSES IN LUNG CELLS.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

Complex urban air mixtures that realistically mimic urban smog can be generated for investigating adverse health effects. UNC Smog chambers that have been used for over 30 years to conduct experiments for developing and testing photochemical models used to predict ambient ozone (O_3) concentrations and secondary organic aerosol (SOA) formation, were used to generate photochemical and non-irradiated systems which were interfaced with an in vitro exposure system to compare the inflammatory effects of complex air pollutant mixtures with and without sunlight driven chemistry. These are preliminary experiments in a new project to study the health effects of particulate matter and associated gaseous co-pollutants. Briefly, two matched outdoor chambers capable of using natural sunlight were utilized to generate two test atmospheres for simultaneous exposures to cultured lung cells. One chamber was used to produce a photochemical active system, which ran from sunrise to sunset, producing O_3 and the associated secondary products. A few hours after sunset, NO was added to titrate and remove completely the O_3, forming NO_2 . In the second chamber, an equal amount of NO_2 was injected and the same amount of the 55-component hydrocarbon mixture used to setup the photochemical system in the first side. A549 cells, an alveolar type II-like cell line grown on membranous support were exposed to the photochemical mixture or the original NO_2/hydrocarbon mixture for 5 hours and analyzed for inflammatory response (IL-8 mRNA production) 4 h post-exposure. In addition, a variation of this experiment was conducted to compare the photochemical system producing O_3 and NO_2, with a simple mixture of only the O_3 and NO_2. Our data suggest that the photochemically altered mixtures which produced secondary products induced an about 2-3 fold greater IL-8 mRNA production than the mixture of NO_2 and hydrocarbons or O_3. These results indicate that secondary products generated through the photochemical reactions of NOx and hydrocarbons significantly contribute to the inflammatory responses induced by exposure to urban smog.

[P08-13] ADJUVANT ACTIVITY DIFFERENCES IN PARTICULATE AIR POLLUTION (COURSE VS. FINE) AT DIFFERENT LOCATIONS THROUGHOUT EUROPE.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

Given that there are widely different prevalence rates of respiratory allergies and asthma between the countries of Europe and that exposure to ambient particles is substantial in urban environments throughout Europe, the EU project Respiratory Allergy and Inflammation Due to Ambient Particles (RAIAP) was designed to collect representative ambient particulate matter samples in Amsterdam (NL), Rome (I), Lodz (P) and Oslo (N), as well from a Dutch sea-side background site. The RAIAP project utilized a high-volume (900 litres/min) cascade impactor technology for simultaneous sampling of ambient air coarse (PM10-2.5) and fine (PM2.5-0.1) particles. PM fractions were tested for their adjuvant activity in an (ovalbumin-induced) allergy model in mice. The results were compared with an urban reference sample collected in Ottawa, Canada (EHC-93). It was found that 3 out of 6 samples collected in spring and only 2 out of 8 summer samples induced increased IgE levels. It was found that 4 out of 7 samples of the course fraction and 2 out of 7 of the fine fraction were active. In this model, intranasal application of ovalbumin neither induces IgE specific for ovalbumin, nor inflammation in the lung. However, combined with particulate matter it was found that the increase of IgE coincidence with significant increase of inflammatory responses in the lung in which the eosinophilic granulocyte was the predominant cell type. This was substantiated by the increase of eosinophils in the BAL. No increase of cytokines skewing the classic Th2 response was observed. PM only affected the adjuvant activity in the sensitization phase and did not induce changes in the challenge phase. The results indicate that at the same PM dose, PM from different fraction (coarse and fine) and collected at various locations were able to induce different effects on ovalbumin induced allergic responses.

[P08-14] CHEMICAL AND BIOLOGICAL CHARACTERISATION OF AMBIENT AIR COARSE, FINE, AND ULTRAFINE PARTICLES FOR HUMAN HEALTH RISK ASSESSMENT IN EUROPE (PAMCHAR).

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

The objectives of our multinational project in 2002-2004 are: (1) characterisation of variations in soluble and insoluble inorganic and organic compositions of the ambient air coarse, fine, and ultrafine particles in contrasting PM pollution situations in Europe, (2) systematic analysis of the associations of the above physicochemical characteristics with the cytotoxic, proinflammatory, and genotoxic effects on human and murine respiratory cells *in-vitro*, and (3) testing of the significant *in vitro* cytotoxic and proinflammatory associations in animal studies and in comparisons with human epidemiological data.

Coarse ($PM_{10-2.5}$), fine ($PM_{2.5-0.2}$) and ultrafine ($PM_{0.2}$) particles are collected with a high-volume cascade impactor (HVCI) in 3 + 4-day periods per week during 1-2 months in six European cities (Amsterdam, Athens, Barcelona, Duisburg, Helsinki, Prague). Numerous low-volume samples are collected with validated samplers to enable a mass balance assessment of the constituents in the PM_{10} subfractions.

Chemical analyses from the collected high- and/or low-volume PM samples include total elements (ED-XRF), watersoluble ions (IC) and watersoluble elements, such as toxic transition metals (Fe, Cu, Ni, V, Zn), (ICP-MS). Elemental and organic carbon contents are analysed with a thermal optical method, bacterial endotoxin with a lipopolysaccharide assay (LAL) and polycyclic aromatic hydrocarbons with mass spectrometry (GCMS-SIM). The oxidant activity of PM samples is measured by the electron spin resonance (EPR) determination of OH-radical generation.

Mass doses of HVCI coarse, fine and ultrafine PM are instilled into cultures of standard human and murine macrophage and respiratory epithelial cell lines. Cytotoxic (MTT test), proinflammatory (nitric oxide and cytokine productions) and genotoxic (comet assay, 8-OHdG, DNA adducts) responses are measured. In addition to whole PM suspensions, water and organic solvent washed PM samples and their leachates are tested as well as the modification of the responses by specific antagonists. The key cytotoxic and proinflammatory findings in these *in-vitro* studies are investigated in primary cultures of human nasal cells, and in intratracheal instillation exposures of healthy mice and compromised rats by measuring response markers in bronchoalveolar lavage fluid and blood.

Further information: http://www.pamchar.org/

[P08-15] FATE AND TOXIC EFFECTS OF INHALED ULTRAFINE CADMIUM OXIDE PARTICLES IN THE RAT LUNG.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

Fate and toxic effects of inhaled ultrafine cadmium oxide particles in the rat lung were examined.
Methods: Female Fischer 344 rats were exposed for 6 h to ultrafine cadmium oxide particles, generated by spark discharging, either at a low concentration of 70 μg Cd/m^3 (40 nm modal diameter) or at a high concentration of 550 μg Cd/m^3 (50 nm modal diameter). Lung morphology and quantification of Cd content/concentration by ICP-mass spectrometry were performed up to 7 days after exposure. Lung lavage was carried out immediately after the end of exposure.
Results: Exposure to a low concentration of CdO particles caused neither exposure related morphological changes of lungs nor inflammatory responses in lavaged cells. Cd content in the lung on day 0 was 0.53 ± 0.12 μg/lung corresponding to 19 % of the estimated total inhaled cumulative dose, and the amount remained constant throughout the study. In the liver no significant increase of Cd content was found up to 4 days. A slight increase was observed in the liver on day 7 (0.09 μg/liver, $p< 0.05$). The lungs of rats exposed to a high Cd-concentration were swollen and showed multifocal alveolar inflammation accompanied by an increased number of neutrophils in the lavage fluid. Although the Cd content in the lung was comparable between day 0 and day 1 (3.9 μg/lung), significant elevation of Cd levels in the liver and kidneys (0.05-0.6 μg/organ) was observed on both days. Two of 4 rats examined on day 0 showed elevation of blood cadmium, indicating rapid systemic translocation of a fraction of deposited Cd from the lung in this group.
Conclusions: These results and comparison with reported data using fine CdO particles indicate that inhalation of ultrafine CdO particles results in efficient deposition in the rat lung. With regard to the deposited dose, adverse health effects of fine and ultrafine particles appear to be comparable. Apparent systemic translocation of Cd took place only in animals exposed to a high concentration of ultrafine Cd particles which induced lung injury.

[P08-16] RESPIRATORY ALLERGY AND INFLAMMATION DUE TO AMBIENT PARTICLES (RAIAP) - A EUROPEAN-WIDE ASSESSMENT - INFLAMMATION SCREENING.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

The overall objective of the RAIAP project is to assess the role of ambient suspended particles in causing local inflammation in the respiratory tract and induction and elicitation of respiratory allergies. In order to understand the underlying mechanisms for involvement of particles in the development of respiratory diseases, knowledge about whether qualitative differences in particulate matter may explain differences in particle-induced inflammatory and/or allergic responses is essential. In the RAIAP project, coarse ($PM_{2.5 - 10}$) and fine ($PM_{2.5}$) fractions of ambient particulate matter have been collected in Amsterdam, Rome, Lodz and Oslo, as well as at a Dutch seaside background site. Particles were sampled during the spring, summer and winter 2001/2002, and all samples are being characterised by physical-chemical parameters as well as analysed for binding of allergens, endotoxins and β-glucans to the particles.

The objective of the study presented here was to investigate if the various particle samples have different capabilities to induce markers of inflammatory processes in different types of epithelial lung cells. Cytokine release after exposure to the coarse and fine fractions collected during the spring season is presented. A human alveolar epithelial cell line (A549) and primary rat type 2 cells were used, and release of the proinflammatory cytokines IL-8, MIP 2 and IL-6 was analysed by ELISA. The results demonstrated that the coarse fractions had higher potencies to induce IL-8 than the fine fractions in A549 cells. Among the coarse fractions, there were significant differences between particles from different sampling sites. With respect to the type 2 cells, MIP-2 release was induced in a relatively similar pattern as compared to the IL-8 release in A549 cells. With respect to IL-6 release, however, type 2 cells seemed more responsive than A549 cells. Also in this case, the coarse fractions were more potent than the fine fractions. Furthermore, the coarse fractions appeared to be more toxic than the fine fractions in both cell types. At higher concentrations, however, all fractions resulted in reduced viability. In summary, the coarse fractions of ambient particulate matter sampled during spring demonstrated a higher potency to induce both cytokine release and toxicity compared to the fine fractions.

The study is supported by a grant from EU (A European Commission Shared-Cost Research Project, QLK-CT-2000-00792).

[P08-17] BIOAVAILABALE CONSTITUENTS OF AIR POLLUTION PARTICLES MEDIATE ALTERATIONS IN CARDIAC METABOLISM AND FUNCTION *EX VIVO*.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

Epidemiological and clinical studies have demonstrated significant statistical associations between air particulate pollution exposure and alterations in cardiac function. Particle physicochemical properties and biological mechanisms responsible for these findings are currently not known. In this study we tested our hypothesis that bioavailable constituents of air pollution particles derived from primary combustion sources directly affect cardiac metabolism and function. Langendorff perfused rat hearts were exposed to a particle-free leachate (L) of residual oil fly ash (ROFA) to determine whether these constituents could replicate alterations in cardiac function previously observed *in vivo*. Heart rate (HR), left ventricular developed pressure (LVDP), perfusion buffer flow rate (FR), arrhythmia frequency (AF), and high-energy phosphate metabolites, were monitored before, during and following exposure of hearts to various ROFA-L doses. ROFA-L exposure produced a dose dependent decrease in FR, LVDP, ATP, and creatine phosphate levels. At the high and intermediate ROFA-L doses, FR and LVDP recovered towards pre-ROFA-L exposure levels during washout perfusion of hearts with normal buffer. An increase in AF was observed at each ROFA-L dose and only during the washout phase. A 28% decrease in HR was only observed during exposure to the high ROFA-L dose. ROFA-L induced alterations in cardiac function could be reproduced using a surrogate metal mixture consisting of vanadium, nickel and iron. These data demonstrate that bioavailable constituents are capable of directly mediating adverse cardiac metabolic and functional effects associated with ROFA exposure *ex vivo*. The ability to replicate alterations in cardiac function *ex vivo* by a ROFA-L or surrogate metal mixture suggest that bioavailable constituents act directly on the heart to manifest the observed *in vivo* cardiac pathophysiology associated with exposure to this type of air pollution particle. (This abstract does not reflect EPA Policy)

Ex Vivo Cardiac Functional Effects of ROFA-L

	Exposure	(% of Pre-	ROFA-L	Washout	(% of Pre-	ROFA-L
			Level)			Level)
ROFA-L (μg/ml)	LVDP	Flow Rate	Arrhythmia Frequency	LVDP	Flow Rate	Arrhythmia Frequency
25	14	24	61	87	65	748
6.25	55	40	60	87	70	918
3.12	58	63	87	97	61	482

[P08-18] DIESEL SOOT BINDS AND CONCENTRATES A PROINFLAMMATORY CYTOKINE THAT CAUSES NEUTROPHIL MIGRATION.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

Combustion emissions induce adverse health effects, including inflammatory responses in the lungs, but the properties of the emissions that induce these effects are not understood. To examine the direct effects of diesel soot (DS) on alveolar epithelial cells, monolayers of the human alveolar epithelial cell line, A549 cells, were exposed to a wide range of concentrations of DS (National Institute of Standards and Technology Standard Research Material 2975). Release of the neutrophil-attracting chemokine Interleukin-8 (IL-8) from these cells was analyzed by enzyme-linked immunosorbant assay (ELISA). Low doses of DS increased the concentration of IL-8 detected in the conditioned medium after 24 hours. Higher doses appeared to suppress the response, although this suppression was not related to acute DS toxicity as determined by release of the cytoplasmic enzyme lactate dehydrogenase. In a cell-free system, incubation of IL-8 with DS resulted in removal of immunoreactive IL-8 in the supernatant of the reaction. In contrast, carbon black did not reduce the concentration of IL-8 in the mixture. The DS-induced loss was only weakly blocked by a large excess of bovine serum albumin (BSA), indicating some specificity of the effect. Neither high concentrations of salts nor extraction of the soot with organic solvents to remove the organic carbon constituents of the soot prevented the interaction. We next examined whether the loss was due to binding of the IL-8 to the DS (rather than destruction of the epitope required for ELISA assay), and whether bound IL-8 was biologically active. Human blood neutrophils were exposed to DS that had been pre-incubated with IL-8, then washed to remove free IL-8. The neutrophils changed shape in a manner suggesting directed movement toward the particles. The transformation of morphology was not observed with either carbon black that had been incubated with IL-8 or with DS alone. These results suggest that DS not only induces the production of IL-8 by epithelial cells, but also binds biologically active chemokine in a particle- and protein-selective manner. DS-induced inflammatory responses may therefore be more focused or sustained as a result of this binding of inflammatory mediators by DS.

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[P08-37] TOXICITY TESTING OF ATMOSPHERIC PARTICULATE MATTER EXTRACTS: SHORT-TERM AQUATIC TOXICITY METHODS VERSUS BACTERIAL LUMINESCENCE AND SUB-MITOCHONDRIAL PARTICLE METHODS.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

Much of the detailed chemical analysis performed on atmospheric particulate matter samples, including organic compound and trace metal characterization, requires extraction of the aerosol sampling into a liquid solutiuon. Therefore, toxicity testing of these filter extracts can be directly related to the trace chemical profiles. A variety of established bioassays are available for conducting toxicity tests of extracted material. In this paper, short-term aquatic toxicity methods using Ceriodaphnia dubia, green algae, and fathead minnows are compared to a bacterial luminescence method (Microtox) and a sub-mitochondrial particle method (Mitoscan). The sensitivities of the methods are compared using ambient particulate matter collected in the Lake Michigan airshed. Additionally, correlation of toxicity data from the different tests is explored.

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[P08-10] VASCULAR EFFECT OF PARTICLE INSTILLATION IN SPONTANEOUS HYPERTENSIVE RATS.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

Exposure to particulate matter (PM) is associated with increased mortality and morbidity among those with cardiovascular impairment. We studied whether ambient particle or LPS pretreatment could impair vascular function in aorta of spontaneous hypertensive rats (SHR) 4 and 24 hours post-instillation. Receptor-dependent and -independent relaxation was induced by acetylcholine (Ach) and sodium nitroprusside (SNP) respectively. We used phenylephrine (Phe) and KCl to study receptor-dependent and -independent contraction. The role of the endothelium was investigated using aorta rings stripped of endothelium. Results. Pretreatment with PM (EHC-93, 10 mg/kg) or LPS (350 EU) caused a significant increase in receptor dependent vasorelaxation of aorta when compared to saline instilled rats. The largest effect was seen with PM at 4hrs after instillation (EC50 Ach = 1,37 vs 1,70 nM control), while at 24 hrs the effect was much smaller (EC50 Ach = 1,75 nM). SNP induced vasorelaxation was increased only in rats treated with EHC-93 (EC50 = 10,79 vs 10,96 nM) at 4 hours. As with Ach, the effect at 4 hours groups was more significant than at 24 hours groups. Phe induced vasoconstriction was dose dependent in rat aorta rings but no difference was seen between treatments in the presence or absence of endothelium at 4 hours. However, at 24 hours after instillation, the LPS group shows diminished contraction in comparison to control (EC50 = 0,071 μM vs. 0,05 μM). Animal pretreatment did not cause a change in receptor independent vasoconstriction induced by KCl, since there was no difference between the groups for both time points, except in the LPS group which contracted less at 24 hours but only in the absence of endothelium. Conclusion. Our data suggests that particle pre-treatment causes a short-term, acute disturbance in normal vasorelaxation but not vasoconstriction of aorta rings. The common mechanism between the receptor-dependent and receptor-independent relaxation which is the NO-cGMP pathway, seems to be involved here. It remains to be established whether such an effect also occurs in smaller blood vessels in the lung that receive a larger effective dose.

[P04-75] CONCENTRATION LEVEL OF FINE AIRBORNE LEAD AND ITS RELATIONSHIP WITH OTHER CHEMICAL SPECIES IN BEIJING, CHINA.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (8:00 AM-9:00 AM) Grand Ballroom 2-4

Airborne lead has drawn global attention in the past decades for its toxic characters by affecting human being health. However, because of lacking continuous study of PM2.5, the fine lead concentration level as well as the source contribution was not so clear. In this work, low-flow rate samplers (LFS, Aerosol Dynamic In., Berkeley, CA) were applied to collect fine particle samples (PM2.5) during July 1,1999 to June 1,2000 at two sampling sites (THU and CGZ site) in Beijing. Three analysis technologies XRF, IC and TOR were adopted to analyze inorganic elements, water soluble ions, and carbonaceous components (OC and EC), respectively. The average concentration of lead at THU site was $0.334\pm0.172 \mu g\ m^{-3}$, higher than that of CGZ site ($0.302\pm0.195 \mu g\ m^{-3}$). It showed obvious seasonal variation trend that the Pb concentration in winter (heating period) was higher than those of other seasons, which was consistent with the monthly variation (the highest value appeared in November). Regression analysis was applied to evaluate qualitative relationship between Pb vs. Br, EC, OC and SO_4^{2-}. During the whole sampling period, the correlation between Pb vs. Br was good with R^2 of 0.79 and 0.62 for THU and CGZ site, respectively, and with positive intercept on Pb axis. At the same time, the correlation between Pb and EC, OC, SO_4^{2-} was weak, for example, at Chegongzhuang site the R^2 were 0.64, 0.65, 0.53, respectively. Considering the seasonal and monthly variation trend discussed above, regression analysis was repeated to the heating period data, and the R^2 of Pb vs. Br was 0.77, and R^2 of Pb vs. EC, OC and SO_4^{2-} have increased to 0.82, 0.86 and 0.81, respectively. In many studies Pb and Br are usually taken as the trace elements of motor vehicle. Although the leaded gasoline has been banned from July 1997 in Beijing, a small quantity of lead (<0.013l) remains in the gasoline, and leaded gasoline was kept in use until July 2000 in most of other national areas. The good relationship between Br and Pb demonstrated that motor vehicle emission is still one of the important sources of Pb. From above results that the Pb concentration presented the highest value in winter, the good correlation between Pb and EC, OC, SO_4^{2-}, as well as the positive intercept on Pb axis, it indicated that coal burning during heating period is another important source of Pb in Beijing.

[P08-35] EFFECTS OF CONCENTRATED AMBIENT PM ON THE FREQUENCY OF ARRHYTHIMIAS IN OLD RATS.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

Epidemiology and panel studies suggest that exposure to particulate air pollution (PM) increases the frequency of cardiac arrhythmias. However, it has been difficult to distinguish between the effects of the fine PM, ultrafine PM, and gaseous co-pollutants in these studies because PM and gases have common sources and the ambient levels of these pollutants usually show a high degree of interrelation. Animal exposure studies offer the opportunity to examine the effects of concentrated ambient fine PM without confounding effects of ultrafine PM or co-pollutant gases. In one series of experiments, 18 month-old male Fischer 344 rats with implanted ECG transmitters were used to determine the effects of PM on the frequency of spontaneous arrhythmias. We found that old F 344 rats had many spontaneous arrhythmias. A standardized definition for each type of arrhythmia was developed, and a procedure for quantifying the frequency of spontaneous arrhythmias in rats was established. The rats were exposed to concentrated ambient PM (CAPS) or air for 4 hours. The rats were exposed twice with a crossover design so each rat could serve as its own control. The CAPS concentrations were 160 micrograms/m3 and 200 micrograms/m3 for the first and second exposures respectively. ECG tracings were monitored for 10 seconds at 15 minute intervals for 24 hours before exposure, during exposure, and 24 hours after exposure. There was a significant increase in the frequency of supraventricular arrhythmias following exposure to CAPS and no change in arrhythmia frequency following air exposure. The same rats were exposed to laboratory-generated ultrafine carbon particles and to SO2 (or air) with a repeated crossover design. In these experiments there was no significant change in the frequency of any category of spontaneous arrhythmia following exposure to ultrafine carbon or SO2. Thus, this series of experiments adds supporting evidence that ambient PM increases the frequency of cardiac arrhythmias.
Supported by grants from NIEHS (ES00260) and EPA (R 82735101).

[P04-61] TRANSIENT ELEVATIONS IN THE CONCENTRATIONS OF SULFATE, NITRATE, AND EC/OC MEASURED WITH SEMICONTINUOUS MONITORS AT THE BALTIMORE SUPERSITE.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (8:00 AM-9:00 AM) Grand Ballroom 2-4

Measurements of particulate sulfate, nitrate, elemental and organic carbon (EC and OC) were made at intervals ranging from 10 minutes to 1 hour for more than 10 months in 2002 at the Baltimore Supersite using commercial and prototype semicontinuous monitors. Additionally, PM2.5 measurements were recorded at 30 minute intervals using the R&P TEOM. Inspection of the data reveals that there were many periods when PM2.5 concentrations were elevated for relatively short periods during which large fractions of the mass and hence most of the excess PM2.5 mass was accounted for either Nitrate, sulfate, or EClOC. Herein, we present descriptive statistical summaries of these data and present the relative contributions of transients to elevated PM2.5 concentrations. In addition, particle size distribution data (collected every 5 minutes with mobillity and time-of-flight particle spectrometers), NOx, single-particle mass spectrometer, and meteorological data, ae used to classify the transient events in terms of the likelyhood of primary vs secondary origin.

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[P04-60] THE BALTIMORE SUPERSITE PROJECT: HIGHLY TIME AND SIZE RESOLVED CONCENTRATIONS OF URBAN PM2.5 AND ITS CONSTITUENTS FOR RESOLUTION OF SOURCES AND IMMUNE RESPONSES.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (8:00 AM-9:00 AM) Grand Ballroom 2-4

The Baltimore Supersite project was designed to provide an extended, highly time, size, and compositionally resolved data set, including cytokine assays as a metric of cardiopulmonary response in support of testing hypotheses relating to source attribution and health effects of PM. Specific hypotheses involve investigations of the toxicity of aerosol components as affected by age, industrial vs urban character, and seasonal differences in source terms and atmospheric chemistry. The project encompass 30-min resolved metals and 30-min resolved cytokine/ROS assays of PM-fine, along with measurements of PM mass, number vs size distribution, light-scattering coefficient; PM sulfate, nitrate, organic carbon, elemental carbon, VOC, NO/NO2, and ozone at time resolutions ranging from 5 minutes to 1 hour. UDE’s third generation single particle mass-spectrometric analysis system (RSMS III) provided continuous size and semi-quantitative determination of individual aerosol particle constituents, from 10 nm to 2.5 μm. JHU's LIDAR was deployed episodically to determine boundary layer conditions and mixing height information up to 8 km. Cytokine assays will be used in correlations with PM metrics in an attempt to apportion ambient PM responses among air pollution sources. Traditional 24-hr collections for FRM mass and selected aerosol constituents were made to provide the link with PM network data. Extensive exploratory organic compound analyses were performed on 3-hr time resolved samples during two intensive sampling campaigns to reveal the presence of potentially useful tracer species for receptor modeling, and identities and concentrations of potentially toxic PM organic constituents. The Highly-time size, and species resolved composition metrics are being used to determine their source contributions and their relationships between health effects metrics and sources. Time-resolved rotating drum impactors (RDI) were employed to separate fresh accumulation aerosol from nearby sources from aged and cloud processed aerosol, and from tailing coarse particle fractions. The spectra determined from RDI measurements were collected to confirm plume hits and as a calibration reference for single particle measurements. Mulitvariate calibration models will be used to statistically interpret and interrelate data developed by the variety of new and established techniques. The prupose of this presentation is to describe the Baltimore Supersite Project and convey the kinds of data available at the various sampling sites and periods.

[P04-59] URBAN AND RURAL CHEMICAL COMPOSITION OF FINE PARTICULATE MATTER IN NEW YORK STATE.

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With the establishment of the Speciation Trends Network (STN) for urban locations by EPA, and the continuation and expansion of the rural IMPROVE network, an extensive data set of concentrations of chemical species in fine particulate matter has become available. Analysis of this data, especially the STN data, is just beginning; and promises to provide insight and guidance for scientists and policy makers as they attempt to meet air quality standards and ensure public health and welfare.

Four STN samplers are located at urban sites in New York State (in the New York City boroughs of Bronx and Queens, and in the cities of Buffalo and Rochester). Rural speciation samplers include two STN samplers at Whiteface Mountain in the Adirondacks and at Pinnacle State Park in Addison; and two IMPROVE samplers, one co-located with the STN sampler at Addison in the Southern Tier, and the other at nearby Connecticut Hill in the Finger Lakes region. The STN and IMPROVE samples are collected on identical one-in-three day schedules. In addition, daily $PM_{2.5}$ samples have been collected for more than a year at Bronx, Queens, Addison, and Whiteface and have been analyzed for sulfate and trace elements only. Data will be presented from all of these samplers and sites, with special attention to urban/rural distinctions and to specific elements like lead and the transition metals, which are sometimes implicated in adverse health effects. In addition, ion balances will be calculated from the data to estimate the acidity of the $PM_{2.5}$ aerosol.

[P04-58] PARTICULATE MATTER CHARACTERISTICS IN THE URBAN AREAS OF LOWER MANHATTAN AND THE BRONX, NEW YORK.

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Particulate characteristics (*i.e.* PM_{10}, $PM_{2.5}$, metals, sulfate, pH, organic carbon (OC), and elemental carbon (EC)) were measured at US EPA-approved monitoring sites in lower Manhattan and in the Bronx. These measurements were taken from January 1, 1999 through November 22, 2000 as part of a study to evaluate whether ambient levels of air pollutants differ in two New York City neighborhoods that have different rates of hospital admissions for asthma. PM_{10} and $PM_{2.5}$ real-time measurements were taken using TEOM® Series 1400a Ambient Particulate Monitors. The daily average for PM_{10} was 23.1 $\mu g/m^3$ for Manhattan and 22.3 $\mu g/m^3$ for the Bronx. Daily averages for $PM_{2.5}$ were 16.2 $\mu g/m^3$ for Manhattan and 15.3 $\mu g/m^3$ for the Bronx. Three-hour measurements of $PM_{2.5}$ OC and EC were taken using a Series 5400 Ambient Carbon Particulate Monitor. EC daily averages were 1.32 $\mu g/m^3$ for Manhattan and 1.19 $\mu g/m^3$ for the Bronx. OC daily averages were 3.09 $\mu g/m^3$ for Manhattan and 3.17 $\mu g/m^3$ for the Bronx. Twenty-four hour samples of $PM_{2.5}$, collected on a filter, were used for the analysis of metals (chromium, iron, lead, manganese, nickel, and zinc). For particulate metals, only iron and nickel were routinely detected. Mean daily iron concentrations were 72 ng/m^3 for Manhattan and 75 ng/m^3 for the Bronx. Mean daily nickel concentrations were 15 ng/m^3 for Manhattan and 12 ng/m^3 for the Bronx. Twenty-four hour samples of $PM_{2.5}$ for pH and sulfate were collected by an 8-channel annular denuder system. Daily average pH values were 5.04 for Manhattan and 5.15 for the Bronx. Particulate sulfate concentrations were 4.0 $\mu g/m^3$ for Manhattan and 3.6 $\mu g/m^3$ for the Bronx. Although small, differences in the concentrations of the analytes mentioned here (excluding particulate iron) were statistically different between Manhattan and the Bronx. Temporal fluctuations were also analyzed. $PM_{2.5}$ concentrations peak in the Bronx around 0600-0700 hours and in Manhattan around 0700-0800 hours, with a corresponding afternoon peak in both locations around 2000 hours. PM_{10} concentrations peak in the Bronx around 0700 hours and in Manhattan around 0800 hours; however, levels remain high until approximately 2000 hours. EC has a distinct peak at 0900 hours, with no corresponding afternoon rise in concentration. Beyond hourly fluctuations, statistically significant differences in particulate concentrations by day of the week were found.

[P04-57] THE VARIATION OF BACKGROUND PARTICULATE MATTER IN THE UNITED STATES.

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Estimating concentrations and composition of major components of background PM is important for the EPA's health risk analyses and the assessment of ecosystem and visibility effects, especially for PM2.5. In common usage, the term "background concentrations" refers to concentrations observed in remote areas relatively unaffected by local pollution sources. However, several definitions of background concentrations are possible. The definition chosen as being most relevant for regulatory purposes is based on estimates of contributions from uncontrollable sources that can affect concentrations in the United States. These are the concentrations that would be observed if the only sources affecting PM in the United States were anthropogenic and natural emissions outside North America and natural sources within North America. Because of long-range transport from anthropogenic sources in North America, it is difficult to obtain background concentrations solely on the basis of direct measurement in remote areas in North America. However, these data may be used to place reasonable upper limits on what these concentrations might be. We investigated background PM concentrations using data from the Interagency Monitoring of Protected Visual Environments (IMPROVE) program. The IMPROVE dataset offers a unique opportunity to identify the variability of 24-hour mean PM concentrations at clean, remote sites. Using the IMPROVE dataset, we characterized 11 western sites, two sites in Minnesota, 1 site in West Virginia, 2 sites in Vermont, and 1 site in New Jersey. The 24-hour average data were summarized by determining the annual mean concentration and the 24-hour percentiles by quarter and year. We focused on the variability of the 24-hour average concentrations for PM2.5, PM10, PM10-2.5, and selected PM2.5 species constituents to determine the annual mean concentration and percentiles by season and year. The year-to-year variability at the 90th percentile for the western IMPROVE monitoring sites for PM2.5, PM10, and PM10-2.5 was characterized. The percentile distribution of the 24-hour PM2.5 concentrations by calendar quarter for the IMPROVE monitoring sites was investigated. We used a different procedure in the eastern United States because of the larger potential for contributions from anthropogenic sources, especially regional sources at IMPROVE sites. Three sites were selected for analysis (Brigantine, NJ; Lye Brook, VT, and Underhill, VT) based on their relative remoteness and the availability of source apportionment analyses using positive matrix factorization as described by Hopke et al.(1999).

[P04-63] SPATIAL VARIATIONS OF PM2.5 DURING INTENSIVE SAMPLING OF PITTSBURGH AIR QUALITY STUDY.

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As part of the Pittsburgh Air Quality Study (PAQS), characterization of PM2.5 has been conducted at a site adjacent to Carnegie Mellon University in the city of Pittsburgh and at 4 other sites in the region during the summer intensive sampling period (06/30/01 - 07/30/01). These sites include Lawrenceville (3 km north of CMU), Hazelwood (3 km south), Florence (48 km west), and Greensburg (56 km east). The CMU site is in Schenley Park, on top of a grassy hill, more than 500 m from the nearest heavily traveled road but within a few kilometers of major roads, coal combustion sources, and the densely populated Oakland area of Pittsburgh. The Lawrenceville site is in an older residential neighborhood, while Hazelwood is close to several former industrial plants. Florence is in a rural area with no major roads or stationary sources within several kilometers, and is typically upwind of Pittsburgh. The Greensburg site is a few hundred meters from a major road in a commercial district, and is typically downwind of Pittsburgh. Data were used to study the spatial variations of PM2.5 species and the contribution of urban sources. Comparison of data from the five sites suggests that the total mass, sulfate, nitrate and OC measured at all sites are the regional concentrations, with only minor contribution from the city. On the other hand, the EC concentration is consistently lower at the rural Florence site, indicating the contribution of EC by urban sources.

[P04-76] PM2.5 AND PM10 MASS CONCENTRATIONS IN PORTUGAL.

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National guidelines for PM10 -- air particulate matter with an equivalent aerodynamic diameter (EAD) under 10 micron -- were passed into environmental rules and then made public in the Portuguese official journal (DR no. 89, series I-A) as of April 16, 2002. According to such legislation, the annual average based on a 3-year sampling should not exceed 40 microgram per cubic meter (microg/c.m.), with a tolerance of 5 microg/c.m. up to December 31, 2002, which must go down to a zero level until December 31, 2004. The 24-h samplings should not exceed the threshold of 50 microg/c.m. more than 35 times a year, with a tolerance of 15 microg/c.m. up to December 31, 2002, and further down to zero until December 31, 2004. As for PM2.5 (particles with an EAD less than 2.5 micron), Portugal and the European Union as a whole are still lagging behind the United States, where the US Environmental Protection Agency (USEPA) already limits airborne-particulate loads to 15 microg/c.m., as an arithmetic mean of annual averages over 3 consecutive years, and to a short-term metric of 65 microg/c.m., as the 98th percentile of 24-h concentrations also averaged over 3 years in a row. Despite the lack of legislation, the Nuclear and Technological Institute (ITN) has been sampling both PM2.5 and PM10 around the country since 1993, at clean, urban, industrial and rural areas, using Gent stacked-filter unit (SFU) samplers. Particulate mass concentrations have been obtained through a 0.1-microg sensitivity balance. PM10 averages are below the now-legislated values, and they are not significantly different for rural, urban and industrial areas. The 24-h measurements do reveal some important episodes of high concentrations, even though their frequency does not exceed the 35-times-a-year limit, as pointed out by the corresponding, relatively low averages. Background levels for remote (clean) sectors are significantly lower than for any of the human-impacted areas. For PM2.5, the situation appears somewhat more problematic. Except for clean areas, and comparing to USEPA's long-term metric, national figures are either above or roughly within the same magnitude. High-loading episodes seem less frequent though, as inferred from an inferior divergence between average and 24-h levels. In general terms, the contribution of finer, deeply-respirable particles (PM2.5, currently thought to reach the innermost respiratory tract, i.e. bronchioles and alveoli) to the bulk aerosol (PM10) is invariably relevant.

[P04-64] SOUTHEASTERN AEROSOL RESEARCH AND CHARACTERIZATION (SEARCH) STUDY: SPATIAL AND TEMPORAL SUMMARY OF FINE PARTICULATE MATTER COMPOSITION.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (8:00 AM-9:00 AM) Grand Ballroom 2-4

The Southeastern Aerosol Research and Characterization (SEARCH) study began in July 1998 and is supported through 2005. The SEARCH network consists of 8 research sites in 4 urban-rural or urban-suburban pairs, each of which is measuring, routinely, an extensive set of gases, fine particulate (mass and composition, fine and coarse mode), meteorology, and extinction. In addition to 24-hr integrated samples for PM, the vast majority of the measurements, including the major components of PM, are made at temporal resulution of one-hour or less. Among it's many objectives, SEARCH is aimed at providing information for policy makers as they decide how to address the air quality issues they face, (e.g., the PM and ozone NAAQS, and regional haze). SEARCH has now accumulated more than four years of fine particle mass and composition data at it's eight sites. This poster will illustrate and summarize the spatial and temporal character represented by this data set. Spatially, the data represents urban, suburban, and rural sites. Sites in large inland cities (i.e., Atlanta and Birmingham) and small Gulf coastal cities (i.e., Gulfport and Pensacola). Temporally, data on mass and composition are available on scales starting at sub-hourly, allowing diurnal profiles to be established. Monthly, seasonal, and inter-annual variability will also be illustrated.

Major findings include:

· North to south gradients are observed for fine mass, sulfate, and organic matter (1.4 times organic carbon). These may represent a true regional (or super-regional) gradient, an inland versus coastal pattern, a big city versus small city pattern, or more likely, a combination of all three.

· Strong urban-rural or urban-suburban differences in EC, OM, and nitrate, but not sulfate or ammonium.

· Strong seasonality in ammonium, nitrate, and sulfate but not in EC and OM. Sulfate and ammonium tend to be highest in summer, while nitrate is highest in winter.

· A decreasing trend in fine mass, sulfate, and ammonium over the four year period at most sites. The highest annual fine mass concentrations were observed in 1999, driven in part by very high concentrations during the summer of 1999, which was unusually hot and dry in the southeast.

· Important diurnal variability in fine mass as well as it's major components and various tracer gases. Urban sites show large excursions in fine EC and OC during rush hours. These are associated with maximum concentrations of CO and NOy. At all sites, sulfate shows a small, but measureable, maximum around midday, while nitrate shows a distinct maximum in early morning.

[P04-74] ENVIRONMENTAL DETERMINANTS OF THE METAL CONTENT OF AIRBORNE PARTICLES IN EDINBURGH.

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Objective: To determine the environmental factors affecting concentrations of metals in urban particulate matter for application to the epidemiological association between metal composition and acute adverse health.

Methods: Concurrent 24 h samples of PM_{10}, $PM_{2.5}$ and Black Smoke were collected at an urban background site in Edinburgh between September 1999 and September 2000, and at a rural site. Each sample was sequentially extracted with ultra-pure water and concentrated HNO_3:HCl. All extracts were analysed by inductively coupled plasma mass spectrometry for Ti, V, Cr, Mn, Fe, Cu, Ni, Zn, Cd, As, Pb. Daily air-mass back trajectories were calculated and grouped by hierarchical clustering.

Results & Discussion: Median daily urban background water soluble metal concentrations in $PM_{2.5}$ ranged from 0.05 ng m^{-3} for Ti to 5.06 ng m^{-3} for Pb, and in PM_{10} from 0.18 ng m^{-3} for Ti to 11.7 ng m^{-3} for Fe. Median daily total acid extractable metal concentrations ranged from 0.3 ng m^{-3} for As to 27.6 ng m^{-3} for Fe in $PM_{2.5}$, and from 0.37 ng m^{-3} for As to 183 ng m^{-3} for Fe in PM_{10}.

The 11 metals analysed together constituted approximately 2% and 0.8% of PM_{10} and $PM_{2.5}$, respectively, in spring and approximately 1.5% and 0.9%, respectively in winter. Over 90% of the water soluble or total mass of metals analysed in this study was contributed by Fe, Zn, Pb and Cu, regardless of particle size fraction. Multivariate correlation identified crustal (Ti, Fe, Mn) and anthropogenic (Cu, Zn, V) and (Pb, As) groups.

For V, Mn, Cu, Zn, As, Pb and Fe, there was greater correlation of metal concentration with gravimetric concentration of Black Smoke than with gravimetric concentration of either PM_{10} or $PM_{2.5}$, suggesting that black smoke monitoring could be an effective surrogate measure of particle metal concentrations in the UK.

PM_{10} and $PM_{2.5}$ mass concentrations were 30-40% higher when air masses were from east/central Europe, and around 25% higher when air masses were centred on the UK, compared with air masses from the N, W or SW. Air masses from the UK and Europe also had a higher proportion of particle mass as $PM_{2.5}$. Water-soluble metal concentrations of UK and central Europe air masses were up to double those from the W, SW and N.

Metal enrichment factors (ng μg^{-1}) differed significantly between air-mass back-trajectory clusters for most metals. This validates the potential use of air-mass source as a means to reconstruct past daily metal volumetric concentrations, although cluster analyses based on trajectory co-ordinates actually reproduced <30% of the variation in metal concentration for the 1 year of measurements.

[P04-72] CHEMICAL COMPOSITION OF PM2.5 AND NUMBER CONCENTRATION MEASURED AT LITHUANIAN COASTAL ENVIRONMENT.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (8:00 AM-9:00 AM) Grand Ballroom 2-4

The recently revised interest can be observed in the health effect of particulate air pollution in the urban and non-urban areas during last decade. General studies have shown that short-term variation in levels of particulate air pollution are associated with adverse respiratory health effects even on the low levels of pollution observed currently in Western Europe. It may be that the adverse effect of pollution on public health is number, not mass concentration dependant.

The goal of this investigation is to study variation of the aerosol number concentration (d < 0.4 um) and the mass concentration of major inorganic ions in fine particles in a rural coastal station located in Preila.

Virtual impactor with the cutoff size of 2.5 um has been employed for the collection of aerosol particles classified into two size fractions. Two field measurement campaigns were carried out. Aerosol samples collected onto the Whatman 40 cellulose filters were extracted with 30 ml of deionized water. Concentrations of anions (SO42-, NO3-, and Cl-) in aerosol water extracts were measured by means of ionic chromatography with the conductivity detector. Meanwhile, spectrophotometric method was used for measurements of NH4+ and flame photometry - for Na+. Commercial optical aerosol counter has been used for continuous aerosol number concentration measurements.

The highest mass concentration of major inorganic ions (14.8 ug/m3) and number concentration (39 cm-3) were measured in winter season. Similar situation occurred with constituents of major ions. The lowest number concentration in both seasons was related with air mass backward trajectories from northwest and highest - from south.

The correlation coefficient is the highest between ammonium mass concentration and number concentration in winter season (R=0.604). The lowest correlation coefficient is calculated between nitrate mass concentration and number concentration in summer (R=0.257). Sometimes course of mass concentration of major ions follows the number concentration curve in a very similar way. However, on the other hand, sometimes it seems that other constituents in fine particles are more important than major ions.

The measured mass concentration of major ions and number concentration varied from 1.8 to 6.3 ug/m3, from 7 to 22 cm-3 in summer season and from 4.2 to 14.8 ug/m3, from 7 to 39 cm-3 in winter season, respectively. The calculated correlation coefficients are generally enough low (< 0.7). Nevertheless in some events the relationship between number and major inorganic ions concentrations can be high and indirectly represent variation of mass concentration of fine particles.

[P04-71] SEASONAL TREND OF THE PHYSICO-CHEMICAL CHARACTERISTICS OF PM2.1: A STUDY BY SEM/EDX AND XPS IN AN URBAN AREA OF ROME.

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A large body of epidemiology research has shown a significant statistical correlation between acute health effects and the fine fraction of urban particulate (PM2.5). It is still widely debated which characteristics of PM are responsible for the adverse health effects. A number of experimental studies has suggested that the fine particles, which act as a carrier of toxic compounds (acids, metals, organics), are related to pulmonary toxicity. Moreover some epidemiological data give indications of hospital admissions and adult mortality higher in summer season than in winter season (1).

The aim of this study was to evaluate the seasonal trend in the composition and in the physico-chemical characteristics of PM2.1 (particulate with aerodinamic diameter<2.1μm) in an urban area of Rome. The role as "carrier" of carbonaceous particles was thoroughly studied using scanning electron microscopy equipped with an EDS X-ray attachment (2) and Photo-electron spectroscopy (XPS). Atmospheric aerosol were analysed by Ion Chromatography (IC) to evaluate the soluble ions collected by annular denuder. X-ray microanalysis data were subjected to Hierarchical Cluster Analysis to classify the particles into groups (clusters) with similar chemical composition.

We identified 4 clusters of particles in the PM2.1: carbonaceous particles, soil erosion particles, sulphates and metals. EDX spectra showed the presence of a surface coating containing S or sometimes S, K, Na on a variable percentage of carbonaceous particles.

XPS data showed that the more abundant element were C, O, N, Si, S whereas Ca, Na, Fe were only present in traces.

XPS spectrum in the region of S2p peak confirm that the sulfur compounds in the PM2.1 are constituted by SO4 -2 anion. The trend of the abundances in weight of S and N obtained by XPS showed an evident maximum in summer season. The abundances of carbonaceous particles with S-coating obtained by SEM/EDX showed the same seasonal trend.

As it was demostrated that the photo-chemical oxidation of SO2 can be efficiently catalysed by carbon, our data suggest that the carbonaceous particles act, particularly in summer season, either as a carrier of sulphates, or as a determinant factor in the acidity production in the atmosphere.

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[P04-70] SIZE SEGREGATED CHARACTERIZATION OF PM_{10}, $PM_{2.5}$, PM_1 AND LONGTERM MEASUREMENTS OF PM_{10} DOWNWIND OF A LARGE CONURBATION IN GERMANY.

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For a period of ten years (1993 to 2002) daily filter samples PM_{10} were collected by a high volume sampler (HV, quartz fibre filters, *PM_{10} Sampler, Sierra-Andersen*) and additionally weekly filter samples PM_{10}, $PM_{2.5}$, and PM_1 from 1999 on by a low flow sampler (LF, Teflon filters, *Partisol 2000, Rupprecht and Patashnik*)) at the IfT-research station Melpitz (12°56' E, 51°32' N) located in the downstream plume of the Leipzig conurbation in Central Europe.

From the weekly LV samples the contributions of $PM_{2.5}$ and PM_1 to PM_{10}(100%) can be derived. Most of the $PM_{2.5}$ mass is PM_1 . During summers the mass of coarse particles (PM_{10} - $PM_{2.5}$) is higher than in other seasons. Reasons could be found in the occurrence of longer periods of dry ground surfaces and faster drying surfaces with re-emission by turbulence and from agricultural activity (Table 1).

An additional impactor for PM_1 (LF) contains a quartz filter for the determination of organic carbon (OC) and elemental carbon (EC) with a thermographic method using a *Ströhlein C-mat 5500 carbon analyser*. OC was detected at 650 °C in N_2 and EC after them during a new heating step at 650 °C in O_2. In the mean about 30% of the PM_1 mass are total carbon (TC = OC + EC). More OC was detected during the summers.

The particle mass concentration PM_{10} (HV) shows a decreasing trend. Highest values have been observed in the winters before winter 1997/1998. In the following winters no pronounced concentration peaks were found. A reason is the decreasing number of coal heating systems in the Leipzig conurbation and its surroundings.

The NO_3^-/SO_4^{2--} molar ratio shows a typical increasing trend with seasonal variation caused by the decreasing SO_4^{2--} mass concentration in PM_{10} which originates in the dramatically decrease of SO_2 concentrations, but also in NH_4NO_3-losses by evaporation from the filters during higher temperatures in summer.

The time series were integrated in a longer historical mass trend (since 1983) for Saxony. In the reconstructed data (1983 to 1990) the total particle mass concentration (TSP) shows big scatter with a mean between 60-80 $\mu g/m^3$. Since the reunification in 1990 a decrease for PM_{10} to a mean of 20-30 $\mu g/m^3$ is clearly recognizable.

Table 1: Mass contribution of $PM_{2.5}$ and PM_1 to PM_{10} (100%) distinguished between winter (W, October to March) and summer (S, April to September) for the years 1999, 2000 and 2001

PM	1999(S)	2000(S)	2001(S)	1999(W)	2000(W)	2001(W)
$PM_{2.5}$	56.7 %	56.8 %	65.2 %	82.0 %	76.4 %	82.8 %
PM_1	46.2 %	47.4 %	50.0 %	62.9 %	56.6 %	59.4 %

[P04-69] CHARACTERIZATION OF TOXIC OF COMPOUND IN ATMOSPHERIC PARTICULATE MATTER IN CATAÑO, PUERTO RICO.

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Puerto Rico has experienced rapid growth and economic development in the past decades. This has led to the establishment of multiple industrial plants, power generating plant and large increase in vehicular traffic. The impact of the emission from these activities ara affecting the health of certain sector of the population.

A region known as Cataño is directly downwind from the San Juan metropolitan area. The impact in air was such that with the EPA PM-10 requirements of air quality it could not meet compliance. Parallel to the high particulate levels were found high levels of respiratory ailments in the residents of this region. Such ailments as asthma, emphysema and lung cancer are close to four times higher in this regiion other areas of Puerto Rico.

We have undertaken a study to chemically characterize by GC/MS the organic pollutants in air in the Cataño area of puerto Rico and compare this composition with other less polluted areas in the Puerto Rico. By comparing it is hoped to identify compounds could be contributing to these respiratory ailments.

Samples were taken on a standard Pm-10 samples and sequentially Soxhlet extracted with hexane, dichloromethane and finally acetone. The goal was to achieve a level of fractionation in the extraction to facilitate the chemical analysis. The more abundant compounds found were fatty acids and their corresponding ester. In addition long chained alcohols. All are indicative of biogenic origin. The anthropogenic compounds observed more consistently were derivatives of morpholine.

[P04-43] AMBIENT POLLUTANT CONCENTRATIONS MEASURED BY MOBILE LABORATORY IN SOUTH BRONX, NY.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

The rate of asthma hospital admissions in the Bronx for all ages was twice that of Manhattan and Brooklyn between 1991 and 1996. In addition, most neighborhoods in the Bronx experienced a 110 to 120 percent increase in asthma hospitalizations between 1987 and 1996, as compared to 35 to 50 percent increase in most other neighborhoods in New York City. The objective of this South Bronx Environmental Study is to characterize the ambient air quality in communities of the South Bronx having high concentrations of diesel trucks and waste transfer facilities. We employed a mobile laboratory for continuous measurements of concentrations of fine particulate matter (PM2.5), elemental carbon (EC), oxides of nitrogen, sulfur dioxide, ozone and carbon monoxide at 6 locations during 2001 and 2002 for period of three to four weeks each. Integrated 24-hr PM2.5 samples were also collected for elemental and PAHs analyses. South Bronx ambient PM2.5 and EC levels were compared to levels measured at Bronx P.S. 154 (central monitoring site maintained by the NYSDEC) and at a Hunter College site located in the Manhattan's Lower East Side (maintained by NYU's EPA PM Center). The comparison of these sites indicated that although the median daily PM2.5 concentrations agreed within 20%, the median hourly EC concentrations were higher at all South Bronx sites with means ranging from 3.50 to 4.35 ug/m3, compared to means ranging from 1.23 to 2.99 ug/m3 at Hunter College. Continuous Aethelometer measurements at additional 27 sampling sites in South Bronx (1-day measurements repeated over a period of 4 weeks) were conducted along major highway with heavy truck traffic. There, EC concentrations showed variability within each site depending on time of day and a large spatial variability from site to site. Median EC concentrations varied from approximately 1.7 to 12 ug/m3 on the weekdays, and were lower (approximately 0.50 to 2.9 ug/m3) on the weekends. A weekend decrease in PM2.5 was also observed at all South Bronx sites except for Crotona Park, a local recreational park where weekend PM2.5 levels were higher. Elemental concentrations were remarkably similar between Hunter College and all South Bronx sites, with the exception of Hunts Point Avenue, an industrial location where significantly higher (approximately 2.5 fold) levels of Fe, Zn, Ba, and Ca. Further research will focus on developing a model using Geographical Information System tools to estimate local population exposure to pollutants.

Supported by EPA (R827351, Agreement X-982152) and NIEHS (ES00260).

[P04-77] HOW MANY MEASUREMENTS FOR EXPOSURE ASSESSMENT? BALANCING COST AND PRECISION FOR AN OPTIMUM ENVIRONMENTAL SAMPLING OF AMBIENT AEROSOL.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (8:00 AM-9:00 AM) Grand Ballroom 2-4

Studies requiring ambient exposure assessments must ask the following question: How often should measurements be taken? Answers to such questions are dictated by budgetary constraints as well as spatial-temporal considerations. For example, do we obtain samples during all seasons, all months within seasons, weeks within months and days within weeks and so on? On the one hand, one can obtain a snapshot sample and regard it as an estimate of the "true" exposure mean. On the other hand, one can obtain a large number of samples and then average those to represent the "true" exposure mean. The former estimate is the least expensive but also the most imprecise. The latter, may be very precise but prohibitively costly. We propose a solution. First conduct a pilot study with a feasible and promising sampling plan and apply the statistical methodology of Variance Component Analysis (VCA) to the exposure data. We demonstrate that an optimum sampling design will maximize the precision of our exposure estimate for a pre-specified total relative cost (relative to the pilot sampling design) of sampling. Alternatively, we can minimize the sampling costs for a certain pre-specified relative precision of the estimate (relative to the precision in the pilot design). Our approach is illustrated with an on-going study of assessing exposure to diesel particulates in a birth cohort. We show that a pilot study followed by the VCA analysis, will lead to considerable savings and can also provide precise estimates for the subsequent full-fledged study based on the optimum design arrived at by the VCA approach.

[P10-06] EFFECTS OF GASEOUS POLLUTANTS AND METEOROLOGICAL PARAMETERS ON NUCLEATION AND GROWTH OF ULTRAFINE PARTICLES IN URBAN AMBIENT AIR.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

Number concentrations and size distributions of fine particles in the size range of 10 to 500 nm were measured the NYS DEC monitoring site (Latitude 43° 09' 40", Longitude 77° 36' 12") in downtown Rochester, NY during the measurement period of December, 2001 to January, 2003. The particle size distributions and number concentrations were measured using a Scanning Mobility Particle Sizer (SMPS) comprising of a differential mobility analyzer (DMA, TSI 3071) and a condensation particle counter (CPC, TSI 3010). The number concentrations were classified and analyzed as a function of size ranges, 11 to 50 nm, 50 to 100 nm, and 100 to 470 nm to characterize the variation of size ranges. Continuous particle mass measurements were made with a 50°C Tapered Element Oscillating Microbalance (TEOM) operated by NYS DEC. In addition, hourly CO, SO_2, O_3, relative humidity, ambient temperature, wind speed and wind direction were measured. Nucleations of fine particles occurred more frequently during summer than during winter months. During the summer months, two types of fine particle nucleation typically occurred between noon and 3 p.m. One type involves only nucleation in the size range 10 nm to 30 nm occurs while the other type begins with nucleation followed by particle growth up to approximately 80 nm during the following 12 hours. At the time of the nucleation event, the highest concentration was in excess of 170,000 cm^{-3}, whereas the average concentration was 11,000 cm^{-3}. The nucleation events also occurred occasionally between 3 p.m. and 6 p.m. with nucleation mostly associated with particles in the 20 to 50 nm diameter range. In addition, SO_2 concentrations dramatically increased at the same time the number concentration of particles rose during the nucleation events, whereas $PM_{2.5}$ somewhat decreased during the nucleation events. The main wind direction was west-north for both nucleation event days or non event days, but the nucleation events tended to occur while wind was blowing from east-north east.

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[P08-38] AIRWAY EPITHELIAL CELLS RELEASE MIP-3 alpha/CCL20 IN RESPONSE TO CYTOKINES AND AMBIENT PARTICULATE MATTER.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

The initiation and maintenance of airway immune responses in Th2 type allergic diseases such as asthma, are dependent on the specific activation of local airway dendritic cells (DCs). The cytokine microenvironment produced by local cells, influences the recruitment of specific subsets of immature DCs and their subsequent maturation. In the airway, DCs reside in close proximity to AEC. We therefore examined the ability of primary culture human bronchial epithelial cells (HBECs) to synthesize and secrete the recently described CC-chemokine, MIP-3a /CCL20. MIP-3a /CCL20 is the unique chemokine ligand for CCR6, a receptor with a restricted distribution. MIP-3a /CCL20 induces selective migration of DCs since CCR6 is expressed on some immature DCs but not on CD14+ DC precursors or mature DCs. HBECs were stimulated with pro-inflammatory cytokines TNF-a and IL-1b or, because of their critical role in allergic diseases, IL-4 and IL-13. Cells were also exposed to small size-fractions of ambient particulate matter (PM). Each of these stimuli induced MIP-3a /CCL20 gene and protein expression. Moreover, these agents upregulated mitogen-activated protein kinase pathways in HBECs. Inhibition of the ERK1/2 pathway, or p38, reduced cytokine-induced MIP-3a /CCL20 expression. These data suggest a mechanism by which AEC may facilitate recruitment of DC subsets to the airway.

[P08-02] ON-ROAD EXPOSURE TO HIGHWAY AEROSOLS: 2. ON-ROAD AEROSOL AND GAS MESUREMENTS.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

On-road experiments were conducted to determine the sensitivity of rats to on-road aerosol. A Mobile Emissions Laboratory (MEL) collected aerosol and gas data and transported the rats. This poster summarizes the on-road aerosol and gas measurements and provides background for the exposure portion of the study.

A 1998 Volvo tractor carries the air-conditioned MEL, instrumentation, data acquisition and MEL operator. The flow distribution system was designed to simultaneously provide on-road aerosol to the instruments and the animal cages. Aerosol instrumentation used in this study included two scanning mobility particle sizers (SMPS) to determine the aerosol size distribution from 10 to 300 nm, two standalone condensation particle counters (CPC) to determine the total aerosol number concentration, an electrical aerosol detector (EAD) to determine the aerosol length and a thermal denuder (TD). The TD was used with one of the SMPS instruments to determine the size distribution of the non-volatile fraction. In addition, three gas analyzers were used to measure ambient levels of CO, CO2 and NO. Integrated filter samples were collected each day and were analyzed for anions, cations, organic and elemental carbon.

On-road measurements and animal exposures were carried out over 10 days, six hours each day over a route from Rochester to Buffalo, NY covering approximately 300 miles. A conscious effort was made to follow Diesel trucks as much as possible in the hopes of sampling the exhaust plume. Aerosol was drawn into the lab from a 4 in diameter sample probe, attached to the front vehicle bumper. Total flow was approximately 400 L/min, of which 20 L/min entered each of three animal exposure cages, 70 L/min was diverted to the aerosol and gas analyzers and 20 L/min was directed through particle filters for mass concentration and chemistry.

Average daily total aerosol number concentration ranged from 200,000 to 540,000 particles/cm3. The average daily NO concentration ranged from 0.10 to 0.24 ppm and the corresponding CO2 concentration ranged from 401 to 423 ppm. For comparison, our past studies on a typical MN urban highways have observed total number concentrations in the 50,000 to 300,000 particles/cm3 range in heavy traffic, 5,000 to 20,000 particles/cm3, in very light traffic. The average daily geometric mean particle size determined by the SMPS ranged from 14 to 28 nm. The TD reduced the average SMPS number concentration by 85% suggesting that most of the particles consisted of volatile material.

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[P08-01] ON-ROAD EXPOSURE TO HIGHWAY AEROSOLS: 1. PARTICLE CHEMISTRY AND RAT EXPOSURE SYSTEM.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 8: Toxicology: Metals, Mixtures, and New Models (8:00 AM-9:00 AM) Grand Ballroom 2-4

There has been growing interest in the heath effects of ultrafine particles over the past decade based on laboratory experiments with generated aerosols. Because ultrafine particles have a relatively short residence time in the atmosphere, it is difficult to provide high concentration exposures to experimental animals. Recently there have been efforts to concentrate the ultrafine particle fraction of the ambient aerosol in order to mimic high ambient exposure scenarios for controlled clinical or animal inhalation studies. However, it is unclear how representative such particles may be after the processing that is necessary in the concentrator systems. Recent studies have shown particle number concentrations over urban roadways are higher than roadside and much higher than downwind. In fact, on-road number concentrations are often higher than provided by concentrator systems. People in passenger cars and trucks are directly exposed to these particles that are present on highways at high concentrations. Thus, an on-road exposure system was developed in which laboratory animals were transported on active roadways in order to provide exposures to fresh ultrafine aerosols. The University of Minnesota\\'s Mobile Emissions Laboratory has been used extensively to make on-road emission measurements. It was adapted for use as both an emission laboratory and exposure system. An inlet brings the on-road aerosol from in front of the truck into the laboratory in the cargo container in the truck bed where measurements and animal exposures are performed. In these experiments, some of the equipment was removed to make room for the animal exposure system. An air delivery system was built to provide exposures for 3 groups: whole highway aerosol; filtered air with the gaseous pollutants present; and clean air without particles, CO, VOCs, or NOx. The cages held 10 animals each so thirty animals could be used for a given experiment. Rats of old age were used, with and without pre-exposure to endotoxin or human influenza virus, as well as spontaneously hypertensive rats, with telemetric EKG and blood pressure implants. The truck was then driven on highways around Rochester under varying conditions to provide a range of exposures to the animals. The physical nature of the observed aerosol and the experimental design and the responses of the animals to the various challenges are presented in two companion posters.

Supported by EPA PM Center grant R827354

[P10-01] INTENSIVE ANALYSIS OF AMBIENT AEROSOLS IN THE GREATER CINCINNATI AIRSHED.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

Respiratory complications and other detrimental health effects have been associated with increased PM2.5 in ambient air. This led to a study examining the "factors affecting the PM2.5 concentration levels" in the Greater Cincinnati metropolitan area. This area is characterized by high interstate highway traffic and therefore increased exposure to Diesel Exhaust Particulate (DEP) matter. To supplement long-term Impactor measurements, more intense measurements were made during the summer of 2002. They included simultaneous measurements of instantaneous mass concentration (TEOM), integrated mass concentration (Harvard Impactor, Teflon and Quartz filters), total particle counts (CPC and OPC), size distributions (SMPS), morphological analysis (Electrostatic Aerosol Sampler) and meteorological parameters.

Samples were collected at five different sites. The Findlay site is downtown, 200m from the interstate. The Mernic site is a suburban backyard, 4500 m from any major highway. The Blue Ash and Spa Store sites were directly across the interstate from each other. Measurements were made between 30 and 200m from the highway at these sites. The Truck Test Track site was on the interior of a banked curve racetrack and provided a signature of diesel truck emissions.

The TEOM was able to detect significant peaks in PM2.5 concentration that were not observed by the Harvard Impactor. At Findlay, the most prominent peaks were observed during certain periods of the day (10-11AM, 12-1PM, and 4-6PM). There were no pronounced peaks after 9PM. Fewer peaks were observed at the Mernic site. There was no discernable difference in mass concentration as a function of distance from the highway (50-200m) in the Blue Ash/Spa Store site. Impactor samples collected on Quartz filters were lower in mass concentration than collocated measurements sampled on Teflon filters for all samples. TEOM data averaged over a 24-hour period was found to be significantly different than Harvard Impactor data collected over the same period for both the Truck Test Track and Findlay. These sites, which had the highest organic carbon concentration, also had a higher DEP contribution. The difference between TEOM and Impactor data was most prominent at the Truck Test Track site, where ambient aerosols were predominantly DEP.

Detailed measurement data obtained from the instruments listed above will be presented.

[P10-02] REGIONAL ULTRAFINE PARTICLE NUCLEATION OBSERVED IN ST. LOUIS, MO.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

Size distributions of ambient particles (0.003 μm~10 μm) were measured as a part of the EPA St. Louis Midwest supersite program. This paper focuses on implications of those measurements for nucleation, and pertains to measurements from the 13-month period beginning in April 2001. Measurements were made continuously with an automated system, which completed 10 size distribution measurements per hour. The sampling system included a nano-scanning mobility particle sizer (3 nm < DP < 40 nm), a long-column scanning mobility particle sizer (30 nm < DP < 400 nm), a PMS Lasair optical particle counter (OPC) (0.1 μ m < DP < 2 μm) and a Climet CI-500 OPC (0.3 μm < DP < 10 μm). The first 10 minutes of each hour were dedicated to calibration of the OPCs with atmospheric particles of 450 nm mobility diameter.

We observed clear evidence for nucleation and subsequent growth on 83 days. Nucleation typically occurred after sunrise and lasted for about 6~8 hours. These nucleation events did not show any clear association with measured gases, and the constant growth rates irrespective of wind direction suggested that they were regional in extent. Nucleation occurred more frequently in spring, summer and autumn than winter, although nucleation was observed during each month of the year. The average diameter growth rate during nucleation episodes on the 83 days was 3.33 nm/hour, but growth rates in the summer were 5-7 times rages in the winter. Estimated particle formation rates during nucleation episodes were typically on the order of several tens cm-3s-1.

In this paper salient features of the nucleation events including conditions that favored nucleation will be discussed.

[P10-03] INTERCOMPARISON OF APS, ELPI AND LPI FOR COARSE, FINE AND BIMODAL PARTICLE MASS SIZE-DISTRIBUTIONS.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

The aim of this work was to compare the Electrical Low-Pressure Impactor (ELPI), the Aerodynamic Particle Sizer (APS) 3320, the APS 3321 and a coventional Low-Pressure Impactor (LPI) for mass size-distribution measurements of aerosols consisting of 1) only coarse mode, 2) only fine mode and 3) both coarse and fine mode particles.

The APS and the ELPI are two aerosol size spectrometers with which particle size distributions in the size-range 0.5-10 μm can be measured with high time-resolution. The main advantage of these instruments compared to conventional optical techniques is the ability to classify the particles according to their aerodynamic equivalent diameter. While the lowest size-bin of the APS is around 0.5 μm, the ELPI covers the size-range from 0.03 to 10 μm.

Coarse particles (MMAD~4 μm) were generated with a medical nebuliser (Pari Boy). The fine particles (MMAD~0.25 μm) were produced with a TOPAS monodisperse particle generator. The aerosol material was in both cases di-octyl sebacate (DOS). The aerosol was passed through a bipolar charger before entering a 0.5 m^3 experimental box. The particles were sampled to the 4 instruments simultaneously using copper tubes. The particle concentration was 1-2 mg/m^3 for each mode. Triplicate experiments were performed each for coarse mode only, fine mode only and bimodal size-distributions.

In the experiments with the coarse mode only it was found that the ELPI overestimated the particle mass in stages 10-12 (particles > 2.5 μm) compared to the LPI. There was good agreement between both APS-models and the LPI mass in the range 1-6 μm. For larger particles the APS 3321 underestimated the concentration, this was assumed to be caused by a combination of impaction losses in the inner inlet of the instrument and droplet deformation. Severe overestimation of particles > 8 μm in the APS 3320 was likely caused by particles recirculating in the sensor.

In the experiments with the fine mode only, it was found that all three spectrometers showed significant contribution to the total mass in the coarse mode range. The overestimation in the ELPI may be caused by fine particle losses in the upper stages of the impactor. It has to be noted that in the experiments with the fine mode the concentration in the APS-channel <0.523 μm was as high as 4000 cm^{-3}, the concentration >0.523 μm was below 800 cm^{-3}. The artefact in this case may be avoided by further dilution.

In the experiments with both the fine and coarse mode present, there was overestimation in the ELPI stage 10-12 and in both APS models. These are caused by a combination of the mechanisms for the coarse and the fine mode respectively.

[P04-62] COMPARATIVE EVALUATION OF AMBIENT FINE PARTICULATE MATTER (PM2.5) DATA OBTAINED FROM URBAN AND RURAL MONITORING SITES ALONG THE UPPER OHIO RIVER VALLEY.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (8:00 AM-9:00 AM) Grand Ballroom 2-4

Summary

This presentation summarizes detailed findings and conclusions drawn from evaluations of data captured to date from the operation of ambient PM2.5 speciation sites in a geographical area encompassing southeastern Ohio, western Pennsylvania and northwestern West Virginia. The overall goal of this program, called the Upper Ohio River Valley Project (UORVP) was to investigate the nature and composition of fine particulate (PM2.5) and its precursor gases in the Upper Ohio River valley and provide a better understanding of the relationship between coal-based power system emissions and ambient air quality in this region through the collection of chemically resolved or speciated data.

Findings:

The following conclusions were made from the observations made:

1) The TEOM equipment performed as well as the sequential filter samplers in accounting for ambient PM2.5 levels; however, the FRM-obtained data was consistently lower than the averages from the TEOM/DRI-SFS measurements;

2) The trending in the PM2.5 levels was similar for urban Lawrenceville and rural Holbrook,

3) The absolute median PM2.5 levels were slightly higher for Lawrenceville than for Holbrook, implying that local urban environmental contributions had a minor but measurable effect on total PM2.5 mass concentration;

4) PM2.5 and PM10 mass concentration levels were consistently higher in summer than in winter, with intermediate levels observed in the spring and fall;

5) Sulfate levels predominated in the speciation data obtained from both the Holbrook and the Lawrenceville sites during winter and summer intensive sampling. Sulfate level measured at Holbrook were higher than those taken at Lawrenceville regardless of the season;

6) Ammonium levels remained relatively constant between seasons and between sites;

7) Nitrate levels measured at Lawrenceville were higher than those measured at Holbrook during winter intensive sampling. Nitrate levels measured during the summer intensive period were found to be very low at both locations;

8) In general, the predominant inorganic fraction of the samples analyzed could be described as being composed of a mixture of ammonium bisulfate and ammonium sulfate with minor amounts of ammonium nitrate;

9) Most high PM2.5 episodes occurred when the predominating wind direction was from the South-West.

[P10-05] MEASUREMENTS OF AEROSOL MASS AND SIZE DISTRIBUTION IN A RESIDENTIAL AREA IMPACTED BY WOOD SMOKE.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

Increased use of small-scale biofuel combustion is considered part of a future sustainable energy system in Sweden. The research programme "Emission and air pollution from combustion of biofuel", financed by the Swedish Energy Agency, includes a study of the air pollution impact of an extended use of wood stoves. FromJanuary to March, 2002, an air quality monitoring campaign was performed in Lycksele, northern Sweden. The small city of 8 000 inhabitants is situated in a river valley. During cold winter nights the ventilation is reduced due to thermal inversion and low wind speeds. Although the district heating system is rapidly expanding, there are still between 600 and 700 individual wood stoves operating in the city.

Particle mass (TEOM), size distribution (DMPS) and hygroscopicity (TDMA) were measured in a residential area with many wood stoves. During the same period, size distribution was measured in a central area, where most of the houses are connected to the district heating system.

The PM10 and PM2.5 levels registered in Lycksele are in general low and close to background levels. However, during cold wintertime episodes, when temperature falls below -10 °C, there is a marked increase in PM levels. While the residential area aerosol has number/volume peaks at ~ 60/350 nm, the central aerosol peaks at ~ 25/150 nm, respectively. Particle number is about the double at the central site, but the volume only about a fourth, if compared with the residential area. During periods with temperature above -10°C both number and mass is strongly reduced in the residential area, while the levels at the central site are about the same as during cold events.

A comparison with PM2.5 data confirms the dominant impact of local emissions in the residential area under those cold periods. The locally generated aerosol shows a low growth rate, indicating fresh combustion particles. Although hygroscopic properties do not allow the separation of wood stove and vehicle emitted particles, it is possible to quantify the fresh, locally generated combustion aerosol from the long distance contribution. Dispersion model results show that wood stove emissions can explain the enhanced levels in both number and volume/mass during cold periods. Except for cold periods, the residential aerosol is determined by background levels (mass) plus traffic (number). Clearly the use of small scale wood stove heating may contribute to local exceedances of the European air quality directive and Swedish Environmental Legislation for daily averages of PM10 (not to exceed 50 μgm-3 more than 35 days during a year), while the yearly average is only marginally influenced.

[P04-56] SEMI-VOLATILE AND PARTICLE-ASSOCIATED NITRO-PAH AS MARKERS OF DAYTIME OH RADICAL-INITIATED OR NIGHTTIME NO_3 RADICAL-INITIATED ATMOSPHERIC REACTIONS OF GAS-PHASE PAH.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4c: Sampling and Analyzing PM - Advances in Organic Carbon Methods (8:00 AM-9:00 AM) Grand Ballroom 2-4

Polycyclic aromatic hydrocarbons (PAHs) and their nitro-derivatives (nitro-PAHs) have been reported to be mutagenic and carcinogenic. PAHs containing from 2- to 4-rings will be present at least partially in the gas-phase in the atmosphere. While hydroxyl (OH) radical reactions will be the major atmospheric loss process for these gas-phase PAHs, nighttime reactions with nitrate (NO_3) radicals may also occur. Both the OH radical-initiated and the NO_3 radical-initiated reactions may produce nitro-PAHs, whose reduced volatility relative to the parent PAH may result in these products being particle-associated. The yields of the nitro-PAHs formed from the OH radical-initiated reactions are typically low ($\leq$ 5%), while for certain PAHs the NO_3 radical reaction may produce nitro-PAHs in high (>20%) yield. The pattern of nitro-PAH isomers formed may be different for the OH vs NO_3 radical-initiated formation pathways and may also be distinct from the nitro-PAH isomers present in emission sources such as diesel exhaust. The nitro-PAHs found in ambient samples are often dominated by those formed from OH radical-initiated reactions, but instances where NO_3 radical chemistry contributes to or even dominates the nitro-PAH formation have been observed. The dominant loss process for the nitro-PAHs is expected to be photolysis. Through comparisons among nitro-PAHs produced in environmental chamber reactions of selected PAHs and daytime and nighttime ambient air samples, nitro-PAHs that can serve as markers of daytime OH radical-initiated and nighttime NO_3 radical-initiated reactions will be identified.

[P10-07] NUMBER CONCENTRATION AND SIZE DISTRIBUTION OF URBAN AEROSOLS NEAR DOWNTOWN DETROIT.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

This paper presents the results from a study conducted in SW Detroit to examine the effect of nearby sources and meteorological conditions on the concentration and size distribution of ambient particles. The number concentrations of ambient particles in 0.01 to 19.8 μm size range were obtained from a scanning mobility particle sizer (SMPS) and an aerodynamic particle sizer (APS). Meteorological parameters including ambient temperature, relative humidity, wind speed, wind direction, rainfall, and solar radiation flux were also monitored concurrently atop a 10-m tower. On average, ultrafine particles ($d_p < 0.1$ μm) accounted for approximately 90 % of the total number concentration (N_T), where mean N_T ranged from $1.5 \cdot 10^4$ to $2.9 \cdot 10^4$ cm^{-3} . Time series plots of the 5-min number concentrations revealed that on several days peaks occurred around solar noon, or within a few hours, when photochemical activity is at a maximum. The number concentrations showed significant variation during the study with standard deviations ranging from $4.6 \cdot 10^3$ to $1.1 \cdot 10^4$ cm^{-3} . The number size distribution exhibited one to three distinctive modes with the most typical mode diameters around 0.01, 0.05, and 0.1 μm. The smaller two modes are mostly seen in the immediate vicinity of motor vehicles emissions, thus known to be indicative of traffic-related particles. On few occasions, the ultrafine particle concentration dropped to levels five times lower than its original concentration immediately after the onset of heavy rain events. The resulting size distribution then showed only one mode in the accumulation range peaking near 0.2 μm. In addition, ultra fine particle-growth was observed before a rain event with winds out of the south and a relative humidity 55 %. Overall, data indicated motor vehicle emission and, to some extent, photochemical reactions are the major sources of ultrafine particles in Detroit area. Meteorological factors are shown to have a substantial effect on the number concentration and size distribution.

[P10-08] DIURNAL AND SEASONAL TRENDS IN OUTDOOR PARTICLE SIZE DISTRIBUTIONS MEASURED AT URBAN AND RURAL LOCATIONS DURING THE PITTSBURGH AIR QUALITY STUDY.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

Numerous epidemiological studies have shown adverse health effects of PM including respiratory irritation and changes in pulmonary function as well as associations between PM mass concentrations and mortality. Some controlled exposure studies have also shown that for a given mass concentration, health effects are larger for smaller particle sizes. This work presents the results of one year of continuous monitoring of size distributions at the Pittsburgh Supersite. Diurnal and seasonal trends will be presented for measurements at an urban site located in a park 5 km downwind of downtown Pittsburgh. These data will be compared to the size distributions measured continuously for 6 weeks at a rural site upwind of Pittsburgh to assess the spatial variability and impact of the urban plume on number distribution.

Two SMPS systems and an APS system (TSI Inc) were used at the main site to measure aerosol size distribution from 3 nm to 20 μm. In addition to the size distribution measurements, other aerosol and gas phase parameters were monitored at the central site. The rural site was located in Florence, PA 38 km west (upwind) of the city. At the rural site an SMPS system was operated for a period of 6 weeks.

It was found that particle number and PM2.5 mass are not correlated in Pittsburgh. This is mostly due to the occurrence of frequent (50% of the study days) particle nucleation events that increase particle number with negligible increase in particle mass (Stanier, 2002). Strong diurnal patterns were evident in particle number concentrations. During weekdays without particle nucleation particle number showed peaks at 8 AM with a weaker secondary peak at 3 PM. During weekdays without particle nucleation particle number had a single peak at noon. This diurnal pattern was most evident in particle size ranges associated with vehicular traffic from 10 nm - 100 nm. Additional analyses, including seasonal differences in aerosol size distributions and a comparison of size distributions at the urban and upwind rural site will be presented.

Stanier, C., Khlystov, A., Pandis, S.N. Nucleation Events During the Pittsburgh Air Quality Study: Description and Relation to Key Meteorological, Gas Phase, and Aerosol Parameters. Submitted to Aerosol Science and Technology, October 2002.

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[P10-09] AEROSOL SIZE DISTRIBUTIONS: A COMPARISON OF MEASUREMENTS FROM URBAN AND RURAL SITES.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

Aerosol size distributions were measured during the summer of 2001 at Queens, NY and during the summer of 2002 at Whiteface Mountain in the northern Adirondack region mountains of upstate New York as part of the PMTACS-NY Supersite program. Several instruments (Nano SMPS, Long Smps, and APS) were used to characterize the aerosol size distributions over a range from 10 nanometers to 10 micrometers. These measurements illustrate the differences in aerosol processes active at rural and urban sites

Size distributions from both sites exhibit a persistent mode at about 85 nanometers to 100 nanometers. This feature is more dominant in the Queens data than at Whiteface. The distributions also show small aerosol events characterized by the appearance of a second mode in the neighborhood of 25 nanometers, independent of location. This mode may appear as distinct from the main mode or may cause the distribution to broaden and have a flat peak. The amplitude of these modes in the Queens data is close to the size of the persistent mode but at White face, the amplitudes may be twice the size of the persistent mode. These characteristics are probably related to the differences in aerosol sources and secondary production as well as the rate of coagulation of small aerosols.

Distributions at Queens frequently have substantial concentrations at sizes larger than 1 micron. The mass concentration during these large particle episodes account for the majority of the aerosol mass. Large particle events at Whiteface Mountain are rare and make a minor contribution to the total aerosol mass.

In both locations, departures of the size distribution from the average tend to occur during events which may be related to advection or local sources. In some cases these changes are clearly related to air mass changes. Diurnal changes are not clearly recognizable because they are masked by a ubiquitous background with a much longer time scale.

Future analysis will concentrate on the incorporation of other data which may provide information on aerosol formation processes. A more detailed analysis of the meteorological data, particularly on a local scale, may provide information on other influences on the size distributions at these sites.

[P10-10] CONTINUOUS MEASUREMENT OF THE ATMOSPHERIC AEROSOL PARTICLE SIZE DISTRIBUTION AT THE ST. LOUIS-MIDWEST SUPERSITE.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

In this paper, we present the design and performance of the instrument system which has been used to measure continuously the particle size distribution of atmospheric aerosols at the St. Louis-Midwest Supersite. We then provide a brief summary of observations during Year 1 of the program (April 2001-April 2002).

We used two scanning mobility particle sizers (SMPSs) and two optical particle counters (OPCs) to cover the 3 nm to 10 μm diameter range. The four instruments operated synchronously and completed 10 measurements every hour. At the beginning of every hour, 10 minutes were spent to measure the responses of the OPCs to 450-nm atmospheric particles selected by a DMA. We found that OPC responses varied with time, due to variabilities in particle composition (and therefore refractive index). We also found that 450 nm mobility diameter particles included an external mixture of "dark" and "bright" particles. The relative humidity of sampled aerosols was controlled and set at 40% before introduction into the instruments. Measurements with the four instruments overlapped in several size ranges, and data in those overlapping ranges were used for measurement quality assurance as well as to identify problems with instrument operation.

In Year 1, the average total number concentration was 4.0×10^4 particles cm^{-3}. Particles from 3 nm to 10 nm made up about a half of this concentration. The concentration below 10 nm was impacted significantly by particle bursts during which the concentrations were as high as ~10^5-10^6 cm^{-3} and which were observed quite often, about 10 days per month throughout the year. The season-averaged total number concentration was lower in summer than in winter, i.e. 3.2×10^4 cm^{-3} in June-August and 4.3×10^4 cm^{-3} in December-February. The daily-averaged number concentration was almost the same on weekdays and weekends. Averaged number concentrations varied diurnally, however; the minimum value of ~2.5×10^4 cm^{-3} was observed at 2-3 a.m., and concentrations increased almost linearly to the daily maximum of ~7.0×10^4 cm^{-3} at 10 a.m., and gradually decreased toward the minimum at 2-3 a.m. This diurnal pattern for the entire size range was dominated by that of particles of ~30 nm and smaller, which reflected the observation that the aforementioned burst events occurred most frequently at around 10 a.m. In contrast, above ~30 nm, the number concentration was almost constant throughout the day, although the period between 9:00 and 18:00 had slightly reduced concentrations in the particle size range between ~30 and ~200 nm compared to the rest of the day.

[P10-11] AEROSOL NUMBER-SIZE DISTRIBUTIONS AT AN URBAN LOCATION: LONG TERM DATA FROM SEATTLE, WA. PARTICULATE MATERIAL CENTER, CENTRAL MONITORING SITE.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

The aerosol number-size distribution from 20nm to 5μm diameter has been measured nearly continuously for two years to produce a representative time series of urban data for incorporation into health effect studies and chemical transport models. The site is located near the confluence of major interstate freeways and local traffic arteries, within a few kilometers of an industrial zone, a major shipping port and the central downtown area of Seattle. Meteorological and aerosol chemistry and optics data are collected at the site including 24-hr filter samples, air toxics samples and 15 minute time resolution, mass, sulfate, nitrate and organic material concentrations.

The data have been processed to determine the mean concentrations, diameters, and standard deviations of the number- surface- and mass-size distributions for up to four log-normally fitted modes within the measured size range. The fitting routine minimizes the residual between the measured concentration as a function of size and the fit values simultaneously for the three moments of the distribution rather than for each moment individually. Fitting individual moments often leads to inconsistencies in the output size distributions which in the atmosphere were single valued. The modes are generally associated with the ultrafine, accumulation and coarse size intervals, 20 to 100nm, 100 to 1000nm and 1μm to 5μm respectively. Time series and time correlation analyses show the cyclic nature of some of the modes and features of the distribution on a diurnal and weekly basis. An initial analysis of 2 months of size, gas phase and meteorological data from the site during the winter season showed that subsets of the size distribution could be attributed to four specific source types through Positive Matrix Factor and UNMIX analysis. The identified source types were diesel and gasoline combustion, wood smoke, and secondary aerosol. Results from other seasons which include photochemically active air masses in the Summer months and periods of air stagnation in the Autumn, show different size distributions and different time variation.

[P04-68] CHARACTERIZATION OF FINE PARTICULATE MATTER ($PM_{2.5}$) IN CENTRAL AND SOUTHEAST OHIO.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (8:00 AM-9:00 AM) Grand Ballroom 2-4

This study presents results from a project on chemical characterization of fine particulate matter ($PM_{2.5}$) measured at three elementary schools in central and southeastern Ohio. The project supported a comprehensive health based study completed by Ohio University. $PM_{2.5}$ aerosol samples were collected from outdoor monitors and indoor samplers at each monitoring location for the period of February 1, 1999 through August 31, 2000. The locations included a rural elementary school in Athens, Ohio, and two urban schools within Columbus, Ohio. The collected samples were analyzed at Texas A&M University - Kingsville using an ion chromatography unit and x-ray fluorescence spectrophotometer. Concentrations of Cl^-, NO_3^-, SO_4^{-2}, PO_4^{-3}, Li^+, Na^+, NH_4^+, K^+, Mg^{+2}, Ca^{+2}, Si, P, S, Cl, K, Ca, Ti, Co, Ni, V, Mn, Fe, Cu, and Zn were determined for each site. A mass balance analysis of the major chemical components was conducted. Approximately 22-25% of the total reconstructed $PM_{2.5}$ mass was sulfates. Other abundant components included nitrate, chloride, ammonium, and sodium ions as well as calcium, silicon and iron. Elemental carbon and organic compounds were not analyzed for this study. The average $PM_{2.5}$ concentrations did not show any significant spatial variations among the three sites indicating homogeneity in the spatial distribution of $PM_{2.5}$ in Ohio. The average indoor $PM_{2.5}$ mass values were higher than the average outdoor mass concentrations. $PM_{2.5}$ and its major component, sulfate ion, showed strong seasonal variations with maximum concentrations observed during the summer months at all three sites. $PM_{2.5}$ concentrations tended to increase with rising temperatures and dropped with increasing wind speeds. High $PM_{2.5}$ concentrations were generally observed when the wind speed was lower than 8 mph and temperature was higher than 70°F. $PM_{2.5}$ concentrations were highest when the winds were blowing from the south and southwest directions at all three sites. This suggested the impact of pollutants transported from the Ohio river valley region. Results from a preliminary outdoor source apportionment using principal component analysis technique showed impact from broad source categories such as industrial, geological, and fossil fuel combustion sources.

[P04-66] FREQUENCY DISTRIBUTIONS AND SPATIAL ANALYSIS OF FINE PARTICLE MEASUREMENTS IN ST. LOUIS DURING THE REGIONAL AIR POLLUTION STUDY / REGIONAL AIR MONITORING SYSTEM.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 4d: Sampling and Analyzing PM - Spatial and Temporal Variation for PM and Precursors (8:00 AM-9:00 AM) Grand Ballroom 2-4

The concentrations of particulate matter (PM), its components, and source contributions analyzed by Hopke et al. (companion poster: Source Identification of Aerosol Measured at Multiple Sites across St. Louis) were determined. The purpose of this study is to characterize the spatial variability in these parameters. PM samples were collected at ten monitoring sites across St. Louis, MO between May 1975 and April 1977 during the Regional Air Pollution Study / Regional Air Monitoring System (RAPS/RAMS). A number of metrics were used to evaluate the degree of spatial heterogeneity in these parameters. These include: Pearson correlation coefficients, calculations of differences between sites, geometric means and standard deviations following Kao and Friedlander (1995. Environ. Sci. Technol. 29, 19-28). S is the most highly correlated element among all the sites, reflecting in large part its secondary nature. Correlation coefficients for other elements show a great deal of variability. A comparison of geometric mean values at the different sites clearly shows the importance of nearby discrete point sources for elements other than S. Several pairs or groups of elements have similar spatial characteristics, which indicates that these pairs or groups of elements originate from the same sources. The overall geometric standard deviation of PM mass, Si, S, K, Ca, Cr, Fe, Br, and Pb is 2.06 ± 0.21 shows reasonable agreement with 1.85 ± 0.14 from previous study for California aerosols (Kao and Friedlander, 1995). The geometric standard deviations of Ti, Mn, Cu, and Zn are higher than the others: 3.29, 2.79, 3.80, and 2.70, respectively, which suggest the presence of multiple sources that give rise to the observed broad or multimodal distributions Since these results for trace elements were derived for a 10 site network, the result also may mean that there are substantially different distributions of concentrations at different locations within a given airshed. The above results suggest that there is a significant potential for exposure misclassification when regressing health outcomes against calculated source contributions. The characteristics of the St. Louis aerosol during the RAPS/RAMS study will also be compared to the aerosol characteristics of other urban areas.

[P10-04] REAL-TIME PM MEASUREMENTS WITH OUTDOOR AIR ELPI.

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Thursday, April 3, 2003, 8:00 AM, Poster Session 4: Workshop 10: Measurement of Particle Size (Ultrafine, Fine, and Coarse) (8:00 AM-9:00 AM) Grand Ballroom 2-4

Electrical Low Pressure Impactor (ELPI, Dekati Ltd.) measures particle size distribution and number concentration in real-time. The operation is based on charging, inertial classification, and electrical detection of the aerosol particles. The particles are first led through a unipolar diode charger where the particles are charged by the ions produced in a corona discharge. After the charger the particles are size classified in a low pressure impactor into 12 size fractions in the size range of 0.03-10 mm. The impactor stages are electrically insulated and the current signal from each stage is measured using sensitive electrometers (Keskinen et al., 1992). Using particle size dependent relations describing the properties of the charger (Marjamäki et al., 2000) and the impactor (Hillamo et al., 2002) the current values are converted into a particle number size distribution.

Outdoor Air ELPI is a stand-alone version of the standard ELPI developed to meet the needs of continuous ambient air measurements. High sample flow rate, 30 lpm, is used to increase the sensitivity of the instrument. The suitability of the instrument to measure PM2.5 mass size distribution of airborne particles was studied. Special focus was on the effect of humidity and particle density on the results.

Humidity affects the particle mass results in ELPI because the instrument operates on real-time basis and most of the airborne particles are hygroscopic. A sample conditioning unit consisting of a temperature controlled sampling line, instrument casing and sample dryer was used to dry the aerosol sample. Field tests were made to compare the results with other methods. With the sample conditioning unit a good correlation with other instruments was found. Outdoor Air ELPI is capable of measuring typical atmospheric aerosols. Instrument has wide size range and good time resolution. Sample humidity has effect on the particle size distributions and it must be considered when comparing results with other instruments.

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[P13-15] A DIRECTIONAL PROFILE APPROACH TO SOURCE-RECEPTOR MODELING.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 13: Receptor Modeling and Source Apportionment (11:00 AM-12:00 PM) Grand Ballroom 2-4

As qualitatively observed in previous studies, a major source of pollutants transported to the NETL sampling site, located in a suburban area 20 km southwest of Pittsburgh, PA, originate from the general direction of the Ohio River Valley to the west and southwest of site. A quantitative directional source profile approach was investigated to model the source / receptor relationship among these remote sources and local sources. Directional source profiles are $PM_{2.5}$ compositional profiles measured at NETL when the geographic origin of the plumes reaching the NETL sampling station was known with reasonable certainty. The CMB8 and UNMIX models were applied to test the hypothesis that directional source profiles could be developed to determine directional apportionment of $PM_{2.5}$ transported into the region.

Initial directional source profiles were developed from a combination of inorganic compositional data from PIXE analysis and elemental carbon / organic carbon (EC/OC) analysis of NETL $PM_{2.5}$ samples from August 2000. The directional source profiles developed from the regression slopes are plotted in Figure 1. (Click to see figure 1) Figure 2. is an example of the CMB8 model results for the distribution of all species, including the primary inorganic + elemental carbon material for August 2000. The amounts of primary $PM_{2.5}$ attributed to sources from different geographic directions are illustrated in the small chart in the bottom right of this figure. (Click to see figure 2) Further data analysis and modeling efforts are underway with an expanded data set to further characterize and clarify the source / receptor relationships.

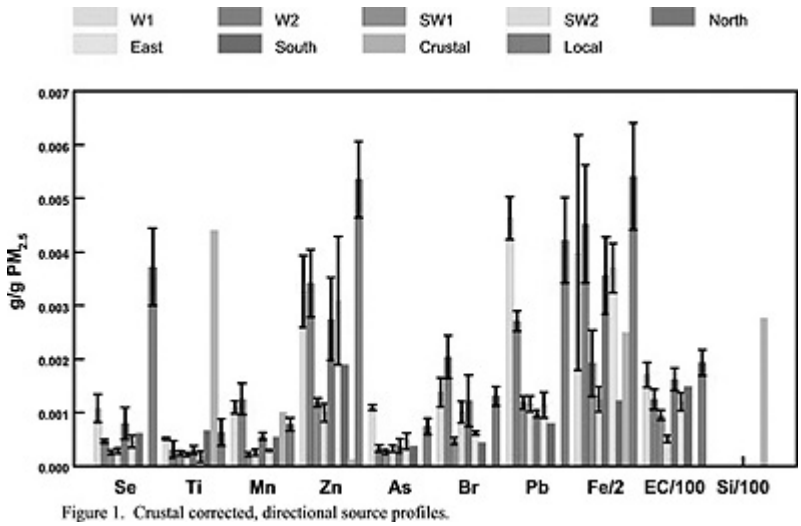

Figure 1. Crustal corrected, directional source profiles.

Figure

[P13-15] A DIRECTIONAL PROFILE APPROACH TO SOURCE-RECEPTOR MODELING. (continued)

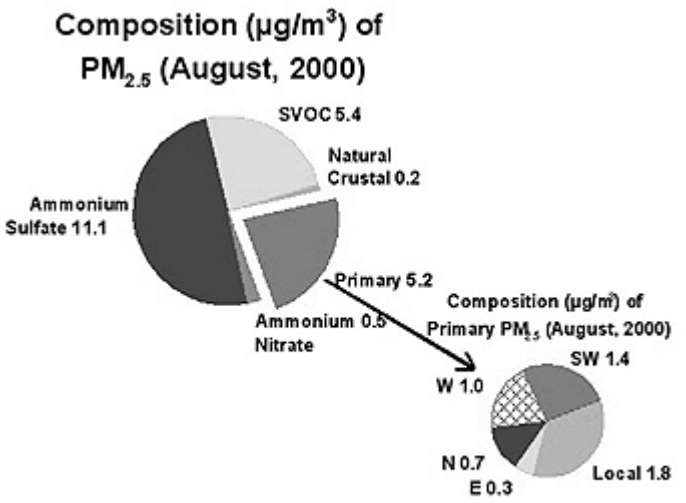

Figure 2. Average $PM_{2.5}$ during August 2000, with associated geographic source directions for crustal corrected primary particles (EC and inorganic)

Figure 1

[P06-12] FILTRATION EFFICIENCY OF A REPLICA OF THE HUMAN NASAL AIRWAYS.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (11:00 AM-12:00 PM) Grand Ballroom 2-4

The adverse health effects of airborne particulate matter (PM) exposure, particularly among sensitive subpopulations, have been recognized in recent years. To assess potential health risks from PM exposure, the initial deposition and subsequent clearance of inhaled material to sites in the lung must be estimated. Since the filtration of particles by the nasal passages strongly influences the amount of PM introduced to the lung, accurate assessments of nasal filtration are critical to the estimation of lung dose. Nasal filtration efficiency is also an important consideration when targeting therapeutic drug delivery to the respiratory tract following nasal administration of the drug. Although the filtration efficiency of nasal airway replicas has been studied previously, more work on the subject is warranted. Discrepancies exist among previous results, and several studies were limited by the use of cadavers in test airway manufacture. Moreover, previous studies focused on either ultrafine or fine and coarse aerosol deposition, whereas a single study of deposition for the entire range of respirable particles is desirable. The goal of this work was to measure the filtration efficiency of a replica of the nasal airways of a human for the respirable range of particle sizes and typical flow rates. A plastic replica of an adult male's nasal passages was manufactured by stereolithography using airway surface coordinate information obtained from MRI scans. The resolution of the digitized data was 1.5 mm. Monodisperse aerosols were generated in the size range of 0.03-10 μm. Aerosols consisted of di-2-ethyl hexyl sebacate (DEHS) droplets formed from larger primary particles produced from a DEHS and ethanol solution. The filtration efficiency of the nasal model was determined for nonoscillatory flows in the inspiratory direction. Filtration efficiency was determined by comparing particle concentrations measured upstream and downstream of the test airway. Flow rates of 20, 30, and 40 LPM, which correspond to slow, normal, and fast breathing rates, were used. For particles < 1 μm, filtration efficiency reached a minimum value of less than a few percent for particle sizes ranging from 0.1 to 1 μm. For particles > 1 μm, filtration efficiency increased from minimal to nearly 100% with increasing particle size and flow rate. The filtration efficiency for particles > 1 μm for different flow rates formed nearly a single curve when plotted as a function of particle inertia. This result indicates that deposition for these particle sizes and flow conditions is dominated by the inertial impaction mechanism.

(Research supported by Bespak Europe Ltd)

[P15-19] EXAMINING FACTORS THAT INFLUENCE THE POTENTIAL FOR CONFOUNDING IN PM EPIDEMIOLOGY.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Introduction: Strong associations between ambient particles and gases have raised concerns about the potential for confounding by gaseous pollutants in epidemiological studies of particulate matter. Single-pollutant studies of gaseous exposures, however, have found weak associations between personal and ambient concentrations, indicating that ambient gas concentrations are poor surrogates of their own exposures. In a recent multi-pollutant study, ambient gases were found to act as surrogates of personal PM and not personal gas exposures (Sarnat et al. 2001). Together, results from these studies suggest that ambient co-pollutants cannot confound PM-associated health effects. We examine this issue further using data from a panel study of older adults in Steubenville, OH and identify factors that could modify the potential for confounding. **Methods:** Data were collected in summer and fall 2000. 25 participants (non-smokers; age 65+) were recruited from 3 apartment buildings in downtown Steubenville; a few participants lived in single-family homes. 24-h PM ($PM_{2.5}$, SO_4^{2-}, EC) and gas (O_3, NO_2, SO_2) measurements were made inside each participant's home twice each week. Corresponding personal particulate and gaseous measurements were also made for a subset of 10 participants. Indoor follow-up questionnaires and time-activity diaries were collected for each indoor and personal sample. Daily outdoor measurements were taken on the roofs of two apartment buildings as well as at a central site. The relationships among personal, indoor and outdoor levels of the measured pollutants were examined using regression techniques that account for the repeated measures structure of the data. **Results:** Ambient PM was significantly associated with ambient O_3 in summer and ambient NO_2 and SO_2 in fall. Similar associations were found between indoor PM and indoor O_3 and NO_2. Univariate analyses of ambient pollutants and their respective indoor levels showed highly significant relationships for all pollutants, except for SO_2 in summer. Home ventilation was found to influence the indoor-ambient relationships significantly for PM in both seasons, for O_3 in the summer, and for NO_2 and SO_2 in the fall. Slopes of indoor-ambient regressions were significantly higher in well-ventilated environments (PM slope: 0.86±0.03) as compared to poorly ventilated environments (PM slope: 0.54±0.05). Building of residence was also found to be an important modifier of the indoor-ambient association. Future analyses will expand these analyses to include examination of the personal-outdoor association and of other building related factors and time-activity patterns.

[P09-07] INFLUENZA AND AIR QUALITY: A TIME-SERIES ANALYSIS OF WEEKLY MORTALITY IN LONDON RELATIVE TO THE MAJOR AIR POLLUTION EPISODES OF THE 1950s.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 9: Regional, Seasonal and Temporal Factors in Health Effects (11:00 AM-12:00 PM) Grand Ballroom 2-4

The London air pollution disaster of December 1952 has recently received renewed attention, in part because of a recent paper that claims a death toll much higher than that reported by the original publications of the time. At issue is whether the excess mortality seen in the three months following the episode should be attributed to delayed air pollution effects or to sequellae of influenza, since a flu epidemic was experienced in the south of England in early 1953 (although influenza was not then an officially reportable infectious disease) and such epidemics may trigger excess mortality from other causes.

This question is addressed through time-series analysis, based on published weekly data from late 1949 to 1958, a period during which 5 additional major air pollution episodes were reported. The analysis uses air quality data from these episodes, reports of influenza deaths, and seasonal adjustments based on weekly sequence numbers, as a means of separating air pollution from influenza effects. The influenza effects are based on data from England and Wales, which show that total deaths associated with flu are about 3.5 times those actually coded as flu. These national flu deaths are then used as a surrogate for London flu deaths, a paradigm that was highly statistically significant.

Major findings from this analysis include:

Flu epidemics occurred regularly during this period, often biennially, but varying in severity and the hardest-hit locations. This periodicity makes it problematic to assess pollution effects solely by contrast with the previous year.1

The apparent delayed (lag) effects of air pollution depend on how well seasonality is controlled in the regression model. Evidence for a 1-week lag effect is strong, but any additional lag effects up to 9 weeks are small or negative. Such negative effects suggest mortality "harvesting."

The absence of persistent excess mortality after the 1952 "Great Fog" is consistent with the relatively constant annual mortality rates reported for the 1950s in London.

The pollution regression coefficients are consistent with others based on daily time-series methods (0.2% excess deaths per 10 mg/m3 smoke; 0.16% excess deaths per ppb SO2). Using the coefficient for a 2-week period and the average SO2 level over (assumed) background yields an excess mortality of about 3900 deaths for the London Administrative County, from 1949-58, or about 1.1%. The same model predicts total influenza deaths of 9500 (2.6%) for the period.

[P09-06] WITHDRAWN

Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 9: Regional, Seasonal and Temporal Factors in Health Effects (11:00 AM-12:00 PM) Grand Ballroom 2-4
WITHDRAWN

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[P09-05] RESPIRATORY ALLERGY AND INFLAMMATION DUE TO AMBIENT PARTICLES - A EUROPEAN-WIDE ASSESSMENT (RAIAP).

Erik Dybing, Flemming R Cassee, Konrad Rydzynski, Marco Martuzzi, Martinus Lövik, Per E Schwarze, Peter A Steerenberg
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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 9: Regional, Seasonal and Temporal Factors in Health Effects (11:00 AM-12:00 PM) Grand Ballroom 2-4

The overall objective of this multinational project in 2001-2004 is to assess the role of ambient suspended particles (PM) in causing local inflammation in the respiratory tract and in induction and elicitation of respiratory allergies, in order to understand the underlying mechanisms for involvement of particles in the development of these diseases.

Coarse (PM10-2.5) and fine (PM2.5-0.1) particles were collected during 4-6 week periods during spring, summer and winter in Amsterdam (NL), Rome (I), Lodz (PL) and Oslo (N), as well as from a Dutch sea-side background site. Samples were collected using a high-volume (900 litres/min) cascade impactor. During the same time periods samples were collected by low-volume sampling for electron microscopic characterisation. Chemical analyses from the high- and low-volume PM samples included inorganic ions, metals, PAHs and traffic markers (hopanes, steranes).

The collected samples are being screened for allergenic potential using the popliteal lymph node assay and measurement of total IgE-production in mice. Human lung cell cultures and primary rat macrophages and type 2 cells are being screened for respiratory inflammation potential by studying cytokine release from the cells.

Verification of allergenic potential of samples is carried out using a mouse ovalbumin model after intranasal application. Studied parameters include antibody response (IgE), eosinophils and cytokines in bronchoalveolar lavage as well as phagocytic activity in macrophages. Inflammation verification is studied in a rat model after intratracheal instillation of samples. Inflammatory parameters include determination of Clara cell protein, albumin and neutrophils in lavage fluid, as well inflammatory reactions studied by histopathological methods.

Later mechanistic studies will focus on modulation of molecular and cellular functions of the immune system, of signalling pathways in lung cell cultures and of immune responses in the respiratory system.

The project will end with a workshop summarising the scientific knowledge on the role of ambient particles for respiratory allergies and the implications of this knowledge for regulators, the general public and industry.

Contract number: QLRT-2000-00792. http://www.raiap.org

[P09-04] QUALITATIVE DIFFERENCES IN PARTICULATE AIR POLLUTION AT DIFFERENT LOCATIONS THROUGHOUT EUROPE.

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Given the widely different prevalence rates of respiratory allergies and asthma between the countries of Europe and the substantial exposure to ambient particles in urban environments, the EU project Respiratory Allergy and Inflammation Due to Ambient Particles (RAIAP) project aimed to relate the chemical composition of collected ambient particulate matter (PM) to different health end-points. PM samples were collected in urban areas in Amsterdam (NL), Rome (I), Lodz (PL) and Oslo (N), as well at a Dutch sea-side background site over a 4-6 week period during spring, summer and winter. High-volume (900 litres/min) cascade impactor technology for simultaneous sampling of ambient air coarse (PM10-2.5) and fine (PM2.5-0.1) particles on large-capacity polyurethane foam (PUF) substrate was used. A multiple chemical analyses was performed on these two size fractions focused on inorganic ions, metals, polycyclic aromatic hydrocarbons and traffic markers (hopanes and steranes, constituents of diesel oil and lubricants).

Levels of PAHs were high in samples collected in Lodz in the cold seasons, and which was less evident in samples collected in Oslo. Steranes and hopanes, indicators of traffic emissions, were generally higher in the fine than the coarse mode, but were still substantial in the latter. The contribution to the total mass varied for the different locations though was in general higher in the winter. Sulfates in the fine fraction were markedly higher in Amsterdam compared to the other locations. This contrast was not observed for the coarse mode. Relatively high levels of potassium, iron and aluminum (indicators for crustal material) were measured in the Rome samples, whereas zinc levels were markedly higher in the fine mode samples collected in Lodz. Although the collection and pretreatment method might alter the samples slightly the results show that distinct differences are present among PM fractions collected at various locations and seasons. The samples will further be screened for the adjuvant allergic activity and capacity to induce respiratory inflammation.

[P09-03] SEASONAL AND SPATIAL VARIABILITY OF THE SIZE-RESOLVED CHEMICAL COMPOSITION OF PM2.5 IN THE LOS ANGELES BASIN.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 9: Regional, Seasonal and Temporal Factors in Health Effects (11:00 AM-12:00 PM) Grand Ballroom 2-4

Previous studies of PM2.5 size-resolved chemistry in the Los Angeles Basin (LAB) have included only a few days or weeks of sampling. In order to provide a more complete picture of LAB aerosol characteristics, more extensive sampling is needed. As part of the routine sampling activities of the Southern California Supersite, one 24-hour size-fractionated PM2.5 impactor sample is collected and analyzed each week. The mobile sampling trailer was moved to different locations in the Los Angeles Basin over the approximately two years of continual sampling. The sites (and corresponding dates) are Downey (10/00 - 2/01), Riverside (2/01 - 6/01), Rubidoux (6/01 - 9/01), Claremont (9/01 - 7/02), and Downtown Los Angeles/University of Southern California (9/02 - present). Micro-orifice uniform-deposit impactors (MOUDIs) collect particles in the following size bins: 1.0 - 2.5 μm; 0.56 - 1.0 μm; 0.32 - 0.56 μm; 0.1 - 0.32; and <0.1 μm. Samples are collected on aluminum and Teflon substrates and analyzed for gravimetric mass, sulfate and nitrate by ion chromatography, and elemental and organic carbon by thermal evolution/optical transmission analysis. High organic and elemental carbon levels in the smaller particles were observed in the upwind sites which are strongly influenced by vehicular emissions. The highest concentrations of nitrate were found in the larger particles at the inland, downwind sites during the warmer months when photochemical secondary particle formation occurs. Correlations within size bins for the different chemical components are also presented.

[P09-02] ISSUES IN THE USE OF SOURCE-ORIENTED PARTICULATE MATTER INDICES FOR AIR POLLUTION EPIDEMIOLOGY.

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Particulate matter (PM) is a chemically non-specific pollutant, and may originate or be derived from different emission source types. Thus, its toxicity may well vary depending on its chemical composition. If the PM toxicity could be determined based on source types, the regulation of PM may be done more meaningfully. A large number of monitors started collecting chemical speciation data from $PM_{2.5}$ filters starting 2000-2001 in the U.S. The data from this chemical speciation network may be useful for source-oriented evaluations of PM health effects. Current approaches in such investigations compute factor-analysis (or its variants) derived PM or air pollution indices, and include them in time-series health effects regression models. While such approaches have merit, there are several issues that need to be considered in the analysis and interpretation of these data. One major issue is a monitor's representation of regional, sub-regional, and local air pollution exposures to the population in a city or metropolitan area. Because health outcomes in time-series air pollution epidemiological studies are aggregated over a wide geographical boundary, the regional pollution may have smaller \\"error\\" in exposure estimates than does local pollution. Under such a condition, the relative significance of associations between health outcomes and various \\"source-oriented\\" pollution indices may not necessarily reflect the source's relative toxicity, due to their differing relative error (spatial variation and analytical uncertainty) in representing population exposure estimates. We examined this issue using newly available speciation data from multiple cities. For example, the speciation data from three monitors (a few miles apart) in New York City during 2001-2002 period showed that the correlations among the three monitors for sulfate (regional secondary aerosol) were higher (0.92 to 0.99) than those for sub-regional soil related element, Si, (0.77 to 0.49), or elemental carbon (0.22 to 0.52), which can be strongly influenced by local traffic patterns. Factor analyses of these data from three monitors also suggest that regional or sub-regional factors are more stable than factors that appear to reflect more local impacts. The implication of these monitor-to-monitor differences in source-specific exposure spatial representativeness on health effects analyses results are illustrated using 2001 elderly hospital admission data.

This work has been funded by the United States Environmental Protection Agency STAR grant R82799701 and PM Center grant R827351, but may not reflect EPA policy.

[P09-01] HOW CAN SOURCE APPORTIONMENT AND RECEPTOR MODELLING DATA BE USED IN EPIDEMIOLOGY?

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Human health effects models based on pollution sources have been proposed as easier to fit and interpret, and more relevant for public health and regulation. We will show that the first of the claims is not entirely correct.

Measurement error in the concentrations of chemical species or size fractions will often be well approximately by a classical additive independent error model. The estimates from a source apportionment model, however, have very complicated non-independent errors due to both the original measurement error and uncertainty in the model.

We will describe possible approaches to this estimation problem. One approach is to regress health outcomes on the concentrations of chemical species, where standard measurement error correction methods are applicable, and then apply an estimated source apportionment model to convert these health effects to the scale of interest. Another approach, when replicate measurements of chemical species are available, is to use instrumental variable methods from econometrics.

[P06-19] DEVELOPMENT OF URINARY METABOLITE BIOMARKERS TO ASSESS POPULATION EXPOSURE TO PM2.5 FROM VARIOUS COMBUSTION SOURCES.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (11:00 AM-12:00 PM) Grand Ballroom 2-4

A primary goal of our research is to validate the use of urinary biomarkers to apportion the sources of human exposure to PM2.5. Organic source tracers have been used in source apportionment studies of ambient PM2.5 to distinguish a range of combustion sources. Both gas and particle-phase organic tracer species have been used as biomarkers of exposure to combustion sources. The nicotine urinary metabolite, cotinine, is an example of a well-validated biomarker of exposure to tobacco smoke that has been successfully used in large population studies. Polycyclic aromatic hydrocarbons (PAH) and their urinary metabolites have been used as exposure markers for combustion sources including traffic and coal sources. Levoglucosan (1,6 -anhydro-β-D-glucose) found in particles and methoxyphenols (lignin combustion products found in both gas and particle phase) are source tracers for woodsmoke. Levoglucosan is a conserved and stable organic tracer for ambient exposure measurements. Methoxyphenols, although less stable when collected on filters, are metabolized and excreted as urinary metabolites. In ongoing ambient and personal exposure studies in Seattle, where woodsmoke and mobile sources (diesel and gasoline) are the major sources of PM2.5, both organic and inorganic source tracers are measured in personal, indoor and outdoor filter samples. Urinary samples are collected and metabolites of these source tracers are measured using GC/MS and HPLC. Validation studies include 1) correlating the exposure to methoxyphenols, levoglucosan and PAH in home-indoor and home-outdoor samples, and 2) examining the relationship between exposure to levoglucosan and PAH in personal air samples and excretion of methoxyphenols and PAH metabolites in urine. Initial studies are examining the time course of exposure and excretion over 10 day sampling periods in susceptible and normal populations. These studies have been conducted in subjects (n=6) that experienced a range of PM2.5 exposure variations over the 10 day period. Mean home-outdoor PM2.5 concentrations for these subjects were 18.8 $\mu g/m^3$; (range 5.0-41.5 $\mu g/m^3$), and mean home-outdoor levoglucosan concentrations were 501 ng/m^3; (range 88-1214 ng/m^3). Studies to determine the half-life of these urinary metabolites are also in progress. *This work has been funded by the U S EPA (Cooperative Agreement #R827177 & EPA Northwest Research Center). It has been subjected to Agency review and approved for publication.*

[P06-18] HEALTH EFFECTS INDICATORS IN HUMAN LUNG IN RELATION TO PARTICLE CONCENTRATION AND METAL CONTENT.

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Little information exists about retained particle/metal burden in human lung and associated health effects. We have shown that anatomical remodeling of the terminal and respiratory bronchioles occur at sites of carbonaceous and mineral dust deposition. We extend the value of these findings by providing information on lung particle and metal content in relation to indicators of effect as classified by standard diagnostic criteria for 1) chronic bronchitis 2) asthma 3) mineral dust disease and 4) smoking-related disease. Lung autopsies were examined from 40 male Hispanics from the Central Valley of California who had died from non-respiratory related causes. Computer-controlled scanning electron microscopy was used to determine particle concentration (No.particles/cm2 sample area/mg ashed tissue) and inductively coupled plasma emission spectrometry for metal analysis. Lung samples w/wo indicators of effect were compared. Significant ($p < 0.05$) fold increases in no. of particles was observed for indicators of mineral dust disease (4.0X); lymph node fibrosis (2.0X) smoking related disease (2.2X). In contrast, no. of particles were (1.6X) lower in samples with indicators of an asthma effect. All samples,. irrespective of disease state, >90 % of the 24,000 particles analyzed were < 2.5 m in diameter, 70 % < 1 m and 42 % <0.5 m. Significant inter-individual variability in metal concentrations was observed. Ti, V and Mn concentrations were significantly ($p < .05$) elevated in mineral dust disease and lymph node fibrosis. Consistent with tobacco contaminants, significant fold increases were shown for Ni (2.9X), Cr (3.6X), and Cd (4.6X) respectively, in samples with indicators of smoking related disease. Elevated metal concentrations were not observed in asthmatic lung tissue. We recently applied PIXIE analysis, monitoring) by adapting the procedure for tissue analysis to provide important data relative concentrations Si. Determining the fate/dose of particulates in humans is essential for predicting health effects and elucidating the mechanisms by which particles cause these effects. Our data support the association between particulate exposure and increased risk of lung disease. Microdissection, histology and evaluation of tissue changes coupled with characterization and measurement of internal particle/metal burden provide a means toward establishing dose levels and anatomical sites in human lung required to produce adverse health outcomes.

[P06-17] RISK FACTORS ASSOCIATED WITH INCREASED FINE PARTICLE DEPOSITION IN HEALTHY CHILDREN.

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Inter-child variability in particle deposition may contribute to variability in observed morbidity associated with inhaled particulate air pollution. We have measured fractional deposition (DF) of fine particles (2um monodisperse, carnauba wax particles) in healthy children, age 6-13 (n=36) while they followed a breathing pattern previously determined by respiratory inductance plethysmography (i.e. that child's spontaneous pattern at rest). Breath-by-breath DF (ratio of particles not exhaled/total particles inhaled) was determined by photometry at the mouth. The variation in DF among the children was most strongly predicted by their tidal volume (Vt) ($r = 0.79$, $p < .001$). Multiple regression analysis further showed that Vt was predicted by age, height and body mass index (BMI), i.e. at any given age and height, Vt increased with increasing BMI ($p = 0.001$). The most obese children (>90th percentile BMI) (n=10) had twice the DF of those in the lowest BMI quartile (<25th percentile) (n=9), 0.28+/- 0.11 vs. 0.15+/-0.06 respectively, $p < 0.01$. In the same groups, resting minute ventilation (Ve) was also significantly higher in the obese children, Ve = 8.1+/- 2.1 vs. 5.9+/-1.1 L/min, $p = 0.01$. Consequently, the rate of deposition, Drate (i.e. particles depositing/time), in the obese children (proportional to the product of DF and Ve) was 2.8 times that of the leanest children ($p = 0.01$). Among all children Drate was significantly correlated with BMI ($r = 0.46$, $p = 0.004$). These results suggest obese children may be at increased risk associated with the inhalation of pollutant particles in ambient air. This is an abstract of a proposed presentation and does not necessarily reflect EPA policy.

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[P06-16] NASAL UPTAKE OF FINE PARTICLES: EFFECT OF AGE, RACE, AND GENDER.

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The nose acts as a partial filter to prevent penetration of particles to the lower respiratory tract. Nasal efficiency for removing fine particles may be affected by variations in nasal structure associated with age, race, and gender. In healthy children (age 6-13, n=22) and adults (age 18-31, n=22) we measured the fractional deposition (DF) of fine particles (1 and 2um MMAD) for oral and nasal breathing using individual breathing patterns measured by respiratory inductance plethysmography during a graded exercise protocol. DF for both nasal and mouth breathing were measured separately by laser photometry at the same tidal volume and breathing rate for resting and light exercise (20% max work load) conditions. From these DF measures, nasal deposition efficiency (NDE) was calculated for each condition. We found that NDE for 2um particles was significantly less in the children vs. adults for their light exercise ventilation patterns, 0.25+/-0.14 vs. 0.37+/-0.14 respectively, $p<0.01$. For light exercise conditions in adults, NDE for both 1 and 2um particles was less in African Americans vs. Caucasians, 0.15+/-0.07 vs. 0.24+/-0.11 for 1um ($p = 0.03$) and 0.29+/-0.13 vs. 0.44+/-0.11 for 2um ($p = 0.006$). Finally, females tended to have lower NDE than males with a significant difference found under resting conditions for 2um particles, 0.12+/-0.07 vs. 0.27+/-0.12 for females vs. males respectively ($p=0.002$). These results suggest that, due to less efficient nasal uptake of particles, the lungs of children, African Americans, and females may be exposed to higher concentrations of inhaled, ambient particles than their counterparts. This is an abstract of a proposed presentation and does not necessarily reflect EPA policy.

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[P13-13] DETERMINATION AND CHARACTERIZATION OF THE AIR POLLUTION SOURCES IN BEIJING.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 13: Receptor Modeling and Source Apportionment (11:00 AM-12:00 PM) Grand Ballroom 2-4

The source characteristics of three major criteria pollutants, PM10, SO2 and NOx, were analyzed for Beijing according to the emissions, their contributions to the ambient air concentrations. Based on a series of field measurements, source investigation and model calculation, the sectoral share of the emissions and their contributions to the air concentrations of 1999 was determined for those three pollutants. It was found that the fugitive sources (emission shared 38%, air quality contributed 26%) and the industrial sources (emission shared 28%, air quality contributed 11%) were the primary local sources of PM10 in Beijing. The heating boilers (emission shared 26%, air quality contributed 36%) and the industrial sources (emission shared 24%, air quality contributed 29%) were the primary local sources of SO2.The vehicles (emission shared 35%, air quality contributed 64%) and the industrial sources (emission shared 26%, air quality contributed 11%) were the primary local sources of NOx. At the same time, the ambient air concentrations of the three pollutants of Beijing impacted by the regional pollution sources were also determined. It was found that the regional source contributed 47%, 26% and 14% to the ambient air quality of PM10, SO2 and NOx in Beijing respectively, which was one of the most important sources of Beijing and should be controlled together with the local sources. And also, the geographic distributions of the emission and their contribution were formulated for Beijing metropolitan area gridded by the size 1km x 1km. From those results, the Shijingshan areas, the south Chaoyang areas, the center urban areas and the main transportation roadways were found to be the seriously polluted areas, which should be controlled in priority.

[P06-13] PERFORMANCE OF A NEW MOBILE WHOLE BODY MOUSE EXPOSURE SYSTEM.

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A mobile whole body exposure system was developed for exposing mice to concentrated ambient particulate matter less than 2.5μm in mass median aerodynamic diameter (MMAD). The compact 20-liter exposure system was designed to simultaneously expose nine mice in individual compartments and enable transportation of the mice to various locations in the Los Angeles basin for acute exposure to concentrated ambient particulate matter. The performance of this exposure system was determined for 0.5 to 2.0μm aerosols by measuring, 1) uniformity of aerosol distribution, and, 2) particle deposition in the tracheobronchial and pulmonary region of mice exposed in the system, in order to detect particle losses to animals/system surfaces. The uniformity of particle distribution in the mobile exposure system is also being studied using computational fluid dynamic predictions.

A 0.6μm MMAD (GSD = 2.0) aerosol was used to experimentally measure the uniformity of aerosol concentration in each of the nine individual compartments. The average data from three runs showed no statistically significant difference among individual compartments. Particle deposition efficiency in adult male Balb/c mice was measured using monodisperse fluorescent polystyrene latex particles (0.5, 1, and 2μm aerodynamic diameter). Animals were exposed for 30 minutes and were euthanized immediately after exposure. First, the trachea was tied shut to prevent further clearance from the tracheobronchial airways and then the lung was removed. The lungs from all animals were pooled into one sample, homogenized and subsequently digested in NaOH. Fluorescent microscopy was used to count the monodisperse fluorescent particles in the digested lung fluid. The measured deposition efficiency in this mobile exposure system for the tracheobronchial and pulmonary region of the adult male Balb/c mice is: 21% for 0.5, 11% for 1.0, and 6.5% for 2.0μm particles respectively. These deposition efficiencies are similar to those predicted by mechanistic computer models, which indicates that particle losses to exposure system surfaces were acceptable.

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[P15-03] INDIVIDUAL PARTICLE ANALYSIS OF PERSONAL SAMPLES FROM THE 1998 BALTIMORE PARTICULATE MATTER STUDY.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

The United States Environmental Protection Agency (U.S. EPA) conducted the 1998 Baltimore Particulate Matter (PM) Epidemiology Exposure Study of the Elderly, the primary goal of which was to establish the relationship between outdoor PM concentrations and actual human PM exposures within a susceptible (elderly) sub-population. The study design included PM2.5 personal exposure samples obtained from elderly (65+ years of age) residents of an eighteen story retirement facility near Baltimore, Maryland. In addition, the personal exposure sampling devices were used to obtain PM2.5 samples at fixed locations within the personal monitoring subjects' apartments. Apartment residence and personal samples collected on Teflon® fiber filters were examined using scanning electron microscopy with individual-particle X-ray analysis (SEM/EDX) to provide a qualitative assessment of the chemical and physical characteristics of geological and trace element particles collected within these micro-environments at the retirement facility. Qualitative differences among the selected personal and apartment residence samples were observed. Differences between the paired personal and apartment samples indicate the localized nature of certain particle types.

[P06-11] LONG-TERM CLEARANCE KINETICS OF INHALED ULTRAFINE INSOLUBLE IRIDIUM PARTICLES IN THE RAT LUNG.

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Currently there is concern about translocation of ultrafine particles (UFP) from the lungs into systemic circulation and uptake in transpulmonary organs causing adverse cardio-vascular effects. While there are conflicting reports about short-term translocation and accumulation in liver ranging from about 50% (Oberdoerster et al., 2002) to 7% (Nemmar et al., 2001) to 0.5% (Kreyling et al., 2002), nothing is known about long-term translocation and whether clearance kinetics of ultrafine particles differs from that of larger particles as one may expect from differing clearance mechanisms for micron-sized versus ultrafine particles.

We have studied lung retention and clearance kinetics in 12 healthy male adult WKY rats over 6 months after a one-hour-inhalation of Ir-192 radiolabeled, insoluble, ultrafine 20 nm iridium particles. Whole body retention was followed by external gamma counting and particle clearance kinetics was determined by excretion radio-analysis. Four rats each were sacrificed after three weeks, two and six months; all organs as well as tissues and the carcasses were radio-analyzed to balance the entire deposited radioactivity of the particles.

The most prominant fraction was retained in the lungs at each time point of sacrifice (26%, 15%, 6%), respectively, and clearance out of the body was solaly in feces. Extrapulmonary particle uptake did not continue to increase but decreased with time in liver, spleen, heart and brain comparably to previous data obtained during the first seven days (Kreyling et al., 2002). UFP long term clearance rates (0.0082 d-1) derived from whole body measurements was comparable to previously reported data using insoluble micron-sized particles (0.01 - 0.007 d-1 (Bellmann et al. 1994)). However, a more detailed analysis including excretion data suggests a twofold faster particle clearance rate (0.016 d-1)of most of the ultrafine iridium particles towards the larynx with a very small fraction (0.05) being virtually not cleared at all.

[P06-10] INHALED ULTRAFINE CARBON PARTICLES CAN TRANSLOCATE TO THE CNS.

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Ultrafine particles (UFP <100 nm) are ubiquitous in ambient urban and indoor air from multiple sources and may contribute to adverse respiratory and cardiovascular effects of PM. Depending on their particle size, inhaled UFP are efficiently deposited in nasal, tracheobronchial and alveolar regions due to diffusion. In previous rat studies we have shown by electronmicroscopy and mass spectrometry that certain UFP translocated to interstitial sites (ultrafine PTFE particles) in the respiratory tract as well as to extrapulmonary organs such as liver (ultrafine carbon) within 4-24 hrs post-exposure. Small increases in the olfactory bulb of the Central Nervous System (CNS) were also measured by 24 hrs, however, they did not reach statistical significance, possibly because the post-exposure observation period may have been too short. Our objective in a follow-up study, therefore, was to determine translocation of ultrafine ^{13}C particles to regions of the brain. We hypothesize that UFP deposited on the olfactory mucosa of the nasal region will translocate along the olfactory nerve to the olfactory bulb thereby resulting in high increases in that region as opposed to other areas of the CNS. We generated ultrafine elemental ^{13}C particles (CMD = 36 nm; GSD = 1.66) from ^{13}C graphite rods by electric spark discharge in an argon atmosphere at a concentration of 160 $\mu g/m^3$. Rats were exposed for 6 hrs. by whole body inhalation, and lungs, cerebrum, cerebellum and olfactory bulbs were removed after 1,3,5 and 7 days. ^{13}C concentrations were determined by isotope ratio mass spectroscopy and compared to background ^{13}C levels of sham-exposed controls (day 0). The background corrected pulmonary ^{13}C added as ultrafine ^{13}C particles was 1.34 μg. This corresponds to a lung ^{13}C concentration of 1.39 $\mu g/g$ (day 1) which decreased to 0.59 $\mu g/g$ by day 7. There was a significant and persistent increase in added ^{13}C in the olfactory bulb with concentrations of 0.35 $\mu g/g$ (day 1) to 0.43 $\mu g/g$ (day 7), with respective ^{13}C levels of 30-40 ng per organ. Day 1 ^{13}C concentrations of cerebrum and cerebellum were also significantly increased but the increase was not always significant over the following days. We conclude from this study that the CNS can be targeted by inhaled ultrafine particles and that a neuronal route of translocation of nasally deposited ultrafine particles via the olfactory nerve may exist. Whether such translocation of inhaled UFP can cause CNS effects needs to be determined in future studies.

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[P06-09] DISTRIBUTION PATTERNS OF INHALED ULTRAFINE SILVER PARTICLES IN THE RAT LUNG.

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In general, alveolar macrophages play a key role in the fate of inhaled particles. However, it is speculated that ultrafine particles may not be readily detected and phagocytized by alveolar macrophages in the alveolar region, but instead directly enter the alveolar wall. To test this hypothesis, distribution patterns of inhaled ultrafine elemental silver (EAg) particles were investigated on the basis of morphology and ICP-mass spectrometry.

Methods: Male Wistar rats were exposed to ultrafine EAg particles, generated by a spark generator in an argon atmosphere, for 24 hours at a concentration of 180 $\mu g/ m^3$ ($3*10^6/cm^3$, 15 nm modal diameter). Up to 7 days, rats were serially sacrificed, and lavaged cells and lung parenchyma were examined ultramicroscopically. The Ag content in the lavage fluid and the lung after lavage was estimated by ICP-mass spectrometry.

Results: Elemental analysis detected 8 μg Ag in the whole lung immediately after the end of exposure (about 20 % of the estimated total inhaled cumulative dose). Even immediately after the end of exposure, 20 % only was detected in the lavaged fluid (pellet and supernatent). 80 % of Ag in the lung was not lavageable. On days 4 and 7, only 12 % and 3 %, respectively, were lavageable.

The amount of Ag in the whole lung decreased rapidly with time. Nevertheless, Ag particles were morphologically detectable in the alveolar septum up to 7 days.

Most particles were located in the cytoplasm and perinuclear regions of lavaged macrophages, type I epithelial cells and endothelial cells. This is quite different from the localization of intratracheally instilled agglomerated Ag particles which were mainly found in the phagolysosomes of alveolar macrophages (Takenaka et al., 2000).

Conclusions: These results indicate that the uptake of inhaled ultrafine particles by alveolar macrophages is limited, instead, prompt access to the alveolar septum occurs. Further investigations using particles with other physicochemical properties, e.g., solubility, size or binding affinity, must be performed to prove whether findings obtained in this study are general features for ultrafine particles.

[P06-08] TURBULENT THREE-PHASE FLOWS IN BUBBLE COLUMNS.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (11:00 AM-12:00 PM) Grand Ballroom 2-4

Gas-liquid-particle three phase turbulent flows at various particle loadings in bubble columns are studied. The liquid flow is modeled using a volume averaged system of governing equations, whereas motions of bubbles and particles are evaluated by a Lagrangian trajectory analysis procedure. A k-epsilon turbulence model is used to describe the motion of the liquid phase. The bubble and particle turbulent dispersion is considered by using a stochastic model. The two-way interactions between bubble-Liquid and particle-liquid are included in the analysis. The interactions between bubble-bubble and particle-particle are accounted for by the hard particle collision model. The bubble coalescence and bubble-particle interactions are also included in this approach. The predicted results for bubbly flow are compared with the experimental data, and good agreement is obtained. The effect of bubble and particle diameters, and particle loading on variation of the flow pattern are discussed. The results show that the bubble size has major effects on the flow pattern.

Key words: Gas-liquid-particle flow, three-phase flow, turbulent flow

[P06-07] CALCULATIONS OF EQUIVALENT HUMAN EXPOSURE CONCENTRATIONS FROM RAT INHALATION EXPOSURE STUDIES.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (11:00 AM-12:00 PM) Grand Ballroom 2-4

In many cases, risk assessment for particulate matter (PM) exposure requires data extrapolation from laboratory exposure settings for animals to equivalent human exposure scenarios. Dosimetric adjustments are essential for realistic interspecies data extrapolations. An appropriate dose metric depends largely on the biological responses under consideration. But, the choice of a relevant dose metric, even within a specific region of the lung, is not clear-cut because of variations in cell composition and potential of biological sensitivities between animals and humans. Here various dose metrics are postulated and equivalent human exposure concentrations (EHEC) obtained based on these metrics. The calculations were carried out using a user-friendly software package (MPPD, CIIT, Research Triangle Park, NC) to determine dose in the respiratory tracts of humans and rats. A realistic asymmetric lung geometry using detailed morphometric measurements of the TB airways in rats was employed in deposition calculations for rats. The use of asymmetric lung geometry allowed for more precise site-specific dose calculations. Various dose metrics were considered for the TB and pulmonary (P) regions. EHEC were found for particle sizes 0.3-5 μm. Particle inhalability for both humans and rats was taken into account. A dose metric based on deposited mass in the TB and P regions yielded an unrealistic low EHEC, leading to severely underestimating the risk from PM exposure. Dose metrics based on different deposited mass per unit areas in the TB region indicated EHEC of 1 to 4 times those of rats. There was an increase in the EHEC with particle size for particles $\leq$ 2 μm; inhalability of particles $\leq$ 2 μm is 100% in humans but not in rats. Due to the limited inhalability of particles $\geq$ 2 μm in rats, EHEC decreased with particle size except when the dose metric was based on deposition in bronchus airways. Due to TB filtering effects, dosimetric values in the P region decreased with particle size and dropped even more profoundly for particles with limited inhalability (i.e., > 2 μm). While dosimetric adjustments based on mass per unit area were similar between TB and P regions, EHEC was less than unity when the dose metric was based on the number of particles deposited per unit of ventilatory units or alveoli. A comparison of various dose metrics indicates that a dose metric based on mass per unit area yields the most conservative EHEC estimate. Results obtained from this study can assist in judging the reasonableness of extrapolating the outcome of toxicological studies in rats to potential risk in humans.

[P06-06] MATHEMATICAL MODEL OF DISPERSION AND DEPOSITION OF PARTICLES IN PULMONARY AIRWAYS.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (11:00 AM-12:00 PM) Grand Ballroom 2-4

Particle dispersion and deposition in the pulmonary airways is the link between exposure and dose, and leads to enhanced risk compromised individuals. In this work, mathematical model will be demonstrated to quantify the amount of particle dispersion as a function of breathing patterns and anatomical parameters. A simplified approach, that the stretch and mix process transports air between the distal and proximal compartments of the lung, is applied to describe dispersion and deposition of particles in the deeper lung. This simple mathematical model can lay the groundwork for simulating multiple breathing cycles, the transport of particles to distal regions during these cycles, and their consequent deposition.

[P06-05] FACTORS INFLUENCING AEROSOL DEPOSITION IN HUMANS AND RATS USING A MULTIPLE PATH PARTICLE DOSIMETRY MODEL (MPPD V1.0).

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (11:00 AM-12:00 PM) Grand Ballroom 2-4

Knowledge of the tissue-specific dose of PM is a critical link between individual exposure and health outcomes. Computer models are suited to analyse PM dosimetry. A Multiple Path Particle Dosimetry model (MPPD) has been developed by CIIT (Chemical Industry Institute of Toxicology, USA) in close collaboration with RIVM (National Institute of Public Health and the Environment, the Netherlands). The MPPD model allows calculation of PM deposition fractions and exposure doses for humans and rats, and includes age-specific human lung models.

The results of monodisperse aerosol deposition calculations with the MPPD model and its sensitivity to various parameters are described. Regional, lobar and alveolar depositions are calculated with a stochastic lung model for human adult.

Age dependency of PM deposition for children and young adults is studied. Coarse mode particles (5-10 μm) thoracic deposited mass is found to be significantly larger for children and adolescents of a specific age group compared to adults (age 18 and older), mainly due to the larger deposition in the head for adults. Increasing coarse particle size from 5 μm to 10 μm reduces the lower boundary of this age group from 8 years to 2 years and increases the difference in thoracic depositions between children and adults. Pulmonary deposition per alveolus is higher for 8-14 years old children compared to adults for particles of about 5 μm.

Dependency of regional deposition on the level of physical exertion is studied for human adults. Increasing physical exertion results in a higher thoracic deposition. The thoracic deposition of ultrafine particles is higher than the thoracic deposition of fine and coarse mode particles for light to modest exercise. When breathing is changed from nasal to oronasal the thoracic deposition behaviour of fine and coarse particles changes - for modest to heavy exercise the thoracic deposition of larger particles is higher.

Thoracic deposition depending on particle size is 45-200 times larger for humans than for rats at rest. Coefficients for the rat-human deposition extrapolation have been determined for three levels of human physical exertion (sleep, rest and light exercise).

In conclusion, age of the subject, physical activity, the functional capacity of the lungs and breathing parameters as well as the individual lung morphometry are factors that significantly affect the particle deposition and can explain differences in responses among people.

[P06-04] CAN AEROSOL SURFACE-AREA EXPOSURE BE ESTIMATED ADEQUATELY FROM MEASURED NUMBER AND MASS CONCENTRATION?

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (11:00 AM-12:00 PM) Grand Ballroom 2-4

In-vitro and in-vivo studies using low-solubility aerosol particles have shown a number of health-related end-points to be more closely associated with aerosol surface-area than mass concentration. These and similar studies have led to the hypothesis that health effects associated with environmental exposure may show a closer correlation with particulate surface-area. Collection of appropriate exposure data necessary to validate the hypothesis is currently restricted by the available instrumentation: Although a number of static monitoring sites now include size distribution measurements that may be used to estimate aerosol surface area, there are few options available for assessing localized and personal exposures.

Personal (or close-locality) measurements of ambient aerosol number and mass concentration are currently made routinely using readily available instruments. If aerosol surface-area could be estimated with sufficient accuracy from these measurements, it would be possible to begin investigating associations between surface area and health effects prior to the development and implementation of more sophisticated instrumentation. However, any method using number and mass measurements to estimate surface-area would be subject to potentially large errors, as insufficient information would available to characterize the simplest of aerosol size distributions. It is possible though that such a method may provide some useful information if suitable assumptions were made about the aerosol being sampled.

A method to estimate aerosol surface area from number and mass measurements is proposed assuming a lognormally distributed size distribution with a given geometric standard deviation. Estimation errors for a range of conditions have been evaluated using simulated number and mass measurements. Simulations show that surface-area estimates made on unimodal lognormal aerosols will frequently lie within 100% of the actual value. Simulations using bimodal distributions indicate estimates of surface area vary from the actual value by less than an order of magnitude. Calculations based on experimental data confirm these findings, with estimated surface area rarely being a factor of 4 greater than the actual value. The proposed method appears to be suitable for estimating aerosol surface area to well within an order of magnitude, and may be sufficient for placing exposed individuals within broad exposure groups. However comparison between the method and established techniques is required to verify these conclusions, and to evaluate the estimated errors with respect to the range of aerosol size-distribution exposures commonly encountered.

[P06-03] ESTIMATED RELATIONSHIPS BETWEEN AEROSOL NUMBER, SURFACE-AREA AND MASS EXPOSURE METRICS USING A SIMPLIFIED NUMERICAL MODELING APPROACH.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (11:00 AM-12:00 PM) Grand Ballroom 2-4

Recent laboratory-based studies using low-solubility particles have shown a number of health-related end-points to be closely associated with aerosol number or surface-area, thus challenging the current practice of characterizing ambient aerosol exposure in terms of mass concentration. A simplified numerical model has been used to estimate relationships between aerosol number, surface-area and mass in an idealized ambient setting. The resulting relationships provide insight into possible consequences of masuring exposure in terms of mass concentration if either particle number or aerosol surface-area are more closely associated with health effects.

Assuming a constant lognormally distributed aerosol source, variations in particle number with aerosol mass, and surface-area with mass, can be approximated by well-defined functions that are independent of source conditions. Aerosol number concentration is shown to increase linearly with mass concentration up to a critical value, above which it becomes approximately constant. Surface-area concentration is also predicted to vary linearly at low mass concentrations, deviating sub-linearly with mass concentration according to a power law above a critical value.

Although the derived relationships are based on a highly simplified model of ambient aerosol behavior, they provide useful insight into possible associations between the various exposure metrics. There is no evidence of health effects associated with ambient aerosol exposure reaching a plateau with increasing mass concentration, indicating number concentration to be an inappropriate exposure metric. Limited evidence exists to indicate that the relationship between surface-area and mass above the critical value may explain non-linearities in exposure-response data at high exposures, supporting the surface-area metric hypothesis. However the most striking conclusion to be drawn is that if the model is a reasonable approximation of ambient aerosol evolution, a threshold mass concentration can be identified for a given set of conditions below which exposure metrics of number, surface-area and mass vary linearly. Below this threshold a good correlations between exposure and health effects is predicted irrespective of the metric used.

While these results need to be validated using field measurements, they do indicate a basis for continuing to use mass as an exposure basis for environmental samples at low mass concentrations despite evidence of toxicity being closely associated with surface-area.

[P06-02] SELECTING REALISTIC PM DOSES FOR IN-VITRO STUDIES.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (11:00 AM-12:00 PM) Grand Ballroom 2-4

In-vitro studies are important for understanding the health effects of inhaled urban particulate matter (PM). Such studies can explore biologic mechanisms of injury, comparative toxicity of PM components, effects of particle size, and species differences in responses. Selecting realistic PM doses for in-vitro studies poses an interesting dosimetric challenge. As an example, a potentially sensitive human subpopulation is postulated, and the surface PM deposition doses calculated for various surface target sizes within the tracheobronchial region. It is suggested that similar surface PM exposures are realistic for in-vitro studies.

The sensitive subpopulation is assumed to: a) have inhomogeneous airflow (due to disease or abnormal anatomy); b) be a mouth-breather; c) be exercising; d) have small body size (and thus small airways); and e) to be exposed to PM at a location near significant PM sources. The effect of inhomogeneous airflow in the respiratory tract can increase PM deposition in well-ventilated regions by a factor of 3 to 5. Mouth breathing, exercise and small body size can increase the deposition of particles in the tracheobronchial tree over that of an average person by a factor of about 10 to 50 (depending on particle size). Considering enhanced deposition at bifurcation zones can lead to surface PM depositions that are as great as 100 times the average for certain particle sizes. Considering these factors, local groups of cells can see PM deposition surface doses that are several thousand times the average surface doses for average subjects. Suggested realistic surface doses for in-vitro studies are presented for a range of particle sizes and biological target sizes. One concludes that substantial PM surface doses can be justified in in-vitro studies that are intended to realistically mimic in-vivo surface doses. (Supported by US EPA grant number R827352, but not subjected to the agency's peer and policy review. Therefore, it does not necessarily reflect the views of the agency, and no official endorsement should be inferred.)

[P06-01] DEMONSTRATION OF A TECHNIQUE TO ESTIMATE INDIVIDUAL, DAILY VALUES FOR THE AMBIENT AND NONAMBIENT COMPONENTS OF TOTAL PERSONAL EXPOSURE TO PARTICULATE MATTER.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (11:00 AM-12:00 PM) Grand Ballroom 2-4

Total human exposure (*T*) to particulate matter (PM) may be divided into two major components: (1) exposure to ambient PM while outdoors plus exposure while indoors to ambient PM that has infiltrated indoors (ambient exposure, *A*) and (2) exposure to nonambient PM due to indoor sources and personal activity or personal cloud sources (nonambient exposure, *N*). For epidemiology using panel studies with measurements of individual health outcomes, it is desirable to know total, ambient, and nonambient exposures as well as ambient concentrations. A data set from a panel study in Vancouver, BC, Canada, that contains measurements of total personal exposure and ambient concentrations of both $PM_{2.5}$ and sulfate, provides sufficient information to estimate daily, individual values of ambient and nonambient exposure to $PM_{2.5}$, and ambient exposure to $PM_{10-2.5}$ and PM_{10}. The technique requires the assumption that either there are no indoor sources of sulfate, or if such sources exist a correction may be made, and the assumption that some information is available on the values of the penetration factor (*P*) and the deposition or removal rate (*k*) for the PM mass or composition fractions of interest. This technique is based on the equilibrium mass balance model which relates ambient exposure (*A*) to ambient concentration (*C*), i.e., A = yC + (1-y)(Pa/[a+k])C, where *y* is the fraction of time spent outdoors, and *a* is the air exchange rate. Also A/C = \{y + (1-y)(Pa/[a+k])\}= the attenuation factor. In the Vancouver panel study, subjects kept activity diaries so it was possible to estimate individual, daily measured values of the fraction of time spent outdoors (*y*). Since *T* = *A* for sulfate, *T/C* = *A/C* for sulfate = the attenuation factor for sulfate. If estimates of *P* and *k* for sulfate are available, then daily, individual values of *a*, which does not depend on the particle size, may be estimated. The *A* for $PM_{10-2.5}$ is estimated using the measured values of *y*, the estimated value of *a*, and estimated values of *P* and *k* for $PM_{2.5}$. Plots of *T* vs. *C* for sulfate, for individual subjects, and for the entire panel, are used to check for the presence or absence of indoor sulfate sources and to check for outliers. If a subject is found to have an indoor source of sulfate, the attenuation coefficient is taken from the regression of personal sulfate on ambient sulfate. The time series of individual, daily exposures have been used to investigate the association of various health effects with the different indicators of exposure.

[P13-25] WITHDRAWN

Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 13: Receptor Modeling and Source Apportionment (11:00:00 AM-12:00:00 PM) Grand Ballroom 2-4
WITHDRAWN

[P06-14] WITHDRAWN

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WITHDRAWN

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[P06-15] REGIONAL DEPOSITION OF ULTRAFINE, FINE, AND COARSE PARTICLES IN THE HEALTHY AND OBSTRUCTED LUNG.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 6: Dosimetry and Exposure Issues for Health Effects Applications (11:00 AM-12:00 PM) Grand Ballroom 2-4

Relative to the general population, individuals with obstructive airways disease have an increased susceptibility to adverse health effects following exposure to urban particulate matter. The site of respiratory particle deposition may be an important determinant of pathological response. We have studied the regional deposition (RDep) of various sized technetium labeled aerosols using gamma scintigraphy. The RDep of ultrafine (0.06 um) and fine (1.5 um) aerosols were investigated in 9 healthy controls and 10 patients with chronic obstructive pulmonary disease (COPD). In an additional 11 controls and 9 COPD patients, the RDep of coarse (5 um) particles was characterized. Measurements of regional lung volume and ventilation were obtained for all subjects from a xenon-133 equilibrium and multi-breath washout, respectively. Twelve regions of interest (ROI) were established by dividing each lung into thirds by height and half by width. The lower regions of the left lung were not analyzed due to activity from particles in the stomach. Remaining regions were categorized as central (2 interior-most regions) and peripheral (8 exterior regions). RDep and RVent were computed for the 8 peripheral regions. RDep was computed as the fraction of aerosol deposited within a region normalized to volume. RVent for each region was determined by normalizing the Xe washout rate for that region by the total washout rate for the 8 peripheral regions. Central to peripheral ratios (C/P) were calculated for the right lung as the fraction of deposition normalized to volume in the central relative to peripheral regions. In general, the RDep of the ultrafine and fine aerosols, but not the coarse aerosol, were significantly associated with RVent in both the patients and controls ($p<0.01$), i.e. deposition followed ventilation. However, relative to the controls, the patients had significantly greater variability in RDep for both the ultrafine and coarse aerosols ($p<0.05$). C/P ratios in patients were also significantly increased relative to controls for the ultrafine and coarse aerosols ($p<0.05$). C/P ratios for the coarse particles were significantly greater than for the fine and ultrafine particles in both patients and controls ($p<0.001$). Our data suggest that COPD patients receive a less uniform dose of inhaled particles (especially coarse and ultrafine) than do healthy subjects. This finding is probably due to the combined effects of airways obstruction and abnormal ventilation distribution on particle deposition in the diseased lung. Funded by USEPA Cooperative Agreement CR829522.

[P15-16] CHARACTERIZING PERSONAL EXPOSURES TO AMBIENT AND NON-AMBIENT PM2.5 FOR THREE SENSITIVE COHORTS IN BOSTON AND BALTIMORE.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

BACKGROUND: Epidemiological studies of PM have indicated that specific sub-populations may be at greater risk from PM-associated morbidity and mortality as compared to healthy adults. To date, it is unclear whether exposures for these cohorts differ from those for healthy cohorts. The objectives of this study are to characterize the personal PM2.5 exposures for susceptible cohorts and examine factors that influence their exposures. METHODS: Personal PM2.5 exposures and corresponding ambient concentrations were measured for 99 subjects (40 healthy senior citizens, 44 children and 15 individuals with COPD), living in the Baltimore, MD and Boston, MA, areas. Mixed regression models were used to assess the contribution from ambient PM2.5 and non-ambient PM2.5 to total personal exposures. RESULTS: Contributions of ambient PM2.5 to total personal PM2.5 were comparable among the measured cohorts, as evidenced by the similar slopes from the mixed model analysis among cohorts in a guven city during the same season (Table 1). Exposure to ambient PM2.5 comprised a greater fraction of total exposures for subjects from all cohorts in both cities during the summer as compared to the winter. Ambient PM2.5 contributed almost twice as much to total personal exposures during the summer and may be due to the fact that individuals spent greater periods of time outdoors and within poorly sealed indoor environments in the summer. The only significant difference in exposure to non-ambient PM2.5 among the cohorts was between children and seniors in Baltimore during the summer.

Table 1. Mixed model results by cohort.

CITY	SEASON	COHORT	SLOPE (SE)	INTERCEPT (SE)
Baltimore	Winter	Seniors	0.25 (0.09)*	13.1 (3.7)*
		Child	0.27 (0.07)*	18.0 (3.9)**
		COPD	0.15 (0.09)	14.7 (3.8)*
	Summer	Seniors	0.52 (0.05)**	8.5 (1.7)**
		Child	0.70 (0.11)**	5.6 (2.7)*
Boston	Winter	Seniors	0.20 (0.06)**	12.9 (1.6)**
		Child	0.29 (0.09)*	14.6 (1.7)**
	Summer	Seniors	0.74 (0.10)**	9.9 (1.6)**
		Child	0.79 (0.07)**	15.3 (1.6)**

(**significant at 0.0001 level; *significant at 0.05 level)

[P15-33] TIME-RESOLVED DETERMINATION OF INDOOR, OUTDOOR AND REGIONAL CONCENTRATION RELATIONSHIPS FOR PM2.5 NITRATE, SULFATE AND CARBON.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Human health effects form the basis for the regulation of outdoor particulate matter, yet time activity studies show that most people, including children, spend the majority of their time indoors. Knowledge of indoor concentrations of particles of outdoor origin is needed to evaluate human exposure, especially for particles with diameters below 2.5 μm, called PM2.5, that are readily transported indoors. This paper examines the indoor concentrations for PM2.5 aerosols of outdoor origin through chemically- and time-resolved measurements in an unoccupied house, and examines the appropriateness of using regional data to model indoor concentrations from outdoor sources.

Sub-hourly concentration profiles of nitrate, sulfate, and black carbon were measured simultaneously at three locations: an unoccupied residence in Clovis, California, the backyard of the same residence, and a regional monitoring site in Fresno, California, located 6 km southwest of the residence. PM2.5 nitrate and sulfate concentrations were determined using an automated collection and vaporization system, and black carbon was assayed by light attenuation through a filter deposit. Indoor concentrations are compared to those measured immediately outside the house, and to those measured at the regional monitoring site.

Outdoors, the time-resolved data showed consistent daily, or twice-daily species concentration peaks of several hours duration. Indoors, these concentration peaks exhibited considerable attenuation and broadening as well as time-lag by comparison to the outdoor data. The indoor concentration reduction was the largest for PM2.5 nitrate, which appears to undergo phase changes in addition to indoor deposition and penetration losses. In general, much greater differences were seen across the building shell than between measurements immediately outside the house and the regional monitoring site. For this data set the regional results provide a good representation of the concentrations seen at the building exterior.

This research was supported by the Assistant Secretary for Fossil Energy, Office of Natural Gas and Petroleum Technology through the National Petroleum Technology Office under U.S. Department of Energy Contract No. DE-AC03-76SF00098, and by the Western States Petroleum Association.

[P15-31] ESTIMATING OUTDOOR CONTRIBUTIONS TO INDOOR AND PERSONAL PARTICULATE AIR EXPOSURES.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Many epidemiologic studies have shown an association between adverse health effects and particulate concentrations measured at centrally located sites. Few studies quantify the contribution of ambient and indoor sources to personal exposures. This study quantifies the outdoor and indoor contributions to personal PM exposures, using $PM_{2.5}$ and PM_{10} measurements collected from 108 subjects and their residences in a large exposure assessment study conducted between 1999 and 2001. The PM data measurements consist of integrated measurements, using the Harvard impactors for fixed sites and Harvard personal environmental monitors for subjects, and continuous measurements using the Radiance nephelometers for fixed sites and personal DataRAM for a subset of subjects. The Teflon filters collected from the integrated monitors were analyzed for sulfur with XRF. We use several techniques to estimate the outdoor contribution to indoor concentrations (i.e., infiltration efficiency, F_{inf}) and to personal PM exposure (i.e., attenuation factor). These techniques include the random component superposition (RCS) model, fixed effect models with random intercepts or random slopes, recursive model, and the sulfur tracer technique. The RCS model, using 24-h integrated measurements, estimates the outdoor contribution to indoor and personal $PM_{2.5}$ concentrations to be 47% and 51%, respectively. The recursive model, using continuous measurements, estimate an average F_{inf} of 0.66 and an average attenuation of 0.68. Results from the fixed effect models using 24-h integrated measurements are similar to those from the RCS model. Based on the sulfur tracer method, the F_{inf} from home outdoor to home indoor site is 61±3% and the attenuation from central site to subjects is 0.45±0.03, and from home outdoor to subjects is 0.49±0.03, indicating that home outdoor $PM_{2.5}$ reflects more of subject exposure than the central site measurements. We examine the variability of F_{inf} and attenuation by subject, type of residence, season, and ambient particulate concentration. For indoor concentration models, the best fitting models have the infiltration efficiency varying by residence and cooking activities. For personal exposure models, the best fitting models assume a constant attenuation factor, with indoor and personal contributions varying by the age of subjects.

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[P15-30] THE ROLE OF SUBPOPULATION, DISEASE STATE, HOUSING, SEASON AND OTHER FACTORS UPON PERSONAL EXPOSURES TO PM OF AMBIENT ORIGIN.

Ron Williams, Jack Suggs, Gary Evans, Anne Rea, Linda Sheldon, Alan Vette, Burke Janet, Carry Croghan, Kelly Leovic, John Creason, Debra Walsh, Charles Rodes, Jonathan Thornburg, Phil Lawless, Ademola Ejire, Margaret Herbst, William Sanders, Jr. National Exposure Research Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC, USA; National Health and Environmental Effects Research Laboratory, U.S. Environmental Protection Agency, Research Triangle Park, NC, USA; Research Triangle Institute International, Research Triangle Park, NC, USA; Shaw University, Raleigh, NC, USA; Department of Cardiology, University of North Carolina-Chapel Hill, Chapel Hill, NC, USA

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A series of longitudinal particulate matter (PM) and related co-pollutant human exposure panel field studies were conducted in Baltimore, Maryland (1997,1998) Fresno, California (1999) and Research Triangle Park, North Carolina (2002-2001). They were designed to evaluate the effects of personal exposures to PM of ambient origin under differing sub-populations, regions of the country, seasons, and housing conditions. Participants were monitored over time (28 days) to investigate both longitudinal and cross-sectional correlations between personal, residential indoor, residential outdoor, and ambient measurements. Measurements of $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ were routinely performed. Copollutant monitoring included CO, O_3, NO_2, SO_2, elemental-organic carbon and metals. Daily time activity diaries and questionnaires documented potential source exposures. The studies involved a variety of potentially susceptible subpopulations made up of non-smoking, ambulatory volunteers being at least 55 years old. Some of the subjects lived in communal (apartment or cottage-style) housing while others lived in single family residences. Results revealed a wide range in the magnitude and variability of daily personal $PM_{2.5}$ exposures (3 to 200 $\mu g/m^3$). Time activity patterns and estimated exposures to indoor generated sources appeared to be some of the primary factors influencing personal to ambient PM mass concentration associations (r ranging from 0.0 to 0.95). Mean personal $PM_{2.5}$ clouds ranged from 3 to 10 μ g/m^3 relative to the various study populations and were clearly influenced by individual time activity patterns among the participants. Results from the RTP-based study showed that ambient $PM_{2.5}$ sources contributed to approximately 50% of the total personal exposure mass concentration regardless of season, residence, occupational status or disease state. This work has been funded wholly by the United States Environmental Protection Agency under contract #68-D5-0040 and 68-D-99-012 to the Research Triangle Institute and assistance agreement #CR-828186-01-0 to Shaw University. It has been subjected to Agency review and approved for publication.

[P15-29] INFILTRATION BEHAVIOR OF $PM_{2.5}$ CHEMICAL COMPONENTS: IMPLICATIONS FOR PM EXPOSURE ASSESSMENT AND EPIDEMIOLOGICAL ASSOCIATIONS.

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Numerous epidemiological studies have reported significant associations between ambient PM concentrations and adverse health effects. Although current toxicological evidence indicates that some PM components may be more toxic than others, epidemiological associations have been predominantly for total fine particle mass rather than the mass of specific PM components. Current efforts are ongoing to develop databases of ambient PM component measures that can be used in epidemiological investigations. Because so much of people's exposures to PM occurs indoors, it is also important to better understand the relationships between ambient, indoor, and personal exposures to PM components for the proper interpretation of epidemiological findings.

As part of this process, we analyzed indoor and outdoor $PM_{2.5}$ components data from a comprehensive indoor particle characterization study conducted in nine residential homes in Boston, Massachusetts to investigate the infiltration behavior of various $PM_{2.5}$ components. Previous analyses of these study data quantified indoor infiltration of $PM_{2.5}$ and specific size fractions (Long *et al.*, 2001), and demonstrated the utility of sulfur as a tracer for $PM_{2.5}$ (Sarnat *et al.*, in press). Focusing on periods with little or no active indoor sources, new analyses were conducted for $PM_{2.5}$ components that have been linked to specific ambient PM sources: polycyclic aromatic hydrocarbons (wood smoke, vehicular exhaust), elemental carbon (diesel exhaust), nickel (oil-burning), and zinc, iron, potassium, silica and calcium (crustal materials).

Current results show that outdoor levels of PAHs, elemental carbon, Ni, Zn, Fe, K, Si, and Ca were significantly correlated with their corresponding indoor levels, with a strong effect of particle size. Data also show that home characteristics such as air exchange rate have differential effects on the infiltration of the various PM components, with larger effects being observed for indicators of crustal particles (e.g., Ca, Si). For example, similar indoor-outdoor Spearman correlation coefficients (r_s) were observed for Ni for summer and winter sampling (0.82 and 0.80), while lower and seasonally-affected r_s were observed for Si (0.65 and 0.42), a larger particle component. Additional analyses are planned to quantify component-specific penetration efficiencies and to tie in particle sizing data for the evaluation of the utility of these different $PM_{2.5}$ components as tracers for various PM fractions.

[P15-28] CHARACTERIZATION OF FINE PARTICULATE MATTER IN OHIO:INDOOR, OUTDOOR, AND PERSONAL EXPOSURES.

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Ambient, indoor, and personal PM2.5 concentrations were assessed based on an exhaustive study of PM2.5 performed in Ohio from 1999 to 2000. Two locations in Columbus, Ohio, were involved, one in an urban corridor and the other in a suburban location. A third rural location in Athens, Ohio, was also established. At all three locations, elementary schools were utilized to determine indoor and personal PM2.5 concentrations for 4th and 5th grade students. Continuous ambient PM2.5 mass concentrations were measured with Tapered Element Oscillating Microbalances (TEOMs). Indoor and personal PM2.5 concentrations were monitored at each location Monday through Friday throughout the school year. The ambient and personal monitoring is part of a comprehensive health based study evaluating the impact of air pollution in Ohio.

Ambient PM2.5 distributed homogeneously throughout the study area. This indicates that ambient PM2.5 concentrations monitored from a fixed site can represent the average ambient PM2.5 level over a large area. PM2.5 concentrations show clear seasonal changes at all three sites, indicating the trend of higher PM2.5 concentrations during the summer months. At all three sites, personal and indoor PM2.5 concentrations exceeded outdoor levels. Personal PM2.5 exposures were significantly affected by indoor PM2.5, presumably the result of resuspension by human activity. The I/O ratios of PM2.5 mass concentrations and of sulfate concentrations were greater than unity at all sites when school was in session. Lower I/O ratios associated with lower indoor sources were found during non-school days when the students were absent.

The impact of local sources on the PM2.5 concentration was identified at the urban location. Relatively strong correlations between indoor and personal concentrations were found among the sites.

[P15-27] CONTINUOUS MONITORING OF FINE PARTICLES FROM SHOWERING.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Solid particle formation from dissolved and suspended solids in domestic tap water during showering may be attributed to evaporation of micron-sized satellite droplets produced during showerhead spray formation or from splashing of millimeter-sized spray droplets on surfaces. Duplicate continuous particle monitors were used to measure particle size distributions in residential bathroom air under various showering conditions, changed by adjusting spray settings and water temperature, flow rate, pressure, and total dissolved solids content. A full-size mannequin was positioned in the shower to simulate splashing effects during showering. Mass concentrations were estimated from the measured bathroom particle number concentrations and used to predict emission factors for various particle size ranges under different showering conditions. Fine particle accumulation rates of 2.7 - 41.3 mg/m3/min were projected for various test conditions with the shower on. Estimated PM2.5 concentrations in bathroom air reached several hundred micrograms per cubic meter. Rates of particle formation tended to be highest for coarse shower spray settings and with direct impact on the mannequin. No consistent pattern was apparent for water temperature and pressure effects on emission rates.

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[P15-26] WITHDRAWN

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WITHDRAWN

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[P15-25] CONTROLLED EXPOSURE CHAMBER STUDIES AND THE IMPACT OF $PM_{2.5}$ ON HUMAN HEALTH.

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A controlled exposure chamber is being used to elucidate the influence of changing the chemical composition of fine particles, including semi-volatile components, on human health. A 40 m^3 Teflon bag equipped with UV lights to simulate atmospheric photochemical conditions, is used to generate a stable test aerosol. Adjacent to the Teflon bag is a 15 m^3 controlled exposure room. An aerosol of approximately 500 $\mu g/m^3$ $PM_{2.5}$ is introduced into the Teflon bag and circulated to the exposure room via a dedicated recirculation system until a desired concentration of approximately 150 $\mu g/m^3$ is obtained in the exposure room. The exposure room will be used to study the effect of $PM_{2.5}$ exposure on cardiovascular function. Several real-time and integrated instruments are being used to characterize and monitor the test aerosol including; a TEOM monitor to measure non-volatile $PM_{2.5}$, a RAMS monitor to measure total $PM_{2.5}$ including semi-volatile components (nitrate and organic), a TSI CPC monitor to determine detailed particle size distribution, an Anderson Aethalometer to measure elemental carbon, a BOSS sampler to determine detailed $PM_{2.5}$ chemical composition, and gas phase monitors for CO, NO_x, NO_2, and NO. Aerosols to be studied include those typical of ambient Wasatch Front $PM_{2.5}$ including; fresh wood smoke generated from a typical wood burning stove, wood smoke aged 4-6 hours, and concentrated ambient particles (CAPS). One minute real-time RAMS and TEOM data are obtainable and are being used to measure the formation and concentration of non-volatile and semi-volatile $PM_{2.5}$ in the Teflon bag and exposure room. Thirty minute BOSS samples give detailed chemical composition of $PM_{2.5}$ in the Teflon bag and exposure room. Results obtained with wood smoke emissions indicate a significant increase in semi-volatile $PM_{2.5}$ is associated with photochemical aging of the wood smoke aerosol.

[P15-24] MECHANISTIC ANALYSIS OF FTIR SPECTRA FROM OUTDOOR, INDOOR AND PERSONAL PM2.5 SAMPLES COLLECTED DURING RIOPA.

Adam Reff, Barbara Turpin, Robert Porcja, Jong Hoon Lee, William Cui, Silvia Maberti, Jay Min Kwon, Shahnaz Alimokhtari, Derek Shendell, Jennifer Jones, Corice Farrar, Clifford Weisel, Maria Morandi, Steven Colome, Thomas Stock, Arthur Winer
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Personal, indoor and outdoor PM2.5 samples (48 hrs, stretched Teflon filters) from the Relationship of Indoor, Outdoor and Personal Air (RIOPA) study were analyzed for functional groups using Fourier Transform Infrared Spectroscopy. FTIR spectra were obtained from 350 homes in Elizabeth, NJ, Houston, TX and Los Angeles County, CA from summer 1999 to spring 2001. Because organic particulate matter is a mixture of hundreds of compounds with a wide variety of properties, typically only 10-20% of the organic mass is identified on the molecular level. FTIR spectroscopy provides functional group and bond information for the entire sample, providing a more holistic analysis of the aerosol, on a compound class basis. Filters were analyzed without extraction or other sample preparation before and after sampling in a Mattson 100 Research Series Spectrometer containing a deuterated triglycine sulfate (DTGS) detector. Filters were scanned 200 times at 4 1/cm resolution from 450 to 4000 1/cm.

Sulfate was almost always present, and was largest in outdoor spectra. This is consistent with the generally accepted understanding that sulfate is of outdoor origin. Strong aliphatic absorbances and amides were found in many personal and indoor samples, suggesting the influence of indoor sources in these homes. We hypothesize that amides form as a result of high temperature reactions between organic acids and amines during the cooking of meat or meat products. Carbonyl absorbances, present in most samples, showed substantial variation in strength, number of peaks, and wavenumber shift from sample to sample, indicating variability in composition and sources. Spectra were sorted based on major distinguishing spectral features, resulting in the identification of a typical outdoor spectrum, and identification of homes with indoor and personal spectra that differ chemically from the paired outdoor spectrum. Using these results, we were able to identify homes impacted by indoor and personal sources and to provide the spectra characterizing the indoor and personal source composition on a home-by-home basis.

[P15-23] ANALYSIS OF INDOOR, OUTDOOR AND PERSONAL PM2.5 SPECIES TO ASSESS THE SOURCES OF EXPOSURE: RESULTS FROM RIOPA.

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The Relationship of Indoor, Outdoor and Personal Air (RIOPA) study measured indoor, outdoor and personal concentrations of VOCs, carbonyls, PM2.5, and PM2.5 species in residences of Houston, TX, Los Angeles County, CA, and Elizabeth, NJ. A total of 212 homes were sampled for PM2.5 and 162 of those homes were sampled a second time approximately three months later. Approximately two-thirds of homes were selected because of their close proximity (less than 0.5 miles) to one or more sources of a target compound. Indoor and outdoor samples were collected on both Teflon filters and on quartz fiber filters for 48 hour periods at 10 lpm. A quartz fiber filter was also placed behind the Teflon filter to serve as a dynamic blank for particulate organic carbon measurements, which are subject to adsorption artifacts. Personal samples were collected on Teflon filters for 48 hours at 3.2 lpm. Teflon filters were analyzed gravimetrically for mass, by Fourier Transform Infrared Spectroscopy (FTIR) for functional groups, and by X-ray Fluorescence (XRF) and Inductively Coupled Plasma- Mass Spectroscopy (ICP-MS) for elements. Quartz fiber filters were analyzed by Thermal-Optical Transmittance (TOT) for organic and elemental carbon and by Gas Chromatography-Mass Spectroscopy (GC-MS) for polycyclic aromatic hydrocarbons (PAHs).

This poster presents the quality control results for the elemental analyses, the species mass balance results, and examines insights that can be gained about the contribution of indoor and outdoor sources on indoor and personal concentrations when numerous species are measured concurrently. Reasonable agreement was obtained for elements measured by both XRF and ICP-MS. Recoveries, based on analysis of NIST standards, were 90-105%. Replicate analysis yielded estimates of analytical precision of better than 5% to 35% for different elements. Estimates of measurement precision, based on analysis of collocated samples, were 10-20% for most elements. A single-component mass balance model was used with elements from homes expected to have minimal indoor sources to examine the mechanistic dependence of air exchange rate, decay rate, and penetration on the contribution of outdoor sources of PM on indoor concentrations.

[P15-22] CHARACTERIZATION OF RESUSPENDED HOUSE DUST AS A SOURCE OF PM EXPOSURE.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

House dust resuspended by human activity can be a major source of human exposure to particulate matter (PM). For a non-smoking home in Redwood City, California with typical human activity levels, we found that 45-65% of the indoor PM-5 was from particles resuspended by the human activities. Two separate studies were performed to characterize resuspended house dust as a source of human PM exposure. The first study compares the personal exposure monitor (PEM) and stationary indoor monitor (SIM) particle concentration during a series of 6 vacuuming events in a home. PEM PM-2.5 and PM-5 concentrations were on average 1.3 and 1.6 times as high as SIM levels, respectively. PEM levels of particles greater than 10 μm were on average 10 times as high as the concentration measured at the SIM location, and up to 200 times as high as the background concentration measured before the activity began. By correlating real-time data with activity patterns, specific activities were associated with increased exposure levels.

For the second study, a series of prescribed human activities were performed while collecting concurrent real-time and integrated filter measurements from PEM, SIM, and stationary outdoor (ambient) monitor (SAM) locations. PEM PM-2.5 and PM-5 concentrations were on average 1.4 and 1.6 times as high as SIM levels, respectively. All prescribed human activities resuspended particles with a similar particle size distribution. Approximately 90% of the total suspended particle (TSP) volume was greater than 5 mm in diameter, and 10% of the TSP volume was less than 2.5 mm in diameter. The submicron particles accounted for less than 1% of the indoor TSP volume.

Indoor, outdoor, and personal PM-5 filters were microwave digested and analyzed for elemental ions using inductively coupled plasma-mass spectrometry (ICP-MS). For most elements, the indoor and personal concentrations were higher than the outdoor concentrations. The indoor and personal profiles matched closely, indicating that the composition of the indoor and personal filter samples was similar. The elemental profile of a dust sample collected from the vacuum cleaner matched the profiles from the personal filter samples collected after human activity periods. This finding suggests that elemental profiles from dust samples collected from respondents' vacuum cleaners can be used to represent resuspended house dust in chemical mass balance (CMB) source apportionment analyses. Using this approach, the source contribution of resuspended house dust could be resolved for larger-scale exposure studies where indoor sources are not prescribed or temporally isolated.

[P15-21] WILDFIRES AND PRESCRIBED BURNS IN COLORADO: IMPACT ON AIR QUALITY.

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The wildfires of the summer of 2002 have increased awareness of the influence of wildfires on urban air pollution. Our current research focuses on two areas. First, we have looked at the impact of wildfires on indoor air quality and the effect of mitigation measures. Secondly, we are looking at determining the contribution of wildland fires to urban fine particulate matter.

Acute exposure to PM2.5 has been linked to increased mortality rates, increased hospitalizations, increased emergency room visits, and decreased lung function. PM2.5 from wildland fires in particular may have adverse affects on the respiratory health of people living in western cities. Information about the impact of wildfires on indoor air quality and the effect of mitigation measures can help residents near wildfires and prescribed burns keep themselves safe from acute exposure to particulate matter. Determining the contribution of wildland fire smoke to urban PM2.5 levels will provide important information for public health agencies and wildland fire managers.

The first prong of our research was conducted from October of 2001 to July of 2002. During this time, air quality characterization equipment was taken to ten different houses during four separate fires. This equipment included particle counters, PM2.5 impactors, and air cleaners. Measurements were taken simultaneously both inside and outside of the residences. Homeowners were instructed to keep windows closed, and half of the houses were equipped with electrostatic air cleaners. Closing the windows yielded a 20% - 50% reduction in PM2.5 levels, while the result of using air cleaners in a house was a 60% - 90% reduction.

The second prong of our research was started in September of 2002. There will be three phases to the project: sample collection, chemical analysis of the samples, and then source apportionment using the chemical data. The samples from the wildfires will be used to find compounds specific to wildland fires. This information will be used in a chemical mass balance model to apportion the affect wildland fires have on urban air pollution. Urban PM2.5 samples have already been collected in Denver and will be compared to the Urban PM2.5 samples.

[P15-20] RELATION BETWEEN AMBIENT AND EXPOSURE CONCENTRATIONS FOR PARTICULATE MATTER AND ITS TOXIC CONSTITUENTS IN AN INDIAN METROPOLITAN REGION.

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In India, as well as in most other countries standards for protection of human health are prescribed for Ambient Air quality (AAQ), which is therefore routinely measured by regulatory authorities,.However,it is well accepted that Personal Exposure (PE) concentration is the true indicator of health risk. Hence, the objective of this work was to carry out simultaneous monitoring of AAQ and PE to investigate the relation between them.

This study was carried out in Mumbai City in India. Outdoor workers like traffic policemen, watchmen, and roadside workers were chosen as respondents, since they are exposed to very high levels of both outdoor and indoor air pollution and bear the worst exposure in the city. The daily integrated exposure of the outdoor workers consists of two major microenvironments viz. occupational and indoor residential. AAQ was measured as prescribed by NAAQS, India by a Hi Vol Sampler with a PM10 attachment. The personal sampler had a 50% removal efficiency for Respirable Particulate Matter (RPM) of size 5 μm. The particulates collected were analyzed for toxic elements by Atomic Absorbtion Spectrophotometer and Voltametry.

The results given in Table 1 show that the average 24-hr integrated exposure exceeded the measured AAQ level by a factor of 2.3. This ratio will be higher if AAQ monitoring of PM5 is done. No correlation was found between paired samples of AAQ and PE, which questions the logic of using AAQ data for health studies. The daily integrated exposure to lead exceeded the corresponding NAAQS, India (1.0 $\mu g/m^3$) by a factor of 4.2, although ambient concentration conforms. The residential concentration of metals is less than occupational except for potassium, since this metal originates from an indoor source. Thus, this study clearly shows that the health risk to city population is significantly more severe than that indicated by AAQ data collected for regulatory purposes.

TABLE 1 : COMPARISON OF AMBIENT AND EXPOSURE CONCENTRATION OF PARTICULATE MATTER (PM) AND ITS TOXIC CONSTITUENTS IN $\mu g/m^3$

Concentration Type	PM	Pb	Cd	Mn	K
Ambient	140	0.34	0.02	0.15	0.54
Occupational Exposure	358	4.38	0.20	1.98	3.47
Residential Exposure	308	4.09	0.11	0.18	4.59
24 Integrated Exposure	322	4.20	0.13	1.98	3.30

[P15-01] REAL-TIME EXPOSURE MEASUREMENTS OF AEROSOL NUMBER, SURFACE-AREA AND MASS (PM2.5) CONCENTRATION IN THE SOUTHERN INDIAN CITY OF MYSORE.

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Despite increasing awareness of the environmental and health effects associated with aerosol exposure, particulate matter (PM) levels in the developing regions of the world remain orders of magnitude above those in the more industrialized countries. In countries such as India, data on PM emissions, exposure and associated health effects are sparse. Consequently there is a need to develop a database on aerosol exposures specific to each country. In recent years, particle number and surface-area concentrations have been hypothesized as being more health-relevant metrics of exposure than the traditional mass metric. It is, therefore, desirable to investigate the association between the particle number and surface area concentration with health effects.

Ambient urban exposures in India have become dominated by vehicle emissions in recent years. However in many other respects exposure patterns in the subcontinent differ from those in the West. Many households rely on burning biomass, kerosene or liquid propane gas on simple stoves to heat water and cook food, often resulting in incomplete combustion and high aerosol exposures. Women and children are exposed to combustion-related aerosols in the home on a daily basis. There is consistent evidence that indoor air pollution increases the risk of chronic obstructive pulmonary disease in childhood and of acute respiratory infections - the most significant cause of death amongst children under 5 years in developing countries.

Aerosol measurements have been carried out in the southern Indian city of Mysore since June 2002. This work is focused on three specific zones: urban areas with heavy vehicular traffic, borderline urban/rural zones and indoor-exposures associated with the fuel used for cooking. Within each group gravimetric determination of PM2.5 levels, along with simultaneous real-time measurements of particulate number, surface-area and mass concentration have been carried out. Results show very high PM2.5 exposures in central urban areas, which fall rapidly towards more rural regions. Measurements of cooking-related PM2.5 exposure in a number of homes indicate time-averaged exposures of around 100 μg/m3, although peak exposures are considerably higher, and seems to be associated with both the type of fuel used and the cooking method. Comparisons between the three exposure metrics show distinct differences associated with aerosol source and mass concentration.

[P15-10] ASSESSING HUMAN EXPOSURES OF COPD-DIAGNOSED INDIVIDUALS TO PARTICULATE MATTER IN LOS ANGELES COUNTY.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Epidemiological studies link particulate matter (PM) exposure to increased cardiovascular and respiratory morbidity and mortality. These studies use central outdoor monitors as surrogates for community exposure. The relationship between personal exposure and centralized measurements is key to understanding whether this is a suitable surrogate, or whether its use as a surrogate could lead to epidemiological measurement error and misclassification of risk.

Personal, indoor, and outdoor air pollution concentrations (24-h) were measured in Los Angeles County during the winter and summer of 2000 for individuals with compromised respiratory systems. Fifteen participants with COPD were sampled in each season for seven consecutive days. Eight of these individuals were sampled during both seasons. Three participants were sampled concurrently during each seven-day period. Measurements include PM10, PM2.5, O3, NO2, SO2, and air exchange rate. A central-site monitoring station provided concurrent measurements over the entire study. Home characteristics, potential sources of pollutants, and participant location throughout the day were documented using household surveys, daily questionnaires, and time activity information.

A total of 855 PM10, 852 PM2.5, and 790 O3, NO2, and SO2 samples were collected. PM samples were weighed in a controlled environmental facility at EOHSI following EPA weighing protocols. Aqueous extracts from gas samples were analyzed by Ion Chromatography at the Meadowlands Environment Center. Field blanks, independent standards, and replicate analyses were used to determine detection limits, analytical accuracy, and precision.

Study participants spent in excess of 80% of their day in their residences. Mean personal PM2.5 was 27 and 53 micrograms/m3 for winter and summer, respectively. Mean indoor PM2.5 was 17 and 26 micrograms/m3 for winter and summer, respectively. Outdoor winter and summer PM2.5 means were 15 and 17 micrograms/m3. Individual correlations between personal and outdoor PM2.5 were sometimes quite high, with Pearsons correlation coefficients as high as 0.92. Outdoor O3 was higher than indoor and personal O3. In some homes, indoor and personal NO2 was substantially higher than outdoor, suggesting the importance of indoor sources to indoor NO2 concentrations for those homes. Mean personal O3 for winter and summer was 8 and 3 ppb (13 and 3% greater than MDL), while outdoor means were 9 and 14 ppb (25 and 53% greater than MDL). Mean personal NO2 for winter and summer was 11 and 7 ppb (81 and 27% greater than MDL), while outdoors was 13 and 10 ppb (91 and 40% greater than MDL). Few SO2 measurements were above detection limits (MDL = 4 ppb).

[P13-29] CHARACTERIZATION OF AMBIENT FINE PARTICULATE MATTER IN DELHI, MUMBAI, AND KOLKATA.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 13: Receptor Modeling and Source Apportionment (11:00 AM-12:00 PM) Grand Ballroom 2-4

Fine particulate matter is characterized in three Indian megacities: Delhi, Mumbai, and Kolkata, including estimating the contributions of biomass and fossil fuel burning using Receptor-based Chemical Mass Balance Modeling. This study is an extension of the work conducted during INDOEX. During March, June, October, and December of 2001, atmospheric fine particle samples were collected over 24-hr periods in Delhi, Mumbai, and Kolkata using PM2.5 samplers. The peak of the average PM2.5 mass concentration occurred during the Winter Dry Monsoon and the lowest concentrations occurred during the Summer Wet Monsoon in all of the three cities sampled. Average fine particulate mass concentrations during the Winter Dry Monsoon were 189.95 $\mu g\ m^{-3}$ in Delhi, 88.47 $\mu g\ m^{-3}$ in Mumbai, and 302.26 $\mu g\ m^{-3}$ in Kolkata. Average fine particle mass concentrations during the Summer Wet Monsoon were 49.24 $\mu g\ m^{-3}$ in Delhi, 20.97 $\mu g\ m^{-3}$ in Mumbai, and 25.65 $\mu g\ m^{-3}$ in Kolkata. Most of the observed daily PM2.5 concentrations in Delhi and the wintertime daily PM2.5 concentrations in both Mumbai and Kolkata exceeded the EPA PM2.5 daily standard of 65 $\mu g\ m^{-3}$ signifying unhealthy air quality during that time. During December the mass percentage of organic matter (OM) and elemental carbon (EC) were 71% OM and 9% EC in Delhi, 53% OM and 9% EC in Mumbai, and 68% OM and 9% EC in Kolkata. EC can be attributed to the burning of fossil fuels and biomass. The presence of potassium during the year was an indication that biomass burning occurred in all three cities since potassium is a tracer for biomass smoke. Biomass burning seemed to peak during December. Relative contribution of crustal oxides or dust to the fine particle mass reached a peak during the Spring Pre Monsoon and the Summer Wet Monsoon in all of the 3 cities. These crustal elements were probably emitted to these cities principally in the form of fugitive dust from both local sources and long range sources of desert dust. Lead concentrations were as high as 2.4 $\mu g\ m^{-3}$ on January 4, 2002 in Delhi, 0.5 $\mu g\ m^{-3}$ on December 11, 2001 in Mumbai, and 3.4 $\mu g\ m^{-3}$ on Dec 17, 2001 in Kolkata, showing that lead is still present at high quantities in the air of Indian cities despite the complete phase out of leaded gasoline in Delhi. More than 100 organic species are currently being characterized, and once those data become available Chemical Mass Balance (CMB) modeling will be used to source apportion the fine particles using organic chemical tracer techniques.

[P15-04] INDOOR AND OUTDOOR ORGANIC PM2.5: ANALYSIS OF RIOPA DATA.

Andrea Polidori, Barbara Turpin, Sandra Lake, Robert Giovannetti, Clifford Weisel, Maria Morandi, Steven Colome, Thomas Stock, Arthur Winer, Jay Min Kwon, Shahnaz Alimokhtari, Derek Shendell, Jennifer Jones, Corice Farrar, Silvia Maberti
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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Numerous epidemiological studies have shown a positive association between outdoor PM2.5 and mortality and morbidity, suggesting an association between exposure to outdoor sources of PM2.5 and adverse health effects. However, people are exposed to air contaminants generated indoors, outdoors and in other microenvironments. Little is known about the composition of indoor and personal PM2.5 and the relative contributions of outdoor and indoor sources to indoor and personal exposure. However, it is known that organic matter comprises a substantial fraction of total outdoor PM2.5 mass (typically 30-70%). In this poster we describe organic (OC) and elemental carbon (EC) measurements made inside and outside of residences.

During the "Relationship of Indoor, Outdoor and Personal Air" study (RIOPA), indoor and outdoor PM2.5 samples were collected for 48-h at 10 lpm in Houston (TX), Los Angeles County (CA), and Elizabeth (NJ). Roughly 2/3 of the houses were within 0.5 miles of an outdoor source of one or more target compounds (VOC, aldehyde and/or PM2.5). Samples for OC and EC were collected on a quartz fiber filter (baked) and on a quartz fiber filter placed behind a Teflon filter. The later provides an estimate of the quantity of organic vapor that adsorbs on the single quartz filter. Thus, particulate OC is calculated by subtracting the Teflon-quartz backup (dynamic blank) from the single quartz filter. Samples were analyzed by thermal-optical transmittance (TOT). Instrument and field blanks, replicates, independent standards, FID sensitivity and samples from collocated samplers were also analyzed.

Mean (48-h) indoor particulate OC (after artifact correction) was higher than mean outdoor particulate OC, suggesting the existence of indoor sources of particulate OC. Mean indoor and outdoor EC concentrations were comparable. The adsorption artifact is approximately 30-40% of measured OC in these samples. The adsorption artifact is a function of the filter face velocity, surface area, and the composition and concentration of organic vapors in the sampled air. OC and EC concentrations, along with other species measurements, will be used to examine the species mass balance for PM2.5 in RIOPA homes, providing a comprehensive assessment of PM2.5 composition indoors and out.

[P15-05] THE EFFECTS OF OZONE AND FINE PARTICULATE MATTER ON THE PULMONARY HEALTH OF ADULT HIKERS IN THE GREAT SMOKY MOUNTAINS NATIONAL PARK.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

As part of an ongoing effort to monitor and improve air quality in the Great Smoky Mountains National Park, the effects of ambient ozone (O_3) and fine particulate matter ($PM_{2.5}$) on the short-term pulmonary function of adult hikers were assessed at Newfound Gap, a popular high-elevation (5048 ft) site in the Park. During August 2002-October 2002, adult (18 and over) day hikers embarking upon hikes of approximately 4 miles or longer along a portion of the Appalachian Trail that originates at Newfound Gap were solicited to participate in the study. Volunteers were asked to have their height and weight measured, submit to pulmonary testing before and after their hike, complete a trip log documenting their pulse and arrival times at certain trail markers, and respond to a health history survey. Pulmonary function was measured using spirometry, with percentage changes in forced expiratory volume in 1 second (FEV_1), forced vital capacity (FVC), the ratio of FEV_1 to FVC, peak expiratory flow rate (PEFR), and forced expiratory volume between 25 and 75 percent of total expiration duration ($FEV_{25-75\%}$) calculated for each hiker who met eligibility criteria, gave acceptable and reproducible tests, and provided a complete set of covariates (age, fitness level, gender, smoking status, history of asthma or wheeze, and hiking time and duration) (N = 270). Continuous ambient ozone and $PM_{2.5}$ concentrations along with meteorological conditions (temperature and relative humidity) were monitored on-site at the trailhead on each sampling day. Local air quality measurements were correlated with continuous Park air monitoring stations located at nearby sites at similar elevations. Ozone exposures ranged from 30 to 90 ppbv, while $PM_{2.5}$ exposures ranged from 5 to 40 $\mu g/m^3$ during this time period.

[P15-06] COMPARISON OF COLLOCATED PERSONAL MULTI-POLLUTANT SAMPLERS VS. A CENTRAL AMBIENT AIR MONITORING STATION IN STEUBENVILLE, OHIO.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Several epidemiological studies have shown an association between PM2.5 concentration and adverse health effects. As a result, the U.S. EPA promulgated new ambient air standards for PM2.5. However, the National Research Council recommended that scientific uncertainties regarding the relationship between PM2.5 and health effects be clarified before PM2.5 standards are finalized. For example, do measurements conducted at a central outdoor ambient air monitoring station accurately reflect personal exposure? Is total PM2.5 mass, a component(s) of PM2.5, a co-pollutant, or a combination responsible for the observed association with adverse health effects? To help address these uncertainties, CONSOL Energy launched a three-year study called the Steubenville Comprehensive Air Monitoring Program (SCAMP). SCAMP is funded by the US DOE National Energy Technology Laboratory, Ohio Coal Development Office, Electric Power Research Institute, American Petroleum Institute, American Iron and Steel Institute, National Mining Association, Edison Electric Institute, National Institute of Environmental Health Services, US EPA, and CONSOL Energy.

SCAMP is comprised of two overlapping and interdependent sampling programs focused on measuring fine particulate and gaseous pollutants in the outdoor ambient air, inside the home, and in the breathing space of individuals. The outdoor ambient air program utilizes a central ambient air monitoring station equipped with federal reference method particulate samplers and federal equivalent method gaseous pollutant analyzers. The indoor and personal sampling program utilizes an integrated, filter-based, multi-pollutant sampler, developed by the Harvard School of Public Health. The multi-pollutant sampler is a modular sampling system that collects both particulate and gaseous pollutants simultaneously and can be deployed to sample in different environments (i.e., on a person, indoors, and outdoors).

A comparative analysis is presented of the federal reference method particulate sampler, federal equivalent gaseous pollutant analyzers, and the multi-pollutant sampler. The analysis is based on 20 weeks of collocated sampling data. The data establish a foundation for quantifying the relationship between personal exposure and a central ambient air monitoring station. Instrumental issues, such as accuracy, precision, and sensitivity, are discussed for the following pollutants: PM2.5, sulfate, sulfur dioxide, nitrogen dioxide, and ozone.

[P15-07] EIGHT YEAR TRENDS IN FINE PARTICLE CONCENTRATIONS, COMPOSITION, AND GASEOUS CO-POLLUTANTS IN THE SOUTHERN CALIFORNIA CHILDREN'S HEALTH STUDY.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Ambient air quality data have been collected in twelve central and southern California communities since 1994 to support the ten-year Children's Health Study conducted by the University of Southern California. The objective of the Children's Health Study is to identify chronic health effects of ambient air pollution and determine which pollutants are responsible for the effects. Twelve communities with differing levels of air pollutants and distinct chemical profiles were selected for prospective air quality and health outcome monitoring. A new sampler was developed to obtain long-term air pollutant data in a cost-effective manner. The novel 5-legged Two-Week Sampler (TWS) collects two-week integrated samples of PM2.5 mass, sulfate, nitrate, chloride, ammonium, elemental carbon, organic carbon, trace metals, and gaseous nitric acid, hydrochloric acid, formic acid, and acetic acid. The TWS measurements were supplemented with continuous measurements of ozone, NO, NO2, CO, PM10 mass, and particle number.

In this presentation, we describe the quality, uses, and trends in the Children's Health study air quality data. Specifically, we discuss the precision of the TWS data based on 8 years of collocated sampling at numerous locations and the accuracy of the TWS based on comparison with reference methods, including the daily FRM samplers. The various uses of the data, ranging from short-term to long-term analyses, are described. Lastly, the trends in ambient concentrations from 1994 to 2001are presented along with their relevance for the health effects study.

[P15-18] MICROENVIRONMENTAL MODELING OF PERSONAL EXPOSURES TO PARTICULATE MATTERS AMONG ASTHMATIC CHILDREN.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Most epidemiologic studies estimate air pollution exposures from fixed-site monitor measurements, as personal exposure measurements are rarely available. Our previous studies have shown that we can predict PM2.5 exposures among elderly populations reasonably well with a microenvironmental model. However, for asthmatic children, the prediction power of the microenvironmental model is usually low. This study demonstrates how real-time monitoring instruments may help improve the performance of the prediction model.

This paper uses a subset of data from a larger panel study conducted in Alpine, CA. Continuous PM concentrations were measured using the Thermo-MIE personal DataRAM (pDR) on 14 pediatric asthmatic subjects, at their residences indoors and outdoors, and at a central site. Three approaches were applied to model personal exposures: (1) The pDR data at the central site were averaged over a 24-hr period to represent the personal exposures; (2) The pDR data at the monitored microenvironments were averaged over a 24-hr period to simulate the conventional time-integrated filter samples. A time-weighted three-microenvironment (μe) model was then used to calculate the 24-hr average personal exposures; and (3) The 15-min personal exposures were estimated from the continuous pDR data with a similar three-μe model. The estimated 15-min exposures were then averaged over a 24-hr period.

The prediction powers (R^2) for the three approaches were 0.07, 0.12 and 0.18, respectively, indicating that applying continuous data (Approach 3) to the μe model improved the prediction power. Further analysis with 1-hr average pDR data with Approach 3 shows that the R^2 between modeled and measured personal exposure in the home-indoors μe is 0.33 while the R^2 between modeled and measured personal exposure in the other μe's range between 0.03 to 0.05. To more accurately estimate the exposure levels in major μe's where no monitoring data are available, a model with spatial and temporal variants (e.g. latitude, longitude, elevation and time of the day) is developed.

This study is funded by the NIH/NIEHS grant ES-06214 and EPA Northwest Research Center for Particulate Air Pollution and Health grant R827355.

[P15-09] WOMEN'S PERSONAL AND INDOOR EXPOSURES TO PM2.5 IN MYSORE, INDIA - IMPACT OF DOMESTIC FUEL USAGE.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

The Indian economy is industrializing at an unprecedented pace, and the urban population is undergoing a rapid risk transition, facing both traditional and modern risks. Such risk overlaps are most frequent among poor urban women. However, little systematic information has been gathered on women's exposures to $PM_{2.5}$ and indoor concentrations, and the exposure variation due to fuel usage patterns and income class (Kandlikar and Ramachandran, 2000).

The results presented here are part of an ongoing larger study that is investigating the relationship between fuel usage for domestic cooking, $PM_{2.5}$ personal exposures and indoor levels, and respiratory health symptoms and spirometry parameters. Personal and indoor 24-hour average exposures to $PM_{2.5}$ were measured gravimetrically for 30 women (15 using kerosene and 15 using LPG for cooking) during summer and winter in Mysore, India. Concurrent gravimetric measurements of indoor $PM_{2.5}$ levels were also made. Gravimetric measurements were made using inertial impactors with $PM_{2.5}$ inlets (PEM Model 200, MSP Inc., Minneapolis, MN). Real-time measurements using a light scattering photometer (DustTrak, TSI Inc.) and a surface area monitoring diffusion charger (LQ1-DC) were obtained in selected residences.

Personal exposures of women using kerosene ranged from 49 to 268 $\mu g/m^3$, while those for women using LPG ranged between 8 and 236 $\mu g/m^3$. Kerosene users had a least squares mean exposure of 111 $\mu g/m^3$ (SE = 11 $\mu g/m^3$) and this was statistically significantly higher than the mean of the personal exposures of LPG users (LS mean = 68 $\mu g/m^3$, SE = 11 $\mu g/m^3$). Indoor concentrations ranged between 25 and 218 $\mu g/m^3$ for kerosene-using homes, while the levels for LPG-using homes ranged between 11 and 156 $\mu g/m^3$. Again, kerosene using homes had a least squares mean $PM_{2.5}$ level of 104 $\mu g/m^3$ (SE = 10 $\mu g/m^3$) and this was statistically significantly higher than LPG-using homes (LS mean = 76 $\mu g/m^3$; SE = 10 $\mu g/m^3$). Although indoor levels were lower than personal exposures, the difference was not statistically significantly. The preliminary data indicate that women who use kerosene as their main cooking fuel face higher exposures to $PM_{2.5}$ than women who use LPG.

Kandlikar, M. and Ramachandran, G. (2000). "The causes and consequences of particulate air pollution in urban India: A synthesis of the science", *Annual Review of Energy and Environment*, Vol. 25: 629-684.

[P15-17] FACTORS AFFECTING PERSONAL AND INDOOR CONCENTRATIONS OF $PM_{2.5}$, PARTICULATE NITRATE, AND ELEMENTAL CARBON FOR INDIVIDUALS WITH COPD IN LOS ANGELES, CA.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

A study characterizing the personal, indoor, and outdoor concentrations of $PM_{2.5}$ and its components, including nitrate (NO_3^-) and elemental carbon (EC), was conducted in Los Angeles, CA for individuals with chronic obstructive pulmonary disease (COPD). Monitoring was performed for 15 participants for 7 consecutive days in the winter and summer of 2000, respectively. During each sampling day, 24-hr personal, indoor, and outdoor samples of the targeted pollutants were collected simultaneously. Housing characteristics and time-activity diaries were also obtained. In the current paper, the ANOVA procedures and the longitudinal regression analyses were performed to examine the effects of potential particle-emitting activities, geographical location, traffic, and population density on the personal exposure and indoor levels.

Results showed that particle-generating activities were not important contributors to indoor particulate levels, as cooking, cleaning and ETS were statistically insignificant predictors of indoor concentrations. This result was due to the relative inactiveness of the participants. For indoor NO_3^-, air exchange rates were found to be an important effect modifier, with its penetration efficiency increasing and the indoor source contribution decreasing with air exchange rates. For other particulate species, air exchange rates were neither a significant covariate nor an important effect modifier.

Microenvironmental models were constructed to evaluate the importance of indoor and outdoor concentrations to personal exposures. In general, especially in the winter, time-weighted indoor exposures were better predictors of personal $PM_{2.5}$ exposures as compared to time-weighted outdoor levels. In the summer, the intercepts of the personal $PM_{2.5}$ exposure models were comparable to those for the indoor models, suggesting that the contribution of indoor and personal sources to indoor concentrations and personal exposures were the same. Microenvironmental models explained more than 40% of the variability in personal exposures for all particulate measures in both seasons with the exception of summertime $PM_{2.5}$. As was the case with indoor concentrations, few particle-generating activities were found to contribute to personal exposures. ETS exposures were also found to be important contributors to personal $PM_{2.5}$ exposures. Finally, in the summer, the personal NO_3^- exposures for participants living in homes within 100 meters of a major road were on average 0.58 (±0.23) $\mu g/m^3$ higher than participants living farther away from major roads.

[P15-11] PERSONAL EXPOSURES TO PARTICULATE MATTER AND ITS COMPONENTS AMONG CHILDREN WITH ASTHMA.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

As part of Community Action Against Asthma, a community-based participatory research project in Detroit, MI, the role of PM on asthma exacerbation is being studied. Over a two-year period, two-week seasonal intensive measurement campaigns were conducted in which daily ambient and indoor measurements of PM2.5 and PM10 were collected at two elementary schools that represent community-level exposure and exposure in the classroom, respectively. Concurrent measurements of PM2.5 and PM10 were also made inside the homes of 20 asthmatic children as well as personal measurements of PM10 for the same 20 children using personal exposure monitors.

Gravimetric examinations of personal PM measurements from 2001 suggest that there are contributions to the children's PM10 personal exposures that are not captured by the fixed community-level monitoring sites. Average concentrations of the personal exposures among children in homes with smokers were 50.1 + 43.4 μg/m3, and for those in homes with no smokers, 39.4 + 29.2 μg/m3-both of which are 2-2.4 times greater than the PM10 measurements made at the community-level sites.

According to the activity data completed by the 20 children conducting personal exposure measurements, they spend, on average, 85% of their day indoors. The children's personal PM concentrations are significantly correlated with their home environment when categorized by smoking status ($p<0.0001$). As a result, the indoor micro-environmental measurements are important in the identification of major contributions to the children's exposures. In order to effectively assess the specific contributions to the children's personal exposures, comprehensive chemical characterization of the filter samples, including trace element and elemental and organic carbon, is conducted. Complete evaluation of the PM components will lend valuable insight on the sources contributing to the children's exposures. Furthermore, in conjunction with other project measurements including lung function and symptom information, the data will be helpful in assessing the role of air pollutants in the aggravation of childhood asthma.

[P15-12] HOURLY PERSONAL EXPOSURE TO INDOOR- AND OUTDOOR-GENERATED PARTICLES AMONG SENSITIVE POPULATIONS IN SEATTLE.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Epidemiologic studies have demonstrated an association between ambient particulate matter (PM) and health effects, and a few other studies have shown that health effects are associated with short-term spikes in PM levels. Very few studies have attempted to separate PM exposure into indoor- and outdoor-generated components, although these two classes of particles may have different chemical compositions and toxicities. In this paper we make such a separation on an hourly basis.

Our data were obtained as part of a larger exposure assessment study that collected indoor, outdoor, and personal PM concentrations from 108 subjects including elderly adults with and without chronic obstructive pulmonary disease (COPD) and coronary heart disease (CHD), as well as asthmatic children. This paper focuses on 55 subjects whose residences and personal air were measured continuously using the Radiance nephelometers and the Thermo-MIE personal DataRAM (pDR) on a subset of 14 subjects, respectively. Indoor, outdoor, and personal filter samples were also collected, and the subjects completed a time-location-activity diary (TAD). This paper uses a recursive mass balance model and the light scattering data to estimate particle infiltration (Finf) for each residence. Using these Finf values and the TAD data in a microenvironmental model, we then estimate hourly personal exposure to indoor- and outdoor-generated particles. In addition, we estimate the fraction of outdoor particles that result in personal exposure to outdoor-generated PM (i.e. the attenuation factor, α)

The overall mean Finf was 0.66±0.23, which was lower during the heating season (0.53±0.18, Oct.-Feb.) than during the non-heating season (0.80±0.19, Mar.-Sep.; $p<0.001$). Outdoor PM2.5 concentrations were higher during the heating season ($p<0.001$), but there was no seasonal difference in indoor or personal PM2.5 concentrations, indicating that the seasonal difference in outdoor PM2.5 concentration is counteracted by an opposite seasonal difference in Finf. The α estimates varied by subject and season, showing the same seasonal trend as the Finf estimates ($p<0.001$). However, there was no difference in α among the four cohorts. Estimates of exposure to outdoor-generated PM did not show any differences between seasons or health groups. Among the pDR subjects, the median longitudinal R2 between the modeled and measured personal exposures was 0.39.

This work was funded by the U.S. EPA under EPA Cooperative Agreement #R827177 and the EPA NW Research Center for Particulate Air Pollution and Health (#R827355).

[P15-13] SPATIAL VARIABILITY OF PM EXPOSURES AS DETERMINED IN THE THE FRESNO ASTHAMTIC CHILDREN\\'S ENVIRONMENT STUDY (FACES).

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

The overall goal of the Fresno Asthmatic Children's Environment Study (FACES) is to examine associations between air pollution and the extent, severity, and evolution of asthma symptoms in 6 to 14 year old children. The exposure assessment portion of the project is particularly aimed at developing estimates of each child's exposure to each pollutant and possible co-factors, such as pollen grains, fungal spores, and endotoxin, on each day of the study. A key hypothesis of the study is that different chemical species have concentrations that vary on urban, neighborhood, and household scales in the Fresno/Clovis study area. The FACES exposure assessment incorporates a variety of air quality and bioaerosol measurements to evaluate and characterize the spatial variability of air pollutants in Fresno as well as indoor/outdoor differences. The spatial variations are evaluated by comparing concentration data collected at homes, schools, and local air quality monitoring sites with those collected at the EPA-sponsored Supersite in Fresno.

The extent of spatial variation depends on the pollutant and proximity to source emissions. Significant spatial differences in the pollutants emitted by combustion sources, particularly PM2.5 elemental carbon, are observed. PM2.5 mass and PM10 mass concentrations also display significant spatial differences in Fresno that are consistent with the proximity of roadways. Likewise, the outdoor concentrations of pollen grains, fungal spores, and endotoxin depend on the local source strength and are shown to vary considerably across Fresno. In contrast, most secondary pollutants, such as PM2.5 sulfate and PM2.5 nitrate are spatially homogeneous on an urban and neighborhood scale. It is more difficult to interpret the spatial variability in the PM2.5 organic carbon concentrations because OC results from both primary formation, that varies on the local scale, and secondary formation, that does not typically vary on a local scale. Overall, the air quality data show spatial variations in concentrations of numerous agents large enough to warrant their inclusion in the exposure assessment methodology.

[P15-14] INVESTIGATIONS OF THE SENSITIVITY OF A PREDICTIVE MODEL OF INDOOR CONCENTRATIONS OF OUTDOOR PM-2.5 TO CHANGES IN HOUSE OPERATIONAL AND ENVIRONMENTAL PARAMETERS.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Interest in determining human exposure to fine PM has intensified due to recent findings associate particulate air pollution with increased morbidity and mortality in the United States. Although people spend an average of 85 to 90 percent of their time indoors, the National Ambient Air Quality Standards for particulate matter (PM) focus on outdoor concentrations. However, the relationship between indoor and outdoor particulate levels is not well established, particularly at more detailed levels of characterization like chemical speciation and size distribution. We conducted a field study in California\\'s San Joaquin Valley to investigate indoor particles of outdoor origin. The objective of the study is to develop a physically-based, semi-empirical model that describes the indoor concentration of PM2.5 sulfate, nitrate, organic carbon and black carbon derived from outdoor sources. The study was conducted in an unoccupied, single-story residence in Clovis, California, manipulating the house to effectively use it as a research laboratory. Intensive measurements were performed for four weeks in the fall and winter of 2000/2001. Measurements included many of the physical and chemical properties of both the indoor and outdoor aerosol as a function of time, as well as important housing and meteorological characteristics.

The use of real-time measurements during the experiment allows for both parameterization and testing of a transient mass balance model for the house. Ventilation rates are predicted using the LBNL/AIM infiltration model with inputs of the leakage characteristics of the house, regional meteorological characteristics, and additional corrections determined from assumptions concerning the human factors affecting building operation (e.g. window and door opening or HVAC operation). The physical parameters affecting particle dynamics are modeled using size-resolved penetration factors and deposition rates directly measured in the research house. A model for the chemical transformation of ammonium nitrate upon transport into the house and subsequent uptake of reactive gases to indoor surfaces is incorporated. The model is evaluated by the degree to which the model captures the important physical and chemical mechanisms affecting particulate sulfate, nitrate, and black carbon. In addition, the sensitivities and uncertainties of the model to individual parameters are assessed for their importance in predicting indoor concentrations of outdoor PM-2.5.

[P15-15] COMMUTERS' EXPOSURE TO PM2.5, CO AND BENZENE INSIDE THE PUBLIC TRANSPORT IN MEXICO CITY:

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

In the last 10 years, the levels of criteria pollutants in Mexico City have decreased substantially with the implementation of Air Quality Programs such as PICCA 1990-1995 and PROAIRE 1995-2000. Replacement and improvement of fossil fuels and introduction of clean technologies for the industry and transport sector are some examples to consider in order to understand why the ambient air pollution levels are now lower than 10 years ago. However, the concentrations of PM2.5, CO and benzene have not been evaluated using an integrated sampler during commuting periods in Mexico City to establish the impact produce from mobile sources as well as other anthropogenic sources that might represent a potential threat for commuters inside public transport.

We carried out a study to measure commuters' exposure to PM2.5 and its composition, to compare CO levels with a previous study carried out in 1991, to sample benzene using an integrated sampling technique and finally to use the data collected to prepare a main campaign to be conducted in winter 2003.

PM2.5 (N=84), CO (N= 78) and benzene (N=26) were measured during morning (6:30-9:30 am) and evening (17:30-20:30) rush hours on minibuses, buses and metro from the 6th of May to the 1st June 2002. Additionally, 2 midday journeys (11:00-14:00 and 14:00-17:00) using the same modes of transport were sampled to compare the differences among morning, evening and midday hours. Three corridors were selected from a previous study conducted in 1991 (1.Indios Verdes-San Angel, 2.Pantitlan-Tacubaya, and 3.La Villa-Auditorio Nacional). For PM2.5, mass concentration was determined in all samples. Nitrates, sulfates, inorganic elements and carbon fraction were evaluated. CO samples were taken using passive monitors and 6-liter canisters were used to collect integrated samples for benzene using flow controller devices. The highest GM concentration for PM2.5 (84 μg/m3) was detected in morning rush hour journeys inside minibuses. A maximum PM2.5 value of 137 μg/m3 was detected in a bus journey during an evening rush hour. The main component identified on PM2.5 samples was carbon fraction (more than 50%). The sulfur element presented the highest concentration among the elements identified in all samples. Carbon monoxide levels were approximately 3 times lower than those found in a study conducted in 1991. Finally, the maximum GM concentration for benzene was detected inside minibuses (8 ppb) during morning peak hours.

[P15-02] FIELD EVALUATION OF A PERSONAL CASCADE IMPACTOR SAMPLER (PCIS).

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

This paper presents field evaluation of a Personal Cascade Impactor Sampler (PCIS). PCIS is a miniaturized cascade impactor, consisting of four impaction stages, followed by an after-filter, which separates particles in the following aerodynamic particle diameter ranges: <0.25, 0.25-0.5, 0.5-1.0, 1.0-2.5 and 2.5-10 μm. The PCIS operates at a flow rate of 9 LPM at a pressure drop of 11 in H_2O (2.7 kPa). For field data comparisons, the collocated samplers were Micro Orifice Uniform Deposit Impactor (MOUDI, Model 110, MSP Corp, Minneapolis, MN), Scanning Mobility Particle Sizer (SMPS, TSI Model 3936) and Aerodynamic Particle Sizer (APS, TSI Model 3320). The results show excellent agreement between PCIS and MOUDI for coarse PM ($PM_{2.5-10}$) mass. The fine PM ($PM_{2.5}$) mass as measured by PCIS is in extremely close agreement with SMPS-APS measurement (~1.03 times) but is slightly higher (~1.2 times) than MOUDI measurement. The size fractionated mass concentrations between PCIS, SMPS-APS and MOUDI were also compared. PCIS and SMPS-APS agree reasonably well for particle size ranges from 2.5-0.5 μm however, the size ranges <0.5 μm are slightly different probably due to the differences between the aerosol sizing principles underlying each instrument. The SMPS-APS and PCIS concentrations for <0.5 μm are in much closer agreement (within 15%) than those measured by the MOUDI. Size fractionated $PM_{2.5}$ Elemental Carbon (EC) and Organic Carbon (OC) measurements by PCIS and MOUDI were compared with those measured by MOUDI. For these measurements MOUDI and PCIS agree well for particles in the range 0.5-0.25 μm, however MOUDI underestimates the carbonaceous matter content for particles < 0.25 μm by about 15%. The lower MOUDI concentrations, observed particularly in the lower stage and the after-filter, could be attributed to volatilization of carbon particles collected under low pressure in these stages. The ability of the PCIS to preserve labile species during sampling is a highly desirable feature, particularly as a significant fraction of fine particles is associated with such species. Finally, $PM_{2.5}$ nitrate and sulfate measurements by MOUDI and PCIS were also compared and found to be in very good agreement.

The performance of PCIS was also evaluated in the wind tunnel. The results show that the particle penetration characteristics of the PCIS 2.5 μm stage are unaffected by the wind speeds. The size-dependent particle penetration for all the wind speeds tested, viz., 3 and 8 km/h show a very close agreement. This is particularly important because it demonstrates that the PCIS can be used throughout the various ambient conditions found in all normal environments.

[P15-08] AIR QUALITY AND COMPARATIVE EXPOSURE: A PARCEL-LEVEL CUMULATIVE RISK ANALYSIS.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 15: Personal, Indoor, and Outdoor Exposures: Measurements and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

The study assesses the potential impacts at the parcel level of air toxics emitted from area sources in sections of the lower South Providence, Washington Park, and Elmwood neighborhoods of Providence, RI. Estimating potential risk at the parcel level enables a more detailed and comprehensive analysis, especially when comparing exposure.

Using emission rates provided by the RI Department of Environmental Management's Air Emissions Inventory, the SCREEN3 dispersion model, and generally accepted chemical toxicity values, estimated risk levels were calculated for each facility and chemical in the study area. Geographic Information System (GIS) was then used to estimate the cumulative maximum risk from exposure to multiple pollutants and sources. Demographic variables within these areas of risk were also addressed.

In order to assess human exposure to toxic and criteria air pollutants in Washington Park and Lower South Providence, this study created and utilized a four-pronged system of comparative exposure analysis. First, the manner in which chemical concentration decreases as distance from a facility increases was determined using the Rhode Island Department of Environmental Management Office of Air Resource's (OAR) Air Emissions Inventory This data was then used as input for the SCREEN3 dispersion model to assess the concentration of chemicals at different distances from facilities.

It is impossible, however, to determine a pollutant's risk to surrounding populations based solely on its concentration in the air. Thus, to evaluate the actual hazard these dispersed concentrations pose to exposed individuals, the Environmental Defense Fund's (EDF) listing of toxicity/potency factors and reference concentrations was incorporated into the model.

The model, coupled with EDF risk factors, determined how risk increased as chemical concentration increased. This study assumed that both cancer and non-cancer risks are additive across pollutants. Next, GIS combined the dispersed risk levels of each chemical from each facility and mapped cumulative risk isopleths. This technique generated maps displaying additively overlapping risks from multiple chemicals emitted from multiple facilities. The study then used these risk isopleths to evaluate comparative exposure of residents in Washington Park and South Providence.

[P05-15] ESTIMATION OF TRACE-ELEMENTS EMISSION BY LIGHT-DUTY VEHICLES IN SAO PAULO METROPOLITAN AREA, BRAZIL.

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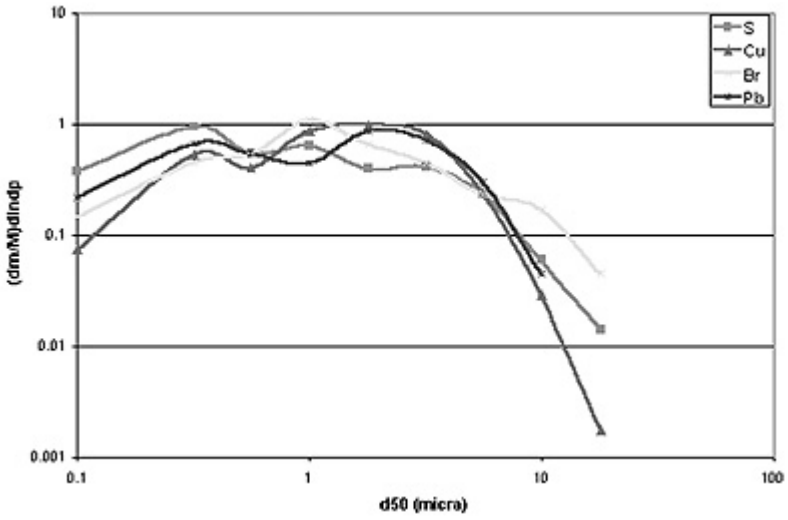
Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Particulate matter short-term measurements data were collected in a tunnel in São Paulo city in order to provide an emission profile for characteristic trace-elements. The tunnel chosen is used only for light-duty vehicles (LDV). Field sampling took place in August 13, 2001. São Paulo Metropolitan Area (SPMA) is one of the largest metropolitan area in the world with a population of more than 17 million inhabitants and almost 6 million vehicles, light and duty. One important characteristic is that the LDV are fulled with a blend of gasoline with 22% alcohol or pure ethanol, resulting that approximately 40% of the total volume of consumed fuel in SPMA is ethanol . Previous studies involved in the estimating the impact of vehicular emission to air pollution by particles in the SPMA pointed out the lack of a vehicular particulate emission profile. The measurements resulted in a first estimation of this profile for SPMA, and some interesting results were achieved. The particles were collected with a Cascade Impactor MOUDI with ten stages and a system of stacked filter unit (MiniVol system). The trace-elements concentrations were obtained by means of PIXE (Particle Induced X-Ray Emission) analysis and the ionic concentration by ion chromatography. Samples were collected inside - in the middle of the tunnel and outside, to have the background concentration. Fuel-based particulate emission factors were computed by relating total carbon emissions in the tunnel to the carbon content of fuel using the equation based in the work of Kirchstetter et al., 1999. The emission factor for some important trace-elements were in mg/g: Al 8.15, Si 8.64, S 10.97, Ca 5.59, Ti 2.04, Mn 1.47, Cu 6.68, Zn 2.95, Br 0.29, Pb 0.33 and Black Carbon 235.78. The concentration size distributions for sulphur and other trace-elements are present in Figure 1.

References:

Kirchstter T.W., Harley R. A., Kreisberg N. M., Stolzenburg M.R., Hering S. (1999). On road measurement of fine particle and nitrogen oxide emissions from light- and heavy-duty motor vehicles. (Click to see figure 1)



Figure

[P05-29] STATISTICAL ANALYSIS OF FUEL, EQUIPMENT, AND DRIVING SCHEDULE EFFECTS ON PM EMISSIONS FROM HEAVY VEHICLES.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Two rounds have been completed in a multi-year experimental program to evaluate the effects of ultra-low sulfur diesel fuels and passive diesel particulate filters in truck and bus fleets operating in southern California. The two rounds represent repeated measurements on the vehicles at approximately 150,000 and 300,000 accumulated miles. Along with the primary objective of evaluating the effects of the experimental factors, estimation of the deterioration of PM emissions under these conditions over time is also of interest.

Owing to the multiple factors encompassed by the experimental design, the statistical analysis of the data is not straightforward. The analysis is driven by considerations of fixed and random effects in a general linear statistical model which are operationalized through the analysis of variance (ANOVA) and analysis of covariance (ANCOVA) methodology. This presentation details the analytical approach and reports findings from the overall study.

The research is significant in that the interrelationship of factors contributing to diesel-related PM emissions in heavy vehicles is not completely understood, nor is their long term persistence due to protracted use of the vehicles fully appreciated. A faithful assessment of the significance of interacting factors and the related uncertainty requires better experimental designs and more sophisticated statistical treatment than have heretofore been applied. Further, greater reliance on heavy vehicles in the transportation sector has the potential to appreciably impact the total burden of PM emissions over time, particularly in urban areas, and thereby encumber efforts to moderate its consequences on the environment and human health.

[P05-28] MODELING VOLATILE NANOPARTICLES GENERATED BY MOTOR ENGINES.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Present engine particulate emission standards are based on mass. Recently it has been pointed out that it is not sufficient to study only the particulate mass. The main concern is that, while nanoparticles (NPs, diameter $\leq$ 50 nm) contribute a small fraction to the mass concentration of the ambient aerosol, they may contribute disproportionately to its toxicity because of their high number concentration and surface area, high deposition efficiency in the pulmonary region, and high propensity to penetrate the epithelium. In view of the potential strong adverse health effects associated with NPs, future standards might be imposed on NP emissions and NP emissions from gasoline engines may also become a concern. Effective and least costly means of NP emission reduction must be based on a firm physical understanding of the formation mechanisms of NPs in vehicle exhaust. Such an understanding is also important to interpret the NP measurements taken under different conditions and to develop emission inventories.

Most of NPs generated by motor engines are formed during exhaust dilution from low volatile precursor gases and the measured NP concentrations are very sensitive to dilution and sampling conditions. In this study, we investigate the key processes and parameters controlling formation and evolution of NPs in vehicle exhaust through model simulations and comparisons with field measurements. The detailed aerosol dynamics are simulated with an advanced multi-type, multi-component, size-resolved particle microphysics model. Measurements of NPs made both in the laboratory and in the atmosphere under various conditions are analyzed. The classical binary homogeneous nucleation of H2SO4-H2O fails to explain the observed NP properties. We find that chemiions generated in engine combustor may play an important role in the formation of NPs in vehicle exhaust (Yu, 2002). The predicted NP properties based on our ion-mediated nucleation of H2SO4-H2O consistently explain the measurements in terms of total NP concentrations, and their sensitivity to fuel sulfur contents, on-road vehicle speeds, soot concentrations, and dilution conditions. Our study indicates that total number of NPs formed in engine exhaust is very sensitive to chemiion concentrations. If our theory is confirmed, removing small ions inside tailpipe with an electrical field can reduce NP emissions. (Yu, F., Chemiion evolution in motor vehicle exhaust: Further evidence of its role in nanoparticle formation, Geophys. Res. Lett., 29, 10.1029/2002GL015004, 2002.)

[P05-27] SPATIAL AND TEMPORAL ASSESSMENT OF A MOBILE SOURCE AEROSOL INDICATOR DURING WINTER IN BOSTON, MA.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Many urban locations are expected to be near or over the annual U.S. EPA standard for PM2.5 of 15.0 $\mu g/m^3$. Data from PM2.5 monitors in the same metro area only a few miles apart can be substantially different, with some over and some under the standard. Variation on this spatial scale is often presumed to be driven by local mobile source particle emissions. It is important to define the spatial extent of elevated PM2.5 for compliance and control purposes, as well as for health effect assessments. One indicator of local mobile source aerosol in urban areas is black carbon soot (BC), which has been shown to be well correlated with integrated EC filter samples. BC can be measured in real-time with a commercial instrument (Aethalometer) that is relatively simple to install and operate; the principle is light absorption through a quartz filter. A pilot study was performed during the winter of 2003 to assess the spatial and temporal extent of variation in the local mobile-source aerosol over the greater Boston metro area out to more than 25 miles from downtown, using BC as an indicator for that PM component. Given that other major mass components of PM2.5 (sulfate, organic carbon) in the NE US are secondary transported aerosols and tend to be uniform over this scale, the locally generated "tailpipe" component of PM should drive the shape of PM2.5 spatial gradients over the metro area. For monitoring locations, a series of eight sites were selected heading WNW from downtown Boston, generally away from immediate large sources of local mobile-source emissions. This design avoids coastal influence and allows the pilot study to be more readily generalized to other large metro areas in the northeast. Winter is the season where this gradient is expected to be largest; that plus the prevailing upwind direction relative to downtown Boston for the sites would give us a maximum spatial gradient result; other seasons and directions could be smaller, but none would likely be larger. Two "hotspot" sites are included to demonstrate the potential range of micro-scale variability over this domain, since the core effort of this pilot study is intended to characterize only large scale spatial patterns. BC data are analyzed for spatial patterns on different time scales (overall mean, day of week, time of day, event periods). Limitations of this pilot study include the lack of seasonality, up-wind versus downwind spatial patterns, effects of local topography on measurements (including high-elevation sites), and minimal hotspot characterization. Some of these aspects are explored with short-term sites at high elevation near Boston, down-wind of Boston, and further west of the city.

[P05-26] MODELING OF THE NUMBER DISTRIBUTIONS OF URBAN AND REGIONAL AEROSOLS - EVOLUTION OF AEROSOL NUMBER DISTRIBUTION NEAR ROADWAYS.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Several studies have suggested that aerosol number concentrations may be more well correlated to health effects than mass concentrations and that particle number concentrations in the vicinity of freeways are significantly higher than their background level, which raises concerns regarding adverse health effects on people living there. Thus it is important to understand how particles transport and transform near roadways for regulatory purposes.

Dilution is the dominant process in the evolution of aerosol number distribution near roadways. We found that exhaust usually experiences two distinct dilution stages after being emitted: the first stage dilution is induced by traffic-generated turbulence and the dilution ratio usually reaches about 1000:1 in around 1s; the second stage dilution is mainly dependent on atmospheric turbulence and the additional dilution ratio is usually around 10:1 in about 10 min.

Also, the aerosol dynamical processes besides dilution were investigated in the two stages. In the first stage dilution, sulfuric acid-induced nucleation is the dominant particle production mechanism, followed by the condensation of low volatility organics, resulting in the rapid growth of nuclei mode particles and relatively slow growth of accumulation mode particles. Although its time span is very short, the first stage is crucial for activation of nuclei mode particles due to high concentrations of condensable species during this period. During second stage dilution, particles can still grow by condensation but the growth rates keep decreasing away from the roadways. At several hundred meters away, the aerosol distributions become background-like as a result of dilution.

In our model simulation, we found that that the possibility of sulfuric acid-induced nucleation strongly depends on the duration of the first stage dilution, i.e., it has to be fast enough to keep sulfuric acid in the gas phase, which otherwise will condense on pre-existing particles rather than initiate nucleation. An implication is that dilution time scale and dilution ratio are equally important for designing dilution tunnels able to simulate real world conditions.

While much effort has been put into studies of particle formation in diesel exhaust, more work needs to be done in gasoline exhaust. The conditions under which there will be a nucleation event in gasoline engine still remain unclear. It will be very helpful to conduct accurate in-cylinder measurements on aerosol size distribution as the starting point of the evolution process.

[P05-25] COMPARISON OF CHEMICAL COMPOSITION OF IN-USE DIESEL AND GASOLINE VEHICLE EMISSION SAMPLES.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Emission samples for toxicity testing and for detailed chemical characterization were collected from a variety of gasoline- and diesel-fueled in-use vehicles operating over the Unified Driving Cycle on a chassis dynamometer. Gasoline vehicles included average PM emitters (tested at 72° F and 30° F), black and white smokers, and two new technology vehicles (tested at 72° F). Diesel vehicles included current technology vehicles (tested at 72° F and 30° F), a high PM emitter, and a new technology light-duty vehicle (tested at 72° F). In addition, samples were collected in the two bores of Fort McHenry Tunnel (Baltimore, MA), one bore dominated by light-duty gasoline vehicles and the other by heavy-duty diesel trucks. Samples for toxicity testing were extracted and submitted to the Lovelace Respiratory Research Institute in Albuquerque. Chemical characterization included the determination of organic and elemental carbon (by the Thermal-Optical Reflectance method), elements (by X-ray fluorescence), ions (by ion chromatography) and a variety of particulate and semi-volatile organic compounds (by gas chromatography/mass spectrometry) including PAH, nitro-PAH, oxy-PAH, hopanes, and steranes. The results of these chemical analyses indicate that the composition of emissions is highly dependant on the fuel type (gasoline versus diesel), the state of vehicle maintenance (low, average or high emitters; white or black smokers), the operating conditions (i.e. rate of acceleration, cold start), and ambient conditions (i.e. temperature) of the vehicles. This paper presents the individual species emission rates for different vehicle categories.

[P05-24] INVESTIGATIONS OF DIESEL SOOT WITH CLASSICAL AND NOVEL TECHNIQUES.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

We have studied soot particles that were generated from diesel and oxygenated diesel in a test engine under load and idle condition. The soot particles had been collected on filters and were then subject to various classical and novel analytical techniques. With X-ray diffraction, the crystallite size and ratio of aliphatic and aromatic carbon was determined. The former results are in line with recently published NMR data, the latter results are in line with thermogravimetric analysis of the samples. X-ray absorption near edge spectroscopy was applied to single soot particles that were selected with a state-of-the-art scanning transmission X-ray microscope. By using a leach technique, we were able to distinguish between spectra from the graphitic core of the particle and spectra of the residual oil and fuel in the particle. Using small angle X-ray scattering, we were able to determine the size distribution of the particles as well as the fractal dimension of the soot aggregates. We found that oxygenates suppress graphitization of soot to the favour of aliphatic carbon. Soot generated under idle condition contains more unburned fuel and generally yields larger primary particles, but smaller graphitelike crystallites, while soot generated under load has larger crystallites, but smaller primary particles. Our results are in line with results obtained from a different research group that used nuclear magnetic resonance spectroscopy.

[P05-23] AMBIENT FINE PARTICULATE MATTER CONCENTRATIONS IN NEW YORK CITY TRAFFIC.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Fine particulate matter (PM) has increased in concentration over the past 100 years due to industrial emissions, automobiles, and other pollution sources. In addition to environmental impacts, such as decreased visibility, PM-2.5 (particles less than 2.5 μm in diameter) can cause cardiovascular and respiratory problems for susceptible populations. This study utilizes data taken with an Aerodyne Research, Inc. Aerosol Mass Spectrometer (AMS) as it was transported around the streets of New York City in a mobile laboratory. With the AMS one can measure both the chemical concentration and size distribution of particles on short time scales.

This study focuses on the total concentration of PM-2.5 across varying traffic densities. Traffic events are categorized according to automobile density and movement along the streets of New York City, and PM-2.5 concentrations are correlated to these traffic indices based on AMS measurements taken in both Manhattan and Queens. As the density of traffic intensified, the concentration of PM-2.5 increased as well. The concentration of PM-2.5 in Manhattan was higher, on average, than pollution concentrations of the same traffic density in Queens. In addition, driver exposure to ambient PM-2.5 concentrations on the streets of New York City are compared to stationary monitors in Manhattan and Queens which are used to assure compliance with the Clean Air Act. The average concentration of ambient PM-2.5, as measured with the AMS, is on the same order of magnitude as the stationary monitors.

[P05-22] ULTRAFINE PARTICLES NEAR MAJOR HIGHWAYS IN LOS ANGELES.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Ultrafine particles (diameter < 100 nm) have been suggested as a possible causative agent for the observed increases in mortality and morbidity with increases in particulate matter (PM) concentrations. We conducted systematic measurements of the concentration and size distribution of ultrafine particles in the vicinity of Interstate 405 (mostly gasoline traffic) and Interstate 710 (heavy-duty diesel traffic) in Los Angeles during the summer, 2001 and the winter 2002. Particle number concentration and size distribution in the size range from 6 to 220 nm were measured by a condensation particle counter (CPC) and a scanning mobility particle Sizer (SMPS). Measurements were taken at increasing distances downwind from each of the freeway. At each sampling location, concentrations of carbon monoxide (CO) and black carbon (BC) were also measured. For the conditions of these measurements, relative concentration of CO, black carbon and particle number track each other well as one moves away from the freeway. Particle number concentration (6-220 nm) decreased exponentially with downwind distance from the freeway. Both atmospheric dispersion and coagulation appear to contribute to the rapid decrease in particle number concentration and change in particle size distribution with increasing distance from the freeway. The maximum number concentration that was observed near the freeway was about 25 time greater than that for the background location. It suggests that people, who live, work, or travel within 100 m downwind of major traffic sources, will have much higher ultrafine particle exposure than those who live farther away from such sources. The decay rates of CO and BC are slightly greater in summer than in winter for both freeways suggesting a weaker atmospheric dilution effect in winter. Particle number concentration in the size range of 6-12 nm is significantly higher in winter than in summer. The associated concentration in that size range decreased at a slower rate in winter than in summer. These results suggest that wintertime conditions favor greater ultrafine particle formation, possibly due to increased condensation of organic vapors. These data may be useful for epidemiological studies to estimate exposure to ultrafine particles in the vicinity of major highways and to evaluate their adverse health effects.

[P05-21] MEASURED REAL-WORLD TRAFFIC EMISSION FACTORS OF PARTICLE NUMBER SIZE DISTRIBUTION AND MASS IN STOCKHOLM, SWEDEN.

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Measurements in a road tunnel in Stockholm, Sweden performed during winter 1998/1999 give the preliminary emission factors (E_{LD} and E_{HD}) for particles divided between the two vehicle types, light duty (LDV) and heavy duty (HDV) respectively. The average PM emission factors and emission factors divided by different vehicle speed intervals are presented in the Table below. It can clearly be seen that the PM2.5 emissions of resuspended dust increase with vehicle speed and that a large fraction of this dust consists of NaCl and metal-oxides. The emissions of carbohydrates and elemental carbon explain 50% of the PM0.6 fraction (not resuspended PM fraction).

An example of the difference between the number size distribution emission factors of an average LDV and HDV is presented in the Figure below, here for the speed interval 70-75 km/h. The "nuclei"- and the "soot"-mode" peak around 20 and 100 nm particle diameter respectively. It can be seen that the HDV emissions are about one size-order higher than the LDV emissions. On average, with a fleet consisting of about 5% LDV diesels, 90% LDV petrol cars and 5% HDV, the total contribution to both particle mass and number from the whole HDV fleet is about 40%.

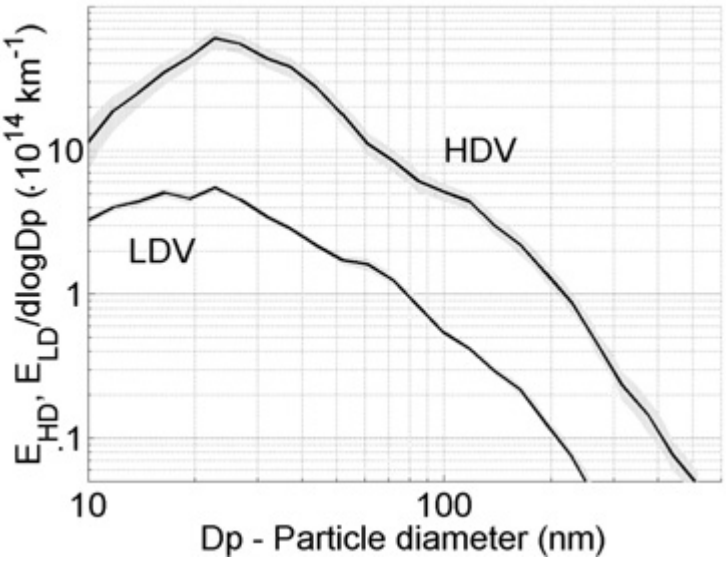
Emission factors of PM10/PM2.5/PM0.6 (mg m^{-3})

Species	Average fleet	35-70 km/h	70-75 km/h	75-95 km/h
PM10	236	91	154	329
PM2.5	67	33	41	100
PM0.6	40	36	31	51
Fraction resuspended PM2.5 (PM2.5-PM0.6)/PM2.5	40%	$\approx$0%	24%	50%
Fraction oxides (Al/Fe/Si) and NaCl of resuspended PM2.5	33%			
Fraction carbohydrates and elemental carbon of PM0.6[1]	47%	38%	45%	50%

[1]Assuming carbohydrates are CH_3 and PM0.6 is the non-resuspended part of PM2.5

(Click to see figure 1)

[P05-21] MEASURED REAL-WORLD TRAFFIC EMISSION FACTORS OF PARTICLE NUMBER SIZE DISTRIBUTION AND MASS IN STOCKHOLM, SWEDEN. (continued)



Figure

[P05-20] THE FORMATION OF NANOPARTICLES IN THE ATMOSPHERE FROM DIESEL AND NATURAL GAS STATIONARY ENGINES.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Nanoparticle formation in the atmosphere from natural gas and diesel engine exhaust has been a recent concern. Research has found high nanoparticle number concentration on and near urban roadways. In addition the relationship between nanoparticles and lung cell inflammatory response and heart attack from animal studies has been also studied. The objective of this study is to investigate the formation of nanoparticles near the tailpipe of two large generator sets, one powered with diesel and one powered with natural gas. The nanoparticle formation as a function of distance from the exhaust outlet, temperature, and relative humidity during idling, medium and maximum engine loads was characterized. This work thus represents the measure of nanoparticles under true ambient conditions as opposed to conditions in a dilution device.

A Scanning Mobility Particle Sizer (SMPS) was used to measured nanoparticle number concentration. The Taped Element Oscillating Microbalance (TEOM) Monitor was used to measure the nanoparticle mass concentration. The Micro-Orifice Uniform Deposit Impactor (MOUDI) was used to measure mass concentration at different particle sizes. A remote weather station is used to monitor airflow and direction as well as humidity, pressure, and temperature. Distance data provides information to understand the time scales and distance from the emissions source that are important to nanoparticle growth. It is expected that low ambient temperature will accelerate particle growth, whereas high relative humidity would increase the formation of nanoparticles. A combination of maximum load, high relative humidity, and low ambient temperature would produce the most of nanoparticle concentration.

[P05-19] RELATIONSHIPS BETWEEN THE CHEMICAL COMPOSITION OF BRAKE PADS AND BRAKE WEAR EMISSIONS.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Brake wear is one of the components of particulate matter and trace metal emissions from motor vehicles. However, the composition of these emissions and their contribution to metals levels in the urban atmosphere are still not well characterized. While the chemical composition of brake pads may be easy to determine, isolation and measurement of brake wear emissions is not. On-road motor vehicle emissions also include those from tailpipes, tire wear, and resuspended road dust, and measurement of emissions with dynamometers has similar complications. To obtain more information about real-world particulate matter emissions from motor vehicle brake wear, brake wear samples were obtained by two methods. First, samples were collected from the non-tailpipe emissions of vehicles operating on a chassis dynamometer. Second, samples were collected from the resuspension and collection of ground brake pads and dust from the brake housings.

In order to compare particulate matter emissions from brake wear with the chemical composition of brake pads and brake-housing dust, the brakes used in the chassis dynamometer tests and the dust from their housings were used for the resuspension tests. To get a broader view of the characteristics of brake wear emissions from on-road vehicles, crushed used brake pads and dust collected from their housings at local garages were also resuspended. These tests provide significant insight into the relationship between the chemical composition of brake pads and of the particulate matter emissions from brake wear.

In all tests, fine (PM2.5) and coarse (PM10) particulate matter were sampled, and size-resolved chemical composition of emissions was also explored. Measurements of trace metals, mass, inorganic ions, and elemental and organic carbon for brake wear emissions are presented. These measurements allow specific source apportionment of metals from brake wear to those in the urban atmosphere.

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[P05-18] MEASUREMENT OF PARTICULATE MATTER EMISSIONS FACTORS FROM IN-USE MOTOR VEHICLES USING LIDAR.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

A new technique developed using an ultraviolet LIDAR was used to measure particulate matter (PM) emissions factors from the in-use fleet of motor vehicles in Las Vegas, NV. Fuel based emissions factors in mass of pollutant per quantity of fuel burned from nearly 150,000 vehicles from all parts of the Las Vegas Valley were measured during this study. By comparing license plate images with registration information from the Department of Motor Vehicles, emissions factors were related to vehicle age, weight class, and fuel type. Average emissions factors were calculated from the real world measurements for four different classes of vehicles: light-duty gasoline vehicles (LDGV), light-duty diesel vehicles (LDDV), heavy-duty gasoline vehicles (HDGV), and heavy-duty diesel vehicles (HDDV). Diesel vehicles were found to emit ~10 times more particulate matter than gasoline vehicles. Vehicle age was found to correlate with particulate emissions from gasoline vehicles. The LIDAR remote sensing technique has the ability to identify smoking vehicles under real world conditions. Potential applications of this instrument include (1) monitoring improvements in motor vehicle emissions as new low emitting vehicles replace older higher emitting vehicles, (2) notifying vehicle owners of malfunctioning vehicles that service is needed to reduce emissions and improve fuel economy, and (3) screening and exempting clean vehicles from mandatory vehicle emissions tests.

[P05-31] THE RELATIVE CONTRIBUTIONS OF DIESEL AND GASOLINE EXHAUSTS TO PM-2.5 INVENTORIES.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

EPA emission inventories show that diesel engines and vehicles make a greater contribution to PM-2.5 emission inventories than do gasoline engines and vehicles. The diesel contribution is greater for both on-road vehicles (trucks and cars) as well as non-road engines (including agricultural equipment, construction equipment, lawn & garden equipment, and recreational marine). The emission inventories are prepared from models using g/mile emission factors for vehicles coupled with vehicle miles traveled. PM-2.5 emission inventories for nonroad engines are prepared from a separate model utilizing emission factors (in g/hour or g-brake horse power-hour) and usage information. These inventories are prepared at the county level. However, source apportionment studies done in various parts of the country show a range of different results. Some studies show that gasoline engines and vehicles make a greater contribution to ambient PM-2.5 while others show that diesel vehicles make a larger contribution. A major issue in preparing emission inventories is gasoline particulate emissions from passenger cars. This paper will discuss how gasoline particulate emission inventories are prepared and what test data are being obtained to improve the emission factors used in these inventories. A discussion of the strengths and limitations in receptor models in informing inventory development is also provided.

[P05-16] IN-USE VEHICLE EMISSIONS SOURCE CHARACTERIZATION STUDY: SQUIRREL HILL TUNNEL, PITTSBURGH, PA.

Eric M Lipsky, Allen Robinson, Natalie Anderson, Heather Leifeste, R Subramanian, Juan Cabada-Amaya, Sarah Rees, Andrey Khlystov, Charles Stanier, Leonard Lucas, Satoshi Takahama, Beth Wittig, Cliff Davidson, Spyros Pandis, Andrea Palidori, Ho-Jin Lim, Barbara Turpin Mechanical Engineering, Carnegie Mellon University, PIttsburgh, PA; Civil Engineering, Carnegie Mellon University, Pittsburgh, PA; Chemical Engineering, Carnegie Mellon University, Pittsburgh, PA; Engineering and Public Policy, Carnegie Mellon University, Pittsburgh, PA; Environmental Sciences, Rutgers University, New Brunswick, NJ

Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Measurements were performed in a highway tunnel to quantify in-use vehicle emissions in Pittsburgh, Pa. Continuous measurements of CO2, CO, SO2, NOx, NO, PM2.5 mass, and particle size distributions from 3 nm to 1 mm were made for the entire study period. PM2.5 samples were collected and analyzed for organic and elemental carbon (OC/EC), organic composition (speciation), trace metals, and inorganic composition. MOUDIs were collected to determine the mass, OC/EC, and trace metals size distributions. Volatile organic compounds were also measured. Videotapes of traffic were analyzed to determine fleet composition and vehicle speed. The sampling focused on three different periods to characterize the effects fleet composition and mode of operation on emissions. The 12 AM to 6 AM period is dominated by fast moving truck traffic (average speed 50 mph, greater than 30% trucks). The 7 to 9 AM period is dominated by slow moving cars (average speed of 20 mph, less than 5% trucks). The 10 AM to 4 PM period is dominated by fast moving cars (average speed of 50 mph, less than 5% trucks).

[P05-32] PM EMISSIONS OF MODERN LIGHT DUTY VEHICLES: CURRENT STATUS AND FUTURE ISSUES.

Matti Maricq Scientific Research Laboratory, Ford Motor Company, Dearborn, MI

Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Motor vehicle particulate matter (PM) emissions vary widely not only from one engine technology to another, but also between different fuels and aftertreatment systems. Understanding these often intertwined effects is critical to developing PM emissions inventories, predicting how new technologies will alter the inventories, and formulating policy. This knowledge is also needed to deal with measuring PM at the upcoming lower tailpipe emissions standard, and to address properties other than PM mass.

Light duty diesel vehicles typically emit ~50 mg/mi over the FTP drive cycle. In general the particle size distribution is bimodal. There is always a lognormal mode with a geometric mean diameter of 40 - 90 nm that originates from soot formed in the combustion cylinder, coated to some degree by sulfate and semi-volatile organic material. Often a second mode, usually in the 5 - 30 nm range, is present from the nucleation of sulfate and semivolatile organic compounds that occurs as the exhaust exits the tailpipe, dilutes and cools. Altering the fuel structure affects these modes in distinct ways. Addition of an oxygenate, such as dimethoxy methane, can reduce mass emissions by ~15 - 30%, while not affecting number emissions, because of a reduction in soot particle size. Removal of sulfur from the fuel often reduces particle number emissions by an order of magnitude by eliminating the nuclei mode, while the reduction in PM mass is perhaps 10-20%. An oxidation catalyst does not directly affect PM emissions, but it has two indirect effects. For high sulfur fuel it oxidizes SO_2 to sulfate, thereby increasing particle emissions. But it also removes hydrocarbons that might nucleate or condense onto soot particles during exhaust dilution, and thereby decreases PM emissions.

Current gasoline vehicles have naturally very low, ~2 mg/mi, PM emissions because the air and fuel are premixed and held in the proper stoichiometric ratio. Sulfur has only a small effect on PM because the three way catalyst is ineffective at oxidizing SO_2. At this low emissions level, however, other issues emerge. Particle sizing instrumentation often indicates less PM mass than recorded by the standard filter measurement. Evidence suggests that this occurs because the filters also trap some gaseous hydrocarbons. Significant artifacts can also appear. The exhaust sampling system can act as a temporary reservoir of organic and particulate matter, that are later released and appear to originate from the vehicle.

[P05-14] MEASUREMENT OF PM2.5 EMISSION FROM STATIONARY SOURCE: BIAS IN TRADITIONAL SAMPLING METHOD AND THE DEVELOPMENT OF DILUTION SAMPLING TECHNOLOGY.

Oliver M.C. Chang, Glenn C. Glenn, Stephanie Wien Energy and Environmental Research Corp., GE, Irvine, CA

Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

The promulgation of new ambient air standards for particulate matter with aerodynamic diameter smaller than 2.5 micrometers (PM2.5) by United States Environmental Protection Agency (EPA) in 1997 resulted in the great need of emission and characteristic profiles of fine aerosols from petroleum industry combustion sources. Majority of PM emitted from gas combustion is condensable PM2.5. However, stationary source air emission sampling methods used for compliance testing (Method201/202A) tend to underestimate or overestimate the emitted PM2.5 because the hot front filter does not collect condensable species and the cold aqueous impingers collect gaseous as well as condensable components. On the other hand, the advanced PM control technology has reduced emission level so low that the error noise in manual method can obscure the actual PM emission rate. The dilution technology has been used as reference method (ISO 8178) for mobile source testing but only serves as research application in stationary sources. Dilution technology can simulate actual plume conditions and collect samples by means of ambient sample so that the emission profiles can be readily compared. However, current dilution system is often too bulky for limited space in stack. The various dilution sampling system designs and the impact of dilution process on particle formation are investigated and reviewed for designing a more compact dilution sampling system, which can be deployed to developing PM2.5 profiles from stationary sources.

[P05-13] PARTICULATE CARBON EMISSIONS FROM COAL FIRED POWER PLANTS: STACK TESTING AND FIELD OBSERVATIONS.

Eric S. Edgerton, Peter K. Mueller, Larry S. Monroe, John J. Jansen, Callie J. Waid HQ, Atmospheric Research & Analysis, Inc., Cary, NC; Data Management, Atmospheric Research & Analysis, Inc., Plano, TX; Southern Company, Birmingham, AL; Headquarters, TropoChem, Palo Alto, CA

Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Organic and elemental carbon (OC and EC, respectively) are significant contributors to PM2.5 mass in many areas of the United States. In the southeast, for example data from the SEARCH network show that carbonaceous material (EC plus OC*1.4) is the dominant component of PM2.5 at urban sites and comparable to sulfate at rural sites. Sources of atmospheric particulate carbonaceous material include primary emissions from gasoline and diesel powered vehicles, biomass burning (e.g., fires and fireplaces) and cooking, as well as secondary products of photochemistry. Limited information is available on primary carbon emissions related to fossil fuel electricity generation. This poster presents results from two investigations designed to estimate: 1) primary emissions of carbonaceous material from coal fired power plants (CFPPs); and 2) the contribution of CFPP emissions to ambient concentrations carbonaceous material. The first of these involves stack testing at 15 facilities in the eastern (primarily southeastern) U.S. The facilities tested approximate the distribution of boiler type, burner configuration, control configuration and coal type for the population of US CFPPs. Particulate material collected on quartz fiber filters at 135-150C during routine stack tests were analyzed for OC and EC using the thermal-optical reflectance method. Results are used to estimate carbon emissions, both on an absolute basis (e.g., tpy) and a relative basis (e.g., % of particulate emissions). Particulate carbon occurs in measurable quantities in CFPP effluents and the split between EC and OC varies from facility to facility. However, total carbon is usually less than 2%, and invariably less than 10%, of CFPP particulate emissions. The second investigation examines the issue from the standpoint of a rural research site in NW GA. In this case, high temporal resolution SO2 data are used to identify plumes from specific CFPPs. Continuous measurements of EC and OC sampled at ambient temperatures are then analyzed to determine if there is a significant increment above background during the plume excursion. Analysis of CFPP plume events shows very weak or non-existent relationships between SO2 and EC or OC. In other words, the contribution of CFPPs to ambient carbon concentrations is nearly undetectable, even under conditions of substantially elevated CFPP SO2. Based on annual mean SO2 concentrations, these findings suggest that CFPPs typically contribute much less than 1% of total particulate carbonaceous material to atmospheric aerosols.

[P05-12] CCSEM ANALYSES OF FINE PM DERIVED FROM THE COMBUSTION OF COAL AND RESIDUAL OIL.

Yuanzhi Chen, Frank E Huggins, Naresh Shah, Gerald P Huffman, William P Linak, C A Miller CFFS/CME, University of Kentucky, Lexington, KY; NRMRL, US EPA, Research Triangle Park, NC

Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Computer-controlled scanning electron microscopy (CCSEM) is an excellent method for determining the chemical composition, particle size, and morphology of large numbers of individual particles in a reasonable measurement time. In this study, CCSEM has been applied to the analysis of particulate matter (PM) derived from combustion experiments on three eastern and four western U.S. coals and two residual oils. Samples were separated aerodynamically by a cyclone with a nominal 2.5 μm cut-point into fine ($PM_{2.5}$) and coarse ($PM_{2.5+}$) fractions. The particle size distribution results show that particles with mean diameter less than 2.5 μm constitute more than 80% of the total number of particles, whereas particles with mean diameter larger than 2.5 μm constitute 80-95% of the total volume. Most western coal fly ash (CFA) PM samples have major amounts of Ca and lesser amounts of S, Mg, and Na, while eastern CFA PM samples typically have abundant amounts of Fe and lesser amounts of S and K. The two residual oil fly ash (ROFA) samples are dominated by carbon, while S and V are the major inorganic elements. Single particle classifications show that Si-rich, Si-Al, Si-Al-Ca, Si-Al-Fe are the major chemical categories for CFA PM samples, while V-rich, V-S, and V-S combined with metals and P dominate the ROFA PM samples. Compositional scatter plots superimposed on various ternary equilibrium phase diagrams were used to display the CCSEM data graphically. Results show that most particles in western CFA PM samples are distributed along the join from the Ca apex to the $Si_{50}Al_{50}$ point in the Ca-Al-Si phase diagram. Major phases along this join include anorthite ($CaO{\cdot}Al_2O_3{\cdot}2SiO_2$), gehlenite ($2CaO{\cdot}Al_2O_3{\cdot}SiO_2$), and lime (CaO). Most particles in eastern CFA PM samples are present as Fe-oxides and iron-bearing aluminosilicates.

[P05-11] COMBINING XAFS SPECTROSCOPY AND LEACHING FOR THE SPECIATION OF ELEMENTS IN PM.

Frank E Huggins, Sidhartha Pattanaik, Gerald P Huffman, William P Linak, C. Andrew Miller CFFS/CME, University of Kentucky, Lexington, KY; NRMRL, U.S. EPA, Research Triangle Park, NC

Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

There is much need to increase our knowledge concerning the occurrence of key elements in particulate matter (PM) from combustion sources. Recent evidence increasingly supports the proposition that metals in fine airborne PM are associated with adverse health effects. Furthermore, elemental concentrations in primary PM samples are used as input to chemical mass balance models for apportioning the contribution of primary sources of PM to ambient PM. Despite these major roles in both health-effect and source apportionment studies, there have been relatively few investigations of how metals actually do occur in PM.

In this work, we have used XAFS spectroscopy to characterize elements in primary PM samples derived from combustion of coals and residual oils in laboratory-scale combustion experiments. A cyclone separator was used to separate the PM into >2.5 μm ($PM_{2.5+}$) and <2.5 μm ($PM_{2.5}$) size fractions. Leaching experiments were also performed on the size-separated PM fractions to generate a suite of samples for more reliable interpretation of the XAFS data.

For PM samples from residual oil fly ash (ROFA) combustion, XAFS spectroscopy established that, in addition to sulfur as sulfate, sulfur also occurred as thiophene derivatives, elemental sulfur, and metal sulfide forms. The thiophene forms comprised between 30 and 40% of the total sulfur in the $PM_{2.5+}$ samples, but lesser amounts in the $PM_{2.5}$ samples, and clearly mirrored the unburned carbon in the ROFA PM samples. XAFS spectroscopy showed that most metals were present as sulfates. However, additional metal species were also encountered in aqueous and acid leached residues; oxides, such as V_2O_4, $NiFe_2O_4$ and ZnO were more prevalent in the $PM_{2.5}$ fractions, whereas sulfides, such as $Ni_{1+x}S$, $Fe_{1-x}S$, and CuS were more prevalent in the coarser $PM_{2.5+}$ fractions. With a firm identification of the different species likely to be present for a given element, least-squares fitting of the XANES spectra was then used to quantify the different forms of an element.

For PM samples derived from coal combustion, XAFS spectroscopy showed that sulfate was the dominant form of sulfur in coal PM, with minor amounts of thiophenic and elemental sulfur forms also present. Arsenic was found to exist in the coal PM predominantly in the As^{5+} oxidation state. Chromium was observed to be exclusively present as Cr^{3+} in PM from eastern bituminous coals, but PM from western coals contained up to 30% of the chromium in the more toxic and carcinogenic Cr^{6+} oxidation state.

The authors acknowledge financial support from NSF (CRAEMS grant CHE 0089133) and the US DOE for its support of US synchrotron facilities.

[P05-10] FENCELINE SAMPLING ADJACENT TO A LARGE COKE PRODUCTION FACILITY IN PITTSBURGH, PA.

Emily A Weitkamp, Eric Lipsky, Allen Robinson, Natalie Anderson, Heather Leifeste, R Subramanian, Juan Cabada-Amaya, Andrey Khlystov, Charles Stanier, Leonard Lucas, Satoshi Takahama, Beth Wittig, Cliff Davidson, Spyros Pandis, Andrea Polidori, Ho-Jin Lim, Barbara Turpin, Patrick Pancras, John Ondov Mechanical Engineering, Carnegie Mellon University, Pittsburgh, PA; Civil Engineering, Carnegie Mellon University, Pittsburgh, PA; Chemical Engineering, Carnegie Mellon University, Pittsburgh, PA; Environmental Sciences, Rutgers University, New Brunswick, NJ; Chemistry and Biochemistry, University of Maryland, Baltimore, MD

Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

As part of the Pittsburgh Air Quality Study, measurements were performed on a hill adjacent to a large coke production facility in Pittsburgh, PA. The goal of the effort is to update chemical fingerprints and emission factors for an important source category in the Pittsburgh Region. A large suite of continuous and integrated measurements was made at both the fenceline and a background site. Continuous measurements included meteorological data, CO, SO2, NOx, NO, PM2.5 mass, and particle size distributions from 3 nm to 1 μm. A combination of meteorological data and pollutant measurements at the fenceline and background sites were used to determine when the coke plant plume was impacting the fenceline site. For example, ratios of SO2 at the fenceline sampling site to the background site as large as 25 are observed when the fenceline site is in the plume. Semi-continuous measurements of OC/EC (2 hr resolution) and trace metals (30 minute resolution) were made to obtain highly time-resolved composition data. The plume contains greatly elevated OC/EC concentrations; for example, ratios of peak plume OC and EC concentrations to the background site were 18 and 48, respectively. The plume also contains greatly elevated metals concentrations; for example ratios of peak plume Se levels to the background were often greater than a factor of 8. Integrated PM2.5 samples were also collected and analyzed for organic and elemental carbon (OC/EC), organic composition (speciation), trace metals, and inorganic composition.

[P05-09] WITHDRAWN

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WITHDRAWN

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[P05-08] ESTIMATING PM EXPOSURE FROM WOOD SMOKE IN RESIDENTIAL NEIGHBORHOODS DURING WINTERTIME INVERSIONS.

Terry E. Baxter Civil and Environmental Engineering, Northern Arizona University, Flagstaff, AZ

Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Particulate matter from residential combustion of wood typically represents a relatively low fraction (<10%) of an area's total annual PM inventory. However, the period over which these emissions occur is seasonal, during the four or five coldest months of the year when radiation inversions are frequent and the wood smoke PM can concentrate within specific neighborhoods. Neighborhoods that are dominated by residents using wood for heating can experience a significant increase in PM exposure, particularly during nighttime hours. Thus, a simple but reliable methodology for estimating wood smoke PM concentrations in these neighborhoods is needed to economically support studies evaluating potential health effects in those areas.

This paper presents results from a study designed to evaluate the use of emission inventory data to estimate residential wood smoke PM concentrations in individual neighborhoods. Results from six neighborhoods are presented and discussed. Statistical analysis of results comparing an intensive (100% distribution rate) and limited survey effort (10% distribution rate) within one neighborhood indicates that the methodology of a limited survey effort can provide usable data. The significance of a neighborhood's meteorological conditions, topography, seasonal wood fuel consumption and wood-burning device distribution on the potential PM exposure experienced is also evaluated. Ongoing work that continues to focus on the study of wood smoke PM exposure in individual residential neighborhoods and related health effects is briefly discussed.

[P05-07] EFFECT OF OPERATING VARIABLES ON PM EMISSIONS FROM WOODSTOVES.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

The adverse effect of PM, particularly PM2.5, on human health and the environment has resulted in Canada setting standards for the ambient concentration of PM2.5. Residential wood combustion (RWC) has been targeted as one of the primary sources of anthropogenic PM in Canada. In order to achieve the PM2.5 ambient standard, PM emissions from RWC require investigation to aid in determining reduction strategies.

The objective of this study was to investigate the effect of operating variables on the amount and size of PM produced from woodstoves currently present in Canadian homes. A factorial experimental design was used to statistically investigate the effect of burn rate (1.5 kg/hr and 3 kg/hr), fuel type (softwood and hardwood) and fuel moisture content (15% and 25%) on total PM, PM10 and PM2.5 emissions. Two conventional woodstoves were set up and operated according to CAN/CSA B415.1-92 Performance Testing of Solid-Fuel-Burning Stoves with the exception of using cordwood as the fuel. Particulate matter was collected using the EPA's Draft Method for Determination of PM10 and PM2.5 Emissions.

Total PM emissions from 16 experiments ranged from 1.7 g/kg fuel to 70.8 g/kg fuel. Averages for the PM10 and PM2.5 size fractions were 95% and 87%, respectively. Burn rate was determined to be the most statistically significant variable. At the 99% confidence bound a woodstove operated at a high burn rate showed a main effect reduction of 30 g/kg in total PM emissions. Fuel type was significant at the 90% confidence bound: the use of a hardwood fuel reduced PM emissions by 11 g/kg. Although moisture content did not have a strong statistical significance, burning fuel with a high moisture content (25%) had a trend of producing fewer PM emissions. High burn rates exhibited at the 99% confidence bound, a reduction in the PM10 and PM2.5 emissions; however, the effect of fuel type and moisture content on PM10 or PM2.5 was not significant. None of the operating variables had a statistically significant effect on the size distribution of PM emissions from woodstoves. The results from this study indicate that woodstoves produce primarily PM2.5. Emissions can be reduced by changing operating practices, but the PM emission size distribution does not vary significantly.

[P05-06] ESTIMATING SURFACE PARTICLE EMISSION AND HUMAN EXPOSURE IN URBAN STREET CANYONS.

Galen A Hon Engineering and Public Policy, Carnegie Mellon University, Pittsburgh, PA

Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Resuspension of fugitive dust is commonly modeled by using similarity theory based on atmospheric momentum and heat fluxes. Iterations of this strategy applied to empirical studies over the last several decades continue to decrease uncertainty surrounding the mechanisms and intensities of particle emission for many surface types. Similarity theories, however, fall short when applied to areas such as urban street canyons where the roughness elements create atmospheric wind profiles that, when modeled with standard estimations, place the logarithmic zero plane displacement value above the level of most human receptors in the environment. When the goal is to better understand PM release and receptor availability within that region, complex turbulence patterns inherent in lower portions of urban canopies necessarily preclude simple interpolation and an alternative method is needed.

Fine mode PM agglomerates readily with larger soil particles and is released by external mechanical forces. Previous studies in open environments have shown that much of the released PM that becomes airborne is deposited near to its origin and a smaller fraction becomes airborne. This effect is increased greatly in areas where particle saltation and entrainment layers (0-3m) are physically bounded. To account for saltation fluxes and turbulence patterns that vary PM concentrations at human receptor level, an approach is developed based on recent micro-scale models of urban momentum flux and kinetic energy balances for particle entrainment. Statistical distributions of turbulence, wind velocity, and ground particle characteristics combined with geometry of local features and changing atmospheric conditions above can allow vertical extrapolation by joining kinetic/friction models for sub-layer approximations with standard logarithmic friction layer theories above. This allows the entire vertical range of urban PM concentrations to be estimated based on data that is attained at or above the local roughness height. For this study, theoretical sub-layer concentrations are anchored by empirical ambient data from the South Coast Air Basin during 2000-2001. Estimates for human exposure are then derived by considering activity levels and biological susceptibility coincident in time with modeled concentrations. These theories are a sub-component of a regional model being developed to estimate the concentration, transport, and exposure potential of entrained lead particles throughout the basin.

[P05-05] PM10 EMISSIONS FACTORS FOR UNPAVED ROADS: CORRECTION FOR NEAR-FIELD DEPOSITION.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Compared to other primary PM_{10} emissions, fugitive dust emissions appear to be overstated. There is a discrepancy between source attribution perfomed on ambient samples and concentrations predicted by regional air quality models. Fugitive dust emissions may be overstated because of incorrect emissions factors or activity levels. It is also likely that regional air quality models do not account properly for the deposition of coarse particles that occurs in the first several hundred meters downwind of a fugitive dust source. Instead, particles are assumed to be instantly mixed up to the height of the first grid cell in the model. The extent of near-source removal of fugitive particles from unpaved roads was investigated. Results from a field study near El Paso, TX were compared with modeling predictions. The field study occured in April under neutral and unstable atmospheric conditions. Three 12-meter towers were placed downwind of an unpaved road at distances of 7, 50, and 100 meters. The profiles of dust plumes generated by vehicles traversing the unpaved road were captured by nephelometer-style instruments located at several heights along the towers. Particle size distributions were also measured at some locations with optical particle counters. Two methods were used to model the near-source removal of the coarse fraction of PM_{10} dust emissions, a simple box model, and a numerical solution to the one-dimensional atmospheric diffusion equation. Modeling results indicated that the box model may be adequate to estimate near-source removal under some conditions, provided it is applied over a limited distance. Furthermore, coarse particle removal in the near source region may reduce the effective PM_{10} emissions by as much as a factor of two. However, model and field study results indicated that under conditions similar to the desert southwestern United States, the fraction of PM_{10} that is removed in the near-source region cannot entirely account for the discrepancy between regional air quality models and source attribution results.

[P05-04] WITHDRAWN

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[P05-03] PROGRESS TOWARD A DUST EMISSIONS MODEL FOR THE COLUMBIA PLATEAU.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

The Columbia Plateau is a region susceptible to wind erosion due to the preponderance of strong winds that typically occur in spring and autumn when soils are dry. These conditions have resulted in severe dust storms that not only have impaired driving of automobiles, but that may also have adversely affected human health. A model for predicting fugitive dust emissions from agricultural soils in the Columbia Plateau was introduced in 1996. Dust emissions are predicted based upon the amount of eroded soil, a dustiness index, and wind speed. The amount of soil eroded by wind is a function of surface characteristics (i.e. wind energy, quantity of surface crop residue, soil surface roughness) and soil physical properties (i.e. soil crusting, soil erodibility, soil moisture). The dustiness index is the fraction of fine particulates (smaller than 10 microns) in the eroded soil and is assumed to be equivalent to the fraction of fine particulates within the upper soil profile. Progress has been gradual in defining all parameters in the model. Field studies were undertaken to define the relationship between soil loss and wind energy, surface residue cover, surface roughness, and soil erodibility. In addition, the dustiness index has been defined for a range of soil types common to the Columbia Plateau. Parameters have not been defined for the relationship between soil loss and soil moisture and soil surface crusting. For non-crusted and dry soils, the model has performed reasonably well in simulating field dust emissions. Further efforts are needed in parameter specification to predict dust emissions from agricultural soils that are variably moist and subject to crust formation.

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[P05-02] CONTRIBUTION OF FUGITIVE DUST TO REGIONAL PM.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

The contribution of fugitive dust to ambient PM is an issue for both attainment of National Ambient Air Quality Standards (NAAQS) and for visibility protection, but there is considerable uncertainty regarding the contribution of unpaved roads to regional PM inventories. A key hypothesis is that near-source deposition of vehicle generated dust can reduce the amount of material that is carried high in the atmosphere and transported long distances.

Recent field studies testing various aspects of this hypothesis will be summarized in the poster. One study involved measurement of the total dust flux under stable atmospheric conditions from a road at a site with large roughness elements simulating an urban area. Another study measured particle deposition on flat substrates and on simulated vegetation downwind of a test road on a military training range. Source sampling and receptor analysis studies are being used to determine the ability of Chemical Mass Balance (CMB) to resolve the geological material and quantify the contribution of dust from specific source areas.

The ongoing field studies support the hypothesis that exposure to geological PM is dominated by nearby sources, except during extreme wind events. Also the studies suggest that current inventory methods may overstate the fugitive dust sources in regional-scale air quality models.

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[P05-17] GAS AND PARTICLE EMISSION RATES AND SOURCE PROFILES FROM NON-ROAD MILITARY DIESEL ENGINES.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

A four-year testing project has been initiated to develop source-, use-, and fuel-specific emission estimates for representative Department of Defense (DoD mobile and stationary diesel equipment, most of which is not extensively used on paved public roadways. These estimates must meet the minimum requirements of the Consolidated Emissions Reporting (CER) rule for emission rates of CO, NOx, VOC, PM10, PM2.5, SO2, and NH3. CER guidance also requests chemical source profiles that can be used to divide PM and VOC emissions into groups useful for chemical transformation models, source-apportionment receptor modeling, and HAPs inventories. The project will also develop, test, and apply new methods for quantifying non-road emissions that more efficiently and realistically represent actual operations than engine dynamometer certification tests. These results will be integrated into U.S. EPA non-road emissions and source profile software. An emissions modeling system will permit quick and efficient estimates to be made and delivered to appropriate agencies in CER-compatible formats.

This project will accumulate information about engine types, fuels, and uses, critically reviews previously published literature, and develop a representative matrix of test parameters. It will assemble and evaluate test equipment for a mobile lab, on-board activity and pollutant monitoring, in-plume measurements, and cross-plume remote sensing, then apply on-board activity monitors to focus the subsequent emissions tests and quantify real-world engine uses. Stationary sources will be tested first with a mobile laboratory that reproduces dilution and methods associated with standard test cycles, then with in-plume and remote sensors for the same engine operating cycles, and finally for a larger number of engines using in-plume measurements during actual operations. The data base for stationary emitters will be interpreted in terms of emission factors, emission distributions, and emission compositions. Non-road mobile sources will be tested using on-board exhaust monitors as well as in-plume and remote sensing. Products of this research are: 1) modern non-road exhaust test methods; 2) documented data bases of emissions rates and chemical profiles for many different fuel/engine/use combinations; 3) integration into national NONROAD and SPECIATE software; and 4) an easy to use emissions model tailored to military applications.

[P13-22] MIDDLE SCALE SOURCE CONTRIBUTIONS TO HIGH TIME RESOLUTION PARTICULATE MEASUREMENTS AT THE SAINT LOUIS - MIDWEST SUPERSITE.

Jason S Hill, Bradley P Goodwin, Jay R Turner Environmental Engineering Program, Washington University, Saint Louis, MO

Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 13: Receptor Modeling and Source Apportionment (11:00 AM-12:00 PM) Grand Ballroom 2-4

Epidemiologic studies of air pollutant impacts on human health often rely upon measurements at a single receptor site to describe pollutant concentrations for a relatively large geographical domain (e.g., an entire urban or metropolitan area). High time resolution measurements of air quality indicators (e.g., gases, aerosol chemical composition, aerosol physical properties) can be used to probe the extent to which the levels of such indicators at a receptor site are influenced by sources from various spatial scales. Such information provides insights into the zone of representation and thus the robustness in using the monitor data to represent a given geographic domain. Following the methodology of Watson and Chow (*J. Air & Waste Manage. Assoc. 51*: 1522-1528 (2001)) which exploits the time scales for fluctuations in an air quality indicator reported at high time resolution (in this case, 5-minute resolution), middle scale contributions (sources nominally 0.1-1 km from the receptor) have been estimated for aethalometer black carbon and selected other parameters at the St. Louis - Midwest Supersite core monitoring location in East St. Louis, IL. This presentation summarizes the estimated middle scale contributions conditioned on day-of-week, season, and wind direction. These estimates are interpreted in light of our knowledge of the geographic characteristics and emissions-generating activities in the neighborhood of the receptor site.

[P05-30] ASSESSING PARTICULATE MATTER EMISSIONS FROM LIGHT-DUTY, GASOLINE POWERED MOTOR VEHICLES.

Rich Baldauf, Joe Somers, Gene Tierney, Carl Fulper, Jim Warila, Peter Gabele, Brent Bailey, Steve Cadle, Doug Lawson
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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Mobile sources significantly contribute to ambient concentrations of airborne particulate matter. Recent source apportionment studies for PM10 and PM2.5 indicate that mobile sources can be responsible for over half of the ambient PM measured in an urban area. Some of these source apportionment studies have attempted to differentiate between contributions from gasoline and diesel combustion. Studies conducted in Denver and Phoenix indicated that gasoline combustion from mobile sources contributed more to ambient PM than diesel combustion. However, studies conducted in Los Angeles and the San Joaquin Valley in California indicate that diesel combustion contributed more than gasoline combustion to ambient PM. Existing emission inventories developed by the U.S. Environmental Protection Agency (EPA) also suggest diesels contribute more than gasoline vehicles to ambient PM concentrations.

The U.S. Environmental Protection Agency (EPA) is conducting a program to evaluate PM exhaust emissions from light-duty, gasoline powered vehicles. The program consists of measuring PM2.5 and criteria gases in exhaust emissions of 480 randomly selected, light-duty motor vehicles in the Kansas City Metropolitan Area using a portable chassis dynamometer. Continuous and integrated PM2.5 measurements will be collected for each vehicle. A select number of vehicle samples will be analyzed for metals, EC/OC, ions, and SVOCs. This paper details the project design, including vehicle selection and recruitment, dynamometer testing methods, and analytical procedures. Preliminary results will also be presented, and compared with existing emission inventories and mobile emission factor modeling results.

[P13-16] IMPROVING SOURCE IDENTIFICATION OF ATLANTA AEROSOL USING THERMAL OPTICAL CARBON FRACTIONS IN POSITIVE MATRIX FACTORIZATION.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 13: Receptor Modeling and Source Apportionment (11:00 AM-12:00 PM) Grand Ballroom 2-4

Data characterizing daily integrated particulate matter samples including seven individual organic carbon (OC) and elemental carbon (EC) fractions collected at the Jefferson Street (SEARCH/AIRES) monitoring site in Atlanta were analyzed through the application of Positive Matrix Factorization (PMF). Particulate carbon was analyzed using the thermal optical reflectance method that divides carbon into four OC and three EC fractions. A total of 529 samples and 28 variables measured between August 1998 and August 2000 were used in the analysis. In the preliminary results, PMF identified eleven sources: sulfate-rich secondary aerosol I, on-road diesel emissions, nitrate-rich secondary aerosol, sulfate-rich secondary aerosol II, wood smoke, gasoline vehicle, metal processing, airborne soil, bus station, cement kiln, and rail yard diesel emissions. The extracted three independent diesel emission sources indicate that fractional carbon data can be utilized to enhance source apportionment study. Conditional probability functions were computed using surface wind data and identified mass contributions from each source. The results of this analysis agreed well with the locations of known local point sources.

[P13-17] SOURCE IDENTIFICATION OF AEROSOL MEASURED AT MULTIPLE SITES ACROSS ST. LOUIS.

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The purposes of this study are to identify the source contributions of ambient particulate matter (PM) at multiple sites in an urban area. Epidemiologic time-series studies typically rely on data for PM and its components that were collected at a single ambient monitoring site of a study area. However, there can be considerable heterogeneity in the within-area concentrations, depending on the study area chosen. There have been very few data sets collected in urban areas from which one could determine the spatial heterogeneity of PM and its components. The Regional Air Pollution Study / Regional Air Monitoring System (RAPS/RAMS) conducted in St. Louis is one such study in which data are available to evaluate the spatial heterogeneity of PM, its components and source contributions across an urban area. In addition, St. Louis was one of the study areas used in the Harvard Six-Cities Study (Schwartz et al., 1996. J. Air & Waste Manage. Assoc. 46, 927-939). We have analyzed composition data for PM collected in St. Louis, MO between May 1975 and April 1977 by Positive Matrix Factorization (PMF). PM samples were collected at ten monitoring sites using dichotomous samplers, analyzed by X-ray fluorescence for elemental composition, and the total PM mass values were determined by beta-gauge. PMF identified six to nine sources of fine PM and four to nine sources of coarse PM at each of the ten sites. Conditional probability functions were computed using surface wind data and identified mass contributions from each source. The results of analyses agreed well with existing information about the location and nature of local point sources.

[P13-18] APPLICATION OF UNMIX AND CMB CALCULATIONS TO AMBIENT PM2.5 AIR QUALITY DATA IN THE CINCINNATI AIR SHED.

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An epidemiological study to evaluate the impact of ambient PM on children's health has been ongoing in the Greater Cincinnati area. One of the objectives of the study is to conduct a detailed characterization of the ambient aerosol, and establish the contribution of diesel engine emissions. The hypothesis of the study is that diesel engine exhaust particulate matter is adjuvant with naturally occurring bioaerosols (such as pollen) in the onset of allergic sensitization. There are several controversial viewpoints on apportionment of the contribution of diesel engine type sources. One of the important aspects is establishing the signature of the truck emissions. The air sampling was performed at specified ambient locations at different distances from interstate highways; in addition, the samples were collected at truck stops and locations that represented truck/bus emissions as the primary sources.

Ambient PM 2.5 samples were analyzed by X-ray fluorescence to determine concentrations of elemental species. The thermal optical analysis was used to determine elemental and organic carbon (EC/OC) concentrations. An optical reflectance method has been used to also determine the EC concentrations from teflon filter samples. A calibration curve was established based on the thermal optical measurements from co-located quartz filters. Thus, a richer database of EC concentrations can be readily developed for use in the models.

The measurements of diesel engine emissions in areas concentrated with trucks and buses are being compared to published source signatures for diesel engine exhausts, and to those obtained by UNMIX analysis of ambient PM 2.5 data. The entire ambient dataset is also being analyzed by UNMIX and CMB modeling approaches. Preliminary analysis indicates that the sulfate component is a large fraction of the PM 2.5 aerosol. Several regions were identified which clearly show an impact of diesel truck emissions, whereas in other areas it is difficult to decipher contributions of diesel engine emissions. The data generated in this study will be used to classify the region into three sections: high, moderate and low contributions of diesel engine exhausts. Strategies to improve the source apportionment specifically to establish contributions of diesel engines are discussed.

[P13-19] SOURCE APPORTIONMENT USING PARTICLE SIZE DISTRIBUTION DATA FROM THE PITTSBURGH AIR QUALITY STUDY(PAQS).

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Previously, Positive Matrix Factorization (PMF) was successfully applied to one month of particle size distribution data acquired during the Pittsburgh Air Quality Study (PAQS) (Zhou et al., 2002, submitted to Aerosol Science & Technology). In this study, a larger set of particle size distribution data acquired in Pittsburgh from July 2001 to August 2002 were analyzed. The data were obtained from Scanning Mobility Particle Spectrometers (SMPS) and Aerodynamic Particle Sampler (APS) with a temporal resolution of 15 minutes. Each sample contained 165 evenly sized intervals from 0.003 to 2.5 μm. Those days with strong nucleation events and particle growth were excluded from this study. The values for each set of five consecutive size bins were summed to produce 33 new size channels. The particle size distributions were analyzed as a bilinear model problem solved by Positive Matrix Factorization (PMF). The factors could be assigned to particle sources by examination of the number size distributions associated with the factors, the time frequency properties of the contribution of each source (Fourier analysis of source contribution values) and the correlations of the contribution values with the gas phase data. Seasonal trends and weekends effects were compared. A conditional probability function (CPF) analysis was performed for each source to ascertain the likely directions in which the sources were located.

[P13-12] SOURCE APPORTIONMENT OF PM10 AND PM2.5 AT A BACKGROUND SITE IN SOUTHERN SWEDEN.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 13: Receptor Modeling and Source Apportionment (11:00 AM-12:00 PM) Grand Ballroom 2-4

PIXE (Particle Induced X-ray Emission) data on the elemental composition of fine (equivalent aerodynamic diameter EAD < 2.5 μm) and coarse fraction (2.5 μm < EAD < 10 μm) aerosol particles were used to apportion PM2.5 and PM10 aerosol mass to various natural and anthropogenic sources. The samples were collected during spring 2000 at the EMEP background air quality monitoring station Vavihill (56° 01′ N, 13° 09′ E, 172 m a.s.l.) in southern Sweden. At the Vavihill site, PM10 average concentrations (12.7 μg/m3) were only 26% higher than the PM2.5 average (10.1 μg/m3). Two statistical source-receptor models were used in the PM source apportionment; COPREM (Constrained Physical Receptor Model) and PMF (Positive Matrix Factorization). Both models give non-negative solutions regarding the source profiles and source contributions. The two models yielded similar results. Fine and coarse fraction PIXE data for the elements Si, S, K, Ca, Ti, Cr, Mn, Fe, Co, Ni, Cu, Zn, Se, Br and Pb were used in the models, in addition to coarse fraction Cl and Sr and fine fraction V. Four sources were chosen to represent the influence of the long-range transported aerosol on the Vavihill background monitoring station: Sea spray, Soil dust, General Pollution and Oil/Coal combustion. The models apportioned the measured PM2.5 and PM10 mass to the four sources as follows (the ranges indicate the results of the two models):

PM10: Soil 19-22%, Sea 16-22%, Pollution 28-34%, Oil/Coal 23-24%

PM2.5: Soil 16-18%, Sea 15-21%, Pollution 34-40%, Oil/Coal 23%

About 4% (COPREM) and 7% (PMF) of the average measured PM2.5 and PM10 mass was not accounted for by the models. According to these results, the twosources sea spray and soil dust, usually considered natural coarse particle sources together account for 38-44% (≈5 μg/m3) of the PM10 and 33-36% (≈4 μg/m3) of PM2.5. This points out the need to incorporate these sources in the modelling of PM levels over Europe for regulatory purposes. A fair portion of the soil dust is likely emitted by anthropogenic activities, as traffic.

[P13-21] HIGHLY TIME-RESOLVED MEASUREMENTS OF ELEMENTAL COMPOSITION AT THE BALTIMORE, ST. LOUIS, PITTSBURGH, AND TAMPA SUPERSITES USING THE UM HIGH-FREQUENCY AEROSOL SLURRY SAMPLER: UNPRECEDENTED RESOLUTION OF THE SOURCES OF PRIMARY ATMOSPHERIC AEROSOL.

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Simultaneous multielement graphite furnace atomic absorption spectrometry was used to determine Al, As, Cd, Cr, Cu, Fe, Mn, Ni, Pb, Sb, Se, and Zn in ambient air sampled for 30 or 60 minute intervals after dynamic preconcentration using the University of Maryland Elements in Semicontinuous Elements in Aerosol Sampler (SEAS). The instrument was operated for more than 10 months in Baltimore, 18 months in St. Louis, and 3 months in Pittsburgh, as a part of the EPA Supersites Program; and for nearly 2 months inTampa under the Florida Department of Environment's Bay Regional Atmospheric Chemistry Experiment. Additional measurements were made near selected, isolated, industrial sources (e.g., Coke plant) in Pittsburgh. Data for a total of nearly 3500 30-min or hourly intervals will ultimately be available. Herein, results are presented for nearly 2000 samples. Trends in elemental concentrations were correlated with wind direction and other meteorological factors to identify the influences of local industrial emissions, including motor vehicle traffic, coal- and oil-fired power plants, and municipal incinerators. The results reveal 10- to 500-fold excursions in concentrations of elemental constituents of aerosol particles during typical periods of influence from plumes of local sources. As might be expected, their concentrations are largely independent of aerosol mass, and are often low when PM2.5 mass is elevated. Interpretation of these highly time-resolved data further show unprecedented resolution of aerosol from high-temperature combustions sources; notably, contributions of individual coal- and oil-fired power plants, a battery recycling plant, copper smelter, steel plants, and other important heavy metal sources are often clearly resolved. The data are being used to develop source profiles for use in Chemical Mass Balance Receptor models and identification of sources in Factor Analysis models and to provide true measures of short term exposure.

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[P13-11] SOURCE APPORTIONMENT OF PERSONAL EXPOSURE TO PM2.5 USING THE CHEMICAL MASS BALANCE MODEL COMBINED WITH PMF-DERIVED SOURCE PROFILES.

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Our overall goal is to understand the relationships between exposures to different sources of ambient PM and the effects of such exposures. To do this, we need to be able to trace the sources of particles in outdoor, indoor and personal environments. The immediate goal of this work is to better understand how the sources of outdoor PM2.5 in urban areas contribute to personal exposures of PM2.5. This work is part of a larger panel study being conducted in Seattle, WA. 24-hr PM2.5 samples were collected both inside and immediately outside the residences of study subjects, as well as on their person. Particles were collected on Teflon filters for subsequent gravimetric analysis followed by x-ray fluorescence (XRF) analysis. Indoor and outdoor samples were also collected on quartz filters for particulate carbon analysis using TOT. A total of 198 indoor/outdoor pairs of Teflon and quartz filters were taken between Autumn 2000 and Autumn 2001. Positive Matrix Factorization was applied to these data in order to derive source profiles separately for both indoor and outdoor samples. We found five features that were similar in the outdoor and indoor samples- vegetative burning, marine, soil/dust, motor vehicle, and a source rich in S, Mn, Fe, Ni, Br and Pb. The identification of a vegetative burning source that readily penetrates indoors was aided by the measurement of levoglucosan on a subset of the data.. A sixth profile that was rich in OC was also found to be associated with a major fraction of the mass on the indoor Teflon filter. We then regressed the five indoor/outdoor PMF derived source profiles onto the personal Teflon filter samples using the chemical mass balance model (CMB8). This additional step was necessary because the personal PM2.5 teflon filter samples did not contain any information on organic carbon (only XRF species). Of 161 personal filters, 138 had satisfactory diagnostic statistics according to the CMB criteria. On average, the five indoor/outdoor profiles accounted for 44% of the personal mass. The remaining unexplained mass was correlated with the mass contribution from the 6th OC rich indoor source. However, this source could not be included in the CMB model due to the lack of distinctive trace element features in its source profile.

[P13-23] LONG-TERM MEASUREMENT OF ULTRAFINE PARTICLE NUMBER CONCENTRATION IN ROCHESTER, NY.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 13: Receptor Modeling and Source Apportionment (11:00 AM-12:00 PM) Grand Ballroom 2-4

During the measurement period of December, 2001 to January, 2003, number concentrations and size distributions of fine particles in the size range of 10 to 500 nm were conducted at New York State Department of Environmental Conservation (NYSDEC) ambient monitoring site in downtown Rochester. Mass concentrations of fine particulate matter ($PM_{2.5}$) and gaseous pollutants were measured at the same site as well as meteorological data. The particle number and size distributions were measured by a Scanning Mobility Particle Sizer (SMPS) system comprising of a differential mobility analyzer (DMA, TSI 3071) and a condensation particle counter (CPC, TSI 3010). Approximately 60% of total number concentration was associated with particles in the size range 11 to 50 nm, 20% was associated with particles 50 to 100 nm. The total number concentrations during the winter, December to February, tended to be higher than those during the summer. Two peaks of the number concentrations were typically found in the size range 11 to 50 nm as a function of time of day. The first peaks occurred around 9 a.m. while the second peaks appeared around 3 p.m. in the period of December 2001 to March 2002. During the measurement period of April to August 2002, the intensity of the first peak slowly decreased while the second peak remained relatively constant. The number concentrations of particles in the size range 50 to 100 nm were also related with morning rush-hour and evening rush-hours, 5 to 7 p.m. during winter months while the number concentrations measured over summer were somewhat increased after 6 p.m. Advanced factor analysis of the particle size distributions was performed to obtain sensible source identification and apportionment. It was necessary to remove the growth periods from the particle size distribution record since the system is non-stationary during that time since there is active growth occurring that cannot be modeled by the superposition of stable source profiles.

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[P13-24] SINGLE PARTICLE CHARACTERISTICS OF GASOLINE AND DIESEL POWERED VEHICULAR EMISSIONS: CLASSIFICATION, DIFFERENTIATION, AND SOURCE APPORTIONMENT.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 13: Receptor Modeling and Source Apportionment (11:00 AM-12:00 PM) Grand Ballroom 2-4

Source apportionment of gasoline and diesel particles in the atmosphere constitutes a major challenge due to close similarities in the chemical composition of these particles. With traditional standardized filter collection/ analysis methods, it is virtually impossible to identify the number of particles arising from each of these sources, due to the fact that these methods provide as an output an average chemical composition, combining the contributions from many sources. Using aerosol time-of-flight mass spectrometry (ATOFMS), the size and chemical composition of individual particles can be evaluated with high temporal resolution, therefore providing information on the properties of single particles at a level of detail which allows distinction between different particle sources.

ATOFMS source characterization studies of particulate combustion emissions from gasoline vehicles and heavy duty diesel vehicles were carried out with the objective of determining the presence of unique combinations of ion markers (fingerprints) in the mass spectra of single particles from these vehicular emissions. By using the single particle fingerprints from these sources, differentiation between carbonaceous particles emitted from gasoline powered and diesel vehicles are readily established and source apportionment of the respective contributions can be successfully tested using ambient datasets acquired with ATOFMS. This poster will provide results from initial dynamometer testing and the application of unique fingerprints to identify and track particles in various locations in the United States including Atlanta, New York, Texas, and California.

[P13-26] SHORT-TERM PM2.5 SOURCE APPORTIONMENT USING CONTINUOUS SAMPLERS.

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As part of the Salt Lake City and Bountiful EPA EMPACT and STAR programs, PM2.5 mass was determined on a continuous basis in Salt Lake City and Bountiful, Utah using two different monitoring techniques. A TEOM monitor operating at 30 °C in the winter and 50 °C in the summer collected the nonvolatile fraction of the fine particulate material, but not semi-volatile nitrate or organic material. The BYU RAMS monitor measured total fine particulate material, including the semi-volatile nitrate and organic material. The difference between these measurements is the semi-volatile fine particulate material. In addition to these mass measurements, measurements were made on a continuous basis of other species associated with primary emissions or with secondary gas phase reaction processes. These included both the EC and UV adsorption measurements with an Anderson Aethalometer, NOx, NO2, CO and O3. Concentrations of nonvolatile and semi-volatile PM2.5 mass, determined from the 1-h average TEOM and RAMS measurements, and the listed marker species, were used in the EPA UNMIX program to identify both primary sources and secondary processes leading to observed concentrations of fine particulate matter. The analysis was successful in identifying the major primary sources of PM2.5, including emissions from diesel vehicles, other motor vehicles, refineries near Bountiful, smoke from home combustion of wood during the winter, and the impact in the urban area of wildfires in the mountains above Salt Lake City in the summer. Both nonvolatile and semi-volatile contributions to this primary PM2.5 were identified. Consistency was seen in all cases in the analysis of these two classes of primary fine particulate material for each source identified. In addition, PM2.5 signatures were identified which were not related to the primary emission markers, but were related to the markers of secondary chemistry. This included the identification of both nonvolatile and semi-volatile secondary material. During active photochemical periods, the pattern of secondary PM was similar to that of ozone, implying a photochemical production mechanism. During the time period when Salt Lake was impacted by the mountain forest fires, the bulk of the PM2.5 in the valley was secondary nonvolatile and semi-volatile products. The analysis technique will be illustrated with examples from both winter and summer pollution episodes. This apportionment method should be generally applicable to the identification of primary and secondary sources of fine particulate material on a short-term basis for use in the interpretation of data collected in epidemiologic and standard attainment studies.

[P13-27] CHARACTERISTICS OF DAILY FINE PARTICULATE MATTER AT ATLANTA, GA.

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Epidemiological studies have shown that increased concentrations of atmospheric fine particulate matter in urban areas are associated with adverse health effects. To better understand the relationship between adverse health effects and particulate matter concentrations, a clear understanding of the detailed chemical composition as well as the sources of the fine particles is required. To support these efforts, daily PM2.5 samples were collected during January 2002 at Jefferson St., Atlanta, Georgia using the Thermo-Andersen high volume sampler. The primary objective of this study is to characterize the fine particles including their concentrations, sources, and chemical compositions such as EC (elemental carbon), OC (organic carbon), inorganic ions, major and trace elements as well as organic compounds in Atlanta on a daily basis. The results are compared with those from daily samples collected during July 2001 at the same site and analyzed under the same analytical protocol to investigate the seasonal variation of fine particle characteristics.

Each daily sample was spiked with 16 deuterated internal standards and extracted with solvents. Identification and quantification were performed using deuterated standards, quantification standards as well as secondary standards. These standards contain more than one hundred organic compounds. Gas chromatography/mass spectrometry (GC/MS) was used to quantify and identify the particle-phase organic compounds, which include n-alkanes, PAHs (polycyclic aromatic hydrocarbons), oxy-PAHs, resin acids, fatty acids, hopanes, steranes, and other key tracer compounds. Organic tracer analysis has been shown to be an effective method for estimating source contributions to ambient fine particles.

Preliminary results show that not only the concentrations of organic compounds exhibit a distinct seasonal variation, but also the sources of fine particles at this site. For example, the source contribution from wood smoke, a contributor to ambient air pollution, shows a significant increase in the winter. Daily variation of the concentrations of inorganic and organic species, especially PAHs, which are known to be mutagenic and carcinogenic, and the characteristics of PM2.5 in the winter and summer will be discussed.

[P13-28] CHARACTERIZATION OF CHEMICAL COMPOSITION OF ORGANIC AEROSOL IN THE NORTHEASTERN UNITED STATES.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 13: Receptor Modeling and Source Apportionment (11:00 AM-12:00 PM) Grand Ballroom 2-4

PM10 sample collection started in January 2000 until November 2000 in North Piladelphia to study the chemical composition of organic aerosol in the Northeast US. Fifteen to twenty daily samples were collected continuously in each season with a total number of 71 samples. Chemical composition of organic particulate matter collected was determined by GC-MS analysis after soxhlet extraction. Over 50 potential organic source markers were identified and quantified, including: n-alkanes, n-alkanoic acids, dicarboxylic acids, hopanes, polycyclic aromatic hydrocarbons (PAHs), levoglucosan and cholesterol. Daily and seasonal variation of those compounds will be discussed and compared, with an emphasis on potential variation correlations. The relative importance of sources contributing to the PM in the Northeast area will be estimated.

[P05-01] ATMOSPHERIC EMISSIONS OF AMMONIA FROM DAIRY FARMS.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Dairy farms are one of the largest sources of atmospheric ammonia emissions. Aerosol nitrate concentrations depend on ammonia concentrations; therefore, predicting PM 2.5 concentrations and developing control strategies require accurate ammonia emissions inventories. Since most of the sources of ammonia are either agricultural or biological, emissions of ammonia have a seasonal variability. Farming practices and climate conditions differ regionally, so emissions of ammonia also vary geographically. Finally, our scientific understanding of these processes is incomplete, which leads to uncertainty in emissions as well. The purpose of this research is to develop an emission inventory for dairy farms that accounts for both seasonal and geographical variation in emission factors and uncertainty.

This research first developed a semi-mechanistic, semi-empirical model for the volatilization of ammonia from major types of manure management systems found in a modern dairy operation. Bayesian parameter estimation has been used to tune the model parameters to match experimental results and to explicitly account for uncertainty. By combining data that describes the national distribution of manure management practices on dairy farms with the model results for the different farm configurations, it is possible to estimate the ammonia emissions for a particular region of the country. By compiling these results with county dairy cow populations, historical climate data, and soil properties data, this research constructed a national ammonia emission inventory for dairy operations that captures both the geographical and seasonal variability and rigorously derives the uncertainty in emission rates.

The second stage of this research is to use the improved emissions inventory as input to a 3-D air quality model of the Eastern United States. The modeled concentrations will be compared against measured concentrations of ambient particulate matter and measured concentrations of wet deposition of ammonium. The air quality model will also be used to estimate the sensitivity of concentrations of particulate matter to reductions in a ammonia emissions.

[P13-20] SOURCE - RECEPTOR RELATIONS OF PM MASS FRACTIONS AND PARTICLE NUMBER CONCENTRATION.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 13: Receptor Modeling and Source Apportionment (11:00 AM-12:00 PM) Grand Ballroom 2-4

Introduction

Within the Austrian Project on Health Effects of Particulates (AUPHEP) TSP, PM_{10}, $PM_{2.5}$, $PM_{1.0}$ and particle number concentration were monitored continuously at four sites for one year. Besides gaseous pollutants and meteorological parameters, daily filter samples of PM_{10} and $PM_{2.5}$ were taken to obtain their chemical composition (OC, EC, main ions, selected polar organic compounds and heavy metals). The sites are representative for a good part of the country and characterize different emission situations: conurbation (Vienna), background/rural and pre-burden of Vienna, industrial area and residential area in a basin.

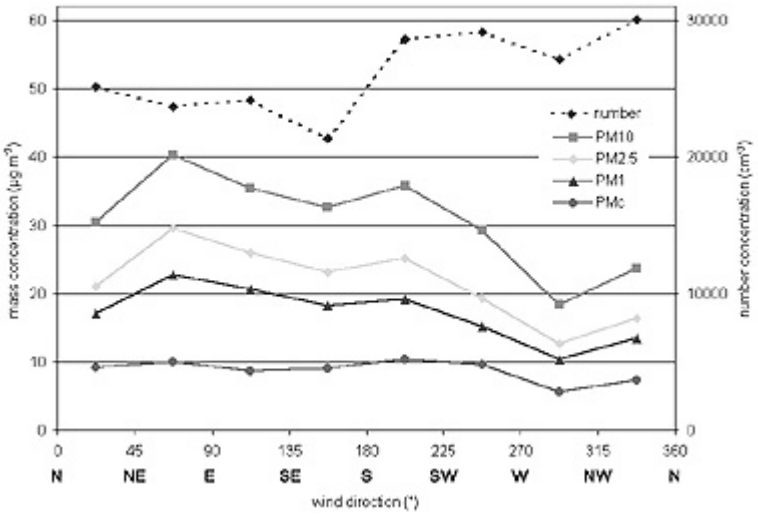
This contribution will focus on sector analyses of wind direction and trajectory calculations related to particle number and mass concentration of the various size fractions and their chemical composition.

Results and discussion

The 30-minutes average PM concentration data set was divided into 8 classes, corresponding to 45° sectors. In the figure the related data for the urban site of Vienna is presented as an example. The lowest mass concentrations were observed in the sector from 270° to 315°, followed by the sector from 315° to 360°. This result is rather surprising, because one of the busiest streets in Vienna runs about 200 m from the site towards W-N. However, in this sector there are almost no other sources than traffic - this part of Vienna is an exclusively residential area. The highest particle number concentrations, however, were found in the less polluted sectors regarding PM mass concentrations.

Conclusions

For the four different receptor sites depending on the strength, characteristics and spatial distribution of the main emitters different source-receptor relations can be found. However, the vicinity of even a main street is not obviously a predominant source of elevated PM fractions. The local traffic situation clearly steers the number concentration of fine and ultrafine particles. Epidemiologic studies focused on mass or number concentration, therefore, may come to contradicting conclusions if time courses of these two parameters are contrary. (Click to see figure 1)



Figure

[P13-03] PRINCIPAL COMPONENT ANALYSIS OF TRACE ELEMENTS IN $PM_{2.5}$ IN PITTSBURGH.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 13: Receptor Modeling and Source Apportionment (11:00 AM-12:00 PM) Grand Ballroom 2-4

Results of many scientific studies support the association of elevated concentrations of atmospheric particulate matter (PM) with increases in morbidity and/or mortality. However, the chemical components of the PM that are causative agents have not yet been identified. One category implicated in contributing to potential health effects is trace elements. Examples of sources of trace elements include emissions from coal-fired power plants, oil and/or gas combustion, diesel- or gasoline-powered transportation, biomass burning, incineration, various industrial processes, and crustal sources. Factor analysis of ambient particulate matter elemental concentrations can be used to identify groups of elements that may come from the same source category. The Pittsburgh Air Quality Study (PAQS) was a large-scale ambient air quality study focused on particulate matter composition and concentration. The study was centered at an EPA supersite monitoring station, with minor measurement sites at other locations in the city as well as in the surrounding region. As part of the PAQS, ambient measurements of trace elements were taken at the supersite from July 2001 until September 2002. For most of this sampling period, the sampling duration was 24 hours, but four- to six-hour samples were collected on some days in July 2001 and August 2001. Elements analyzed include aluminum, arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, selenium, silver, vanadium, zinc and other metals. Samples were collected on Whatman 41 filters using two ThermoAndersen high volume samplers, one with a PM_{10} and one with a $PM_{2.5}$ size-selective inlet. Microwave-digested sections of filters were analyzed by Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Additional metals data will be obtained at or near sources in the Pittsburgh area to provide fingerprints of specific source types. The fingerprints and the supersite data will be used with Principal Component Analysis (PCA). PCA can be used to estimate the importance of various sources affecting ambient PM concentrations, which may aid in policy making to improve regional air quality and consequently human health. In this study, PCA will provide information on the relative contribution of sources in the Pittsburgh area to ambient PM.

[P05-33] CORRELATING PARTICULATE MATTER MOBILE SOURCE EMISSIONS TO AMBIENT AIR QUALITY.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

Federal Highway Administration (FHWA) has developed its research needs for understanding particulate matter (PM) emissions resulting from vehicle traffic on transportation facilities. Particulate Matter is a pollutant that impacts transportation project development and highway usage due to air quality regulations that have been implemented to protect human health. Laws and regulations such as the Clean Air Act and the transportation conformity rule as well as other initiatives covered by the National Environmental Policy Act are highlighting the need for a better understanding of PM and its association with the transportation sector.

In an effort to broaden the understanding of mobile PM emissions, the FHWA established an integrated research program to fill gaps in the current understanding of mobile source induced PM pollution, including both PM10 and PM2.5, the two size fractions currently being regulated. This effort was initiated with a strategy document listing fourteen different projects that the transportation community should undertake to understand and apportion PM emissions from vehicles. One of these projects involved working with the EPA Supersites to collect traffic and air quality data.

The PM Traffic-Air Quality Supersite Project was initiated in the summer of 2001 using traffic data collected by transportation departments and PM emission data collected at EPA Supersites and other EPA monitors. This effort, intended to continue for a two-year period, will collect data from seven Supersite cities across the United States representing different geographical regions. Source apportionment will be performed to estimate highway vehicles' contribution to ambient PM2.5 in each urban area. The two-year collection period is considered adequate to establish trends or capture anomalies resulting from weather patterns. The study will also investigate the contribution from regionally transported vehicle emissions and the fugitive dust component generated locally by vehicle traffic.

Initial data for this project is currently being collected and analyzed to determine the extent to which correlations can be made between traffic and PM emissions. Reporting from this study is intended to be quarterly to understand seasonal variations. This data and the results of this project are intended to serve as a planning resource for State and local agencies responsible for reducing PM emissions by enabling them to develop accurate apportionment of mobile source PM emissions.

[P05-34] PM CONCENTRATIONS AND SOURCES IN SWEDEN.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

A network of Swedish sites, ranging from regional rural background, urban background to kerbside sites, measuring PM2.5 and PM10 on one hour basis has been operated over 2 years in Sweden. The results show two important features determining the concentrations, long distance transport of particles and re-suspension of road dust. Strong low level inversions especially in the inland of Northern Sweden during lock out the long distant transport and lead to less dilution of the local emissions and induce at times very high concentrations in areas like the inland of northern Sweden during winter time.

Typical annual mean values for PM2.5 at rural background, urban background and kerb site are 5 - 10, 6 - 11 and 10 - 15 μg/m3, respectively, while for PM10 it is 7 - 13, 12 - 18 and 20 - 30. The ratio PM2.5/ PM10 is about 0.8, 0.6 - 0.7 and 0.4 - 0.6. The strongly decreasing ratio implies the strength of road dust emissions and other mechanical wearing processes giving coarse particle emissions.

Using NOx as a tracer for traffic emission and assuming a fixed relation to NOx for the particle exhaust emissions the non-exhaust emission factors for PM2.5 and PM10 is estimated to 25 and 200 mg/vehkm compared to the estimated 23 mg/vehkm for exhaust related particle emissions. Totally the non-exhaust emission factor for PM10 is 9 times larger than the PM10 exhaust emission factor but for PM2.5 the non-exhaust emission factor is equal to the exhaust emission factor.

Road dust emerges as the major local source responsible for exceedance of limit values in Sweden. However it is superimposed on strongly enhanced background concentrations due to long distance transport.

Emission factors and high resolved sixe distributions show clearly that PM2.5 is strongly disturbed by non-exhaust coarse particle sources. PM2.5 do not reflect the correct concentrations due to combustion sources and long range transported emissions. Using PM2.5 will strongly complicate the assessment of sources and the choice of abatement strategy. Use of PM1 would avoid these problems.

[P05-35] SENSITIVITY OF VISIBILITY AND REGIONAL HAZE TO EMISSIONS REDUCTIONS.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

The Environmental Protection Agency (EPA) has established a national goal that calls for a return to natural visibility conditions within the next 60 years. Five Regional Planning Organizations (RPOs) have been established to develop emissions reduction strategies that will begin the process of moving toward that goal. A component of the work to be performed by the RPOs will be photochemical modeling to evaluate the relative efficacy of alternative emissions reduction strategies for the purpose of making recommendations to states for their use in developing State Implementation Plans (SIPs). This application of photochemical models puts untested demands on the models and the interpretation of the modeling results. The work presented in this paper describes winter and summer season Community Multiscale Air Quality (CMAQ) modeling performed to better understand the implications of the use of CMAQ for regulatory decisionmaking.

The models-3 system was used to determine the sensitivity of regional haze and visibility in the southeastern United States to changes in emissions of SO_2 and NH_3. CMAQ-ready input files of meteorological and emissions data (outputs from MM5/MCIP and SMOKE) for the year 1996 were obtained from EPA. Model simulations were conducted for the months of January and July 1996 in order to determine the sensitivity to wintertime and summertime conditions. Four sets of simulations were conducted for each month: a basecase simulation, a simulation in which SO_2 emissions were reduced, a simulation in which NH_3 emissions were adjusted for seasonality and a simulation which included both the SO_2 and NH_3 emissions changes. The grid covered the entire continental United States and was made up of grid cells that were 36 km in size.

The simulation results were analyzed by looking at the differences in visibility between the basecase and other scenarios to determine the effects of these emissions reductions on visibility in the southeastern United States.

[P05-36] GEOGRAPHIC INFORMATION SYSTEMS AND PM10 EXPOSURE MODELING

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 5: Emissions: Measurement, Characterization, and Modeling (11:00 AM-12:00 PM) Grand Ballroom 2-4

This research investigates the use of a Geographical Information System (GIS) method for the spatial distribution of air emissions, to estimate environmental exposures over a geographic area. The research uses PM10 emission sites as the source of pollution emissions. The region of interest is Allegheny County and its neighbors in Southwestern Pennsylvania. The dispersion of emissions from PM10 emission sites is used to estimate PM10 exposure over the six county region. Two issues are important when using GIS for exposure estimation in this setting. The first is called the edge effect, which examines the effect of border county emission sites on the exposure estimates within the county. The second issue concerns the appropriate emission sites to contribute to a receptor site estimate. We explore, and illustrate by GIS mapping, the effect of these factors.

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[P13-14] AEROSOL ELEMENTAL COMPOSITION AND SOURCE APPORTIONMENT IN CHILLAN CHILE.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 13: Receptor Modeling and Source Apportionment (11:00 AM-12:00 PM) Grand Ballroom 2-4

In order to study air pollution in that Chillán area located in the southern Biobío Región of Chile, an aerosol monitoring study was established to measure ambient aerosol composition for one sampling site at the University of Concepción. The Chillán campus is located approximately 2 km North of the city's downtown. The aerosol monitor was operated on the campus from October 9th to December 9th, 1998. The study employed an IMPROVE sampler with PM_{10} Anderson inlet at 3 meters collecting PM_{10} on Teflon membrane filter. Proton Induced X-ray Emission (PIXE) and X-ray Fluorescence Analysis (XRF) were used to measure the concentration of 22 elements to levels below 0.48 ng/m^3.

Moderate aerosol concentration was observed (up to 60 $\mu g/m^3$). The main aerosol particle sources in Chillán are resuspended soil dust, which accounts for 55% of the PM_{10} aerosol. Aerosol associated with transportation activities accounts for only 2%. Sulfate particles account for only 3%, mainly originating from SO_2 gas-to-particle conversion. Organics associated with hydrogen measured by Proton Elastic Scattering Analysis (PESA), are an important component accounting for 24%. Direct traffic emissions are generally mixed with resuspended soil dust. The presence of Pb, Br, and Cl, and other heavy metals in analyzed samples points to traffic emissions in the city. In addition, presence of several trace metals, including Mn, Zn, Cu, Ga, As, and Sr in our sample seems to correspond well with industrial emissions in the city.

[P13-02] A SOURCE APPORTIONMENT OF FINE PARTICULATE MATTER IN LOWER MANHATTAN FOLLOWING THE WTC DISASTER.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 13: Receptor Modeling and Source Apportionment (11:00 AM-12:00 PM) Grand Ballroom 2-4

Following the World Trade Center (WTC) Disaster in New York City (NYC), it was presumed by many that all particulate matter (PM) air pollution measured in Lower Manhattan was emanating from Ground Zero. But NYC is a polluted city even without the addition of the WTC pollution. So we sought to determine how much fine particle mass (PM2.5) measured in Lower Manhattan was associated with the WTC dust and combustion plume.

We analyzed PM2.5 samples collected daily (sometimes twice daily) by our monitors at the NYU Downtown Hospital, located some 5 blocks east of Ground Zero, from Sept 14 through December, 2001. Each sample was analyzed for trace elements via X-ray Fluorescence and for elemental carbon (EC) via reflectance. Positive Matrix Factorization (PMF) source apportionment analysis was applied to determine the PM components contributing to the ambient PM2.5 measured in September-December, 2001. The PMF identified 5 PM2.5 source components: 1) the WTC fire's plume (S, Cl, K, Cu, Zn, Pb, EC); 2) the WTC Collapse-related Dust (Mn, Cr, EC); 3) WTC Demolition-related Dust (S, Si, Ca, Ti, Fe); 4) oil combustion particles (S, V, EC); and, 5) soil (Al, Fe). Time-series plots of the source factor impacts indicate that the WTC fire plume impact were maximum during September, diminishing greatly during October. In mid-October, the demolition operations dust increased as the rescue operations ended and the clean-up began, and then decreased greatly during November. Oil combustion was a large contributor to PM2.5 throughout the entire study period, irrespective of World Trade Center operations. PM2.5 concentrations during late September averaged 35 ug/m3, and during the month of October some 22 ug/m3, while during November and December levels returned to more usual NYC levels (18 and 15 ug/m3, respectively). Analyses of the source contributions indicated that the WTC-related sources (Factors 1-3) contribution = 50% of the pollution in Lower Manhattan during September14-30th, = 27% in October, = 14% in November, and only = 6% in December. While the WTC pollution added greatly to the PM2.5 levels in lower Manhattan in September, it had a diminishing impact on this pollutant in the following months, and non-WTC sources of PM2.5 (such as fuel oil burning) were also major contributors to pollution in Lower Manhattan throughout the entire period. Clearly, any analysis of fine PM outdoor exposures seeking to assess the impacts of the WTC Disaster must take other non-WTC PM2.5 sources into account.

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[P13-30] SPECIATION OF ORGANIC FINE PARTICULATE MATTER IN HOUSTON AND SOURCE APPORTIONMENT USING MOLECULAR MARKERS.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 13: Receptor Modeling and Source Apportionment (11:00 AM-12:00 PM) Grand Ballroom 2-4

Samples of atmospheric PM2.5 were collected in Houston, TX every second day during the summer of 2000 as part of the EPA sponsored Houston Fine Particle Matter Supersite program. Sampling occurred at three sites, including one industrial location (HRM-3), one suburban location (Aldine) and one coastal location (La Porte). Twenty samples collected over a 24 hour period have been analyzed to quantify the concentration of 95 individual organic compounds, including: n-alkanes (C20 to C36), aromatic hydrocarbons (PAHs), n-alkanoic acids (C5 to C34), n-alkenoic acids (C18:1 and C18:2), carboxylic diacids (C3 to C10), petroleum biomarkers and others. As a whole, the extractable compounds were dominated by acids, especially by octadecanoic acid and hexadecanoic acid. The measured concentration of n-alkanes exhibited a peak at C29, with carbon preference index (CPI) values in the range of 0.97 to 2.0.

Using organic molecular markers, including seven alkanes, four petroleum biomarkers, seven PAH, one alkanoic acid, one alkenoic acid, levoglucosan, and three chemical components (Al, Si and Elemental Carbon), Chemical Mass Balancing (CMB) calculations have been performed on the ambient speciation data. These calculations are used to determine the contribution of seven different primary emission sources including: diesel powered vehicles, gasoline vehicles, wood combustion, fuel oil combustion, road dusts, meat cooking and vegetation waxes. The contribution of diesel powered vehicles and gasoline powered vehicles are the most important primary sources at all three sampling locations, with road dusts important at the industrial location. Meat cooking emissions were significant at all three locations. Wood combustion is an important contribution during a four-day period when uncontrolled wildfires in eastern Texas and Louisiana brought biomass combustion aerosols into the sampling region.

[P13-04] DETERMINATION OF THE SOURCES CONTRIBUTING TO $PM_{2.5}$ IN TORONTO USING POSITIVE MATRIX FACTORIZATION.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 13: Receptor Modeling and Source Apportionment (11:00 AM-12:00 PM) Grand Ballroom 2-4

There is a growing need to routinely monitor fine particulate matter ($PM_{2.5}$) in ambient air to better understand the processes controlling its concentration, to determine its sources and to learn more about its health effects. The chemical composition of Toronto $PM_{2.5}$ was measured daily from Feb. 2000 to Feb. 2001 to help address these issues. Source apportionment was undertaken using Positive Matrix Factorization (PMF). $PM_{2.5}$ is mainly generated from combustion processes or from gas-particle interactions and transformations. In Toronto, $PM_{2.5}$ levels are influenced both by local urban activities and also by regional-scale transport. The PMF analysis identified eight sources contributing to Toronto $PM_{2.5}$. The four main sources were coal combustion (26%) related to regional transport, secondary nitrate (36%) related to both local and upwind sources of NO_x and NH_3, secondary organic aerosols (SOA)+biomass burning (15%) and motor vehicle traffic (10%). The other detectable sources were road salt (winter), smelters or related industry and oil combustion. Low molecular weight organic acids, such as oxalic acid, were used to identify the SOA/biomass component. Without organic acids measurement this portion of the observed $PM_{2.5}$ was assigned to the coal combustion component, increasing its contribution significantly. This suggests that in the northeastern part of North America receptor modeling results that are unable to separate SOA/biomass from the sulfate-rich coal component may have attributed too much of the mass to coal combustion.

[P13-05] SOURCE ALLOCATION OF CARBON IN PM2.5 USING C-14 AND TRACER INFORMATION.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 13: Receptor Modeling and Source Apportionment (11:00 AM-12:00 PM) Grand Ballroom 2-4

Ambient particulate organic carbon (OC) consists of hundreds, if not thousands, of idividual compounds in a dynamically evolving medium of water, inorganic ions, elemental carbon (EC), crustal and trace elements. The sources of OC include primary emissions from motor vehicles, forest fires and other forms of combustion, as well as secondary production from gas phase precursors (e.g., sesquiterpenes and aromatics). This poster synthesizes data from various measurements to estimate major source categories for OC at research sites in the southeastern U.S. Measurements include: carbon-14 analysis, tracer/CMB analysis for primary carbon species and continuous CO and EC. The analysis hinges on the notion of a source matrix for OC. In its simplest form, a source matrix is a 2x3 grid with primary, secondary and total carbon along the rows, modern and fossil carbon along columns. Other categories can be used for the columns, if desired, and these can be subvdivided to add detail as data and creativity permit. Thus, the simplified source matrix contains six cells and specification of any four solves for the remaining two. Carbon-14 analysis differentiates between modern and fossil carbon and is a more or less direct measure of total (i.e., primary plus secondary) OC in each category. Exploratory carbon-14 measurements at three SEARCH sites in the southeastern U.S. show that modern sources, on average, contribute ≥80% and ≥]60% of OC observed at rural and urban sites, respectively, and that this percentage is surprisingly constant across seasons. Differentiation between primary and secondary OC is technically demanding and generally requires detailed chemical analysis of tracer species in air samples or sophisticated air quality models. Zheng et al. (2002) have used the former approach and recently published seasonal estimates for major sources of OC at SEARCH sites. Results for wintertime samples show that primary sources can account for virtually all OC in air samples. Results for summer, in contrast, consistently show that primary sources cannot account for observed OC, thus providing evidence of secondary production. Sources used in the above analyses can also be classified, to a first approximation, into fossil and modern categories, then combined with carbon-14 results in the OC source matrix. Results show interesting contrasts across sites and seasons. Winter data for rural southern MS show that OC is almost entirely primary-modern. Summer data for Atlanta, GA suggest that OC is about 35 % primary-modern, 35% primary-fossil, 25% secondary-modern and ≤5% secondary fossil.

[P13-06] SEPARATING DIESEL AND SPARK-IGNITION VEHICLE PARTICLES IN THE SAN GORGONIO NATIONAL MONUMENT.

Weixiang Zhao, Philip K. Hopke Department of Chemical Engineering, Clarkson University, Potsdam, NY

Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 13: Receptor Modeling and Source Apportionment (11:00 AM-12:00 PM) Grand Ballroom 2-4

Airborne particulate matter has been shown to have adverse effects on public health and welfare. A wide variety of sources (including natural and anthropogenic) emit particles, so identification of particle sources is a key aspect of the development of an effective and efficient control strategy.

In this study, positive matrix factorization (PMF), an advanced factor analysis method, was used to examine the separation of diesel engine exhaust from spark ignition vehicle particles in particle samples collected in the San-Gorgonio National Wilderness. This IMPROVE location that is downwind of the Los Angeles area is likely to contain a variable mixture of gasoline and diesel emissions. In the IMPROVE protocol for OC/EC, subfractions of both the OC and EC are determined. The concentrations of these subfractions are viewed as key components in this task. The results of this analysis will be compared to other source resolutions made in Seattle and Atlanta and thus, the value of these subfractions can be assessed.

[P13-07] ASSESSING SOURCE CHARACTERISTICS FOR PM2.5 IN THE EASTERN UNITED STATES USING THE MULTILINEAR ENGINE TECHNIQUE.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 13: Receptor Modeling and Source Apportionment (11:00 AM-12:00 PM) Grand Ballroom 2-4

The main objective of this project is to characterize the spatial and temporal variations of PM2.5 concentrations at nearly 300 of monitoring sites in the eastern United States. A multilinear factor analytic model (Mutltilinear Engine) is being applied to a set of data collected over a period of two years within the US PM2.5 measurement network. The data consists of PM2.5 concentrations as daily averages and hourly concentrations of ozone, CO, NO, NO2, and SO2. Meteorological parameters, such as wind direction, temperature and humidity are included into the analysis to reveal how spatial factors correlate with meteorological data. The results will be applied to discern the influences of local and regional influences to PM2.5 levels. Model results will be compared with emission inventories and previous studies.

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[P13-08] SPECIATION OF AMBIENT PARTICULATE MATTER USING ELECTRON MICROSCOPY TECHNIQUES.

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Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 13: Receptor Modeling and Source Apportionment (11:00 AM-12:00 PM) Grand Ballroom 2-4

A major part of current air quality studies initiated with the implementation of the US Environmental Protection Agency (EPA) revisions to the National Ambient Air Quality Standards (NAAQS) has focused on identifying and quantifying sources that contribute to PM2.5. Electron microscopy (EM) techniques offer the potential to increase the amount of information on PM2.5 by characterizing individual particles. Samples for EM analyses were collected at the DOE-NETL ambient air monitoring research sampling station, the Holbrook and Lawrenceville monitoring sites, and the CMU ambient air monitoring supersite. This approach to apportion ambient PM2.5 to a source relies primarily on the individual particle characteristics such as morphology and elemental composition. Spherical aluminum-silicate (SAS) particles are being evaluated because emissions of this nature are indicative of coal-fired power plants. Regional and localized impact from power plants is being addressed based on the measurement of SAS concentrations in ambient samples collected from rural and urban locations. EM data on carbonaceous particles are being used to help resolve organic and elemental components based on distinctive morphological characteristics. EM data is also being compared to results obtained from analyses using time of flight mass measurements.

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[P13-10] SOURCE APPORTIONMENT OF PM2.5 IN SEATTLE, WA URBAN IMPROVE SITE: COMPARISON OF THREE RECEPTOR MODELS AND SOURCE PROFILES.

Joellen Lewtas, Naydene Maykut, Eugene Kim, Timothy Larson NERL, US EPA, Port Orchard, WA; Puget Sound Clean Air Agency, Seattle, WA; Clarkson University, Potsdam, NY; Univ. of Washington, Seattle, WA

Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 13: Receptor Modeling and Source Apportionment (11:00 AM-12:00 PM) Grand Ballroom 2-4

IMPROVE protocol data were collected at the urban Beacon Hill monitoring site in Seattle, WA from 1996-99. The 289 sets of PM2.5 filters were analyzed for: metals using PIXIE and XRF, anions using ion chromatography, elemental hydrogen (H) by proton scattering, and elemental and organic carbon fractions (OC1-OC4 and EC1-EC3) by thermal optical reflectance (TOR). The data was analyzed by CMB8, Positive Matrix Factorization (PMF) and UNMIX. The CMB8 model determined the contribution of minor industrial sources (7%), two combustion sources, vegetative burning (16%) and mobile sources (44%), soil (4%), and 3 marine and secondary sources. The PMF model was able to utilize all of the data (30 species) to derive 8 sources. The sources with the highest contribution of the 5 most abundant carbon fractions (OC1-OC4 and EC1), all appear to be combustion sources. We have designated those as gasoline vehicles, diesel, vegetative burning, and fuel oil based on the profiles derived from the PMF model. The following components are found in relatively high abundance for each of these sources: OC3, Pb, Zn, K, and Ti in the gasoline profile; EC1, Fe, Zn, and Mn in the diesel profile; OC3, OC4, EC1, OC2, and K in the vegetative burning profile; OC4 and V in the fuel oil profile. The other 4 profiles derived from the PMF model we have designated as follows with the distinguishing elements indicated in parentheses: soil (Si, Al, Ti), marine (Na, Cl), Na rich (nitrate, Na, and both OC and EC fractions, Ca, and K), and a sulfate (secondary) source (sulfate, nitrate, and EC1). UNMIX was more restrictive in deriving 6 sources based on a statistically acceptable model solution using 15 out of the 30 available species including OC2, OC3, OC4 and EC1 but not OC1 or EC2. Both of these receptor models derived source profiles for 4 different combustion sources containing OC fractions and EC1 whose abundance differ between the sources. Both models derived a profile for soil (Si and Al) and marine/sulfate source(s) (sulfate, Ca, and K). The marine and sodium rich source(s) containing EC1/EC2 fractions may contain some marine diesel combustion emissions. Both of these multivariate models agree in the estimated relative contributions of the combustion sources to the PM2.5 mass as follows: vegetative (28-37%), diesel (18-19%), fuel oil (10-15%), gasoline (4-9%).

This work has been funded by the U S Environmental Protection Agency. It has been subjected to Agency review and approved for publication.

[P13-01] REVIEW OF SOURCE APPORTIONMENT TECHNIQUES FOR AIRBORNE PARTICULATE MATTER.

Michael J Kleeman Civil and Environmental Engineering, University of California, Davis, Davis, CA

Thursday, April 3, 2003, 11:00 AM, Poster Session 5: Workshop 13: Receptor Modeling and Source Apportionment (11:00 AM-12:00 PM) Grand Ballroom 2-4

Epidemiological studies have established a relationship between the concentration of airborne particulate matter smaller than 2.5 microns in aerodynamic diameter (PM2.5) and increased morbidity and mortality. In response to this finding, the United States Environmental Protection Agency has developed a National Ambient Air Quality Standard for PM2.5 concentrations. Air quality managers at the national, state, and local levels will soon need to characterize their particulate air quality problems and devise a strategy to reduce PM2.5 concentrations to protect public health. The most effective set of emissions controls is not obvious, however, since a variety of sources are response for fine primary and secondary particulate matter to the atmosphere.

A large number of statistical source apportionment techniques have been proposed in the past 30 years to identify source contributions to airborne particulate matter concentrations. In recent years, a mechanistic source apportionment technique also has been developed for this purpose. Each of the statistical and mechanistic techniques has individual strengths and weaknesses. In this paper, the mathematical basis for each state-of-the-art source apportionment techniques will be discussed and contrasted. The strengths and weaknesses of each method will be identified, and promising areas for further research will be recommended.

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[P01-08] CONCEPTUAL MODEL OF PM IN THE WINDSOR-QUEBEC CITY CORRIDOR.

Jeffrey R. Brook, Michael D. Moran Meteorological Service of Canada, Environment Canada, Toronto, ON, Canada

Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 1: The NARSTO North American PM Assessment (4:00 PM-5:00 PM) Grand Ballroom 2-4

The Windsor-Quebec City Corridor, a long narrow area stretching from Windsor/Detroit in the southwest to Montreal and Quebec City in the northeast, is the most heavily populated region of Canada. As part of the 2003 NARSTO North American PM Assessment, we have synthesized available information on emissions, meteorology, and ambient PM levels in the Windsor-Quebec City Corridor to produce a region-specific conceptual model for PM. This poster summarizes this regional conceptual model, including the nature of the PM problem in the Windsor-Quebec City Corridor, contributing sources and processes, and implications for air-quality management.

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[P03-01] RATIONALE AND DESIGN OF THE CARDIOVASCULAR LINKAGE BETWEEN ENDOTHELIAL DYSFUNCTION AND AIR POLLUTION (CLEAN AIR) STUDY.

Robert D Brook, Jeffrey R Brook, J Tim Dvonch, Sanjay Rajagopalan, Jack R Harkema, Bruch Urch, Renaud Vincent, Frances Silverman, Gerald J Keeler Internal Medicine, University of Michigan, Ann Arbor, MI; University of Toronto, Toronto, ON, Canada; School of Public Health, University of Michigan, Ann Arbor, MI; Michigan State University, East Lansing, MI; Health Canada, Ottawa, ON, Canada

Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (4:00 PM-5:00 PM) Grand Ballroom 2-4

Objective: The aim of this abstract is to introduce the rationale and design of the CLEANAIR study, a series of human clinical experiments to be jointly performed at the Universities of Michigan and Toronto.

Background: Short-term inhalation of concentrated ambient fine particles (CAP) plus ozone causes acute arterial vasoconstriction in healthy adults. Vascular endothelial dysfunction and arterial vasoconstriction may be important biological linkages between air pollution exposure and increased cardiovascular morbidity. However, the biological mechanisms responsible are unclear.

Hypotheses: The chief hypothesis of this research is that alterations in vascular reactivity following exposure to CAP and ozone are key mechanisms linking air pollution exposure with cardiovascular events. We hypothesize that the previously observed vascular dysfunction results from systemic inflammation (pro-inflammatory cytokine release) and oxidative stress that triggers enhanced vascular expression of endothelins and reduces endogenous vasodilator production. Secondary hypotheses are that the vascular dysfunction significantly impacts systemic hemodynamics, increases blood pressure, and reduces blood flow. We also intend to identify the specific air pollution components responsible for the detrimental impact on human vascular function.

Design: CLEANAIR consists of two separate double-blind, cross-over studies using controlled human exposures to CAP + ozone. A new mobile human exposure facility (AirCARE 1) will be employed at the University of Michigan to focus on the underlying biological mechanisms. AirCARE 1 is the result of a joint collaboration between the University of Michigan and Michigan State University. The effects of pre-exposure treatments with anti-oxidants and endothelin receptor blockade on the vascular responses to air pollution exposure will be investigated compared to placebo. The exposure facility located at the University of Toronto will be used to investigate the importance of CAP versus ozone, as well as specific particle constituents, in the etiology of the vascular dysfunction following air pollution exposure.

Conclusion: The CLEANAIR study will provide important information regarding the biological mechanisms linking air pollution with increased cardiovascular morbidity and mortality.

[P03-15] DEVELOPMENT AND EVALUATION OF A COMPACT FACILITY FOR EXPOSING HUMANS TO CONCENTRATED ULTRAFINE AMBINET PARTICLES.

Chandan Misra, Philip M Fine, Manisha Singh, Constantinos Sioutas Civil and Environmental Engineering, University of Southern California, Los Angeles, CA

Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (4:00 PM-5:00 PM) Grand Ballroom 2-4

Abstract: This paper presents development and evaluation of a very compact facility for exposing humans to concentrated ambient ultrafine particles The development of the facility has been based on an already developed and published versatile aerosol concentration enrichment system (VACES) to concentrate ambient ultrafine particles. The human ultrafine concentrator operates at versatile intake flow rate of up to 1300 liters per minute (LPM). The concentrator is preceded by an ultrafine impactor which collects the accumulation mode particles under a very low pressure drop (0.015 kPa), a feature that is essential in enabling us to conduct inhalation studies to ultrafine CAP. The ultrafine concentrator was characterized in field experiments, in which the total flow was 600 LPM. Tests were done to determine the enrichment of ultrafine particles in terms of their number and mass concentration as well as chemical composition including elemental carbon (EC), inorganic ions (sulfate an nitrate) and polycyclic aromatic hydrocarbons (PAHs) at minor flow rates of 10, 15, 20, 25 and 30 LPM. Results showed a near-ideal increase in number concentrations (corresponding to the ratio of total-to-minor flow rate) of ultrafine particles after enrichment. Measurements were done using a Scanning Mobility Particle Sizer (SMPS) for the following size bins: 180-140, 140-100, 100-70, 70-40 and 40-15 nm. Results also indicated a uniform concentration enrichment across all the size bins. For the minor flow of 10 LPM, a 50-fold increase could be obtained with just a single virtual impaction stage. Similar results were obtained for EC and PAHs concentrations (measured by an Aethalometer), for which the maximum obtainable concentration enrichment was by a factor of 50, corresponding to a minor flow of 10 LPM. Furthermore, tests were also conducted to characterize the system for mass concentrations, including ions such as sulfate and nitrate at a minor flow of 30 LPM (corresponding to an ideal enrichment factor of 20). The mass, sulfate and nitrate concentrations were compared after collecting ultrafine particulate matter (PM) on 47 mm Teflon filters before and after enrichment. For all the observations, the average ratio of enrichment factor was found to be 18.9, 20.6 and 17.8 for ultrafine PM mass, sulfate and nitrate, respectively, thus very close to the ideal values indicating perfect collecting efficiency with minimal particle losses. The ultrafine concentrator will be used to expose humans to ultrafine CAP beginning in the spring of 2003.

[P03-14] DEVELOPMENT OF A SYSTEM TO ASSESS THE TOXICITY OF SECONDARY COAL COMBUSTION EMISSIONS: THE TERESA STUDY.

Annette C Rohr, Pablo A Ruiz-Rudolph, Joy E Lawrence, J Mikhail Wolfson, Petros Koutrakis Environment, Electric Power Research Institute, Palo Alto, CA; Department of Environmental Health, Harvard School of Public Health, Boston, MA

Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (4:00 PM-5:00 PM) Grand Ballroom 2-4

The Toxicological Evaluation of Realistic Emissions of Source Aerosols (TERESA) study is a comprehensive effort to evaluate the formation and toxicity of secondary particles from coal combustion. To date, the toxicity of coal combustion emissions has been examined only in terms of primary particles, but these emissions may not reflect population exposures because of atmospheric chemistry. TERESA involves on-site sampling of emissions at multiple coal-fired power plants across the U.S., followed by simulation of atmospheric chemistry in a reaction chamber, and exposure of normal and compromised rats. In preparation for fieldwork at the first TERESA study plant in Wisconsin, the sampling apparatus and reaction chamber are currently being developed and tested. Stack samples will be diluted with dry air and introduced into the chamber, where hydroxyl radicals are added to convert SO_2 to sulfate. Light, $NH_{3\,(gas)}$, VOCs, and inert particles are also added. Target mass concentration output from the chamber will be in the range of 200-300 $\mu g/m^3$. Prior to fieldwork, the composition of appropriate mixtures of added chemical species will be estimated using kinetic models and existing plant emission profiles. These models will allow for variation of the mixtures to simulate a range of atmospheric conditions and to predict both gaseous pollutant and particle concentrations. Results of the photochemical modeling and chamber testing will be presented at the PM2003 meeting. Extensive characterization of emissions will be carried out, including gases (CO, CO_2, NO_x, SO_2, O_3, NH_3, hydrocarbons), particle number, size distribution, mass, and composition (including SO_4, NO_3, NH_4, strong acidity, metals, EC, OC, and organics). Aged emissions will enter an exposure chamber in a mobile toxicological laboratory. Normal rats and a susceptible rat model (myocardial infarction) will be exposed to emissions and multiple toxicological endpoints will be evaluated. Particle formation, composition, and toxicity will be compared for different atmospheric conditions and dilution scenarios, providing information on the effects of atmospheric chemistry on the formation of secondary particles and their health effects. The ultimate goal of TERESA is to compare the toxicity of secondary coal combustion and mobile source emissions to better understand the components of PM responsible for adverse health effects. The TERESA study is the first to investigate the toxicity of actual power plant emissions using mobile laboratories, and the first to incorporate secondary atmospheric chemistry.

[P03-12] EFFECTS OF ACUTE AND SUBCHRONIC EXPOSURE TO CONCENTRATED AMBIENT PARTICULATES IN HEALTHY AND COMPROMISED RODENTS.

W P Watkinson, L B Wichers, J P Nolan, D W Winsett, U P Kodavanti, M J Schladweiler, L C Walsh, E R Lappi, D Terrell, R Slade, A D Ledbetter, D L Costa ORD/NHEERL/ETD/PTB, USEPA, RTP, NC; UNC SPH, Chapel Hill, NC

Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (4:00 PM-5:00 PM) Grand Ballroom 2-4

A host of epidemiological studies have reported a slight but consistent association between exposure to higher concentrations of ambient particulate matter (PM) and excess cardiopulmonary-related morbidity and mortality. To further examine this phenomenon, we exposed various rodent models of cardiopulmonary dysfunction to Concentrated Ambient Particulates (CAPs) from Research Triangle Park, NC, and monitored changes in indices of cardiopulmonary function and injury. Animal models used included young (3 mo) Spontaneously Hypertensive (Y-SH), old (11 mo) Spontaneously Hypertensive (O-SH), and healthy (SD) and monocrotaline-treated Sprague-Dawley (MCT-SD) rats. Subsets of animals were implanted with radiotelemeters (Data Sciences International) to monitor (5-min intervalsX24h/d) electrocardiogram (ECG), heart rate (HR), systemic blood pressure (BP), and core temperature (T_{co}). Exposure protocols for Y-SH rats were either Continuous (4h/dX2-3d/wkX11wk) or Intermittent (4h/dX1d/wkX11wk) while SD, MCT-SD, and O-SH were exposed 4h/dX2-3d/wkX1wk. All exposures were conducted in nose-only exposure chambers. Pulmonary function tests (Buxco Electronics) were performed on all animals before, during, and after exposures. At the termination of the study, animals underwent bronchoalveolar lavage (BAL) and the BAL fluid was examined for biochemical indices of pulmonary injury and inflammation. Heart and lung tissues were harvested for histological and morphological analyses. PM exposure concentrations ranged from 135-1600$\mu g/m^3$. In general, despite the variety of exposure protocols and compromised animal models used, these studies demonstrated minimal adverse effects on cardiopulmonary and thermoregulatory function in cardiopulmonary-compromised rats after exposure to RTP CAPs. As such, these studies underscore the inherent complexities of conducting discrete, limited toxicology studies using environmentally-relevant exposure protocols in order to verify large scale epidemiological studies. Furthermore, these studies emphasize the importance of companion source characterization/apportionment studies to the overall PM research effort. (Abstract does not represent USEPA policy. This research was supported in part by EPA CT826513.)

[P03-11] CONCENTRATED AMBIENT PARTICLES ATTENUATE ALLERGEN-INDUCED AIRWAY RESPONSES IN THE LUNGS OF BROWN NORWAY RATS.

Jack Harkema, James Wagner, Constantinos Sioutas, Edward Timm, Norbert Kaminski, Michael Kleinman, John Froines
Pathobiology and Diagnostic Investigation, Michigan State University, East Lansing, MI; Southern California Particle Center and Supersite, Los Angeles, CA

Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (4:00 PM-5:00 PM) Grand Ballroom 2-4

Health effects of inhalation co-exposures of air pollutants and airborne allergens have not been thoroughly investigated. The purpose of the present study was to determine the effects of inhalation exposure of concentrated ambient particles (CAPs) on the lungs of rats that were concurrently exposed to a pulmonary allergen (ovalbumin; OVA). A mobile air research laboratory, equipped with inhalation chambers and ambient particle concentrators, was used to conduct the study. The mobile lab was parked in a residential site in Claremont, CA. OVA-sensitized, male, Brown Norway rats were exposed to filtered air (controls), concentrated ambient coarse (2.5-10μ m; CCAPs), fine (0.15-2.5μm; FCAPs) or ultrafine (0.01-0.15μ m; UFCAPs) particles for 5 h/day (11am -4pm) for three consecutive days. Immediately prior to each daily inhalation exposure, the rats were intranasally challenged with saline alone or a 0.5% solution of ovalbumin in saline. Rats were exposed to average mass concentrations of 554, 515 and 45 μg/m3 for CCAPs, FCAPs, and UFCAPs, respectively. 24 hours after the end of the exposures, rats were sacrificed, their airways lavaged with saline, and their lungs processed for microscopic and mRNA analyses. OVA-instilled rats had allergic bronchiolitis with mucous cell hyperplasia and allergic alveolitis with marked increases in eosinophils in the bronchoalveolar lavage fluid (BALF). OVA-instilled and air-exposed rats had 538% more eosinophils in the BALF, 104% more stored mucosubstances in the bronchiolar epithelium, and a 6-fold increase in mucin-specific gene expression in bronchiolar airways than saline/air controls. Exposures to FCAPs or UFCAPs, but not CCAPs, caused a marked attenuation (50-100%) of the OVA-induced allergic alveolitis, mucous cell metaplasia and mucin-specific gene expression. These results indicate that fine and ultrafine particulate matter may significantly interfere with allergen-induced airway responses during co-exposure of these airborne agents. (Research funded in part by USEPA Grant #R-82921601)

[P03-10] EXPOSURE TO CONCENTRATED FINE AND ULTRAFINE AMBIENT PARTICLES NEAR HEAVILY TRAFFICKED ROADS INDUCES ALLERGIC REACTIONS IN MICE.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (4:00 PM-5:00 PM) Grand Ballroom 2-4

The goal of this study was to test the hypotheses that: (1) mobile emissions will exacerbate airway inflammation and allergic airway disease; (2) the magnitude of allergic airway disease responses will be greater at sites with higher concentrations of ultrafine particles; and (3) organic and inorganic PM constituents that can generate ROS will be associated with responses. Ovalbumin (OVA)-sensitized Balb/c mice were exposed to concentrated fine and ultrafine ambient particles (CAPs), to purified air, at three sites at increasing distances downwind from a heavily trafficked roadway. The three sites were 50m (BH1), 100m (BH2) and 500m (BH3) downwind. The average mass concentration for the CAPs exposures at each of the 3 sites was maintained at 400 micrograms per cubic meter. The exposures were conducted for 4 hours per day, 5 days per week for 2 weeks. Prior to each day's exposure, OVA was administered to each mouse by nasal instillation. Two weeks after the final exposure the mice were challenged with OVA aerosol. Their lungs were lavaged and blood samples were obtained. The numbers of inflammatory cells (PMN) and eosinophils (EOS) in BAL were determined. The lavage fluid was analyzed for interleukin-5 (IL-5) and interleukin-13 (IL-13). The serum was analyzed to quantitate the amounts of OVA-specific antibodies (IgE and IgG1). These endpoints represent important hallmarks of allergic and asthmatic responses.

Exposure to CAPs elicited significant increases in numbers of eosinophils, increased concentrations of IL-5 in lavage fluid and increased concentration of OVA-specific IgG1 in blood serum in mice exposed at BH1, but not BH2 or BH3, compared to measurements in mice exposed to purified air. A 2-factor analysis of variance showed that for each of these endpoints mice exposed at BH1 showed changes consistent with allergic responses to the OVA-challenge following CAPs exposure but not after purified air exposure (EOS, $p = 0.04$; IL-5, $p < 0.001$; IgG1, $p = 0.002$). Particle numbers at BH1 were 5 to 8 times those measured at BH2 or BH3 during the exposures.

The results of this study suggest that exposure to fine and ultrafine particles at sites near a heavily trafficked roadway can elicit allergic responses. The importance of this finding is that it is consistent with the role of an environmental contaminant (ambient fine and ultrafine particles) in the exacerbation and/or development of allergic airway diseases, such as asthma.

This project was funded by the California Air Resources Board and the U.S.E.P.A. Southern California Particle Center and Supersite.

[P03-09] EFFECTS OF CONCENTRATED AMBIENT PARTICLES ON HEMODYNAMIC PARAMETERS IN SPONTANEOUS HYPERTENSIVE RATS.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (4:00 PM-5:00 PM) Grand Ballroom 2-4

Epidemiological studies have shown that increased concentration of ambient particles is associated with cardiovascular morbidity and mortality. However, the exact mechanisms remain unclear. Recent studies have revealed that particulate air pollution exposure is associated with indicators of autonomic function including heart rate (HR), blood pressure (BP), and heart rate variability (HRV). However, this association has not been clearly demonstrated in animal studies. To overcome the problems of wide variations in diseased animals and circadian cycles, we have developed a novel approach using mixed-effects model to investigate whether ambient particle exposure was associated with the changes of HR, BP, QA interval (QAI), and HRV in diseased animals. QAI reflects the ventricular contractility, anwas calculated to represent HRV. In this study, spontaneously hypertensive rats were implanted with radiotelemetry and exposed to concentrated ambient particles generated by an air particle concentrator developed by Sioutas et al. Four rats were held in nose-only exposure chambers for 6 hours per day exposing to concentrated particles for 2-6 times and filtered air for 2-5 times in the periods of February-March and June-July, 2002. The particle number concentrations for tested animals ranged between 7-46x104/m3 in February-March and 13-40x104/m3 in June-July. Statistical analysis using mixed-effects models revealed that particle exposure was associated with changes in HR, BP, and QAI after particle exposure, the hourly-averaged heart rate increased for a maximal of 53 beats per minute in the period of February-March ($p < 0.01$) and 38 beats per minute in the period of June-July ($p < 0.01$). The hourly-mean blood pressure also increased after the particle exposure for a maximal of 11 mmHg ($p < 0.01$) in February-March but not in June-July. QAI was found to decrease after PM exposure in the periods of February-March and June-July. These changes of HR, BP and QAI were observed during the particle exposure, then returned to the baseline within 2-3 hours after the end of exposure. The results of the particle effects on SDNN will be presented in the meeting. Our findings suggest that ambient particles may induce alterations in the autonomic nervous function.

[P03-08] META ANALYSIS OF DUTCH INHALATION TOXICITY STUDIES WITH CONCENTRATED PARTICULATE MATTER IN COMPROMISED RATS.

Flemming R Cassee, John F Boere, Paul HB Fokkens, Daan LAC Leseman, Jan Bos, Ingeborg N Kooter, Peter Steerenberg, Leendert Van Bree, Jan AMA Dormans Center of Environment and Health Research, National Institute for Public Health and the Environment, Bilthoven, Netherlands; Laboratory of Toxicology, National Institute for Public Health and the Environment, Bilthoven, Netherlands; Office for Environmental Assessment, National Institute for Public Health and the Environment, Bilthoven, Netherlands

Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (4:00 PM-5:00 PM) Grand Ballroom 2-4

Ambient particulate matter (PM) can be seen as a complex mixture of fractions with greater and with lesser health relevance. The most efficient and cost-effective reduction of health effects will be achieved by reducing the most toxic part of PM. Although significant progress has been made over the past few years, there are currently only suggestions for the causal fractions, as they have not yet been identified. Studies with concentrated ambient PM0.15-2.5 (CAPs) have been performed in experimental animals since 1998. This paper will present an overview on the only CAPs studies performed in Europe.

Experiments were focussed on 1-day inhalation exposures in healthy and compromised rats thereby mimicking possible human risk groups primarily focussing on pulmonary inflammation and blood hypertension. Studies have been performed in an industrialized area in the city of Utrecht as well as a location that is strongly dominated by freeway emissions. It was hypothesized that exposure to CAPs resulted in an oxidative stress, which subsequently induces (pro) inflammatory mediators, endothelium damage and blood viscosity, supporting the plausibility of PM induced cardiovascular effects. The effects of CAPs exposures were studied two days post exposure focussing on pathology and cell proliferation, bronchiolar lavage analysis (including cytokines, cell viability and proliferation, Clara cell protein CC16), and blood analyses (endothelines, fibrinogen, cell differentials). There is no PM mass concentration-effect relationship for the investigated parameters. Inhalation up to 2000 ug CAPs/m3 did not induce severe toxic or pathological effects in the lung. Cell proliferation (BrdU-labeling of predominantly Clara cells in the terminal bronchioles) is frequently increased after exposure to CAPs, as well as indicators for oxidative stress in the lungs. Signs of PM being able to cause adverse effects in both healthy and compromised animals and humans are emerging. The available evidence from CAPs exposures studies in healthy and compromised animals advocates that PM mass concentrations are not evidently correlated with the adverse health effects. This suggests that other metrics might be more appropriate, like chemical composition or physical properties.

[P03-07] FINE AND COARSE PARTICLES OF THE CALIFORNIA CENTRAL VALLEY DIFFERENTIALLY INDUCE ADVERSE EFFECTS IN THE LUNGS OF RATS.

Kevin R Smith, Seongheon Kim, Chandan Misra, Julian J Recendez, Ann E Aust, Constantinos Sioutas, Kent E Pinkerton Center for Health and the Environment, University of California, Davis, CA; Civil and Environmental Engineering, University of Southern California, Los Angeles, CA; Chemistry and Biochemistry, Utah State University, Logan, UT

Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (4:00 PM-5:00 PM) Grand Ballroom 2-4

Epidemiological studies have suggested particle size is an important determinant in adverse health effects. Fine particles with a diameter less than 2.5 μm are thought to be the most deleterious, while coarse particles with a diameter between 2.5 to 10 μm are considered to produce less injury to the cardiopulmonary system. During the fall and winter, rats were exposed in Fresno, CA to the fine fraction of PM_{10} in 6 separate experiments. Additional rats were exposed to the coarse fraction of PM_{10} in both Fresno and Davis, CA in 4 separate experiments. Fine PM was concentrated 20-fold and coarse PM 40-fold, while preserving chemical composition, size distribution and surface morphology. Exposures were for 4 hours per day for 3 consecutive days. Mass, particle numbers, and chemical composition of the concentrated PM were determined for each study. The mean mass concentration ranged between 200 to 900 $\mu g/m^3$ for fine PM and 200 to 1100 $\mu g/m^3$ for coarse PM. Both fine and coarse PM were enriched with nitrate, organic and elemental carbon, metals and other inorganics. Viability of cells recovered by bronchoalveolar lavage (BAL) from rats exposed to fine PM was significantly decreased during 4 of 6 weeks. Total cell number was significantly increased during 1 week and neutrophils during 2 weeks, compared to rats exposed to filtered air ($p<0.05$). Total BAL cells from rats exposed to coarse PM were increased during 3 of 4 weeks, while neutrophils were increased for all 4 weeks, and lymphocytes were increased during 2 of 4 weeks. A decrease in cell viability is indicative of cell membrane damage, while increased neutrophil numbers is reflective of an inflammatory response. These observations suggest that exposure to enhanced concentrations of fine or coarse PM in Fresno and Davis, CA is associated with significant effects in the lungs of rats. However, striking differences were observed following exposure to fine or coarse PM. Elevated toxicity to alveolar macrophages was noted with fine, but not coarse particles, while neutrophil influx was most prevalent with coarse particles. These observations strongly suggest additional studies are needed to more fully characterize the toxicological effects of particles in the complete size range for PM_{10} in the California Central Valley.

USEPA 827995 and NIEHS ES05707

[P03-06] CARDIOPULMONARY EFFECTS OF ASIAN DUST EVENT IN DISEASE ANIMAL MODELS.

Lei Yu-Chen, Chan Chang-Chung, Chang Chuen-Chau, Wang Peng-Yau, Cheng Tsun-Jen Institute of Occupational Medicine and Industrial Hygiene, National Taiwan University, Taipei, Taiwan; Institute of Environmental Engineering, National Central University, Chung Li, Taiwan

Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (4:00 PM-5:00 PM) Grand Ballroom 2-4

To investigate the health effect of Asian dust event, we used two animal models to evaluate the cardiopulmonary toxicity of concentrated ambient particles (CAPs) of Asian dust event on March 18 and 19, 2002 in Taiwan.

MCT pulmonary hypertensive rats were used to examine inflammation markers in the lung and peripheral blood, and DNA damage in peripheral blood after exposure to CAPs of dust storm. Eight rats were exposed to CAPs generated by a particle concentrator by nose-only inhalation exposure system during dust storm (n=4 for 315.6 ug/m3; n=4 for 684.5 ug/m3), and four rats as controls were exposed to room air. Inflammation markers in peripheral blood and bronchoaleolar lavage were analyzed. Whole blood was collected to analyze the DNA single strand breakage in leukocyte using comet assay in CAPs (n=8) and room air (n=4) exposed groups.

Spontaneously hypertensive rats (SHRs) were used to investigate the hemodynamic changes. After implanted with radiotelemetry, three were exposed to CAPs (315.6 ug/m3, 6hr) and two were exposed to room air. Hourly averaged heart rate and blood pressure were compared between CAPs and room air groups. Further, heart rate and blood pressure of these CAPs exposed rats were compared between Asian dust event period and non-Asian dust event period for adjusting inter-individual differences. Elemental components were determined using XRF. Main component were silica and aluminum (53.3 and 14.0μg/m3).

In pulmonary hypertensive rats, WBC counts in peripheral blood, total cell and the proportion of neutrophil in BAL increased with CAPs levels ($p<0.05$). Positive dose-response relationship between CAPs exposure and total protein, LDH activity and IL-6 were observed ($p<0.05$, test for trend). In the evaluation of single strand DNA breakage, CAPs group demonstrated higher percentage of tail intensity then room air group ($p<0.05$) and similar finding was also observed for the tail moment ($p=0.08$). SHR exposed to CAPs have higher heart rate than those exposed to room air ($p<0.05$). Heart rate of these CAPs exposed rats was higher during dust event than that during the corresponding hours of non-Asian dust event ($p<0.05$). However, blood pressure was not significantly between CAPs and room air exposed groups.

Our results revealed that exposure to CAPs during Asian dust event could cause lung inflammation and injury, and DNA damage in peripheral blood in pulmonary hypertensive rats. Heart rate in SHRs also increased after CAPs exposure. We conclude that CAPs of dust storm may cause adverse cardiopulmonary outcome. The component of particles leading to the toxicity need further study.

[P03-05] EFFECTS OF CONCENTRATED FINE AMBIENT PARTICLES ON RAT PLASMA LEVELS OF ASYMMETRIC DIMETHYLARGININE.

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Background and Aim: The health effects of fine ambient particulate matter ($PM_{2.5}$) and its potential impact on vascular endothelial function have not been thoroughly investigated. As endothelial dysfunction plays an important role in atherosclerosis and cardiovascular disease, we examined the effects of concentrated fine ambient particles (CAPs) on the plasma levels of asymmetric dimethylarginine (ADMA) in a pilot study. ADMA is an endogenous inhibitor of nitric oxide synthase that is associated with impaired vascular function and an increased risk of cardiovascular events.

Methods: A mobile air research laboratory (AirCARE 1), equipped with whole body inhalation chambers and a Harvard type ambient fine particle concentrator, was used in the study. AirCARE 1 was designed and constructed collaboratively by Michigan State University and the University of Michigan. The CAPs exposures for this study were conducted in the urban community of southwest Detroit. Fourteen Brown Norway rats were exposed to filtered air (FA) (n=7) or CAPs (0.1-2.5 μm) (n=7) for 3 consecutive days (8h/day) in July, 2002. Rats were exposed during these periods to average particle mass concentrations of 367 $\mu g/m^3$. Rat plasma samples were collected 24h post-exposure.

Results: Plasma concentrations of ADMA were significantly elevated in the rats exposed to CAPs versus those exposed to FA (1.49 ± 0.18 vs 1.29 ± 0.26 μM, $p \leq 0.05$ by 1 tailed t-test).

Conclusion: Fine particulate air pollution exposure at high concentrations triggers an acute increase in circulating ADMA level. This could potentially cause impaired vascular endothelial function and enhance the risk for cardiovascular disease.

[P03-04] RELATIVE CONTRIBUTIONS OF $PM_{2.5}$ CHEMICAL CONSTITUENTS TO ACUTE ARTERIAL VASOCONSTRICTION.

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Introduction: We have recently reported a significant ($p=0.007$) decrease of 0.09 ± 0.15 mm (mean ± SD) in the mean brachial artery diameter (BAD) of humans immediately following exposure to 153 ± 36 $\mu g/m^3$ concentrated ambient $PM_{2.5}$ (CAP) and 120 ± 3 ppb O_3. Subsequent analyses of the major $PM_{2.5}$ chemical constituents now allow us to compare the strength of the associations between each constituent and individual BAD responses. Such knowledge is critical for public health risk management and abatement strategies. **Methods:** Twenty-four healthy adults underwent a randomized, controlled, double-blind, cross-over study in which we measured the change (post - pre) in BAD (ΔBAD) over a 2-hr exposure at rest, to CAP+O_3 and particle-filtered air (FA). Filter samples were collected from the CAP+O_3 airstream for gravimetric measures of $PM_{2.5}$ mass concentration (MC) followed by IC analyses for inorganic ions. In addition, co-located 24-hr ambient $PM_{2.5}$ measures were used to estimate exposures to trace elements and elemental & organic carbon EC/OC. Linear regression analyses using two response variables were performed with each single PM constituent as a predictor. One response variable was the individual's ΔBAD on the CAP+O_3 exposure day (model #1), and the other was the difference in an individual's ΔBAD with CAP+O_3 minus their Δ BAD with FA (model #2). A standardized regression coefficient (SRC) was then calculated by dividing the regression coefficient by the ratio of the SD of the response variable to the SD of the predictor. **Results:** Total MC poorly predicted ΔBAD in both model #1 (SRC=-0.07, r=0.07, p=0.74) and model #2 (SRC=0.18, r=0.18, p=0.40). There were no significant ($p \leq 0.05$) associations between ΔBAD and any PM constituents with model #1. In model #2 we observed significant SRCs for both OC (-0.45: r=0.45, p=0.036) and EC (-0.42: r=0.42, p=0.05). OC accounted for 89 ± 3% of total carbon MC (EC+OC). **Conclusions:** We have shown that carbon in $PM_{2.5}$ accounted for a significant amount of the variability of ΔBAD. Studies of PM with high organic carbon (CAP and diesel exhaust) have demonstrated cytokine production/release *in vitro* and cytokine and cellular inflammation in the lungs and circulation of animals and humans. It follows that organic carbon may initiate a pulmonary response capable of systemic effects, such as altering vascular tone.

Funded by: Health Canada TSRI and Air Quality Health Effects Research Section, Government of Canada.

[P01-10] OVERVIEW OF THE SAINT LOUIS - MIDWEST SUPERSITE.

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The Saint Louis - Midwest Supersite is a comprehensive research effort to provide physical and chemical measurements of ambient particulate matter in a setting broadly representative of the urban Midwest. One of the eight EPA-funded Supersites, the Saint Louis - Midwest Supersite is a public/private partnership that features significant leveraging of resources. The regional characteristics of St. Louis and its historical prominence as one of the original 'Six-Cities Study' sites has provided an ideal opportunity for the confluence of a number of air pollution health and epidemiology studies with this Supersite. This presentation will summarize the project's overarching objectives and measurement strategy; as such, it serves as a roadmap for the emerging data streams and other work products. In particular, this presentation will highlight: characteristics of the Saint Louis area that influence the measurement observations (e.g., climatology, emission sources), synergies with exposure and health effects studies and particulate matter model evaluation studies, and efforts to characterize and improve a battery of research-grade, prototype and commercially-available instruments subjected to sustained operation for a two-year period.

[P03-02] EXPERIMENTAL EXPOSURES OF ASTHMATIC AND HEALTHY VOLUNTEERS TO CONCENTRATED AMBIENT COARSE PARTICLES IN LOS ANGELES.

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Twelve asthmatic and 4 healthy adults were exposed to filtered air (FA) and to concentrated ambient coarse particles (CCP) using 15 parallel virtual impactors interfaced to a whole-body exposure chamber. Exposures lasted 2 hr with intermittent exercise. Mean CCP concentration was 157 (range 56-218) $\mu g/m^3$ by continuous monitoring with a tapered-element oscillating microbalance (TEOM); on average, 85% was coarse (2.5-10 μm aerodynamic diameter) and the rest <2.5 μm. No clinically important symptoms were observed during/after CCP, relative to FA, and CCP did not significantly alter spirometry, arterial O_2 saturation, or airway inflammation as judged from total cell counts of induced sputum. After CCP, small increases in heart rate and decreases in several measures of heart rate variabililty were statistically significant ($P < .05$) or suggestive ($P < .1$). Conclusion: Exposures to ambient coarse particles had no obvious pulmonary effects but appeared to alter autonomic nervous system influence on the heart.

[P03-18] COMPOSITION MATTERS: INVESTIGATION OF TOXIC POTENCY VERSUS CHEMICAL COMPOSITION IN MOTOR VEHICLE EMISSIONS.

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Exposure to engine exhaust has been linked to adverse health effects. However, little is known about the effect of different engine types, operating conditions, fuels, technologies, and emission chemical composition on the relative toxic potency of vehicular emissions. To this end, a study was conducted with the aim of evaluating the relative mutagenic, cytotoxic, and inflammatory potencies of particulate matter (PM) and semi-volatile organic compound (SVOC) co-pollutant emissions collected from a range of different vehicle types operating under varying conditions. The vehicles included normal- and high-emitter gasoline and diesel passenger vehicles operated at 72°F, and normal-emitter groups operated at 30°F. Emissions were characterized for over 150 different chemical components, including carbon (organic/elemental), inorganic ions, metals and other non-metal elements, and several classes of speciated organics including polycyclic aromatic hydrocarbons (PAH), oxygenated/nitrated PAH, and hopanes/steranes. All samples induced bacterial mutagenicity, and the highest mutagenic potency was observed from diesel exhaust at 30°F. This same vehicle operated at 72 ° F yielded ~5 times less mutagenicity. The former sample contained a larger relative portion of organic carbon and higher amounts of the more complex higher molecular weight PAH. Intratracheal instillation of rats with the combined PM+SVOC demonstrated that cytotoxic and inflammatory potencies per unit mass were similar for normal-emitter gasoline and diesel vehicles, and for emissions collected at different temperatures. However, equivalent masses of emissions from high-emitter diesel and gasoline vehicles were more potent than those from normal-emitters. These higher emitting vehicles generally contained higher relative proportions of particle bound organic carbon, average to lower metal contents, lower relative proportions of PAH compounds, and higher proportions of the hopane/sterane compounds. Since the hopane/sterane compounds are components of oils, and the PAH compounds are formed during combustion, the observed proportions of these components in these high emitter samples suggest that emissions with higher proportion of unburned lubrication oil cause greater *in vivo* cytotoxic and inflammatory responses. *Supported by the Office of Heavy Vehicle Technology, US. Department of Energy.*

[P03-19] EFFECTS OF PHYSICO-CHEMICAL PROPERTIES OF ULTRAFINE PARTICLES ON THE PERFORMANCE OF AN ULTRAFINE PARTICLE CONCENTRATOR.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (4:00 PM-5:00 PM) Grand Ballroom 2-4

Ultrafine particle concentrators are used to conduct in-vivo animal and human inhalation exposures. Ultrafine particles grow in supersaturation conditions to supermicron sizes and get concentrated via a virtual impactor. Excess water from the grown droplets is removed to return the particles to their original size. Various studies have explored the ability of ultrafine particles, with different chemistry, to act as cloud condensation nuclei. Based on our understanding from these studies, we explored the hypothesis of differential concentration enrichment of ultrafine particles due to their hygroscopicity. Initial experiments were conducted, with indoor air, using a recently developed ultrafine particle concentrator. Varying the temperature in the saturator and condenser units attained different supersaturation conditions. Ultrafine particles must grow to droplet sizes above the cut-point of the virtual impactor. Results from this experiment showed an increase in concentration factor with increasing supersaturation ratio. Theoretically, targeted supersaturation ratio should be in the range of 2.5-3.0 in order to activate particles as small as 10nm. To assess our hypothesis that above result also indicate the underlying heterogeneous composition of indoor air, we challenged the particle concentrator with artificially generated single-component ultrafine aerosols. A fixed supersaturation ratio of 3.0 was maintained. Ultrafine particle size-distributions were measured, using SMPS, both upstream and downstream of the particle concentrator. Table 1 summarizes the results from these experiments. These results suggest that physico-chemical properties of ultrafine particles considerably affects the final droplet size to which particles grow and hence the overall concentration enrichment factors. Considering the fact that about 50-70% of atmospheric ultrafine mass consists of carbonaceous materials, these results provide us with insight in terms of what supersaturation ratios should be maintained in such an ultrafine particle concentrator.

Table 1: Aerosol characteristics for condensational growth experiments.

Aerosol	Property	Median dia (nm)	Up conc (#/cc)	Down conc (#/cc)	CF
Amm. sulphate	Hygroscopic	58.2	3170	220000	69
NaCl	Hygroscopic	91.9	6940	371000	54
Indoor air	Variable	98.1	3310	127000	38
PSL	Hydrophobic	81.8	324	10200	32

[P01-21] REDUCED FORM MODEL TO ESTIMATE AIR POLLUTION IMPACTS.

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Although many Latin American countries are already suffering the direct and indirect consequences of global climate change, climate mitigation policies are usually not ranked high in their political agenda. Such policies when exist are mostly driven by local air pollution abatement and this is likely to remain so in the near future.

The main objective of this work is to devise clear, quantifiable, replicable indicators that can be used by policy makers, to estimate the local and regional health damages induced by local human activities and the benefits from reducing air pollution associated with GHG and air pollution mitigation measures and changes in social habits, based on the results of co-benefit analysis from 3 SA cities (Santiago, Chile; Buenos Aires, Argentina; and São Paulo, Brazil).

Based on analysis and comparison of case studies already being developed in Argentina, Brazil and Chile, we have developed an approximate way of computing health benefits for different policy options, along with their associated carbon reductions. As part of the work, we have also determined the common issues that dominate the estimation of effects as well as the differences, to determine the factors that settle the health benefits: atmospheric conditions, population characteristics, economic conditions.

The final objective of this work is to propose a reduced-form model that can be used to estimate the health benefits, the GHG abatement, and their relative importance in different SA cities. The information produced by this work will be very useful for decision-makers in most south American cities, at the moment of considering different policy options. We thus hope to effectively effect policy making regarding global change and air pollution abatement in the Americas.

[P01-20] URBAN AIR QUALITY MODELING IN THE NETHERLANDS AND THE IMPACT OF (EUROPEAN) ABATEMENT PROTOCOLS.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 1: The NARSTO North American PM Assessment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Reducing the adverse impact on human health is the focus of national as well as European regional and urban air quality management. Ground-level ozone, NO2, and PM10 and some related PM fractions seem to be major air pollution components in this respect and their ambient levels appear to be associated with a variety of adverse health effects ranging from respiratory symptoms and complaints to enhanced morbidity and premature mortality with cardiac and respiratory causes. Both short-term and long-term exposures to these pollutants appear to be important.

Very recently, the European Union (EU) has initiated the Clean Air For Europe (CAFE) programme with the objective 1. to review existing limit values, emission ceilings, and abatement protocols (as set out in the current legislation, including the position of the EU as Party to the UN-ECE Convention on long-range Transboundary Air Pollution (LRTAP)) and 2. to develop an cost-effective clean air strategy. Thereby efforts are being made to focus not only on the impact on a regional scale but also on an urban scale, where large groups of the population are exposed. Urban air pollution is also of particular concern because of the more complex air pollution mixture, the local sources contributing to air quality, including those of motor vehicle exhaust emissions. In addition, there is an interest to evaluate whether specific reduction measures on local emissions could add to the more regional and EU-transboundary influence on ambient air pollution abatement, as set the LRTAP protocols. Data on how the typical urban air pollution situation differs from that in regional areas requires, however, a more fine-scale modeling approach then usually applied.

This study has therefore focused on the impact of abatement protocols for acidification and ground-level ozone reduction using fine-scale modelling in The Netherlands. Emissions, concentrations, and human exposure of a number of major air pollutants has been modeled and estimated on a typical fine scale and the outcome for urban areas have been be compared with those for regional areas. The modelling has focussed on ozone, NO2, and the various PM fractions (different particle size and composition) and the first results will be presented. The data suggest that air quality management may have positive effects on both regional and urban air quality. Possible consequences for human health will be qualitatively discussed awaiting further exposure and risk assessment studies.

[P01-19] AMMONIA ABATMENT AND SECONDARY PM REDUCTIONS.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 1: The NARSTO North American PM Assessment (4:00 PM-5:00 PM) Grand Ballroom 2-4

The major components of the atmospheric aerosol are carbonaceous components, inorganic ionic compounds, crustal components and water. These components are thus the main contributors to PM2.5 and PM10 and are important concerning compliance with legal standards. Secondary formed particles contribute to a large extent to the PM2.5 fraction. In large parts of Europe the contribution is between 60 and 80%. In order to reduce PM concentrations it is therefore necessary to decrease precursor emissions. Up to know emissions of SO2 have decreased with more than 60%, but particle concentrations have not decreased that much. In this paper the role of ammonia in particle formation is addressed. It is shown that the secondary PM concentrations can only be reduced if, apart from SO2 and NOx, also ammonia emissions are equally decreased.

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[P01-18] AEROSOL CHEMICAL COMPOSTION UPDATE: CAN WE ACHIEVE THE ANNUAL PM2.5 NAAQS BY CONTROLLING ORGANIC CARBON?

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 1: The NARSTO North American PM Assessment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Extensive new monitoring data now confirm that organic carbonaceous materials and sulfates are the major contituents of fine particulate matter in Eastern North America. Reduction of particulate sulfates by reducing precursor gaseous SO_2 has been the target of multiple control strategies since the 1970s. Control of organic aerosols could be considered, but it is complicated by several factors: the complexity of organic aerosols, the paucity of knowlege concerning their many sources, and the mix of natural biogenic and anthropogenic sources. The fraction of modern carbon derived from ^{14}C measurements using the two source assumption can be used to derive the relative magnitude of biogenic (modern) and fossil-derived carbonaceous aerosols. An extensive body of data (reported herein) from a background site near the Great Smoky Mountains National Park show that, with the exception of one late summer period, only 10-40% of the carbonaceous aerosol is of fossil origin. The biogenic fraction of aerosol carbon may, however, derive from natural sources such as gas-to-particle conversion of biogenic hydrocarbon and other biogenic emissions, or from anthropogenic activities in which biogenic materials are combusted (burning of wood and agricultural waste). Efforts to determine the fraction that man-made combustion sources contribute to modern carbon in ambient aerosols have been limited, especially in urban areas. From the limited data, however, we conclude that about 50% of aerosol carbon (of the order of 15-20% of observed fine mass) derives from fossil combustion sources or from human combustion of wood fuels and other biogenic materials. In most areas, controls on those combustion sources could be used to bring average fine mass levels below the annual $PM_{2.5}$ NAAQS.

[P01-17] ADVANCED FACTOR ANALYSIS OF SPATIAL DISTRIBUTIONS OF PM2.5 IN THE EASTERN UNITED STATES.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 1: The NARSTO North American PM Assessment (4:00 PM-5:00 PM) Grand Ballroom 2-4

This work analyzes PM2.5 24-h average concentrations measured every third day at over 300 sites in Eastern U.S. during 2000. The non-negative factor analytic model, Positive Matrix Factorization, has been enhanced by modeling the dependence of PM2.5 concentrations on temperature, humidity, pressure, ozone concentration, and wind velocity vector. The model comprises 12 general factors, augmented by 5 urban-only factors intended to represent excess concentration present in urban sites only. The computed factor components or concentration fields are displayed as concentration maps, one for each factor, showing how much each factor contributes to the average concentration at each site. The factors are also displayed as flux maps that illustrate the spatial movement of PM2.5 aerosol, thus enabling one to pinpoint potential source areas of PM2.5. The quality of the results was investigated by examining how well the different alternative models reproduce especially high concentrations of PM2.5 on specific days at specific sites. Delimiting the spatial extent of all such factors that exhibit a clear regional maximum surrounded by an almost-zero outer domain lowered the uncertainty in the computed results.

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[P01-16] DEVELOPMENT OF A DATABASE AND ANALYTICAL TOOLS FOR THE MANAGEMENT OF DATA DERIVED FROM U S-DOE (NETL)-FUNDED FINE PARTICULATE ($PM_{2.5}$) RESEARCH.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 1: The NARSTO North American PM Assessment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Large amounts of data have been collected through several research projects funded by the U.S. Department of Energy (NETL). These data collection efforts have focused on the characterization of fine particulate ($PM_{2.5}$) matter present in ambient air along the Upper Ohio River Valley (UORV) corridor, and the data resides in disparate datasets, with no capabilities for analyzing or processing the different datasets simultaneously. NETL has contracted Advanced Technology Systems, Inc. (***ATS***) to provide these capabilities to the project sponsors, interested stakeholders, and the general public through a web interface and a server-based database application.

Project Goals and Objectives: The purpose of this project is to develop a comprehensive solution to integrate the ambient air quality data being collected under multiple monitoring programs in the UORV corridor and other NETL-funded projects. The project's end product will be one tool with two separate interfaces; one designed with the sponsors and stakeholders in mind and the other open to the general public.

Application Infrastructure: The underlying data and application infrastructure are key to any computerized data analysis tool. ***ATS*** has assembled a network of hardware, software, and technical personnel to build the underlying infrastructure for this data management and analysis tool.

Development Tools: The project team has selected Microsoft's .NET platform of development tools contained in Visual Studio.NET. The .NET development tools provide direct access to the database server and incorporate very useful debugging tools into the development suite, thus reducing the overall development time required to complete this project.

Development and Testing Schedules: The entire project is expected to last until October 2004. By this time, the project will have moved from the conception phase, to design and development phases, and finally to completion and implementation. The first year's tasks involve the design and development activities that occur at the server level, while the second year's tasks will involve developing the two user interfaces for access to the data via an Internet connection.

[P01-15] SOUTH BRONX ENVIRONMENTAL STUDIES PROJECT: COMPARISON OF GROUND-LEVEL AIR QUALITY DATA WITH NEW YORK STATE DEPARTMENT OF CONSERVATION MONITORING STATIONS DATA.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 1: The NARSTO North American PM Assessment (4:00 PM-5:00 PM) Grand Ballroom 2-4

The South Bronx is a low-income, minority community in New York City. It has one of the highest asthma rates in the country, which community residents feel is related to poor air quality. Community residents also feel that the air quality data provided by the New York State Department of Environmental Conservation (DEC) through their network of monitoring stations do not reflect the poor quality of the air they breathe. This is due to the fact that these monitoring stations are usually located about 15 meters above ground. In the years 2001 and 2002 this project collected air quality data at various locations in the study area. They were collected at ground level by a mobile laboratory placed in a van. On average, the van collected hourly data at each location for periods of three to four weeks. This poster compares those data with data collected by DEC's monitoring stations in Bronx County during the same periods. Although there is good agreement in the data among DEC stations there are some important differences between ground level measurements and DEC data. For PM2.5, during the period November 7-29, 2001, the average daily concentration recorded by the van was 16.70 μg/m3. The average values for three DEC monitoring stations in the area ranged between 15.39 and 15.54 μg/m3. In the case of ozone, the concentrations recorded at ground level were generally lower than those recorded by DEC stations. During that same period, the average daily concentration of O3 recorded by the van was 0.0035 ppm. Two DEC stations in the area recorded daily averages of 0.0059 ppm and 0.0062 ppm. For the other pollutants the concentrations measured by the project are substantially higher than those recorded by DEC's monitoring stations. For NO2 the concentrations recorded at ground level are over twice as high as those recorded by DEC. In the case of SO2, ground level measurements are also substantially higher, being about 40% greater than DEC's values. Similarly, CO concentrations measured at ground level tend to be 60-90% higher than those recorded by DEC monitoring stations. Such differences between ground level and monitoring station measurements have important implications for policy development.

Supported by EPA Agreement X-982152. The co-Principal investigators on the project are Rae Zimmerman, Ph.D (New York University's Wagner Graduate School of Public Service, Institute for Civil Infrastructure Systems) and Lung Chi Chen, Ph.D (New York University School of Medicine, Nelson Institute of Environmental Medicine).

[P01-14] THE STATISTICAL ANALYSIS OF PM 2.5 IN ATLANTA: AN APPLICATION TO THE CONTROL STRATEGY.

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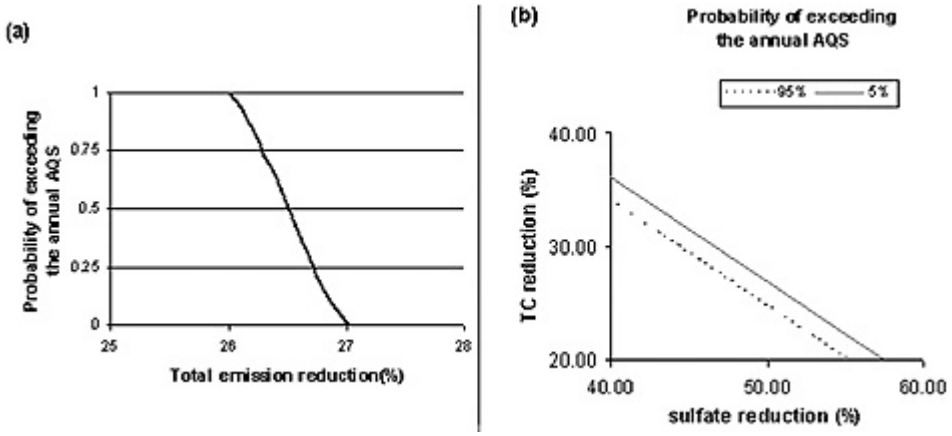
Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 1: The NARSTO North American PM Assessment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Speciated, daily PM2.5 levels for Atlanta, GA are analyzed to develop the underlying distributions. Using these distributions, the levels of control needed to meet the NAAQS, and the of success, were assessed for varying levels of reductions in sulfate and organic carbon, the two dominant species found in Atlanta's fine particulate matter. In this case, data from three sites in Atlanta were used: Fort McPherson., South Dekalb and Tucker, with data available from 1999 to 2002. The measured annual PM2.5 mass concentrations in Atlanta are generally higher than the 15 μg/m3 standard: 19.1 μg/m3 at the Fort McPherson site, 17.0 μg/m3 at South Dekalb and 20.2 μg/m3 at Tucker. While occasional values were above the 65 μg/m3 daily standard, the 98th percentiles of daily concentrations were not: 39.4 μg/m3, 38.5 μg/m3 and 46.5 μg/m3, at Fort McPherson, South Dekalb and Tucker, respectively. Using the probability distributions found for sulfate and carbon at each site, and assuming a linear reduction in each pollutant in response to controls (which is open to question), the necessary reductions in each pollutant, and their combinations, were calculated. However, because of the limited number of the observed annual mean concentrations, instead of calculating the required reduction of the total emission sources directly, as the total emission sources were reduced, the probability to exceed the annual AQS was calculated. Fig.1 shows the probability of exceeding the annual NAAQS in Tucker for varying levels of emission reductions. Fig. 1also shows the probability to exceed the annual NAAQS when either TC or sulfate or combinations are reduced. In this case, it was found that the distributions lead to a relatively tight response, i.e., the difference of 1% reduction in levels corresponds to either a nearly 100% chance or negligible chance of meeting the NAAQS. The reasons for this finding are explored, along with the reasonableness. (Click to see figure 1) Fig.1. The probability of exceeding the annual AQS. (a) is as the total emission sources are reduced. (b) is when the TC and the sulfate are reduced.



Figure

[P01-13] SOUTHEASTERN AEROSOL RESEARCH AND CHARACTERIZATION (SEARCH) STUDY: KEY FINDINGS FOR POLICY MAKERS.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 1: The NARSTO North American PM Assessment (4:00 PM-5:00 PM) Grand Ballroom 2-4

The Southeastern Aerosol Research and Characterization (SEARCH) study began in mid-1998 and is supported through 2005. The SEARCH network consists of 8 research sites in 4 urban-rural or urban-suburban pairs, each of which is routinely measuring an extensive set of gases, particuate matter (mass and composition in fine and coarse mode), meteorology and extinction. In addition to 24-hr integrated samples for PM, many measurements, including major components of PM, are made at temporal resolution of one-hour or less. Among it's many objectives, SEARCH is aimed at providing information for policy makers as they decide how to address the air quality issues they face, (e.g., the PM and ozone NAAQS, and regional haze).

This poster will illustrate and summarize key messages that the SEARCH data support. These messages include:

· Carbonaceous material (elemental carbon plus organic carbon *1.4) makes up the largest fraction of fine PM; sulfate is the second major component.

· Organic carbon and sulfate are largely regional in nature. However, organic and elemental carbon account for almost all of the difference between urban and rural fine PM, thus providing evidence of important local contributions to EC and OC.

· Wood smoke from various sources is an important component of organic carbon across the southeast, especially in winter and spring.

· Coarse particulate matter has substantial carbonaceous material. These should be included in any future speciation plans.

· There are many ways to display the composition of particulate matter. The perceived message can be dramatically different depending on which method is used. Therefore, definitions and assumptions should be provided by the author and demanded by the reader.

· SEARCH uses two approaches to illustrate relative composition. The first of these seeks to explain mass reported on FRM filters. The second seeks to explain mass as it exists in the real atmosphere; that is, independent of biases imposed by the FRM sampling methodology.

· All SEARCH sites are in attainment relative to the daily and annual NAAQS for fine mass, except those near downtown Birmingham, AL (N. BHM) and Atlanta, GA (JST), both of which exceed the annual standard only.

· Saharan dust and sea salt represent intermitten sources of fine mass with annual contributions of roughly 0.5 - 0.75 μg/m3.

· FRM Biases can have an important effect on attainment status as well as spatial interpretation of fine mass data. Two important biases identified to date include: 1) failure to blank correct data: and 2) differences between vendors of FRM samplers.

[P01-12] DIURNAL CYCLES AND SPORADIC EVENTS IN THE SAINT LOUIS AEROSOL.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 1: The NARSTO North American PM Assessment (4:00 PM-5:00 PM) Grand Ballroom 2-4

The Saint Louis - Midwest Supersite is generating long (year+) time series of high-quality hourly concentration data for a variety of gas and particle species. The resulting data streams are novel in their combined temporal and chemical resolution, and present correspondingly novel challenges and opportunities for analysis. From the emissions-management perspective, patterns of temporal behavior and meteorological associations carry information that can help to distinguish pollutants from different source categories. As examples, diurnal cycles of surface concentration reflect differing mixes of tail-pipe and tall stack emissions during nocturnal inversions and daytime convection; concentrations of local emissions are more sensitive than those of distant emissions to variations in local wind speed; emissions from some point sources may be confined to certain wind sectors. From the health perspective, long time series make it possible to assess whether routine 24-hour samples provide an adequate measure of community exposures. In particular, it is only through such series that the potential for threshold effects from non-periodic and short-lived concentration excursions can be examined.

This presentation examines the first year of data for PM-2.5 mass, sulfate, black carbon, elemental and organic carbon, and aerosol number together with the standard criteria gases and surface meteorological variables. Two-dimensional distributions of mean concentration vs. the peak/mean multiple illustrate how simple screening plots can reveal differing patterns of intra-day variation and highlight unusual days. Diurnal cycles, averaged over all observations and over subsets exhibiting selected conditions of concentration or meteorology, can reveal source fingerprints that are obscured in 24-hour data.

[P01-06] CONCEPTUAL MODEL FOR PARTICULATE AIR POLLUTION IN LOS ANGELES.

Michael J. Kleeman Civil and Environmental Engineering, University of California, Davis, Davis, CA, USA

Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 1: The NARSTO North American PM Assessment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Airborne particulate matter and the processes that govern its formation in any given area can be described in a conceptual model that accounts for its sources, and chemical and meteorological processes. A conceptual model is a qualitative compilation of the physical and chemical processes that govern the formation of PM, which to the extent possible, is supported by quantitative information. These models describe the processes that affect emissions, transport and transformation and are used to identify the limiting processes, or those aspects of the PM problem, which if addressed will most effectively reduce the ambient mass or chemical concentration, for a given area or airshed. The elements of the model are: source characterization, chemical processes, physical processes (transport) and meteorological influences. Conceptual models when complete are used to: 1) define the important components of an air quality management strategy for effective control of PM concentrations by identifying limiting processes, 2) guide data collection to characterize important processes and to fill key knowledge gaps, and 3) point out where chemical transport models should be used to examine the likely opportunities to maximize multi-pollutant control opportunities and minimize potential co-pollutant.

In this paper, a conceptual model for particulate matter formation in Los Angeles will be presented. PM10 and PM2.5 monthly average concentrations (by species) will be presented for two annual average sampling periods: 1993 and 1998-99 at multiple locations in the Los Angeles area. Spatial and temporal trends for various PM components will be discussed, and underlying meteorological, emissions, and chemical influences will be identified. Recommendations then will be made about appropriate strategies to reduce airborne particulate matter concentrations to meet State and Federal standards.

[P03-03] SEPARATE AND COMBINED EFFECTS OF AMBIENT FINE PARTICULATE POLLUTION AND NITROGEN DIOXIDE IN ELDERLY VOLUNTEERS.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (4:00 PM-5:00 PM) Grand Ballroom 2-4

Volunteers of mean age 72, including 13 with moderate chronic obstructive pulmonary disease (COPD) and 6 healthy, were exposed to 0.4 ppm NO_2, approximately 200 $\mu g/m^3$ concentrated ambient fine particles (CAP), NO_2 and CAP together, and filtered air alone. Exposures lasted 2 hr with intermittent exercise. No meaningful changes in symptoms or spirometry were attributable to NO_2 or CAP, separately or combined. Arterial oxygen saturation (SaO_2) showed significant ($P < .01$) negative changes associated with CAP (estimated mean -0.4%) and NO_2 (estimated mean -0.2%) which appeared to be additive in the combined exposure, and not significantly different between healthy and COPD. Preexposure SaO_2 showed a negative association with prior 24-hr mean ambient PM_{10}, significant ($P < .05$) in COPD but not in healthy subjects. Conclusion: Ambient fine particle pollution, and to a lesser extent NO_2, may have acute negative effects on blood oxygenation.

[P02-03] BEYOND THE HARVESTING EFFECT: MEASURING THE EFFECT OF LONG TERM TSP EXPOSURE ON LIFE EXPECTANCY.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4

In a recent paper, Murray and Nelson (JAWMA, 2000) attempt to quantify the effect of exposure to tsp on life expectancy. Using daily Philadelphia data from 1974 through 1988, they estimate the unobserved atrisk population, and conclude that short term exposure to tsp has a small effect on life expectancy. The main result that exposure to tsp reduced life expectancy by at most 2 days is consistent with what has been termed the harvesting hypothesis.

One weakness of the Murray and Nelson model is that it does not allow entry into the atrisk pool to be affected by longer term exposure to pollution. In this study, we extend the model of Murray and Nelson to allow for the possibility that longer term exposure to tsp influences entry into the pool of atrisk individuals. We postulate the existence of an unobserved atrisk population, and an unobserved process via which individuals are allowed to enter the atrisk population after being exposed to longer term pollution. We use moving averages of tsp to proxy for long run pollution. The model is cast into state space form, and the Kalman filter is used to estimate atrisk population, entry into the atrisk population, and life expectancy.

Our main result is that while longer term exposure to tsp does indeed increase the pool of atrisk individuals, this effect is quite small. Therefore, while the data appear to be inconsistent with the "harvesting only" hypothesis, the effect of longer term exposure to tsp appears to be much smaller than has been indicated elsewhere in the literature.

[P02-18] WITHDRAWN

Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4
WITHDRAWN

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[P02-17] THE EFFECT OF ANTHROPOGENIC POLLUTION OF THE ATMOSPHERE ON HUMAN HEALTH ON THE TERRITORY OF GEORGIA.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4

The effect of air-polluting substances on mortality of population has been studied on the basis of real statistical and hydro meteorological materials for 1980-1999. There have been revealed those harmful ingredients, which stimulate the development of the most widespread diseases causing mortality. Correlation links between some ingredients entering in communal boilers and fumes from the traffic and increased frequency of such diseases as cardiovascular system, blood organs, respiratory organs and appearance of new diseases.

On the basis of the obtained results, we can conclude that during the last decade on the whole territory of Georgia the main source of anthropogenic pollution of atmosphere is auto transport and substandard petrol, and one of the main factors of the morbidity and mortality of population can be considered harmful components of exhausted fumes of auto transport.

[P02-16] THE LEVEL OF PM10/PM2.5 IN INDOOR AIR AND RESPIRATORY HEALTH OF THE PEOPLES IN BEIJING, CHINA: A COMMUNITY-BASED PILOT STUDY.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4

Background and objective: Lots of studies around the world indicated that indoor air pollutants play an important role on the human health. But few such studies were conducted in china and the relationship between indoor air pollution and the human health is not very clear. In this study, we attempt to investigate the level of indoor air pollution and to assess its effects on the residents' health in Beijing. Methods: 270 houses were selected randomly in three municipal districts (90/per district) as the subjects for indoor air monitoring and represented respectively industrial, old urban and cultural/educational areas of Beijing. The concentrations of indoor air pollutants, including particulate matter ≤ 10/2.5 micro in aerodynamic diameter (PM10/PM2.5) and SO2, were measured in the bedrooms and the kitchens of the subjects. At the same time, more than 1,500 residents living in these houses were investigated with the questionnaire for their respiratory health and other confounding factors. Results: The levels of indoor air PM10/PM2.5 were quite vary(22μg/m3 for bedroom~1469μg/m3 for kitchen)in winter of Beijing. The concentrations of indoor air PM10 and PM2.5 in the houses with coal stove for heating were much higher than that in houses with central heating system (P<0.01), but not for SO2. From the graphs of 24-hours real time monitoring, we have found that the peaks of the curves for indoor air PM10/PM2.5 emerged often in the cooking time. It suggested that the coal stove using for heating or cooking is major source of indoor air pollution in winter of Beijing. Conclusions: More attention should be paid to the indoor air pollution and residents' health in Beijing and the work in this area should be continued.

The Indoor Air PM2.5 Level among Three Districts in Beijing(mg/m3)

district	Dongchen		Shijingshan		Haidian	
	bedroom	kitchen	bedroom	kitchen	bedroom	kitchen
count	75	72	80	78	81	80
average	0.535	0.539	0.447	0.508	0.519	0.550
S.D	0.341	0.310	0.218	0.577	0.451	0.654
Min.	0.147	0.144	0.037	0.041	0.066	0.061
Max.	2.630	2.13	1.03	6.09	5.13	7.92

[P02-15] ASSOCIATIONS BETWEEN PARTICULATE AIR POLLUTION AND ACUTE CARDIO-RESPIRATORY VISITS IN AN AMBULATORY CARE SETTING.

Amber H Sinclair, Dennis D Tolsma Research Department, Kaiser Permanente Georgia, Atlanta, GA

Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4

Existing studies of particulate matter (PM) and cardiorespiratory outcomes have mainly concerned emergency department visits, mortality, and individual symptoms and pulmonary function measurements, and do not investigate characteristics of PM. Kaiser Permanente (KP), a not-for-profit health maintenance organization with over 270,000 members in the Georgia Region, is collaborating with the Electric Power Research Institute (EPRI) on the Atlanta superstation component of the Study of Particulate Health in Atlanta (SOPHIA). Atlanta is an air quality-monitoring site for ARIES, which provides detailed information on the physical and chemical characteristics of PM. The KP study is a time series investigation of the possible associations between daily levels of suspended particulate matter and ambulatory care acute visit rates during the 25-month period, August 1, 1998 to August 31, 2000. Acute visits were identified as those visits with a same day appointment or urgent visit type code. Acute visits to the nine Atlanta KP health facilities with a respiratory diagnosis of asthma, COPD, or upper or lower respiratory infections were identified through electronic visit data. Air quality variables of *a priori* interest for our study were: 24 hour average measurements of PM2.5, coarse PM (2.5-10 μm), PM10, PM2.5 components (acidity, sulfates, OC, alkenes, aromatics and elemental carbon), 10-100 nm PM count and area (ultra-fines), pollen, mold, polar VOCs (OHC), ozone, NO2, CO, HNO3, and SO2. Visit counts for diagnosis case groupings were modeled by selected air quality metrics using Poisson general linear modeling controlling for temporal trends and meteorologic variables. Moving averages of the 0 to 2 day, 3 to 5 day and 6 to 8 day lagged air quality variables were investigated. Preliminary statistically significant findings show that the strongest associations by case group were 1.11 for OHC for child asthma for the 0 to 2 day lag; 1.14 for pollen for the 6 to 8 day lag; and 1.13 for OHC for the 6 to 8 day lag. For LRI, the most important lag was the 3 to 5 day (4 out of 6 findings), while the most important lag for URI was the 0 to 2 day (6 out of 10 findings). We will present final results from the 25-month data set for the respiratory illnesses, as well as initial findings for cardiac outcomes. This study provides a unique assessment of air quality and health effects by investigating characteristics of particulate matter in an ambulatory care setting, and complements the mortality and emergency department studies in Atlanta under ARIES.

[P02-14] AIR QUALITY AND RESPIRATORY HEALTH IN OHIO.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4

The relationship between air pollution and human health has attracted the attention of the public, scientists, and policy makers worldwide. Despite the mounting evidence identifying a relationship between air pollution and negative health effects, few data are available to make informed decisions in the state of Ohio. Epidemiological data from one region are not necessarily applicable to another; therefore, it is necessary to evaluate air pollution levels and their influence on public health as it relates to specific geographic regions.

Recognizing the gap in the data about the health effects of air quality in Ohio, the need for geographically-based research, and the emphasis on children's health issues, researchers at Ohio University and Texas A&M University -Kingsville initiated the Air Pollution and Pediatric Health Impact project.

First, in this study we have presented the adjusted long-term trends analysis for air pollutants from major cities in Ohio. Second we statistically correlated hospital admission with air quality. In this analysis we controlled for the confounding affects of meteorology and seasonal variations.

Long-term trends of ozone, PM10, CO, SO2, and NO2 concentrations in the major urban centers were analyzed using an advanced technique called the Kolmogorov-Zurbenko (KZ) filter. Long-term trends analysis for ozone at several of the sites shows an increase trend in ozone levels. For PM10 the trend line remained fairly constant at all sites. All the sites showed visible decreasing trends in CO and SO2, while NO2 concentrations slightly increased.

After partitioning out the effects of seasonality and weather, there was little evidence of a consistent relationship between any of the air pollutants and any of the measures of respiratory health across the major metropolitan areas in Ohio. No general pattern for a given pollutant across the state was identified.

[P02-13] AMONG CHILDREN WITH ASTHMA, LUNG FUNCTION IS DECREASED WITH THE COMBINATION OF COCKROACH ALLERGY AND EXPOSURE TO AMBIENT OZONE, BUT NOT WITH EXPOSURE TO PARTICULATE MATTER.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4

Asthma prevalence is increasing worldwide among children living in urban settings. Cockroach allergy is a recognized risk factor for asthma severity in the urban environment. Exposure to air pollutants, such as particulate matter (PM) and ozone, has been associated with decreases in lung function and increases in respiratory symptoms among asthmatics. We hypothesized that children with asthma who are allergic to cockroach may have an increased sensitivity to the negative efects of air pollution compared to those who are non-atopic.

This study was conducted as part of Community Action Against Asthma (CAAA). CAAA is a community-based participatory research project that combines investigation of the role of the indoor, outdoor, and social environments on asthma with interventions to reduce exposure to environmental asthma triggers. The project takes place in predominantly African-American and Hispanic communities in Detroit, MI. Measures of ambient air pollution, including PM_{10}, $PM_{2.5}$, and ozone were made on the rooftops of two elementary schools in the communities of interest. Lung function was measured for approximately 100 children with asthma twice daily for two weeks each season for 2 years. Sensitization to cockroach antigen was assessed by skin prick test. The impact of air pollutants on the day of exposure and 1 or 2 days after exposure was assessed using generalized estimating equation (GEE) statistical models.

A pattern of reduced lung function was seen with exposure to ozone among cockroach allergic children compared to non-allergic children. Of 24 ozone models assessed, 10 showed a negative impact of ozone on lung function and 9 of the 10 showed a stronger impact among children with allergy to cockroach compared to those without allergy. The strongest observed effect was a 2% decline in peak flow at 2 days post exposure for every 10 ppb increase in daily average ozone among allergic children ($p=0.0001$), whereas no significant effect was seen for the same exposure among non-allergic children. No similarly consistent pattern was identified for cockroach allergic children with exposure to coarse or fine fraction PM.

For children with asthma, an interaction is seen between the lung function effects of ozone exposure and cockroach allergy. A similar interaction has not yet been demonstrated between cockroach allergy and fine or coarse fraction particulate matter exposure.

[P02-11] THE SUSCEPTIBILITY OF OLDER ADULTS TO AIR POLLUTION.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4

While older adults clearly have higher overall risks of dying from air pollution due to their higher underlying risks, it is less clear that their relative risk (RR) from air pollution is higher. We consider two data sets, one looking at the risks of long-term exposure to PM, and one at the risk of acute exposures. We compare the RR's of dying from Particulate Matter (PM) air pollution to investigate the age dependence of risk from PM air pollution.

In the analysis of long-term pollution exposures, we consider the national American Cancer Society (ACS) Cancer Prevention II cohort. After controlling for other risk factors, using a Cox-Proportional Hazards Model we found that there is a 1.06 RR of death from Cardiopulmonary disease associated with long-term exposure to 10 ug/m3 of PM2.5 over the period 1982-1998 (Pope et al, JAMA, 2002). We have now reanalyzed these data to consider the pollution RR's for adults <75 yrs. old vs. those 75+ . We find the 10 ug/m3 PM2.5 Cardio-pulmonary RR for 75+ to be greater than for those <75 years of age (RR = 1.049;CI=1.023-1.076 for those < 75, vs. RR = 1.098;CI=1.050-1.148 for those 75+).

In an analysis of short-term PM exposures, we consider daily mortality in New York City for the years 1985-1994. After controlling for other factors such as season and weather using a Generalized Additive Model (GAM), the PM10 RR for Circulatory Deaths without Respiratory disease listed as a cofactor on the death certificate is similar for both adults <75 and adults 75+ years of age (RR per 18 ug/m3 PM10 = 1.027; CI=1.012-1.043 vs. RR=1.022; CI=1.008-1.035, respectively). However, for deaths in which respiratory disease was listed as a co-factor, the PM10 RR for persons <75 is approximately half that for those 75+ years of age (RR per 18 ug/m3 PM10 = 1.033; CI=0.98-1.089 for those <75 vs. RR=1.066; CI=1.027-1.106 for those 75+ years of age). This indicates that higher acute cardiovascular risks from air pollution are found in older adults who have co-existing respiratory disease. Thus, the cardiovascular Relative Risk from long and short term exposure to air pollution are apparently higher per ug/m3 in older adults than younger adults, especially among those who have respiratory disease.

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[P02-10] THE EPRI-WASHINGTON UNIVERSITY VETERANS COHORT STUDY: MODEL SENSITIVITY STUDIES AND RESULTS FOR ADDITIONAL AIR POLLUTANTS.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4

The Veterans Cohort comprises about 50,000 male veterans who had been diagnosed as hypertensive; 35% were African-American and 81% had smoked. We considered all-cause mortality with county-level air quality.

Sensitivity studies showed that successive deletion of individual subjects' height, interactions between age and body-mass index (BMI), and interactions between age and systolic blood pressure (SBP) had no effect on model fit (AIC) or on the effect estimates for PM10 or peak O3. Further, deletion of all blood pressure variables increased AIC, decreased the PM10 effect by 12% and increased the peak O3 effect by about 5%.

The additional variables tested included peak and mean SO2; average (as opposed to peak) O3, 1999 PM10, PM2.5, and PM10 - PM2.5; and vehicle-miles traveled (VMT/area, an index of vehicular pollution). The results for SO2, PM2.5, and PM10 were sensitive to the inclusion of ecological variables (EVs) in the model, as shown in the first paper. With EVs included, mean and peak SO2 showed similar effect estimates that were largely negative, significantly so for the more recent exposure and follow-up periods. These findings are similar to those for SO42-.

Without EVs in the model, 1999 PM2.5 was associated with an excess 1989-96 mortality risk of about 12%, which lost significance and dropped markedly to about 3% excess risk when EVs were included. The corresponding PM10 values were similar but slightly lower; the risks associated with PM10 - PM2.5 were nil.

In contrast, the risks associated with O3 and vehicles were not sensitive to the inclusion of EVs. Effects of mean O3 were negative for all exposure and follow-up periods, largely significantly so. This is consistent with findings from other cohort studies and in sharp contrast with the previous positive findings for peak O3. For the vehicular pollutant variable (ln[VMT/county land area]), attributable mortality risks were significant at about 2-3% when all U.S. counties were considered, but increased to 5-8% when the analysis was limited to counties having the 1979-84 PM2.5 data used in previous studies.

[P02-09] THE METAL CONTENT OF AIRBORNE PARTICLES: APPLICATION TO EPIDEMIOLOGICAL RESEARCH.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4

This work is the first long-term study in the UK of the quantitative relationship between elevated respiratory & cardiovascular mortality and morbidity rates and the variance in daily metal composition of PM10 in urban background air.

Concurrent 24-hour samples of PM10 and PM2.5 were collected at an urban background site in Edinburgh between September 1999 and September 2000. Each sample was sequentially extracted with ultra-pure deionised water followed by a concentrated acid mixture. Extracts were analysed by inductively coupled plasma mass spectroscopy for Fe, Cu, Ni, V, Zn, Mn, Cd, Cr, As, Ti, Pb.

The time series of particle-bound metal concentrations were extended backwards in time to 1992 by analysis of the influence of air mass source region on metal content. A statistical hierarchical clustering method was used to group 2800 daily meteorological air mass back trajectories for the period October 1992 to September 2000. Metal content enrichment factors were computed for each trajectory cluster to enable retrospective estimation of daily airborne concentration of each metal from archived PM10 and back trajectory data for Edinburgh.

Generalised additive Poisson regression models were used to determine whether adjustment for specified metals explained a higher proportion of the variance in health outcome data (deaths and hospital admissions (classified by ICD codes) in Edinburgh during the period January 1981 to September 2000) than the gravimetric measure alone. The relationship between health outcomes and particle pollution metric (particle mass and metal concentration expressed as the mean of the three days prior to outcome) was examined, with adjustment for day of the week, and minimum temperature.

To minimise statistical artefacts from multiple testing, a subset of 60 primary analyses was defined. These primary analyses comprised three health outcomes (cardiovascular admissions, respiratory deaths and all-cause deaths in subjects aged over 65) in relation to five of the eleven metals (Fe, Cu, Ni, V, Zn) in aqueous and total (water plus acid) filter extracts of PM10 and PM2.5.

For the eight-year cluster-based analyses there was a significant association with cardiovascular admissions for both total PM10 (consistent with previous analyses) and some of the metal fractions. However, further multiple regressions showed that the metal effects were no longer significant after adjusting for total PM10.

These epidemiological analyses have not excluded the hypothesis that the concentration in PM10 of one or more of the metals analysed here is the explanatory factor in the observed association between gravimetric PM10 and acute adverse health outcome.

[P02-08] A COMPARISON OF HEALTH EFFECTS FROM EXPOSURE TO AMBIENT AND NON-AMBIENT PARTICLES.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4

The plausibility of epidemiological associations between adverse health effects and outdoor concentrations of airborne particulate matter (PM) is supported by studies demonstrating high correlations between individual exposures to ambient PM and ambient PM concentrations. Since personal exposure to PM is dominated by exposure to non-ambient particles, it is also important to evaluate the potential health impacts of these exposures. In summer 1998, personal exposures to $PM_{2.5}$ and sulfate, and ambient concentrations of PM_{10}, $PM_{2.5}$ and sulfate were measured for a repeated measures (7 repeats) panel study of respiratory and cardiovascular effects in chronic obstructive pulmonary disease (COPD) patients (n=16) in Vancouver. In a further analysis of this dataset, we used an estimation method based on time-activity data and the use of sulfate as a marker for the infiltration of ambient particles with the same size distribution, to develop separate estimates of exposures to ambient $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$ and to non-ambient $PM_{2.5}$. The concentrations and health effects of these estimated exposures were compared to the originally measured total personal exposures and to measured ambient concentrations. As in previous studies, personal exposures to $PM_{2.5}$ were dominated by exposures to non-ambient $PM_{2.5}$ (56% on average) which were uncorrelated with exposures to ambient $PM_{2.5}$ and to measured ambient $PM_{2.5}$. For lung function the largest effect estimates were for exposures to ambient $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$. Systolic blood pressure was negatively associated with ambient PM_{10} and $PM_{10-2.5}$ and to a lesser extent with exposures to ambient PM_{10} and $PM_{10-2.5}$. Increased heart rate and increased supraventricular ectopic heartbeats were associated with all ambient PM measures except for sulfate and with exposures to ambient $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$. Heart rate variability measures showed less consistency; decreased r-MSSD was associated with ambient concentrations of $PM_{2.5}$, PM_{10} and $PM_{10-2.5}$, however no associations between SDNN and any PM parameters were observed. Neither exposures to non-ambient PM nor measured personal PM were associated with any of the health outcomes. Results, especially for the lung function, heart rate and heart rate variability outcomes, were sensitive to inclusion of one day of exposure associated with transported Asian dust, with larger effect estimates observed when this day was excluded. Overall, these results indicate the lack of associations between non-ambient PM and any of the measured health outcomes, whereas ambient coarse fraction ($PM_{10-2.5}$) mass, in addition to ambient $PM_{2.5}$, was associated with some adverse effects.

[P02-07] FURTHER ANALYSIS OF THE ASSOCIATIONS BETWEEN AIR POLLUTION SOURCE FACTORS AND MORTALITY IN A SMALL AREA NEAR THE MONITORING SITE IN PHOENIX, 1995-1997.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4

Recent questions concerning the validity of results from the General Additive Model (GAM) using nonparametric smooths, as implemented in current statistical software packages, has led to concerns about the reliability of results from epidemiologic studies using GAM. In addition, new studies using the Phoenix data base have led to an interest in re-investigations in which missing temperature and relative humidity are replaced with imputed values using measurements from the Phoenix Sky Harbor airport (thus increasing the data days from 700 to 765). Also, we were interested in examining the difference between replacing missing source factor data with the average value compared to omitting days with missing source factor data. Results for various models including GAM-D (default convergence criteria), GAM-S (stricter convergence criteria), and GLM (General Linear Model with natural splines) will be reported for both treatments of missing values. Although there are some variations in calculated values of beta and standard error among the models, the major conclusions are unchanged. Factors associated with regional sulfate, vehicular traffic (including resuspended road dust), and vegetative burning are statistically significant. Regional sulfate yields a higher statistical significance and beta than sulfate from XRF measurements of sulfur, presumably because the regional sulfate factor discriminates against coarse particle sulfate from soil or construction/demolition activities. The three source factors are statistically significant on different lag days, regional sulfate on lag day zero, vehicular traffic on lag day one, and vegetative burning on lag day three. These difference in time between exposure and death suggest the possibility of different biological mechanisms for the different types of particles.

% Increase in Risk of Cardiovascular Mortality per Interquartile Increase in Source Factor with 95% Confidence Intervals

	GAM-D (Missing values replaced with average)	GLM +60days (Days with missing values omitted)
Regional Sulfate	5.8 (0.2-11.7)	7.1 (0.9-13.6)
Vehicular Traffic	6.7 (1.7-12.0)	5.0 (0.1-10.1)
Vegetative Burning	5.0 (1.3- 8.8)	4.3 (0.4- 8.3)

[P02-06] ASSOCIATIONS BETWEEN PARTICULATE MATTER COMPONENTS AND DAILY MORTALITY AND MORBIDITY IN PHILADELPHIA, PA.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4

In evaluating the health risks from particulate matter (PM), the question remains as to which component(s) of PM are most harmful. We investigated this issue using PM mass, PM constituents, mortality, and the elderly hospital admission data in Philadelphia, PA. Daily paired $PM_{2.5}$ and PM_{10} samples were collected at one site in downtown Philadelphia between May 1992 and September 1995. Trace elements as analyzed by energy dispersive X-ray fluorescence from $PM_{2.5}$ filters (including Br, Ca, Fe, K, Mn, Ni, S, Se, Si, V, and Zn), gaseous pollutants (CO, NO_2, SO_2, and O_3), and coefficient of haze (CoH) were also analyzed. Daily cardiovascular mortality, total (non-accidental) mortality, cardiovascular elderly (age over 65) hospital admissions, and respiratory elderly hospital admissions were aggregated for the Philadelphia Metropolitan Statistical Area. Generalized Linear Poisson regression Model (GLM) was used to estimate the excess health outcomes associated with PM components and gaseous pollutants adjusting for temporal trends, weather, day-of-week, and major holidays. Several alternative weather models as well as varying extent of seasonal smoothing were applied to examine the sensitivity of results to model specifications. Among the PM components examined, the most consistent associations with health outcomes were observed for S, $PM_{2.5}$, and PM_{10} (70% of whose mass, on the average, was $PM_{2.5}$). Of these, S often showed the most significant associations. For example, the estimated relative risks for cardiovascular mortality at lag one day in a GLM model were 1.055 ($t = 2.50$), 1.044 ($t = 2.04$), and 1.039 ($t = 1.68$) for S, $PM_{2.5}$, and PM_{10}, respectively per corresponding 5th-to-95th percentile distribution increment. $PM_{10-2.5}$ was not significantly associated with any of the health outcomes. These results suggest the strongest PM associations are between regionally uniformly distributed secondary aerosol and health outcomes in Philadelphia during this time period.

This work has been wholly funded by the United States Environmental Protection Agency under cooperative agreement number CR827358 to New York University School of Medicine. It has been subjected to Agency Review and approved for publication

[P03-16] ATOFMS CHARACTERIZATION OF AMBIENT FINE AND ULTRAFINE PARTICLES FROM A VERSATILE AEROSOL CONCENTRATION ENRICHMENT SYSTEM (VACES).

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (4:00 PM-5:00 PM) Grand Ballroom 2-4

Recently ambient particle concentrators have been developed to investigate exposures to real ambient aerosols because ambient aerosol concentrations are generally too low to induce measurable acute toxic effects. Besides particle number concentration and size, particles with different chemical composition generate different toxic effects. By using a particle concentrator in health effects studies, the number concentrations of ambient particles can be significantly enriched. However, the chemical composition of the enriched ambient particles may also vary because particles undergo a series of pumping, saturation, and desolvation processes when passing through the concentrator. In this poster, an aerodynamic lens aerosol time-of-flight mass spectrometer (ATOFMS) was used to characterize fine and ultrafine ambient particles sampled from the outlet of a versatile aerosol concentration enrichment system (VACES) in Rochester, NY. Major particle types observed for the enriched particles and the temporal variations of these types observed over the course of the study are presented and compared with those obtained during direct (i.e. non-concentrated) ambient sampling. Based on the data analysis results, influences of the concentrator on the particle composition will be evaluated and discussed.

Acknowledgements

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[P02-04] A CASE CROSSOVER ANALYSIS OF PARTICULATE AIR POLLUTION AND CARDIAC ARRHYTHMIA IN PATIENTS WITH IMPLANTABLE CARDIOVERTER DEFIBRILLATORS.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4

We investigated the relationship between air pollution and cardiac arrhythmia in a study of patients with implantable cardioverter defibrillators (ICDs). Thirty-four patients (ages 15-85, 80% male) with ICDs residing in the Vancouver area were included in the analyses, representing all patients attending the two ICD clinics in the study region who had recorded at least one ICD discharge during the February 14 to December 31, 2001 study period. Air pollutant ($PM_{2.5}$, PM_{10}, SO_4^{2-}, elemental carbon [EC], organic carbon [OC], O_3, SO_2, NO_2 and CO) concentrations on days with ICD discharges ('case days') were compared to control days (7 days before and after each case day) in case crossover analyses. ICD discharges occurring within 72 hours of one another were grouped and considered as one discharge event-day. Temperature, relative humidity, barometric pressure, rainfall and windspeed were included simultaneously as covariates. Sensitivity analyses were conducted to examine the effect of grouping ICD discharges, of including meteorological variables, and including/excluding discharges that were considered inappropriate by a cardiologist. As in previous studies, mean concentrations and interquartile ranges of air pollutants in Vancouver were low. Although in general there were no statistically significant results, there were consistent trends indicating associations between pollutants and ICD discharges. Odds ratios (OR) were consistently higher in summer (7 of 9 were > 1) than in winter (only 1 of 9 > 1) and the highest ORs were observed for lag 0. While an OR of 1.5 (0.51 -4.7) was found in summer at lag 0 for PM_{10}, no indications of associations were observed for $PM_{2.5}$ or SO_4^{2-}. For local combustion-source pollutants, EC, OC, CO and SO_2, ORs were elevated above 1 at all lags (0-3 days) in summer. These findings suggest a weak association between summertime combustion-source primary air pollutants and cardiac arrhythmia.

[P03-17] METHODS FOR EXPOSING RODENTS AND CELLS TO CONCENTRATED AMBIENT PM USING VACES.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (4:00 PM-5:00 PM) Grand Ballroom 2-4

We have assembled, tested, and validated the Versatile Aerosol Concentration Enrichment System (VACES) developed by Sioutas et al in preparation for a subchronic experiment that will involve exposure of mice in vivo and respiratory epithelial cells in vitro to concentrated ambient particles (CAP). Since the labor-intensive nose-only exposure regimen is not an option in a long-term experiment, a whole-body exposure mouse chamber was designed specifically for use with the VACES. The exposure system consists of a 5-gallon (20 inches X 12 inches X 6 inches) stainless steel (SS) tub with 32 cubicles (1 mouse per cubicle) separated by perforated SS sheets. The tops of these cubicles are covered with perforated plastic sheets to allow telemetry monitoring during the exposure. In each exposure chamber, six SS tubes (each 22 cm in length) with 15 0.25 mm holes 13.5 mm apart, are used to distribute CAPs evenly throughout the exposure chamber. The exhaust consists of 4 SS tubes (each 40 cm in length), each with 28 0.5 mm holes, covered with a semi-circular urine shield. In addition, a major modification was made to the original design of the VACES to facilitate the operation of the system in a subchronic study: the salt-ice slurry used in the condensation process was replaced by a refrigerated circulator (chiller). Mass flow controllers are used to maintain a constant flow rate through these exposure chambers. For a sham control experiment, the identical system is used, except that a HEPA filter at the inlet to the VACES removes ambient particles. The entire system allows for simultaneous exposure of 64 mice to CAPs, with an equal number of sham- exposed mice as controls. Telemetry receivers have been modified so that 16 mice per group with ECG transmitters can be monitored during exposure. Furthermore, a Biosampler is used to collect CAPs (one sample per day) for the in vitro exposures. A respiratory epithelial cell line (BEAS- 2B) stably transfected with NF-kB-luciferase reporter plasmid is used to assess daily biological activity of ambient PM. We will present the assessment of flow and particle distribution of the exposure chamber as well as preliminary data of in vivo and in vitro responses to CAP. Research supported by: The NYU-EPA Particulate Matter Health Research Center (R827351) and The NIEHS Center Grant (ES00260).

[P02-02] KEY ATTRIBUTES OF AMBIENT AIR QUALITY DATASETS FOR ASSESSING SHORT-TERM HEALTH EFFECTS: AN EPIDEMIOLOGIC PERSPECTIVE.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4

For epidemiologic time-series studies assessing the short-term health effects of ambient air pollution, desirable attributes of air quality databases depend on the specific study questions, but several features are generally useful. It is important that the ambient pollutant monitor(s) be appropriately sited to maximize spatial representativeness for the geographic area under study; knowledge of the extent of spatial heterogeneity of each pollutant of interest is crucial for the interpretation of epidemiologic study results. An assessment of the influence of local sources immediately surrounding the monitoring station(s) is helpful. Because the relationships of specific pollutants with adverse health outcomes have yet to be fully understood, information on an extensive suite of analytes may be useful (including criteria gases, mass of different size fractions of particulate matter (PM), physicochemical characteristics of PM, gas-phase hydrocarbons, and meteorological parameters); however, strong correlations among pollutants, due to common sources and meteorological phenomena, may limit the epidemiologic utility of such data. To evaluate the association between health outcomes and ambient pollution concentrations at a daily, or sub-daily, level, the temporal resolution should be as fine as is feasible, to allow for flexibility in choosing the level of aggregation needed. Measurements should, of course, be made with the highest level of validity and precision. It should be kept in mind that the primary goal in time-series studies is to capture true day-to-day variation in air quality measures, rather than absolute levels, in order to evaluate the relationship between daily fluctuations in ambient pollution levels with daily fluctuations in health outcome measures. The amount of missing data during the monitoring period should be minimized, a factor that is particularly important when evaluating the health effects of pollutants using multiple-day lag structures. Instrument uncertainty, determined from colocation or previously conducted reliability studies, should be estimated. The ambient air quality data should also be accompanied by thorough documentation of the measurement methods and quality control procedures. The attributes of the ambient air quality database generated by Aerosol Research and Inhalation Epidemiology Study (ARIES) at the Jefferson Street monitoring station in Atlanta, Georgia, from August 1, 1998, to August 31, 2000, will be used to illustrate the extent to which an existing database has met the needs of epidemiologists.

[P02-01] METANALYSIS OF THE IMPACT OF PM10 ON PREMATURE MORTALITY.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4

Many analyses have been conducted worldwide to estimate the health benefits from air pollution abatement. A key issue in the estimation of these benefits is the unit risk of the concentration-response function. Among all effects, premature mortality is with no doubt the most important. When local studies (i.e. studies conducted in the same region or city in which the benefits of abatement are being calculated) are available, they are usually used directly in benefit estimation. When no local studies are available, the current practice is to extrapolate results from a similar locality, or to take an average (sometimes weighted) of a given set of studies. However, these methods do no consider the difference in conditions of the target place from the original study place.

In this work we present a meta-analysis of studies of the short term impacts of particulate matter (PM10) impacts on premature mortality, considering explicitly the factors that may influence it. Through a weighted regression model, a meta-analysis of the PM unit risk for a sample of 85 cities around the world was performed, considering as explanatory variables the average concentrations of air pollutants, the monitoring sites density, the mean temperature, the city's surface, the population density, the percentage of population over 65 years old, the average annual mortality rate, and gross income per capita.

Population density, average concentration of PM10, and mean temperature had the greater explanatory power. The effect of PM10 concentrations on unit risk was negative, with the slope decreasing 0.000035 for each 10 μg/m3 of PM10. The effects of temperature and population density were both positive. The proposed model allows to better predicting the effect of particulate matter on mortality for any city on the base of its environmental and demographic attributes.

[P02-12] A PILOT STUDY OF TRAFFIC EXPOSURES AND THEIR HEALTH EFFECTS AMONG SOUTH BRONX CHILDREN WITH ASTHMA.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4

Traffic-related pollution has been associated with adverse respiratory health effects using distance from roadways as an exposure index, rather than direct personal monitoring. Therefore, our goal was to assess the feasibility of a program to measure personal traffic-related PM exposures (using Elemental Carbon, EC, as an index) among inner-city elementary school children with asthma, and to relate these exposures to nearby truck traffic and to health.

A group of ten 5th grade children with asthma from a South Bronx elementary school located adjacent to the Major Deegan Highway were followed for 3 weeks in April-May, 2002. For each child, continuous fine PM concentrations (MIE Data RAM) and 24-hour average fine EC (via reflectance), and daily NO2 (using Super-Palmes) were determined via personal monitoring. Daily filter PM2.5 personal samples were analyzed for EC using reflectance. The subjects' data on personal respiratory symptoms, asthma medications, lung function, and activity pattern data were also collected. PM2.5, EC, NO2, CO, SO2, and O3 were also monitored at the NYU PM Center mobile air monitoring lab, located beside the school. Daily diaries of asthma symptoms and medications were filled out, and spirometry collected, at the start and end of the school day, and each evening. Counts of trucks and cars were made using automated counters during one week of the study.

Measurements were successfully completed, with collection rates usually above 90%. Personal PM2.5 levels were weakly correlated with, and usually higher than, central site PM2.5, suggesting indoor sources dominated PM2.5 exposures. Personal PM2.5 concentrations were higher for the most ETS exposed children. Peak outdoor EC concentrations at the central van were correlated with peak truck traffic periods. Personal EC levels were also variable, but more strongly correlated with (r^2=0.72), and usually lower than, central EC, suggesting outdoor sources dominated personal EC exposures. Unlike PM2.5, EC exposures were similar for ETS vs. non-ETS affected subjects. Peak flow lung function was negatively associated with both average EC and PM2.5 levels ($p<.05$). Presence of shortness of breath and wheezing symptoms were significantly associated with EC levels, but not with PM2.5. This suggests that traffic-related EC is more strongly associated with adverse asthma symptoms than PM2.5 in general.

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[P11-07] AN EVALUATION OF THE MODELS-3 CMAQ AEROSOL MODULE.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 11: Air Quality Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Ambient air concentrations of particulate matter (PM) continue to be a major concern for the U.S. Environmental Protection Agency. High concentrations of fine particles have been linked to detrimental health effects and visibility degradation. Accordingly, the Clean Air Act and its Amendments require EPA to establish National Ambient Air Quality Standards (NAAQS) for PM and to assess current and future air quality regulations designed to protect human health and welfare. One of the most reliable tools for performing these assessments are air quality models, such as the Models-3 Community Multiscale Air Quality (CMAQ) model, which simulates air concentrations and deposition of various pollutants, including PM. These simulations, which can be conducted on numerous spatial and temporal scales, support both regulatory assessment by EPA Program Offices, as well as scientific studies by research institutions.

The aerosol module within CMAQ is designed to simulate the complex processes involving both PM2.5 and PM10, which are not single entities, but consist of varying mixtures of chemical species, each having its own emission, transport and deposition characteristics. Aerosol species considered within CMAQ are sulfate, nitrate, ammonium, water, secondary organic aerosols from both anthropogenic and biogenic sources, primary organic aerosols, elemental carbon, and unspecified primary aerosol material. These species are contained in the fine particle size range (PM2.5, which are represented by two interacting lognormal distributions, the Aitken and accumulation modes. Particles with diameters larger than 2.5μm are represented by a third lognormal distribution that does not interact with those representing PM2.5. The coarse mode chemical species are represented by two categories, soil-derived particles and chemically unspecified particles.

In order to determine its value to the regulatory communities, CMAQ, like all models, must be evaluated using observational data. Accordingly, this research compares PM simulated by CMAQ during a three month simulation (June through August, 2001) with PM data collected by two networks: 1) the Interagency Monitoring of PROtected Visual Environments (IMPROVE) network; and 2) the Clean Air Status and Trends Network (CASTNet). A suite of metrics will be used in the evaluation, including summary statistics, numerous measures of bias (mean, mean normalized, mean fractional, normalized mean) and error (root mean square, normaized mean, mean absolute gross and mean normalized gross).

[P11-06] AIR QUALITY MODELING OF AN EXTREME PM10 EPISODE AT SANTIAGO, CHILE.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 11: Air Quality Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

The city of Santiago, Chile is subject to strong anticyclonic, subsidence-based thermal inversions reinforced by low coastal troughs on the Pacific Ocean (110 km to the west). In such episodes, ambient concentrations of pollutants start to rise as the episode worsens.

We are using the Comprehensive Air Quality Model with Extetensions (CAMx) to study one episode that happened from May 14 through May 19, 1998. The atmospheric conditions were such that the PM10 hourly levels reached dangerously high levels (see Table), and 24h moving average values rose as high as 350 (μg/m^3).

In addition, the air temperature difference between 2 and 8 m above ground was near 4 K at all those hours, signaling a strongly stable surface boundary layer, with Richardson numbers exceeding the critical value of 0.25 at those hours. The episode enden on Monday, May 18th, when authorities shut down 50% of the stationary sources and banned near 60% of the older vehicles in the city, curbing down pollution levels.

The modeling exercise was carried out applying CAMx to a region extending 120 km E-W and 80 km N-S, completely covering the greater metro area of Santiago (30 by 35 km in size) with a 2 by 2 km grid resolution.

The meteorological information was obtained by applying the CALMET preprocessing scheme to the following configuration of data:

a) A dense surface network, consisting of 30 surface meterological stations b) The output of the HIRLAM regional scale meteorological model, at 0.1 degrees of resolution, covering central Chile.

The model outcome was assessed using the ambient air quality monitoring performed routinely by the local authorities at 8 monitoring sites apread across the city, covering most of the urban zone.

The results of the model performance are assessed in graphical and statistical ways, showing the capabilities of the CAMx modeling system to simulate the transport and chemistry over such a complex terrain flow.

Summary of PM10 episode, May 1998

Day	LST at peak PM10	PM10 (μ/m^3)	Ri (5m)
Friday, 15th	22-23	600	0.20
Saturday, 16th	21-22	818	0.37
Sunday, 17th	21-22	495	1.86
Monday, 18th	22-23	198	2.45

[P11-05] DEVELOPMENT AND APPLICATION OF THE PMCAMx MODEL TO TREAT FINE PARTICULATE AND VISIBILITY ISSUES.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 11: Air Quality Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

The Comprehensive Air-quality Model with extensions (CAMx) is a photochemical grid model that was developed in the late 1990s to treat urban and regional ozone issues under a one atmosphere concept. CAMx was first applied to address ozone issues as part of the Ozone Transport Assessment Group (OTAG), but has undergone continuous development and refinement. Because CAMx consists of all new computer coding in a modular framework, it is ideally suited for extension to other air quality issues beyond ozone and the platform has become a host fotr several "probing tools" including Ozone Source Apportionment Technology (OSAT), Decoupled Direct Method (DDM), and Process Analysis. This paper discussed the extension of the CAMx to treat particulate matter (PM) and visibility issues through the inclusion of state-of-science aerosol modules. A sectional approach has been adopted in PMCAMx to treat size resolved PM. Aerosol thermodynamics are treated using either a full dynamic module or the ISORROPIA equilibrium module. A multi-sectional aqueous-phase chemistry algorithm has also been implemented. Secondary organic aerosol is being treated using a reversible semi-volatile scheme. New dry and wet deposition schemes have been developed. A PM Source Apportionment Technology (PSAT) is also being developed and implemented into PMCAMx that allows source attribution of primary and secondary PM to user selected geographic source regions and source categories.. This paper presents the technical formulation of the PMCAMx treatment of aerosols, the application and evaluation of the model to western and eastern US cities, and the formulation and performance of the PSAT PM source apportionment scheme.

[P11-04] SIMULATION OF THE ATMOSPHERIC AEROSOL SIZE/COMPOSITION DISTRIBUTION IN A THREE-DIMENSIONAL CHEMICAL TRANSPORT MODEL.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 11: Air Quality Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Atmospheric pollutants have been implicated in the development of adverse effects on human health, the formation of acid rain and acid fogs, visibility reduction, and influence on the energy balance of the planet. Models that accurately describe the physical and chemical atmospheric transformations of these pollutants are necessary to determine how changing emissions will affect downwind airborne concentrations and how to best go about controlling air pollution.

Improvements and additions have been made to the chemical transport model CAMx to create a new transport model PMCAMx. These improvements focus on aerosol and aqueous-phase treatment. The first addition was a hybrid mass transfer approach to determine partitioning between the gas and aerosol phase for volatile inorganic species. Here bulk equilibrium is assumed for fine particles and mass transfer equations are solved for larger particles. To simulate the behavior of secondary organic aerosol (SOA) components and their interactions with inorganics, an SOA model was also integrated into PMCAMx. Finally, in an effort to describe cloud and fog processing of pollutants, a variable size resolution aqueous-phase chemistry module also was incorporated into the model.

We will present an overview of our additions to PMCAMx and explore the accuracy and efficiency of these additions.

[P11-03] USE OF HIGH-TEMPORAL-RESOLUTION PM DATA FOR MODEL PERFORMANCE EVALUATION.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 11: Air Quality Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Speciated, high-temporal-resolution particulate data available from the SouthEastern Aerosols Research and CHaracterization Study (SEARCH) and concurrent monitoring programs were used to evaluate the performance of two particulate matter (PM) air quality models, as applied to two multi-week modeling episode periods. The SEARCH measurements include speciated particulate matter with diameters of less than 2.5 microns (PM2.5) and between 2.5 and 10 microns (PMCOARSE), and trace gas measurements of ozone, oxides of nitrogen (NO, NOx), NOy, carbon monoxide (CO), and sulfur dioxide (SO2). The SEARCH data provide a basis for beginning to evaluate in detail the ability of PM models to simulate hourly variations in PM species for a variety of geographical locations (including urban, suburban, rural sites and both coastal and inland locations).

Several air quality models are being developed and tested for the purposes of evaluating strategies for reducing PM concentrations and exposure. The reliable application of such models requires that the models be rigorously evaluated and tested - not only relative to whether longer-term averages of PM constituents can be reproduced, but also with regard to whether the detailed daily and hourly concentrations that comprise the longer-term averages are consistent with available speciated, high-temporal-resolution data.

This poster presents the methods and results of the evaluation of the REgional Modeling System for Aerosols and Deposition (REMSAD) and the particulate version of the variable-grid Urban Airshed Model (UAM-VPM), with emphasis on the ability of the models to represent hourly variations in particulate and gaseous concentrations of several species. Ratios of various species are also used to compare the modeling results with observed data and obtain information about whether the processes represented by the chemical mechanisms are in line with those indicated by the relative species concentrations in the observed data. Conclusions regarding model performance for longer-term averages versus daily and hourly variations are also compared. The high-temporal-resolution SEARCH data provide a basis for a detailed evaluation of the modeling results.

Results for REMSAD for the two episode periods suggest good representation of PM2.5 but somewhat mixed representation of the various component species. Organic aerosols tend to be underestimated. For one simulation period, ozone is well simulated while, for the other, ozone is generally overestimated. As of the writing of this abstract, the evaluation of UAM-VPM is not complete.

[P11-02] PERFORMANCE EVALUATION OF MULTI-PHASE INORGANIC AEROSOL THERMODYNAMIC MODULE: UHAERO.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 11: Air Quality Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Over the past decade, several atmospheric aerosol thermodynamic modules predicting the equilibrium partition of inorganic compounds have been developed. The most popular modules are SCAPE2 and ISORROPIA. These models have been used in a number of studies for the analysis of ambient measurements. However these models rely on a priori knowledge of the presence of components in certain relative humidity, and often fail to accurately predict delequescence point depression in the multi-phase aerosol growth. The present approach, relying on the Extended UNIQUAC activity coefficient model, incoperates the TABLEAU analysis and Newton-type active-set method to determine the right set of governing equations automatically given temperature, relative humidity and the total ammonia, nitric acid, sulfate, sodium and hydrochloric acid. The comparison is conducted between our approach and available experimental results. The current model agrees with experimental results for single salt systems. For multi-component systems, our model reproduces observed multi-stage growth patterns and deliquescence point depression.

[P11-01] INORGANIC AEROSOL THERMODYNAMIC MODEL WITH N(III).

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 11: Air Quality Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Heterogeneous reactions are generally taken as the major formation mechanisms of atmospheric nitrous acid. The concentrations of nitrous acid in the South Taiwan are 0.16~ 18.3 $\mu g/m^3$ and those of nitric acid are 0.14~13.6 $\mu g/m^3$. Thus, the concentrations of nitrous acid are greater than those of nitric acid in Taiwan. Although the concentrations of nitrite have been measured in many studies, there are few studies including nitrite and nitrous acid in aerosol model development and application. Because of the importance of nitrous acid and particulate nitrite, the purpose of this study is to establish an aerosol thermodynamic model with nitrous acid and nitrite.

In this aerosol thermodynamic aerosol, Pitzer method and Bromley method are used to estimate binary activity coefficients and multi-component activity coefficients, respectively. ZSR relationship is used to calculate the aerosol water content. The species in this model include aqueous phase species (K^+, Na^+, Ca^{2+}, Mg^{2+}, NH_4^+, Cl^-, NO_2^-, NO_3^-, SO_4^{2-}, CO_3^{2-}, H^+) and gaseous phase species (HCl, HNO_3, HNO_2, NH_3). Atmospheric gaseous species and $PM_{2.5}$ samples were collected at Annan in southern Taiwan. Gaseous species (HCl, HNO_3, HNO_2, NH_3) were collected using annular denuder system and filter pack was used to collect particles. The samples were then analyzed by ion chromatography to determine the concentrations of Cl^-, NO_2^-, NO_3^-, SO_4^{2-}, K^+, Na^+, Ca^{2+}, Mg^{2+}, NH_4^+, .

The average concentrations and standard deviations of gaseous HNO_2, HNO_3, NH_3, particulate (<2.5 μm) NO_3^- and NH_4^+, NO_2^-, SO_4^{2-}, Na^+ were 4.5(±2.6), 1.6(±2.3), 22.1(±9.62), 0.7(±0.4), 3.0(±2.0), 0.64(±0.76), 7.3(±3.8), 0.29(±0.16) $\mu g/m3$, individually. Meteorological conditions were humid with relative humidity from 74%~84% and temperatures were between 297.2 K~302.2 K during sampling. Note that the concentrations of nitrous acid were greater than those of nitric acid. Nitrous acid may be important than nitric acid at this site.

The measurements of nitrous acid and nitrite($PM_{2.5}$) were used to evaluate this thermodynamic model. The measured and simulated results of nitrous acid are in good agreement. The average relative error, defined as [simulated-measured]/measured, was 0.185 and the correlation coefficient was 0.937. The acidity of HNO_3 is much greater than that of HNO_2. Therefore, more HNO_2 volatilizes into gaseous phase while most of HNO_3 remains within aerosol.

Aerosol thermodynamic model that include nitrite/nitrous acid has been established in this study. The measured and simulated results are in good agreement. Due to the weaker acidity of nitrous acid, the concentrations of nitrite are lower than those of nitrous acid.

[P03-13] LACK OF EFFECT OF AGE AND ANTIOXIDANT DEPLETION ON RESPIRATORY RESPONSES TO CONCENTRATED AMBIENT PARTICULATES (CAPs) IN RODENTS.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 3: Ambient Air Pollution Concentrators and Dose-Response Data (4:00 PM-5:00 PM) Grand Ballroom 2-4

Metal-mediated generation of reactive oxygen species (ROS) and oxidative stress have been proposed as one of the main mechanisms for emission source PM toxicity. Oxidative stress has also been implicated in aging and in the pathogenesis of asthma. Asthma, an inflammatory airways disease, has become an urgent health problem; with elderly asthmatics experiencing some of the highest mortality rates of any age group. Thus, we evaluated whether antioxidant responses were important in the respiratory effects associated with ambient PM exposure. In study 1, 12-wk Sprague Dawley (CD) rats were exposed to CAPs from central North Carolina (NC). Buthionine sulfoximine (BSO) was administered systemically to deplete lung glutathione prior to and during air or CAPs nose-only exposure (4h/day x 2 days). Airway responsiveness (AR) to methacholine wasalso assessed. In study 2, young adult (10-wk) and geriatric (15-mo) spontaneously hypertensive (SH) and WKY (background) rats were exposed to air or CAPs in a whole-body chamber (4h/day x 2 days). In addition to hypertension, SH rats have neutrophilic lung inflammation seemingly related to antioxidant deficits. Lung, blood, bronchoalveolar, and nasal lavage fluid (BALF, NALF) samples were collected 20h later. In study 1, PM chamber levels were 150-800 μg/M^3. Although BSO treatment depleted lung glutathione levels by 50%, neither saline- nor BSO-treated rats exhibited increased AR after CAPs exposure. Likewise, regardless of antioxidant status, neither group developed significant lung injury /inflammation. In study 2, PM concentrations were 1400-1800 μg/M^3. Data indicated that for many BALF indices, relative to WKY rats, SH rats had higher levels (e.g., albumin, TP, lysozyme, cytokines) and cell counts (due to more macrophages). While the magnitude of these differences increased with age, relative to these changes, CAPs-induced effects in geriatric rats were negligible. In young rats, CAPs exposure was associated with minor increases in BALF GGT and trends towards increased albumin, TP, and neutrophils. In summary, reduction in lung antioxidant levels failed to predispose CD rats to developing greater lung changes after exposure to summertime CAPs from the NC airshed. Similarly, although geriatric SH rats had greater changes in BALF biochemical and inflammatory indices, advanced age alone did not predispose these rats to developing greater CAPs-induced lung injury or inflammation. (Abstract does not reflect EPA policy.)

[P01-09] LINKAGES ACROSS PM POLICY AND RESEARCH: EXAMINING THE POLICY RELEVANT FINDINGS FROM THE PM2.5 SUPERSITES PROGRAM.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 1: The NARSTO North American PM Assessment (4:00 PM-5:00 PM) Grand Ballroom 2-4

The PM2.5 Supersites program was designed to complement routinely operating PM2.5 networks by providing enhanced temporal and chemical/physical composition data in addressing three overarching objectives: supporting health effects and exposure research, advanced monitoring methods development and testing, and increased air quality characterization in support of national and State emission reduction strategies. As the Supersites are in the final stages of an intensive measurement campaign in eight cities across the United States that commenced in 1999, the program is expected provide relevant information for the technical assessments underlying development of national and State implementation plans (SIPs) that currently are underway and expected to continue over the next five years. The objective of this paper is to illustrate the program design attributes and highlight selected preliminary findings from the Supersites, and related PM research efforts, that should support these planning efforts.

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[P02-05] ASSOCIATION OF SINGLE AND MULTIPLE COMPONENTS OF PM AND HUMAN MORTALITY IN ATLANTA, GA.

Rebecca J Klemm None, Klemm Analysis Group, Inc., Washington, DC

Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 2: Epidemiology: Short-Term and Long-Term Health Effects (4:00 PM-5:00 PM) Grand Ballroom 2-4

Aerosol Research and Inhalation Epidemiological Study (ARIES) is a program sponsored by the Electric Power Research Institute (EPRI) that involves the collection of air quality and meteorological data at a single site in Fulton County of Atlanta, GA. High-resolution air quality indicators (AQI) are used to examine statistical relationships between air quality and health outcome endpoints. Contemporaneous mortality data are collected for Fulton and DeKalb counties in Georgia. Currently, 24 months of AQI, weather, and mortality data are available for analysis, from August 1998 through July 2000.

We compare the estimated associations of daily mortality and two dozen AQI using Poisson regression in a generalized linear models (GLM) framework. The estimated log-linear association of mortality with various AQI is adjusted for smoothed functions of time and meteorological data using natural splines. Our analysis considers daily deaths due to non-accidental causes by whether the decedent was at least 65 years of age. Associations are also investigated by subgroups of decedents defined by cause of death: deaths due to respiratory conditions, deaths due to circulatory conditions, deaths due to non-circulatory or non-respiratory conditions, and deaths due to cancer.

We also investigate the interaction of various AQI by using comparable models with two AQI, the impact of the placement and number of knots on the estimated associations, and whether the death occurred in Fulton or DeKalb Counties. A chart compares the effect of degrees of freedom for time in the estimated association of fine particles in Atlanta compared to six other cities, and a parallel chart shows the changes in the standard error of the estimated associations. In general, as the number of degrees of freedom for time increases, the estimated associations decrease, and the standard errors eventually begin to increase. The drop is very fast for Atlanta, partly due to a shorter time series and less seasonality.

$PM_{2.5}$, PM_{10} and oxygenated hydrocarbons (OHC) appear strongest in the presence of other AQI in Atlanta. Graphical displays illustrate differences in estimated associations, by AQI alone, and in combination with other AQI. The impact of the number and location of knots are graphically compared by cause of death and AQI. They show, for example, that deaths due to respiratory conditions are more sensitive to whether time is smoothed using monthly knots or quarterly knots. Results are not sensitive to changes in fixed placement of the knots within each month or quarter.

[P11-21] APPLICATION OF PMCAMX TO THE SOUTH COAST AIR BASIN AND THE EASTERN UNITED STATES.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 11: Air Quality Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Three-dimensional chemical transport models are essential tools used by policy makers in determining effective strategies to address air pollution problems. To be effective, models must be versatile enough to accurately predict observed atmospheric conditions in multiple regions, which can have differing local air quality problems. Here we apply the chemical transport model of PMCAMx to two regions, California's South Coast Air Basin (SCAB) and the Eastern United States.

In the case of the SCAB, we have simulated a two-day PM episode from October 1995. The episode exhibits meteorological conditions (e.g., extensive fog cover) typical of fall PM episodes in the SCAB. Also important was the existence of data to evaluate model performance. There were five sampling sites for measurement comparisons during this period, located at Los Angeles, Anaheim, Diamond Bar, Riverside, and Fontana.

The Eastern United States case is validated with more recent measurements taken during the intensive sampling periods at Pittsburgh and other supersites. High PM in the Pittsburgh region is characterized by high sulfate and organic material, in contrast to the SCAB, where high PM contains high concentrations of nitrate and ammonia, particularly east of Anaheim and Diamond Bar.

The performance of PMCAMx in both of these regions is evaluated. PMCAMx and other chemical transport models have previously been shown to perform relatively well in the SCAB, but few studies have been done in the eastern United States to date. The preliminary results for PMCAMx in this region will be given to show how the different atmospheric conditions affect the performance of the transport model. PMCAMx allows the use of different aerosol and cloud modules, and some of the differences between these approaches will also be shown.

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[P07-13] THE COMPARISON BETWEEN THERMAL OPTICAL TRANSMITTANCE ELEMENTA CARBON AND AETHALOMETER BLACK CARBON MEASURED AT MULTIPLE MONITORING SITES.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

As a part of the University of Rochester Particulate Matter (PM) Center study and the Philadelphia summer intensive PM program, a semi-continuous organic carbon / elemental carbon (OC/EC) analyzer (Sunset Lab) and a two-wavelength Aethalometer (AE-2, Megee Scientific Company) were operated simultaneously. The OC/EC analyzer was operated every two-hour resolution using both optical transmittance (λ= 680 nm) and thermal/optical transmittance. The Aethalometer measured black carbon (BC) and polycyclic aromatic hydrocarbon PM (UVPM) using their light absorption (λ= 880 and 350 nm, respectively). In addition, daily integrated filter samples were collected to measure the integrated OC/EC carbon fractions using the convential laboratory system.

During the Rochester intensive program conducted between June 6 and 18, 2002, BC and UVPM were approximately same and highly correlated (r^2 = 0.98, slope = 0.91). Thermal EC and optical EC were highly correlated and the thermal EC was about 11 % higher than the optical EC. BC was more correlated with optical EC (r^2 = 0.78) than thermal EC (r^2 = 0.72). However, BC was much higher than the optical EC. During the Philadelphia summer intensive PM program measured between July 10 and August 3, 2002, UVPM was approximately 18% higher than Rochester UVPM. The correlation coefficient between optical EC and BC (r^2 = 0.78) was consistent with the correlation coefficient of Rochester study. Also, BC was 30% higher than the optical EC indicating inclusion of light-absorbing OC in Aethalometer BC.

[P07-12] A REMOTE SENSOR FOR VEHICLE EXHAUST PARTICULATE MATTER.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

There is a need to establish vehicle emission inventories. A recent promising approach is to measure the emissions from many on-road vehicles. The major gaseous pollutants in vehicle exhaust - hydrocarbons, carbon monoxide, and nitrogen oxide - have been measured via roadside remote sensing for a number of years. Technology for the measurement of particulate matter (PM) in vehicle exhaust is less well developed. Opacity measurements of vehicle exhaust plumes have been made, but the technique generally suffers from a lack of sensitivity and opacity is only a measure of elemental carbon, but not of PM mass.

We describe a PM measurement system using a pulsed ultraviolet (266 nm) laser that utilizes a light detection and ranging (LIDAR) system to measure the PM-sensitive backscattered light in addition to the extinction of the transmitted beam (opacity). Light from a laser pulse is partially scattered back toward the system by particles in the exhaust plume. The backscattered light is used as a sensitive measure of PM mass density. This is complemented by a transmission measurement resulting in a UV opacity that quantifies PM mass density for very dense plumes. Therefore, PM mass densities can be measured over a broad range of sparse and dense vehicle exhaust plumes. Simultaneous with the PM measurement, an infrared source is used to quantify the carbon dioxide content of a similar column. The ratio of PM to carbon dioxide gives a fuel-based PM emission rate (units of milligrams of PM per kg of fuel). Ambient PM background is measured before the vehicle passes by the system and subtracted from the total PM concentration measured after the vehicle, yielding the vehicle's PM emission.

Inversion of the road-side measurements requires a laboratory calibration as well as a number of assumptions about the PM. Assumptions about the particulate characteristics are necessary to calculate the single-particle backscatter and extinction cross sections needed to predict the received power that will be measured by the system. Backscatter and extinction cross sections are calculated for solid spheres of organic carbon to represent the exhaust particles from spark-ignition vehicles and for layered spheres consisting of a core of elemental carbon surrounded by a shell of organic carbon to represent the exhaust particles from diesel-powered vehicles. A log-normal size distribution with a specific particle mass median diameter is assumed. On-road PM measurements from nearly 150,000 vehicles are analyzed in a companion poster.

[P07-11] MEASUREMENTS OF PARTICLE INORGANIC AND ORGANIC CHEMICAL COMPOSITION WITH THE PARTICLE-INTO-LIQUID SAMPLER (PILS).

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

We describe the latest developments of a new instrument for near real-time quantitative measurements of bulk aerosol particle chemical composition. The device continuously captures particles into a small flow of purified water. This flow may then be analyzed by existing analytical chemical techniques for measurements of the dissolved aerosol particle chemical composition. Coupled to a dual channel ion chromatograph (IC), the instrument is capable of measuring a suite of aerosol ionic constituents at sensitivities down to approximately 10 ng per cubic meter of air with a duty cycle of roughly 4 minutes. Coupled directly to a total organic carbon analyzer the organic carbon (OC) aerosol component is measured online, or alternatively, by placing a liquid filter inline, the water-soluble carbonaceous component of atmospheric aerosol particles can be determined. The detection limit of either measurement is to approximately 0.1 ugC per cubic meter at a duty cycle of 2 to 6 minutes. Both PILS IC and PILS OC devices has been deployed for surface and airborne measurements in studies whose focus has ranged from urban air quality to characterization of Asian outflow. Current work is focused on speciation of the water-soluble organic carbon component and the extension of the technique to solvents other than water. Examples from various field studies will be presented.

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[P07-10] NEW INSIGHTS INTO THE DYNAMICS OF SOURCES OF FINE PARTICULATE MATTER USING SEMI-CONTINOUS CHEMICAL SPECIATION SAMPLERS.

James J Schauer, Min-Suk Bae, Yu-Chen Chang, Sarala Gazula, Petros Koutrakis, John M Ondov, J. Patrick Pancras, Jay R Turner, Warren H White, Megan Yu Environmental Chemistry and Technology Program, University of Wisconsin-Madison, Madison, WI; Chemistry Department, University of Maryland, College Park, MD; School of Public Health, Harvard University, Boston, MA; Environmental Engineering Program, Washington University, Saint Louis, MO; Cocker Nuclear Laboratory, University of California at Davis, Davis, CA

Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

Much of the current understanding of the dynamics of the sources of atmospheric fine particulate matter is derived from laboratory based chemical analyses that are performed on 24-hour averaged samples. As new instruments have come available to measure the chemical composition of fine particulate matter on a semi-continuous basis, new opportunities have arisen to better understand the dynamics of fine particulate matter sources. Such instruments, including semi-continuous fine particle mass, organic and elemental carbon (ECOC), sulfate ion, nitrate ion, and trace metals have been operated at the St. Louis- Midwest Supersite since the spring of 2001 and will continue to operate until the spring of 2003. Examination of the hourly averaged data from these instruments over this extended sampling period provides information of the frequency and duration of source impacts including high concentrations of organic carbon and trace metals that are sustained for periods in the range of a few hours. Likewise, the temporal patterns of secondary ion including sulfate and nitrate ion show significant differences among different days. It is of great importance that these events are virtually impossible to detect using 24-hour averaged fine particle concentration data. Furthermore, they can be masked in the summary statistics (e.g., seasonal mean diurnal profiles) commonly used to characterize aerosol climatology for higher time resolution data. Examples will be presented for specific days that have similar daily average fine particle compositions but drastically different peak concentrations and temporal patterns. As efforts continue to better understand the relationship between atmospheric fine particle concentrations and public health, there is a need to better understand impact of the dynamics of the components of atmospheric fine particulate matter.

[P07-09] LASER-INDUCED BREAKDOWN SPECTROSOPY (LIBS) FOR ELEMENTAL ANALYSIS OF AMBIENT PARTICLES: DATA FROM THE PITTSBURGH SUPERSITE.

Gregg A Lithgow, Allen L Robinson, Steven G Buckley Mechanical Engineering, University of Maryland, College Park, MD; Mechanical Engineering, Carnegie Mellon University, Pittsbugh, PA

Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

Laser-induced breakdown spectroscopy (LIBS) is increasingly under consideration as a method for rapid elemental analysis applied to multiple media. Applications of LIBS typically employ a pulsed laser with a high peak power to form a spark (breakdown) in the medium to be examined. In gases, the temperature of the resulting plasma at short times (< 10 microseconds) is in the range of 10,000 - 15,000 K, hot enough to dissociate molecules into their constituent atoms, and to excite the electrons in the neutral atoms and ions formed in the plasma out of the ground state and into excited electronic states. As the plasma cools, excited electrons and ions relax back into their ground states, emitting light at characteristic atomic frequencies. Identification of the atoms present in the sample volume occurs using well-known atomic emission lines, and quantification of the elemental species concentration occurs via quantification of the intensity of the emission lines.

LIBS has been used for elemental analysis of ambient particles at the Pittsburgh Supersite. Individual particles are interrogated to determine elemental distributions. Data from a week-long measurement campaign revealed a predominence of Na, Mg and Ca in the sampled particles, with smaller numbers of Cr, Mn, Fe, and Cu-containing particles. Several multi-element particles were observed. Detection limits for the method are on the order of 20 - 100 fg, depending on the element. This paper will focus on the application and potential of the method, data processing, the implications for monitoring, and the potential for source / receptor measurements.

[P07-08] QUALITY CONTROL OF CONTINUOUSLY SIZE-FRACTIONATED FINE AND ULTRAFINE PARTICLE DATA.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

Aerosol technology has recently advanced to detect fine and ultrafine particles in semi-continuously size-fractioned data for short time-intervals, such as those generated by Scanning Mobility Particle Sizer (SMPS) and Aerodynamic Particle Sizer (APS). Aside from applauding tremendous amount of data available, investigators encounter a new challenge of quality control issue of such data. In addition to assure that the instruments are operating in proper procedures and conditions, potential outliers may occur from inherent and unknown mechanisms, which could heavily influence estimation of summary statistics. In this report, a two-stage approach is presented to identify potential outliers so that the integrity of good data is maintained without distortion by the outliers and the potential mechanisms of generating such outliers can be investigated. The first stage considered the entire spectrum of size-fractionated data by date-time as a whole. Total concentration, representing the overall magnitude of the group, and the coefficient of variation (CV), representing the relative strength of group variability, were used to partition the data into four distinct sub-groups. In each sub-group, the second stage of potential outlier screening was employed, by taking into accounts the relative spike and a modified Z-score of each observation, to identify potential outliers. Based on the results from the first stage analyses, we found normal (mass and good) data of particle number concentrations generated by SMPS were contaminated with data of four distinct outlier patterns, one was known due to instrument error and the other three were probably due to inherent and unknown mechanisms of SMPS. The second stage effectively identified potential outliers (high sensitivity and specificity) and revealed the pattern of outliers was consistent within each distinct group. Unlike those of SMPS, APS data were rarely contaminated with potential outliers. In conclusion, the proposed new approach is a useful quality control tool to identify potential outliers in semi-continuously size-fractioned data.

[P07-07] PARTICULATE MATTER MASS CONCENTRATION MEASUREMENTS AT THE SAINT LOUIS - MIDWEST SUPERSITE.

Elizabeth M Simon, George Allen, Scott A Duthie, Petros Koutrakis, Jay R Turner Sonoma Technology, Inc., Petaluma, CA; Northeast States for Coordinated Air Use Management, Boston, MS; Environmental Engineering Program, Washington University, Saint Louis, MO; School of Public Health, Harvard University, Boston, MA

Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

The St. Louis - Midwest Supersite features an extensive array of equipment designed to measure ambient particulate matter mass concentrations. As of November 2002, eighteen months of data have been collected at the East St. Louis (IL) core site. Daily filter-based mass measurements at this site include 24-hour integrated PM-1 by sharp cut cyclone and 24-hour integrated PM-2.5 and PM-10 by Harvard Impactors. Hourly PM-2.5 mass concentrations are obtained using two semi-continuous colocated Andersen CAMMS. In addition to these sustained daily measurements, a medium-volume dichotomous sampler (PM-2.5 and PM-10 cuts) samples on alternating days. To complement these measurements, in March 2002, the Supersite deployed a Rupprecht and Patashnick PM-2.5 TEOM (operating at 50°C). Adjacent to the site, the Illinois Environmental Protection Agency operates a MetOne PM-2.5 Beta Attenuation Monitor, Andersen PM-2.5 FRM (1-in-3 day schedule), Andersen SA1200 PM-10 sampler (1-in-6 day schedule), and GMW/Andersen 2310 TSP sampler (1-in-12 day schedule). This measurement matrix provides not only a robust data stream for aerosol climatologic assessment but also an extensive data set for evaluating the intercomparability of the various measurement methods.

This presentation will summarize our experience with the aforementioned mass concentration monitors at the St. Louis - Midwest Supersite. Emphasis will be placed on the following issues: measurement precision for the Andersen CAMMS; comparisons of the CAMMS data to 24-hour average filter-based mass concentration and hourly-average TEOM mass concentrations; analyses of meteorology and aerosol composition to explain the variations in CAMMS mass and TEOM mass compared to filter mass; and a comparison of the PM-2.5 FRM to other PM-2.5 mass data streams.

[P07-06] CONTINUOUS ULTRAFINE PM MEASUREMENTS IN SOURCE AND RECEPTOR SITES OF THE LOS ANGELES BASIN AND RELATION TO PM2.5 MASS, CHEMICAL COMPOSITION AND SOURCES.

Bhabesh Chakrabarti, Manisha Singh, Philip M Fine, Constantinos Sioutas Civil and Environmental Engineering, University of Southern California, Los Angeles, CA

Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

Population exposure to ambient particulate matter (PM) has received considerable attention due to the association between ambient particulate concentrations and mortality. Recent toxicological studies and controlled human and animal exposures suggest that ultrafine fractions of PM may be responsible for observed health effects. Recently, technologies for continuously measuring coarse and fine PM mass concentrations have been developed and/or improved. A device to continuously measure ultrafine PM mass concentrations based on beta attenuation has now been developed and characterized as part of the activities of the Southern California PM Center and Supersite in Los Angeles, CA.

In this study, two different Beta Attenuation Monitors (BAMs) are employed to measure ultrafine and PM2.5 mass concentrations. The BAM for measuring ultrafine PM is preceded by a 150 nm cut point low pressure drop impactor. Both the BAMs are operated for 2-hour cycles at a typical urban site near a freeway. Among the other instruments co-located with the BAMs are an SMPS (Scanning Mobility Particle Sizer), an APS (Aerodynamic Particle Sizer), an ESP differential TEOM and an Aethalometer.

The main objectives of this study are to document diurnal variation in the ambient ultrafine PM and PM2.5 mass concentrations and to compare the BAM measurements with time-integrated impactor measurements as well as continuous data from the SMPS, APS, and TEOM in source and receptor areas of the Los Angeles Basin (LAB). These data will be presented in context with wind speed and direction and traffic density. The degree of temporal correlation between the ultrafine and fine PM modes is of particular interest because it yields insight into the contributions of particular sources to each mode.

Results in the receptor areas of the LAB show low correlation between ultrafine and PM2.5 mass concentrations, demonstrating that continuous PM2.5 measurements cannot predict UF mass. By contrast, much higher associations between PM2.5 and ultrafine mass concentrations, as well as total particle counts and EC concentrations, are observed in source (urban) sites of the LAB, leading to the conclusion that vehicular sources are the main contributor to PM concentrations at these sites. Our comparison shows that there are significant differences in the diurnal pattern of the ultrafines at the source and the receptor site. Data on the chemical composition of ultrafine PM between these two locations will also be presented.

[P07-05] DIURNAL PATTERNS IN $PM_{2.5}$ MASS AND COMPOSITION AT A BACKGROUND, COMPLEX TERRAIN SITE.

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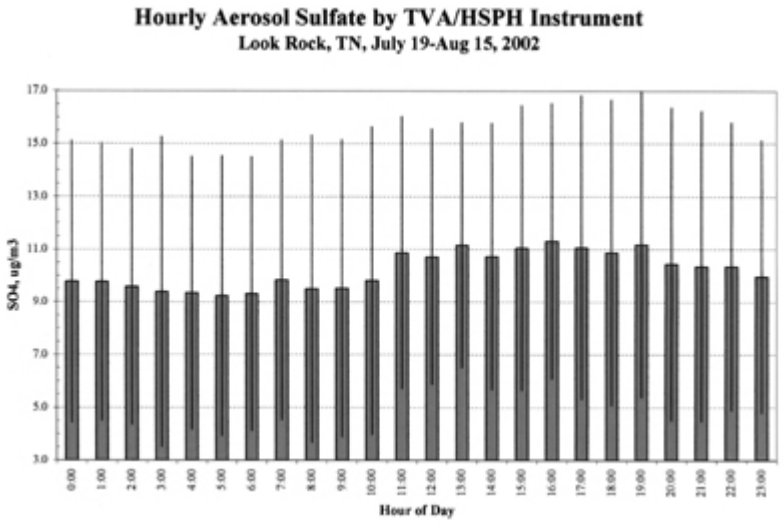
Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

Current fine particle NAAQS specify 24-h integrated mass measurements as the compliance metric. The value of continuous short-time resolution (1h or less) sampling is, however, recognized and being including in US EPA monitoring strategies. An extensive body of mass concentration data has been acquired using continuous $PM_{2.5}$ TEOM monitoring at Look Rock, TN, along with trace gas measurements. This data set has now been augmented by continuous sampling for sulfate (2 methods) and black carbon during enhanced monitoring periods at the site. We compare the 12- and 24-h averaged values with mass and compostion data from integrated samplers, then report the diurnal variations in concentrations from continuous monitoring for 3 summers (see Figure for summer, 2002, sulfate data) and for more limited periods throughout the year. The role of upslope-downslope circulation and daytime production processes on the observed diurnal variability are discussed. These factors appear to largely control the observed diurnal patterns, and do influence the time variability of concentrations leading to pollutant exposure in the complex terrain environment of the Great Smoky Mountains National Park. (Click to see figure 1)



Figure

[P07-04] THE RELATIONSHIP BETWEEN BOTH REAL-TIME AND TIME-INTEGRATED COARSE AND FINE PARTICULATE MATTER AT AN URBAN SITE IN LOS ANGELES.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

Population exposure to ambient particulate matter (PM) has received considerable attention due to the association between ambient particulate concentrations and mortality. Current toxicological studies and controlled human and animal exposures suggest that all size fractions of PM may be responsible for observed health effects. Recently, technologies for continuously measuring coarse and fine PM mass concentrations have been developed and/or improved.

In this study, coarse (PM_{10}-$PM_{2.5}$) and fine ($PM_{2.5}$) PM mass concentrations near a typical urban site are measured with both continuous sampling devices and a time-integrated sampler. The collocated continuous monitors include: a Beta Attenuation Monitor (BAM) to measure $PM_{2.5}$, an ESP differential Tapered Element Oscillating Microbalance (TEOM) to measure $PM_{2.5}$, a Scanning Mobility Particle Sizer (SMPS) and Aerodynamic Particle Sizer (APS) to measure both coarse and fine PM, and a Continuous Coarse Monitor (CCM) to measure coarse PM. This device consists of a 2.5 μm cutpoint virtual impactor placed upstream of a Tapered Element Oscillating Microbalance (TEOM). Time-integrated samples are taken every sixth day with a Micro-Orifice Uniform Deposit Impactor (MOUDI).

The main objective of this study is to document both short-term and diurnal variation in ambient fine and coarse particulate mass concentrations with respect to each other while considering the effects of sources, weather, wind speed and wind direction. Of particular interest will be how well each size fraction tracks the other, for this will yield insight on the contributions of particular sources to each mode during various conditions.

[P07-03] INFERRING THE SOURCES OF FINE AND ULTRAFINE PARTICULATE MATTER AT DOWNWIND RECEPTOR SITES IN THE LOS ANGELES BASIN USING MULTIPLE CONTINUOUS MEASUREMENTS.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

Recent studies that have found increased health effects of atmospheric ultrafine particulate matter (PM) have refocused attention on particle number rather than particle mass concentrations as a relevant measurement of PM pollution. As part of the Southern California Supersite program, ambient particle characteristics were measured over 13 months at three different sites in the eastern portion of the Los Angeles Basin: Riverside, Rubidoux and Claremont, CA. The sites represent receptor locations that are influenced by local particle sources as well as advection from the more intense particle sources upwind closer to Downtown Los Angeles. An SMPS/APS tandem system was employed to collect continuous particle size distributions, from which particle number and mass concentrations were calculated. An aethalometer provided continuous particulate elemental carbon (EC) concentrations. Results so show no meaningful correlation between particle number and mass, indicating that fine particle standards may not be effective in controlling ultrafine concentrations. Diurnal patterns show a morning traffic peak indicated by increases in particle mass, number, and EC. Afternoon periods in the warmer months are characterized by high number counts while mass and EC remain low, suggesting the formation of new particle by photochemistry. Particle mode diameters range from 30 nm up to above 100 nm, a result not seen in most other studies of particle size distributions in other urban or rural areas where mode diameters are generally less than 50 nm. Evidence is presented that the observed ultrafine particle concentrations and size distributions are influenced by long range advection and photochemical processes as well as vehicular emissions, which have been previously assumed to dominate day to day ultrafine particle levels.

[P01-11] A SPATIO-TEMPORAL AEROSOL CLIMATOLOGIC CONTEXT FOR THE SAINT LOUIS-MIDWEST SUPERSITE.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 1: The NARSTO North American PM Assessment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Conceptual models that capture key features of an airshed's emissions and meteorological characteristics can illuminate observed patterns of ambient aerosol behavior. Such models can be developed by analyzing aerosol characteristics in terms of local surface meteorologic parameters and broader spatio-temporal patterns in weather and aerosol climatology. Numerous tools are now available to support such investigations. This presentation will demonstrate the application of selected tools/strategies for the St. Louis - Midwest Supersite data.

One strategy focuses on the integration of synoptic scale weather patterns into the particulate matter chemical composition data set. The great multiplicity of parameters potentially relevant to synoptic scale weather motivates the search for classification schemes that reduce synoptic weather patterns to relatively few distinct types. Examples of such schemes include clustered air mass back trajectories (e.g., S.R. Dorling et al., *Atmos. Environ., 26A*: 2575-2581 (1992)) and hybrid manual/automatic synoptic-weather typing (e.g., S.C. Sheridan, *Int. J. Climatol., 22*: 51-68 (2002)). This presentation will present and interpret frequency distributions for aerosol mass and selected aerosol chemical components as stratified by the synoptic scale weather classes.

A second strategy combines visual representations from multiple sources into a single "picture" of the aerosols' multi-dimensional characteristics, such as distribution in space and time (x,y,z,t), with respect to particle size, and chemical composition. Two classes of tools for conducting multivariate pattern and trend analyses will be presented. A 'virtual wall' has been developed to replace taped-up plots in hallways for data visualization. Consisting of side-by-side views of different data, it provides an effective method for capturing and assessing relationships among aerosol parameters. The 'wall' is particularly effective for temporal analysis in the form of animations. An example 'wall' configuration includes pollutant concentrations, times series, weather maps, trajectory plots, satellite imagery and web cams. A second class of tools fuses multiple data into a single map or time view to identify similarities or reconcile differences in spatio-temporal patterns. A common set of fusion tools are geographic information systems (GIS) that overlay data for spatial analysis.

[P07-01] EVALUATION OF PM10 EMISSIONS FROM AGRICULTURAL OPERATIONS IN SAN JOAQUIN VALLEY, CALIFORNIA.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

In California's San Joaquin Valley (SJV), agricultural operations are a highly complex but potentially significant source of PM10. In late summer and fall a large fraction of PM10 is attributed to soil dust (Chow et al., 1992) becoming airborne due to agricultural activities.

We have used point sampler arrays to evaluate PM concentrations (vertical point sampler profiles) and calculate point sampler emission factors. However, because of many limitations associated with point sampler techniques, especially limited spatial resolution in the vertical direction, the results may significantly underestimate the plume concentration and result in underestimates of emission factors (Holmén et al., 2001).

Application of lidar (Light Detection and Ranging) to PM measurements will be presented. Data collected with point samplers and CNL lidar (simultaneously) during a variety of agricultural operations in the summer and in the fall of 2000 will be reported. Analytical methods developed in our laboratory will show lidar contribution to clarify if the shapes of plumes measured as three-point PM vertical profiles are representative of the average plumes recorded during the sampling period and help to determine the dust plume height which should be considered for integrating the modeled PM10 concentrations.

The relationship between the amount of PM10 generated from the soil during agricultural practices and the soil texture measured by clay, silt and sand content (Carvacho et al., 2002) will be establish for these series of experiments.

Results will be presented showing comparisons between three-point PM vertical profiles (for selected tests), averaged vertical profiles obtained from the lidar two dimensional (2D) scans and PM10 index values calculated for corresponding soils. Further, soil moisture content measured during summer and fall studies will be presented and correlated with emission factors calculated based on PM models and verified with lidar (Holmén et al., 2001).

[P07-16] COMPARISON OF FILTER-BASED AND SEMI-CONTINUOUS CARBON AEROSOL MEASUREMENTS AT RESEARCH TRIANGLE PARK, NORTH CAROLINA.

Joann Rice OAQPS, EMAD, U.S. Environmental Protection Agency, Research Triangle Park, NC

Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

Particulate carbon is a major constituent of fine particulate matter (PM2.5) mass in many parts of the United States. Carbon has been found to account for as much as 50% of the total fine particle mass in the atmosphere. The carbon fraction of PM2.5 consists of elemental carbon (EC) and organic carbon (OC). Particulate elemental carbon is a primary emission from incomplete combustion of fossil fuels and biomass burning and serves as a tracer for combustion-derived particles. Particulate organic carbon has both primary and secondary emission sources. Primary emissions originate from combustion, chemical, geological (fossil fuels), and biogenic sources, whereas organic carbon is secondarily formed from gas-to-particle transfer of anthropogenic and biogenic precursor gases. Both EC and OC have significance in relation to atmospheric visibility, EC as a light absorbing material and OC as a light scattering material, and control strategies for PM2.5. The goal of this paper is to provide results from the intercomparison of measurements made by the Rupprecht & Patashnick series 5400 carbon analyzer, the Magee Scientific Aethalometer and a filter-based Andersen Chemical Speciation sampler in Research Triangle Park, NC. In addition, observations regarding temporal patterns, diurnal patterns and seasonality of the semi-continuous measurements are provided.

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[P11-20] CHARACTERIZATION OF PM AND METEOROLOGY TO SUPPORT SELECTION OF MODELING EPISODES.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 11: Air Quality Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Data available from the ongoing SouthEastern Aerosols Research and CHaracterization Study (SEARCH) and concurrent monitoring programs provide a basis for examining the relationships between aerosols and other geographical and meteorological factors that influence the phenomenon of regional haze in the southeastern U.S. Daily measurements of particles, trace gasses, and meteorological parameters from the SEARCH monitoring network are available for eight monitoring sites located throughout the Southeast (in urban, suburban, and rural locations).

This poster describes the use of the SEARCH data to explore the relationships between aerosol formation, composition, and transport and meteorology. The findings are then used to guide the development of recommendations for selecting modeling episode periods for air quality modeling applications, with consideration of the frequency and magnitude of measured PM2.5 events, observed variations in the relative importance of the PM constituents, important PM-related processes, and the geographical scales encompassed by both urban-health and regional-haze issues. The emphasis of the analysis is PM2.5 and regional haze.

In this study, we used the Classification and Regression Tree (CART) statistical analysis software to extract information about the physical relationships among the variables and to classify the days according to species concentrations and meteorological parameters. Specifically the CART analysis technique was used to determine the types of conditions that lead to high PM concentrations and poor (and good) visibility, and distinguish among different types of PM and visibility events.

CART was applied for each SEARCH site and for PM2.5 concentration, PM constituents, and calculated visibility. The results of the CART analysis have provided interesting insights into the relationships among the input parameters. These relationships vary among the different locations and between the urban, suburban/rural monitors. The CART results indicate that different meteorological conditions lead to differences in concentration as well as constituency.

Objective episode selection procedures were then used to construct a set of episode days for regional-scale modeling of the Southeast. An optimization procedure was applied to the selection of multi-day episodes for optimal achievement of specified selection criteria for various combinations of geographical areas and PM/visibility metrics. The episodes are expected to represent the characteristics (and ultimately the response to emission reductions) of PM2.5 air quality relative to the annual NAAQS for PM, and visibility relative to the regional haze goals.

[P11-19] PRIMARY AND SECONDARY ORGANIC AEROSOLS OVER THE UNITED STATES: ESTIMATES ON THE BASIS OF OBSERVATIONS AND MODELED PRIMARY OC/EC RATIOS.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 11: Air Quality Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

The temporal and spatial distributions of primary (OC_{pri}) and secondary (OC_{sec}) organic aerosols over the US were estimated with observational data from the IMPROVE and SEARCH networks, coupled with the modeled primary OC/EC ratios from EPA's Models-3/CMAQ during the two month summer periods (period 1: June 15 to July 17 and period 2: August 3 to August 31) in 1999. For the results of period 1, the mean OC_{pri} concentrations over the Northeast, Southeast, Central, West and California regions were 0.5, 1.5, 0.6, 1.0, 1.4, and 1.4 μ g C m^{-3}, respectively, while the mean OC_{sec} concentrations were 1.1, 1.2, 0.7, 0.5, 0.7, and 1.1 μg C m^{-3}, respectively. The contribution of OC_{sec} to the measured OC ranged from 34% over the West to 69% over the Northeast. The mean values of modeled primary OC/EC ratios ranged from 1.18 over the Northeast to 3.71 over the West. The similar conclusions for the period 2 can be obtained. The daily temporal variations at SEARCH sites indicate that the daily mean values of primary OC/EC ratios can change from 0.84 to 2.99 at Yorkville and the contributions of secondary OC to OC can change from 0% to 66% at North Birmingham during the period 1. The hourly results at Cornelia Fort, Nashville (TN) and Atlanta, GA, show great variations of contributions of secondary OC to OC. These results indicate the difficulties in estimating the relative contributions of primary and secondary OC at a site. There is large uncertainty in the estimation of the relative contributions of primary and secondary OC based on the assumption of a constant representative ratio of primary OC/EC at a location. The analysis also reveals that there was some association between the secondary OC, K and Zn (correlation coefficients> 0.45), indicating that biogenic origin may contribute to the formation of secondary OC significantly since K and Zn are abundant in plant tissues.

[P11-18] JET OF STRETCHING DURING THE PARTIAL COALESCENCE.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 11: Air Quality Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

During the falling in free atmosphere of drops of various sizes their collision happens. The result of this process can be rebound, coalescence and partial coalescence which is transition process.

The result of interaction of drops is determined by process of displacement of gas interlayer between drops. If the interlayer between drops will stay then the rebound happens. If during the approachment the interlayer will be displaced then the coalescence happens. In case of partial coalescence the interlayer of gas is broken though locally. For partial coalescence it is necessary that the break off of an interlayer of gas has taken place at the stage of rebound. In this case the drop has a sufficient kinetic energy to break off the arisen necking. This necking brakes a flying away drop that results in stretching it (the drop) in a jet. During the certain ratio of parameters the jet acquires the cylindrical form. The process of partial coalescence was in detail investigated in Kolpakov (1983). In experiments the generator of monodisperse drops of "vibrating needle" type, impulse light source synchronized with the generator of drops through the generator of delay of a light pulse was used. The characteristic time of drop appearance was about 10^{-2} sec and characteristic time of interaction was 10^{-4}-10^{-5} sec. At the save time the using of the mentioned above generators has allowed to visualize the process of collision of drops and to study all three kinds of interaction in detail.

It turns out that the ratio of a radius of a jet *a* in the moment when it takes a cylindrical form to an initial radius of a drop *R* which is stretching in a jet is in a range from 0.9 to 0.56.

The solution of such problem was represented in Aslanov (1999). The process of separation of a drop forming on the latter cycle of beaking off of the jet were the hydrodynamic instability of the latter achieves its maximum significance is considered.

Including such process regular we apply to this control volume the equation of balance of mass and energy.

The solution of this equation gives the significance $\eta = a/R \approx 0.53$.

If we compare this significance with the result obtained experimentally (0.56) we can see a good agreement between the result of the experiment and theoretical account.

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Aslanov S.K. (1999). To the theory of disintegration of liquid jet on drops. *Journal of Tech. Phys. RAS*. 69: 132-133.

[P11-17] COMPUTATIONAL METHODS FOR MULTI-PHASE MULTI-REACTION EQUILIBRIUM PROBLEM - MODELING URBAN AND REGIONAL AEROSOLS.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 11: Air Quality Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Atmospheric particulate matter (PM) models are effective tools to quantify the relationship between sources of air pollutants and their health and environmental impacts. An ubiquitous component of the PM models is the thermodynamic module that simulates the partitioning of chemical species among the gas, aqueous, and solid phases and predicts the total mass and chemical composition of PM. When the temperature and pressure are both constant, the number of phases and the amount and composition of each phase which occurs at equilibrium in nature - the true composition - corresponds to the global minimum of the Gibbs free energy of the system. It is often the case that there are multiple local minima in the minimization approach and multiple solutions the equation solving approach. In this talk, we discuss the issues and challenges associated with multiple local minima and numerical scaling, and approaches to reducing the likelihood of methods giving the wrong solution. We present a new avenue to appropriately predict the phase transition between the aqueous and solid PM phases, based on the reformulation of the optimality system as a nonlinear system of variational inequality type. Consequently, active set based Newton method is developed to obtain robust and stably convergent numerical solutions of multi-phase multi-reaction equilibrium problem. We conclude with numerical experiments, showing that the method is efficient, computationally suitable for its use in 3D Eulerian urban air-shed models.

[P11-16] ATMOSPHERIC BOUNDARY LAYER CHARACTERIZATION AND THE AEROSOL EXTINCTION COEFFICIENT DURING THE BALTIMORE PM SUPERSITE - JULY 2002.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 11: Air Quality Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

During the Baltimore PM Supersite July 2002 intensive field campaign, a set of instruments were deployed to measure and derive Atmospheric Boundary Layer (ABL) properties, particularly aerosol extinction coefficient and mixing layer height.
In this presentation we will present analysis of aerosol backscatter data obtained with the Johns Hopkins University elastic backscatter lidar system. In addition we make use of micrometeorological instruments, a nephelometer, an APS (Aerodynamic Particle Sizer), and a SMPS (Scanning Mobility Particle Sizer). The data obtained with these instruments are used in Mie theory computations to get aerosol scattering / extinction / backscattering coefficients. The aerosol extinction coefficient determined for λ =1.064 μm is used as boundary condition in the lidar equation to obtain the vertical profile of aerosol extinction coefficient.

[P11-15] GAS-PHASE NITRIC ACID AND SULFURIC ACID FORMATION: RESULTS FROM PMTACS-NY SUMMER 2001 CAMPAIGN.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 11: Air Quality Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Hydroxyl (OH) radical, other trace gases such as SO_2, NO_2, nitric acid (HNO_3), and aerosol composition (including nitrate and sulfate) were measured during the PMTACS-NY summer 2001 field campaign at Queens in New York City. These observations provide an opportunity to study the formation rates of gas-phase HNO_3 and sulfuric acid (H_2SO_4) and the relationship between formation rates and concentrations. For gas-phase HNO_3, its concentration followed very well the production from OH reaction with NO_2 for both composite diurnal variation and individual days. This agreement indicates that the reaction of OH with NO_2 was the main gas-phase HNO_3 source and that the HNO_3 deposition rate was very fast in this area. Based on the measured OH, NO_2 and SO_2, the maximum production rates of HNO_3 and H_2SO_4 were about 10 $\mu g\ m^{-3}\ hr^{-1}$ and 0.5 $\mu g\ m^{-3}\ hr^{-1}$, respectively, at midday. On average, the daily cumulative HNO_3 and H_2SO_4 production rates were 135 $\mu g\ m^{-3}\ d^{-1}$ and 5.2 $\mu g\ m^{-3}\ d^{-1}$, respectively. Comparisons with the results from Whiteface Mountain field site (representing a relatively clean environment) show that HNO_3 and H_2SO_4 production rates in New York City were higher by factors of 24 and 13, respectively. Results also show that the nitrate concentrations (in $\mu g\ m^{-3}$) in the particles were lower than the calculated HNO_3 production rates (in $\mu g\ m^{-3}\ hr^{-1}$) by a factor of 10 on average. On the contrary, the sulfate concentrations (in $\mu g\ m^{-3}$) in the particles were higher by a factor of about 15 than calculated gas-phase H_2SO_4 production rates (in $\mu g\ m^{-3}\ hr^{-1}$). This very different relationship between the gas phase production and particle phase concentration of sulfate and nitrate provides useful information about sources and sinks of these important species.

[P11-14] EVALUATION OF NITROGEN DIOXIDE PHOTOLYSIS RATES IN SAO PAULO (BRAZIL).

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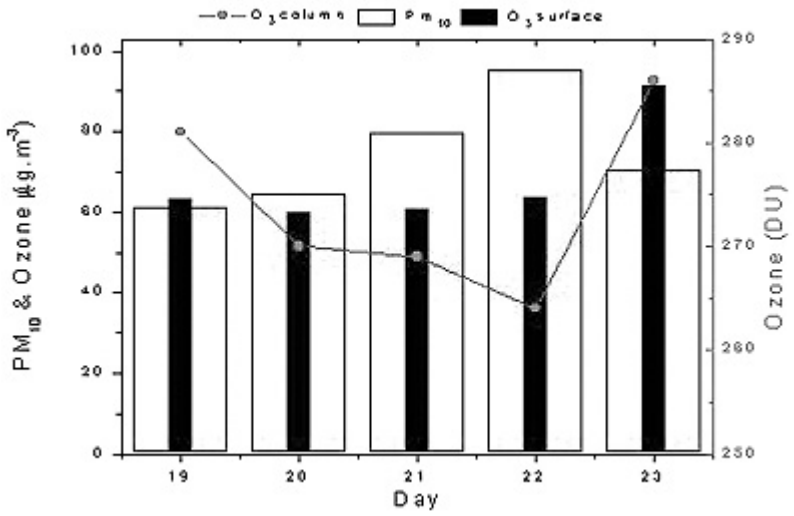
Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 11: Air Quality Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

The São Paulo Metropolitan Area with 16 million inhabitants and more than 5 million vehicles has several problems concerning air pollution. A problem which is worrying the community is the ozone concentration, whose values are increasing in spite that other pollutants concentrations are decreasing.

This study is involved in the analysis of NO_2, O_3 and particulate matter relations. Since NO_2 is an O_3 precursor, photolysis rates of this gas were predicted for São Paulo during a specific week in August, 2002, using the Tropospheric Ultraviolet-Visible (TUV) radiation transfer model (NCAR 2000, http://acd.ucar.edu/models). The results correlated particulate, NO_2, O_3 concentrations and meteorological parameters. Optical properties were obtained from Aeronet (Remote Sens. Environ., 66:1-16, 1998) for São Paulo. Urban aerosol concentrations seemed to influence the rates, which decrease when occurs an increase in particles concentrations. In Figure 1 are presented the O_3 and PM_{10} at surface (data from CETESB, the São Paulo State Environmental Agency) O_3 column (data from TOMS) for August, 19 to 23. Aerosol optical depth (AOD), single scattering albedo and the Angstrom parameter alpha are showed in Figure 2. It was observed that urban aerosol can decrease the rates due to the absorption fraction of the particles, and then the decrease of the actinic flux. The single scattering albedo behavior shows also a decrease. The rates decreased through the week and then the O_3 concentrations, as expected. (Click to see figure 1) Figure 1. Ozone and PM_{10} concentrations for August, 19-23 (2002) (Click to see figure 2) Figure 2. Aerosol optical depth (AOD), single scattering albedo and alpha for August, 19-23 (2002)



Figure

[P11-14] EVALUATION OF NITROGEN DIOXIDE PHOTOLYSIS RATES IN SAO PAULO (BRAZIL).
(continued)

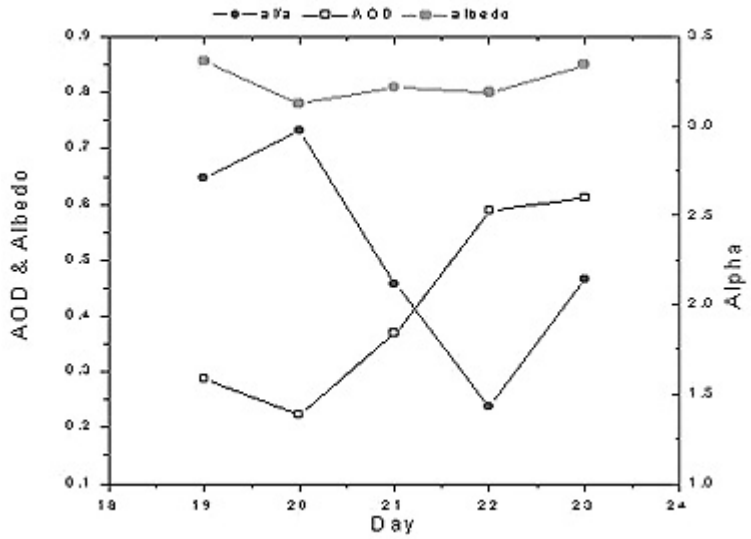


Figure 1

[P11-13] ESTIMATED SCAVENGING COEFFICIENTS OF SOLUBLE AEROSOL FROM OBSERVATIONS IN THE EASTERN UNITED STATES.

Constantin Andronache Boston College, Gasson Hall, Chestnut Hill, MA

Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 11: Air Quality Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

The scavenging of atmospheric aerosol by falling precipitation is a major removal mechanism of airborne particles. This process involves complex interactions between aerosols and hydrometeors and is dependent on precipitation and aerosol properties. Atmospheric aerosol models employ wet scavenging coefficients (WSC) to describe the fate of various aerosol species under precipitation conditions. Given the complexity of precipitation process and the variability in the physical and chemical characteristics of ambient aerosols, the representation of wet removal processes in numerical models requires detailed comparisons with observations. In this work we present: (1) a conceptual microphysical model to estimate the WSC of soluble aerosol by rain; (2) an independent method to estimate average WSC of soluble aerosol (sulfate) based on available data from Eastern United States locations. The paper shows that model calculations of WSC are well supported by the independent estimates from observations and discusses the sources of uncertainties. The study indicates the needed measurements to validate microphysical models of WSC for conditions of interest in atmospheric aerosol modeling.

[P11-12] A PARTICULATE MATTER AIR QUALITY FORECAST MODELING SYSTEM FOR THE NORTHEAST U.S. - COMPARISONS WITH SUMMER 2001 EPA SUPERSITE FIELD INTENSIVE DATA.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 11: Air Quality Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

An air quality forecast modeling system (AQFMS), which has run reliable18-hr oxidant air quality forecasts for the Northeast United States for over a year, has been further developed to consider the prediction of PM air quality in the region. The AQFMS was designed to operate with forecasted meteorological fields from either of two mesoscale meteorological models, the Penn State/NCAR Mesoscale Model MM5 or the University of Athens' ETA-SKIRON meteorological model. The meteorological fields are used to drive the Comprehensive Air Quality Model with Extensions (CAMx), a photochemical air quality simulation model.

This prototype system has recently been upgraded to incorporate emissions of SO2, NH3, and primary particulate matter and a rudimentary secondary formation mechanism for sulfate, nitrate and organic particulate matter. Archived meteorological forecasts, generated as part of the PMTACS-NY Supersite Summer 2001 Field Intensive, have been used to re-run the forecasts with updated emissions generated by the SMOKE emission model and the modified chemical mechanism within the CAMx model.

Preliminary assessment of the PM air quality forecast modeling system is presented and forecasted PM model results for the northeast and New York metropolitan areas are compared with measurements performed during the EPA Summer 2001 Supersite intensive field campaign.

[P11-11] SIMULATION OF PARTICULATE MATTER IN SOUTHERN TAIWAN BY MODELS-3/CMAQ.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 11: Air Quality Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Particulate matter is one of major pollutants causing the ambient air quality standard to be exceeded in southern Taiwan, especially during November to February in the following year. The results from field measurements showed that the abundant species in PM2.5 were sulfate, nitrate, ammonia, organic carbon and elemental carbon. In this study, Models-3/CMAQ was used to simulate the particulate matter in southern Taiwan from the 21st to 27th, November 1996 and the simulated results were then compared with field measured data. The meteorological data were provided by MM5 with FDDA and the emission data were from Taiwan Emission Data System version 4.2 (TEDS 4.2) by using SMOKE for stationary, mobile and area sources. The VOCs emitted from biogenic sources were estimated by BEIS2. Four layers of nested grids with the finest grid of 4 km by 4 km, 15 vertical sigma layers, RADM2 and RPM mechanisms were used in the simulation. In southern Taiwan, measured data showed that sulfate concentrations were about 1.5 times greater than those of nitrate. However, the simulated results revealed that nitrate concentrations were about 2 times greater than those of sulfate. But the simulated nitrate concentrations were similar to the observed data and sulfate concentrations were significantly underestimated. Note that the average ratios of measured to simulated NOx and SO2 were 1.4 and 1.1, respectively. That is, both were in good agreement for SO2 and the simulated NOx were slightly underestimated. Therefore, the formation of sulfate was underestimated by RPM in Models-3/CMAQ. The underestimation of ammonia may due to the underestimation of sulfate, because ammonia sulfate was the major compound in secondary aerosol. Based on measured results, carbonaceous species accounted for about 20% of PM2.5 in Kaohsiung City. Thus, the simulated concentrations of organic carbon (OC) and elemental carbon (EC) were underestimated, too. However, the differences between simulated and measured NMHC concentrations were even greater. Therefore, the underestimation of VOCs emission may cause the lower simulated concentrations of OC/EC. Diurnal variation patterns of NO3--N and HNO3-N were similar between simulation and observation data: greater HNO3 concentrations occurred in daytime and the opposite pattern was observed for nitrate. However, the peak concentrations of HNO3 and NO3- were not in the same ranges between simulated and observed data. Additionally, ammonia was highly correlated with sulfate in measured data, but in simulated results, ammonia was strongly correlated with nitrate.

[P11-10] MODELING PARTICULATE MATTER WITH THE COMMUNITY MULTISCALE AIR QUALITY (CMAQ) MODELING SYSTEM DURING THE PACIFIC NORTHWEST 2001 (PNW2001) FIELD CAMPAIGN.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 11: Air Quality Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

The Community Multiscale Air Quality (CMAQ) modeling system is examined for its ability to predict particulate material (PM) concentrations in the Pacific Northwest. Particulate matter pollution in the Pacific Northwest is unique due to few large pollution point sources and to the large contribution of biomass burning. The worst particulate pollution occurs on cold, stable, stagnant days when wood stoves are heavily used. Strong inversions trap PM close to the surface and often concentrate it in narrow valleys around the Puget Sound. Summertime PM production impacts visibility in the numerous Class I areas in the region. Transport is important from other urban areas such as Portland, OR and Vancouver, BC as well as from forest fires east of the Cascade mountain crest.

To understand PM and gaseous pollution in this region, Pacific Northwest National Laboratories (PNNL) and others conducted the Pacific Northwest 2001 (PNW2001) campaign in August, 2001. This was done in concert with Pacific 2001, a Canadian study of pollution in the Lower Fraser Valley of British Columbia and northwest Washington. Air pollutants, gaseous precursors, and meteorological variables were measured from the ground and by aircraft within the boundary layer. CMAQ simulations were performed using 12 km and 4 km gridded domains for August 20th, 26th, and 27th, the days when the most intensive observations were conducted. The states of Washington, Oregon, and Idaho as well as Environment Canada provided a ground-up emissions database for this study. MM5 produced meteorological fields using a combination of analysis nudging at the coarse resolution and observation nudging to winds at the fine scale. Sensitivity to analysis and observational nudging and to boundary layer parameterizations is investigated by comparison to observations from surface profilers, PNNL aircraft, and more than one hundred surface sites. The results indicate nudging to a gridded analysis improves meteorological fields throughout the simulation. In addition, the MRF boundary layer parameterization produced more realistic profiles and PBL heights than the Asymmetric Convection Model PBL scheme. The CMAQ modeling results are compared to aircraft and ground measurements of PM size, mass, species, and optical properties.

[P11-09] MODELING PHOTOCHEMISTRY AND AEROSOLS IN POLLUTANT PLUMES WITH THE CMAQ PLUME-IN-GRID APPROACH.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 11: Air Quality Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

Significant emissions of NOx and SOx are released into plumes emanating from the tall stacks of point sources, such as isolated power plants. These primary species are important precursors of a variety of secondary pollutants, including ozone and aerosol species. However, important characteristics of point sources plumes are their initially small dimensions and their finite growth rates downwind due to meterological processes. Since the traditional Eulerian grid model method is to instantly mix point source emissions into a large grid cell volume, considerable artificial dilution can occur which adversely impacts chemical and aerosol processes. The plume-in-grid (PinG) approach integrated into the EPA Community Multiscale Air Quality (CMAQ) grid modeling system was specifically designed to provide a realistic treatment of the physical and chemical processes affecting pollutant concentrations in major point source plumes. The PinG method simulates the gradual horizontal and vertical expansion of subgrid scale plumes and more properly treats the chemical evolution in individual plume cells during the subgrid scale phase within a CMAQ Chemical Transport Model (CCTM) simulation.

The PinG treatment has been extended with the incorporation of the same aerosol module being applied in the CCTM grid model, which allows gas-phase chemistry and aerosol processes to be performed concurrently in the PinG submodel. The aerosol module employs a modal approach with the size distribution defined by Aitken, accumulation, and coarse modes. The fine aerosol mass for secondary species, including sulfate, nitrate, ammonium, and organics from anthropogenic and biogenic sources are determined. Simulations have been performed for a group of major point sources exhibiting a range of NOx, SOx, and particulate emission rates located in the region surrounding Nashville, TN during summer periods from the Southern Oxidant Study (SOS) experimental studies in 1995 and 1999. Model runs were conducted with two different chemical mechanisms (Carbon Bond IV and RADM2) and two different chemical solvers (QSSA and SMVGEAR) to explore the impact on aerosol species concentrations. Comparisons of model results for selected gas species and aerosol concentrations will be examined against plume data obtained by research aircraft traverses across plumes. Initial results are encouraging as the evolution of ozone and aerosol sulfate appears to agree with emerging plume data. More fine sulfate was generated in the SO2-rich plumes which exhibited lower NOx emission rates than in plumes containing greater NOx levels.

[P07-02] A NEW INSTRUMENT FOR MONITORING NUMBER AND MASS OF AMBIENT PARTICLES: LABORATORY AND FIELD EVALUATIONS.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

Current air quality standards are based on particle mass concentration and consequently various instruments are available for mass measurement. However, there are other metrics, such as number concentration, which, according to recent studies, may be more closely related to health effects resulting from atmospheric particulate matter than just mass (measured for example as PM10). For such metrics there is currently a lack of suitable instrumentation for monitoring purposes. Since it is not yet clear which of these metrics best correlates with the health effects, simultaneous monitoring of both particle mass and number would be useful especially in urban areas.

A novel real-time particle-counting instrument has been developed in an attempt to achieve this aim. It is capable of counting particles with diameters from approximately 10 nm to 10 μm in several size ranges. The instrument uses a parallel combination of optical counting for larger particles plus condensation nucleus counting for the smallest sizes. Gravimetric sampling of PM10 or PM2.5 provides the possibility of comparing the measured number concentrations with widely used mass concentration standards and with mass measurements from other instruments.

The new instrument was calibrated in the laboratory using standard PSL aerosol and sodium chloride particles and comparing its performance with that of a condensation particle counter (CPC) from TSI (model 3010). The performance was then further evaluated in field trials at various sites including a monitoring station in Birmingham (UK) city centre, a site mainly influenced by traffic emissions from major roads. Results are reported from this site, at which the instrument was collocated with a CPC (TSI model 3022A) and a TEOM. Very good correlation was observed between the ultrafine particle concentration indicated by the new instrument and the total number concentration measured by the CPC. Mass concentration calculated from the particle numbers in the various size fractions correlated well with the values measured by TEOM, implying that the number-to-mass conversion method could be used for near real-time monitoring of PM10 as well. The correlations between the new instrument and the TEOM and CPC data as function of particle size are also discussed. The number and mass concentrations from this field trial have been further analysed in relation to source distribution in and around the sampling site and various meteorological parameters.

[P07-28] WATER CONTENT OF AMBIENT AEROSOL DURING PITTSBURGH AIR QUALITY STUDY.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

The ability of atmospheric particles to absorb water affects their lifetime, their light scattering properties, their interactions with semi-volatile compounds, and probably their deposition efficiency in the respiratory tract. Due to the hysteresis effect of the hygroscopic growth, the physical state (dry or wet) of particles in the troposphere is uncertain below about 80% RH, leading to uncertainties in their optical and chemical properties. Aerosol size distributions, dried and at ambient RH conditions, have been monitored within the Pittsburgh Air Quality Study (PAQS), for several months starting with July 2001. The measurements were made using the Dry and Ambient Aerosol Size Spectrometer (DAASS) (Stanier et al. 2002).

A comparison of "dry" and "wet" size distributions revealed that during summer and autumn the ambient aerosol in Pittsburgh always contained water, even at RH as low as 30%. During the winter, however, several periods were observed when particles were dry up to 65% RH. This behavior is consistent with the chemical composition of the aerosol and our understanding of its hygroscopic properties. During the summer, particles in the area are often acidic. The dominant component, ammonium bisulfate does not crystallize down to about 10% RH. During the winter months the inorganic aerosol in Pittsburgh is dominated by ammonium sulfate and ammonium nitrate and crystallizes at higher RH. The observed aerosol growth factors are compared with the thermodynamic equilibrium model GFEMN (Ansari, Pandis, 1999) prediction. This comparison indicates that the aerosol on some occasions may be composed of a mixture of crystallized and wet particles. The difference in the physical state maybe the result of either different chemical composition (externally mixed aerosol) or different histories of the air parcels (particles may have experienced different RH).

An important implication of the aerosol being wet during acidic conditions is that the PM mass measurements may suffer a positive artifact due to the retained water on the aerosol during the weighing.

Ansari, A.S.; Pandis, S.N. (1999) Prediction of multicomponent inorganic atmospheric aerosol behavior. Atmos. Environ. 33, 745-757

Stanier C.O., Chan W.R., Khlystov A., Mandiro M., Pandis S.N. (2002) Semi-continuous measurements of the aerosol size distribution and liquid water content in Pittsburgh, PA using the Dry/Ambient Size Spectrometer System (DAASS). To be submitted to Aerosol Sci. & Technol.

[P01-07] CONCEPTUAL DESCRIPTION OF PM OVER MEXICO CITY.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 1: The NARSTO North American PM Assessment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Mexico City has 18 million inhabitants in an enclosed valley, with among the highest concentrations of ozone and PM in the world. The Mexican 24-hour PM_{10} standard (150 $\mu g/m^3$) is violated on about 30% of days, and the annual average PM_{10} standard (50 $\mu g/m^3$) was violated at eight of ten stations in 2000. Average concentrations range from 50 $\mu g/m^3$ southwest of the city, to 95 $\mu g/m^3$ NE. There is currently no Mexican standard for $PM_{2.5}$, and $PM_{2.5}$ is not measured routinely. Measurements of $PM_{2.5}$ during the IMADA campaign (Feb.-Mar. 1997) show that average $PM_{2.5}$ is 25 (SW) to 55 $\mu g/m^3$ (E), with peaks exceeding 150 $\mu g/m^3$. IMADA measurements show that $PM_{2.5}$ is about half of PM_{10}, and is ~50% organic and black carbon, ~30% secondary sulfate, nitrate and ammonium, and ~15% crustal. PM_{10} is ~50% crustal, ~32% organic and black carbon, and ~17% sulfate, nitrate and ammonium.

PM concentrations are highest in the winter due to dry conditions that favor dust suspension and reduce wet deposition. Morning thermal inversions are common, causing a morning PM_{10} peak. An afternoon PM_{10} peak is likely due to increased dust suspension and secondary aerosol formation, as predominant winds transport pollution from the NE industrial area to the city. Meteorological modeling shows that the valley is well-ventilated overnight, meaning that pollution is primarily due to same-day emissions. Ammonia exists in abundance, causing sulfate aerosol to be fully neutralized and allowing the formation of ammonium nitrate. Preliminary analysis suggests that 30% of the organic aerosol is secondary, appearing mainly during daylight hours.

The official emissions inventory attributes 40% of primary PM_{10} to dust, and 36% to transportation, mainly diesel trucks. This suggests that diesel vehicles are the largest sources of primary $PM_{2.5}$, and of carbonaceous particles. The inventory also reports that NO_X emissions are dominated by transportation, SO_2 by industry, and VOCs by services and transportation. The influence of sources outside of the valley is not well understood, but much of sulfate may be regional.

The contribution of organic and black carbon to $PM_{2.5}$ suggests that it is important to control primary emissions from diesel vehicles. SO_2 and NO_X emissions reductions are expected to effectively reduce $PM_{2.5}$, while NH_3 emissions reductions may be less effective. Proposed ecological actions to reduce windblown dust should be effective at reducing PM_{10}. Finally, creating an emissions inventory for primary $PM_{2.5}$ and implementing routine $PM_{2.5}$ measurements are clearly important recommendations.

[P01-05] NARSTO PM ASSESSMENT: RECOMMENDED RESEARCH TO INFORM PUBLIC POLICY.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 1: The NARSTO North American PM Assessment (4:00 PM-5:00 PM) Grand Ballroom 2-4

The NARSTO Particulate Matter Assessment addresses the state-of-science pertinent to managing particulate matter air quality in North America. Experts in the areas of health effects, atmospheric processing, emissions characterization, particle and gas measurements, spatial and temporal characterization, receptor methods, chemical transport models, and visibility and radiative balance effects synthesized what is known in those areas, and what additional knowledge is needed to provide information that would enable policy makers to make more informed decisions. This poster summarizes the consensus of the NARSTO authors regarding future research that is needed to inform public policy.

The recommendations for these science needs fall into five broad themes:

(1) The need to continue the development and evaluation of chemical transport models for particulate matter.

(2) The need to invest more resources in archiving, evaluating and synthesizing data from ambient measurements

(3) The need for a better understanding of carbonaceous aerosols.

(4) The need for long-term monitoring of mass, aerosol composition, gas phase precursors of secondary aerosols, copollutants, and size distributions. The importance of using measurement methods and sampling networks that facilitate comparison across national borders is emphasized.

(5) The need to refine emissions inventories and to develop more detailed emissions models.

These recommendations are interconnected, so work must be done in all areas at the same time. Therefore, the recommendations are not prioritized. The poster will provide a more detailed summary of each recommendation along with its policy rationale.

[P01-04] VISIBILITY EFFECTS DUE TO PM-2.5: IMPLICATIONS FROM THE NARSTO PM ASSESSMENT.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 1: The NARSTO North American PM Assessment (4:00 PM-5:00 PM) Grand Ballroom 2-4

NARSTO has completed an assessment of the scientific understanding of air pollution by particulate matter in Mexico, Canada, and the United States, including a review of the policy implications of that understanding. One component of the assessment addresses effects of PM-2.5 concentrations and chemical composition on visibility through the atmosphere, discusses current understanding of visibility effects in all three countries, and addresses approaches being taken to manage visibility.

Knowledge about spatial and temporal variability of visibility differs in the three countries and reflects the regulatory emphasis that has been placed on visibility in each. The United States has implemented a program for mitigating visibility impairment in national parks and wilderness areas. The geographic distribution of rural visibility and concentrations of the chemical components of PM are relatively well known and measurements have been made long enough to discern trends. Development of atmospheric models for evaluating the visibility effects of emission management strategies has advanced rapidly, but application of such models requires significant improvement in emission inventories for PM-2.5 and its precursors. Canada is addressing visibility, both rural and urban, in the context of the health-based Canada-Wide Standard for PM-2.5. While aerosol composition is not as well characterized in Canada, a recent assessment suggests that maintenance of air quality at the level of the Canadian standard will result in improvements in visibility in some eastern urban areas and degradation of visibility elsewhere. Mexico does not have a national program for managing visibility, but efforts to reduce ambient PM concentrations in urban areas will have beneficial effects on visibility. Visibility is used as an indicator of particulate air pollution trends in Mexico City, where visibility has decreased markedly over the past several decades.

Since visibility-impairing air pollution is a regional phenomenon that does not respect political boundaries, increased coordination of measurements and analyses among the three countries is essential if national goals are to be met. This will be facilitated by development of consistent, comprehensive emission inventories; measurements of the chemical components of PM by consistent methods; and continent-wide air quality modeling.

[P01-03] RECEPTOR METHODS: A REVIEW FOR NARSTO'S PARTICULATE MATTER ASSESSMENT.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 1: The NARSTO North American PM Assessment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Receptor methods for source apportionment include a variety of approaches for interpreting measurements of the physical and chemical properties of ambient particles to infer their possible or probable sources and to quantify the contributions from these sources. In areas with a $PM_{2.5}$ or PM_{10} problem these techniques help identify possible solutions, especially when applied in a systematic fashion in combination with a detailed examination of the local emissions inventory and of the available observational data.

Also called "receptor models," receptor methods, use the differences in chemical composition, particle size, and concentration patterns in space and time to identify source types and to quantify source contributions that affect particle mass concentrations, light extinction, or deposition. Receptor models provide a theoretical and mathematical framework for quantifying source contributions. The goal of this presentation/poster is to summarize the contents and findings/recommendations reported in the receptor methods chapter (Chapter 6) of the recent NARSTO Particulate Matter Assessment.

The main recommendations of this chapter are that receptor methods should be part of a corroborative approach for source identification and that quantitative receptor modeling should be preceded by extensive semi-quantitative receptor-oriented data analyses. These analyses can provide useful insights regarding the sources or source regions influencing the PM concentrations in an area. They will also help develop or refine a conceptual model, which can help guide future studies, including application of source-oriented models (i.e., chemical transport models).

[P01-02] NORTH AMERICAN EMISSIONS INVENTORIES APPLICABLE TO MANAGEMENT OF AIRBORNE PARTICULATE MATTER (PM).

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 1: The NARSTO North American PM Assessment (4:00 PM-5:00 PM) Grand Ballroom 2-4

A part of the 2003 NARSTO PM Assessment concerns the current state-of-the-art of emission inventory development in North America. Emissions inventories serve a variety of needs, ranging from regulatory responses by government and industry to research on PM origins, and the health and environmental effects of PM. Examples of annual inventories at the national and local levels are compared for primary partricles, and for precursor gases, SO2, NOx, VOC and NH3. The major emissions categories are similar in all three countries, and derive largely from the historical evolution of development beginning in the 1970s. While the nationwide inventories of Canada and the U.S. have improved substantially for regulatory and modeling applications, the Mexican effort until recently has focused on the Valley of Mexico. Emissions characterization for research, including air quality modeling, has placed additional requirements for spatial, temporal and species resolution on inventories. These requirements are facilitated with emissions models coupled with air quality codes. Emissions models are complex mathematical treatments that require evaluation and validation, which generally is accomplished through comparison with ambient data and specialized source testing. The uncertainties and limitations in inventories are noted. Uncertainties are attributable both to the paucity and aggregation of direct measurements characterizing different sources, and to methodology for deriving emissions. The uncertainties in PM components appear to be highest for ammonia, carbon constituents and fugitive components such as soil dust. The three nations are working closely to develop methods and analyses to reduce uncertainties in the current inventories.

[P01-01] THE NARSTO NORTH AMERICAN PM ASSESSMENT: CHAPTER 6 - SPATIAL AND TEMPORAL CHARACTERIZATION OF PARTICULATE MATTER.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 1: The NARSTO North American PM Assessment (4:00 PM-5:00 PM) Grand Ballroom 2-4

Geographical and temporal variations of the concentration and composition of particulate matter provide important insights into the processes that influence particle formation and distribution. This presentation summarizes the findings of Chapter 6 of the NARSTO North American PM Assessment. Spatial patterns of PM concentration and composition in Canada, the United States, and Mexico are discussed, with consideration given to spatial variations over distance scales ranging from a few to over 1000 km. Trends, and their detectability, are considered for periods of 10 to 50 years. The principal conclusions of interest to PM management are:

(1) The composition of $PM_{2.5}$ varies with region and locale. Sulfates and organic carbon are relatively abundant in eastern North America; the contribution of nitrates increases in winter, when low temperatures favor the condensed phase. Organic carbon and nitrates are abundant in much of California.

(2) Forest fires or biomass burning can contribute significantly to local particulate mass concentrations. Satellite images and measurements of composition can be used to determine periods when such fires are significantly affecting PM concentrations. Intercontinental transport of dust from Asia or Africa occurs but does not contribute significantly to annual average concentrations of particulate mass concentrations in North America. It occasionally contributes significantly to 24-hour average concentrations.

(3) In both eastern and western North America, local emissions lead to urban fine PM concentrations that are typically ~25% higher than fine PM concentrations at nearby nonurban sites.

(4) $PM_{2.5}$ concentrations in eastern North America tend to reach their highest values during summer, when high relative humidities and solar radiation favor the formation of sulfates from regional sulfur dioxide emissions, while in Mexico PM_{10} concentrations reach their maxima during the dry period from November through May.

(5) Relatively coarse spatial and temporal resolution is typically adequate to describe regional pollutant distributions. For locally emitted pollutants or pollutants that vary diurnally due to photochemical production or variations in temperature and relative humidity, measurements must be made with much higher spatial and temporal resolution.

(6) Long term measurements (typically 10 years) are required to assess trends. Comprehensive measurements of the multipollutant mixture are needed to understand relationships between emissions, ambient concentrations, and effects.

[P12-08] ON HEALTH RISKS OF AMBIENT PM IN THE NETHERLANDS.

Editors: Eltjo Buringh, Antoon Opperhuizen, Authors team: Aben, J.;Ameling, C.B.; Beck, J.; Boere, A.J.F.; Breugel, P.B. van;, Brink, H.M. ten; Brink, R.M.M. van den; Buijsman, E.; Brunekreef, B.;, Buringh, E.; Cassee, F.R.; Dekkers, A.L.M.; Dolmans, J.; Eerens, H.C.;, Fischer, P.H.; Harmelen, A.K. van; Keuken, M.P.; Kooter, I.M.; Loon, M. van; Loon,, W. van; Loveren, H. van; Marra, M.; Matthijsen, J.; Noordijk, H.; Opperhuizen, A.;, Schaap, M.; Schlesinger, R.B.; Slanina, J.; Smeets, P.;, Smeets, W.L.M.; Spoelstra, H.; Steerenberg, P.A.; Visschedijk, A.J.H.;, Visser, H.; Vries, W.J. de; Weijers, E.; Winter, R. de; , National Institute of Public Health and the Environment, Bilthoven, Netherlands; Netherlands Aerosol Programme, Coordinated by NOVEM, Utrecht, Netherlands

Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 12: Integrating Epidemiology, Toxicology, and Human Clinical Studies (4:00 PM-5:00 PM) Grand Ballroom 2-4

There are significant associations between particulate air pollution (PM) and mortality and morbidity in time-series studies. However, the causal factors within this complex mixture are not yet clear. It is recommended that PM10 be retained as a standard for the time being, as it covers effects of both fine and coarse particles. In view of the emerging evidence implicating fine particles in health effects, it is recommended to develop a standard for fine PM and/or a source related fraction as well.

Even with PM concentrations well below the European Union (EU) standards, there will be an impact on health because no threshold has been found for the occurrence of health effects. PM is a complex mixture containing fractions that are to a greater or lesser extent health-relevant. This differentiation in potency has profound implications for an efficient reduction of health impacts when abating PM emissions.

PM abatement can be justified with the precautionary principle. Further source- oriented actions could focus on reduction of the total PM10 aerosol mass or could first of all focus on those PM fractions that are expected to be more health-relevant. This last option is preferred. These fractions are probably transport-related (diesel soot) and, more generally, combustion-related primary PM emissions. Abatement should therefore focus on such sources. In this respect, the abatement of uncontrolled shipping emissions has been identified as one of the more cost-effective control options. Abatement of other combustion sources such as industrial combustion, wood burning in fireplaces and off-road machinery are also possible, but less cost-effective.

Compliance with the yearly average EU standard seems feasible for PM10 in the Netherlands in 2005, although local exceedances at ‘hot spots’ cannot be ruled out. Compliance in 2005 of the EU daily standard is not possible everywhere. Compliance in 2010 with the indicative EU standards of 20 μg/m3 as annual average or 7 daily exceedances of 50 μg/m3 is not feasible, even at high cost.

[P12-07] AIRNET - THEMATIC NETWORK ON AIR POLLUTION AND HEALTH IN EUROPE.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 12: Integrating Epidemiology, Toxicology, and Human Clinical Studies (4:00 PM-5:00 PM) Grand Ballroom 2-4

AIRNET was initiated within the Quality of Life and Management of Living Resources programme of the European Commission (QLRT-2001-00441, Key Action 4, Environment and Health) to develop an European-wide framework for air pollution and health research to strengthen the science-policy interface and to integrate information from individual projects. Apart from its function as a Network project, the focus and output of AIRNET is harmonised with focus of the EU Clean Air For Europe (CAFE) programme (http://www.europa.eu.int/comm/environment/air/cafe.htm). This programme has been initiated by EU Commission to strengthen their air pollution policy, based on the best available science and created in a broad, open, and transparent dialogue with a scientific community, as well as the public and the stakeholders. The specific AIRNET objectives are:

• Develop an information, interpretation and communication framework for the results of research of EU-funded as well as nationally supported studies

• Function as a Thematic Network project including researchers, regulatory bodies, stakeholders, and public and professional organisations

• Link the findings from exposure assessment, epidemiology, toxicology, risk and health impact assessment, to build and strengthen a science-policy interface (the project includes separate working groups targeting on these issues)

• To provide comprehensive views and reports on risk assessment and risk management of air pollution that supports more effective and cost-efficient air pollution control policy and decision-making in Europe.

AIRNET consists of co-ordinators and additional key investigators of EU funded projects of the 4th and 5th Framework Programmes, key investigators of non-EU funded major recent or ongoing studies on air pollution and health. In addition, WHO and UN ECE representatives, policy makers at EU and national levels, representatives of the automotive, oil, gas and metal industries, as well as key consumer organisations and environmental NGOs are also participating. The (net)working structure of AIRNET is Working Groups, Annual Conferences, and Website information (http://airnet.iras.uu.nl).

Current activities, workplans of the working groups, as well as the contributions to the EU air pollution control strategy will be presented.

[P12-06] HEPMEAP - AMBIENT PM10 AND PM2.5 AND THE ROLE OF MOTOR ENGINE EMISSIONS - THE FIRST EUROPEAN HYBRID APPROACH LINKING AIR QUALITY, TOXICOLOGICAL, AND EPIDEMIOLOGICAL INFORMATION.

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PM fractions or components responsible for adverse health effects associated with ambient particulate matter (PM) exposure still remain largely unknown. This uncertainty seriously limits PM risk assessment and standard setting as well as identifying of cost-effective emission source and risk control measures. Clean air legislation has resulted in significant reductions of certain emissions and in improvement of air quality. However, the volume of traffic has increased substantially, and despite improvements in engine technology the total amount of emissions from the current number of automobile engines has increased significantly, especially the amount of particles related to diesel engines. Remarkably, an increasing number of health effects studies show positive associations between traffic-related air pollution indicators and adverse health effects, including increased morbidity and premature mortality.

The EU-funded HEPMEAP project (QLRT-1999-01582; http://www.hepmeap.org) therefore focuses on the role of traffic exhaust emissions in PM-related toxicity and health effects and is the first integrated approach where air quality and toxicological/epidemiological disciplines work closely together.

The overall objectives of HEPMEAP are:

1. to assess the (human-)toxicity potency (in vitro, in vivo) of ambient PM10 and PM2.5 collected at places across Europe with contrasts in traffic intensity (using ISAAC-2 network of epidemiological studies), as well as from ambient sites with high (tunnel site)and low (marine and rural sites) traffic exhaust emissions, and to compare this with diesel and gasoline exhaust PM,
2. to characterise the (chemical) properties of all these particles, and,
3. to determine the PMsize/composition-PMtoxicity-PMhealth effects relationships and the role of traffic exhaust PM emissions.

The PM sampling campaign across Europe has now been completed and the chemical characterisation is ongoing. Toxic potency is currently analysed, including the chamber studies with human volunteers. An overall analysis plan has been developed to determine the relationships and to assess the traffic emissions' impact. The first results of this study will be presented.

[P12-05] IS PM MORE TOXIC THAN THE SUM OF ITS PARTS? DISCORDANCE BETWEEN "EFFECT FUNCTIONS" FOR PM MASS *VS.* RISK-ASSESSMENT TOXICITY FACTORS.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 12: Integrating Epidemiology, Toxicology, and Human Clinical Studies (4:00 PM-5:00 PM) Grand Ballroom 2-4

PM impact analyses use linear "effect-functions" that relate ambient PM mass concentration to increments in disease and death rates. A key assumption is that generic PM causes increments in mortality and morbidity. For each "effect-function," the impact analyses assume all varieties of PM have identical potency, regardless of PM physical or chemical form. Unlike risk assessment, where personal exposure is estimated, the impact analyses utilize PM levels reported as daily or annual averages at central monitoring locations. Unlike established risk-assessment procedures for non-cancer endpoints, where no-effect thresholds for sensitive populations are identified, the impact analyses assume that any increase in PM mass (as recorded at central monitors) will quantitatively result in increases in death and a variety of diseases. Such predictions for generic PM disagree with the absence of health effects predicted for equivalent concentrations of a wide range of chemicals, many of which are constituents of PM. We examined chemical-specific health-effects data available in a broad range of sources (IRIS, HEAST, DWCD, HSDB, ACGIH, NIOSH, and ATSDR). In these sources, we were unable to find chemicals likely to be present in outdoor PM that would, for example, lead to mortality at ambient PM concentration levels. Available data indicate that the major constituents of ambient PM (sulfate, nitrate, and elemental carbon) have limited toxic potential, even at occupational concentrations. Reference concentrations (RfC's) and unit risk values (UR's) for chemicals of known toxicity are not in accord with the RfC's and UR's that would be predicted for PM constituents from epidemiologic associations. Hence, the predictions of impact analyses appear to be at odds with results that would be projected by a standard health-risk-assessment approach. The resolution to this paradox may be that (1) the mixtures of chemicals present in ambient PM are vastly more toxic than the sum of individual components, (2) small portions of the general population are vastly more sensitive to certain ambient PM chemicals than currently appreciated, or (3) generic PM *per se* is not the causal factor in the epidemiologic associations underlying the "effect functions." The unexpectedly high level of toxicity per unit PM mass suggested by epidemiologic associations may instead be due to unmeasured co-pollutants (*e.g.*, HAPs), residual confounding by weather variables, or confounding by unmeasured societal, behavioral, or stress factors.

[P12-04] FINE PARTICULATE ($PM_{2.5}$) AIR POLLUTION EXPOSURE AND PULMONARY FUNCTION IN AN ADULT POPULATION.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 12: Integrating Epidemiology, Toxicology, and Human Clinical Studies (4:00 PM-5:00 PM) Grand Ballroom 2-4

Studies have shown increased morbidity and mortality in susceptible individuals associated with ambient levels of particulate matter (PM). We studied adults >50 years of age with and without chronic obstructive pulmonary disease (COPD) or cardiovascular disease (CVD) from the first two years of a continuing study of PM exposure in Seattle, Washington. Personal $PM_{2.5}$ measurements were made with Harvard personal exposure monitors, while indoor and outdoor $PM_{2.5}$ levels at subjects' homes were collected with Harvard Impactors (HI) during ten consecutive 24-hour periods. Seattle area central site TEOM measurements were collected from three sites and an average daily (24 hour) value was computed. During the 10-day monitoring period, coached FEV_1 measurements were obtained from subjects at each daily home visit using VM+ portable spirometers. Associations between changes in FEV_1 and $PM_{2.5}$ measurements were evaluated using mixed-effects random intercept regression models to test for a within-subject effect of $PM_{2.5}$ exposure on FEV_1. Models were adjusted for time of year, temperature, relative humidity, age, gender, height, weight, body mass index, and anti-inflammatory pulmonary medication use. Subjects were stratified by health status: normal (n=14), COPD (n=30), CVD (n=31). Overall mean age was 77 years (range 57-92 yrs). In subjects without reported COPD or CVD, we observed a decrement in FEV_1 of 107ml (95%CI: [-206, -7]; 123 observation days) for a $10ug/m^3$ increase in Seattle area central site $PM_{2.5}$ values. Similar results [-82ml (95%CI: [-169, 4]; 121 observation days)] were obtained using local outdoor $PM_{2.5}$ measurements, but not for indoor or personal $PM_{2.5}$ measurements. No significant association between same day $PM_{2.5}$ exposure and coached FEV_1 was observed among subjects with COPD (271 observation days) or CVD (284 observation days). Funded by: EPA Grant R827355 (NW PM Research Center) & Cooperative Agreement #R82717701 (This abstract does not necessarily reflect EPA policy.)

[P12-03] THE USE OF EXHALED NITRIC OXIDE AS A NON-INVASIVE MEASURE OF INFLAMMATION IN OLDER SUBJECTS WITH CARDIORESPIRATORY DISEASE.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 12: Integrating Epidemiology, Toxicology, and Human Clinical Studies (4:00 PM-5:00 PM) Grand Ballroom 2-4

Nitric oxide is known to play a pivotal role in biological inflammation. Recently methods for exhaled nitric oxide (eNO) collection have been shown to be useful for documenting airway inflammation. As part of a large exposure assessment study in Seattle, eNO was measured in 12 older adult subjects with cardiorespiratory disease during the winter of 2001-2002. An exhaled breath sample was collected daily from each subject in her/his home over 5 days during potentially high PM periods. An offline collection device scrubbed ambient NO from the inhaled air and provided flow restriction on exhaled breath to prevent contamination by nasal NO. Flow rate was not controlled. The samples were analyzed within 24 hours of collection using an API chemiluminescent nitrogen oxides monitor. The range of concentrations of eNO in subjects with cardiovascular disease (CV) (n=8) was between 5.2 and 66 ppb (mean ± SD = 22.3 ± 13.5 ppb). The range of concentrations of eNO in subjects with chronic obstructive pulmonary disease (COPD) (n=4) was between 6.1 and 51 ppb (mean ± SD = 17 ± 10 ppb). $PM_{2.5}$ was measured using Harvard personal environmental monitors, at the subjects' residences with Harvard impactors (indoors and outdoors), and at a central site with an FRM monitor. For this analysis, the central site 24 hour average of $PM_{2.5}$ from the previous day was used. The results were analyzed using a linear mixed effects model with random intercept controlling for age and temperature to test for within subject associations between eNO and $PM_{2.5}$. A 10 $\mu g/m^3$ increase in $PM_{2.5}$ was associated with a 11.4 ppb increase in eNO (p=0.018; 95% CI: 1.93, 20.93) in the CV subjects. No significant associations were seen in the COPD subjects. This research was supported by Grant # R 827355 (EPA) and # PO ES 07033(NIH).

[P07-14] MEASUREMENT OF REAL-TIME $PM_{2.5}$ MASS AND FINE CHEMICAL COMPOSITIONS AT NORTHWEST PHILADELPHIA.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

As a part of the North East Oxidant and Particle Study (NE-OPS) program, a summer intensive particulate matter (PM) measurement was conducted during July 10 to August 3, 2002. Real-time $PM_{2.5}$, particulate sulfate, semi-continuous thermal/optical organic carbon (OC) and elemental carbon (EC) concentrations were measured at NE-OPS site in Philadelphia. In addition, 24-hour integrated filter samples were obtained to measure OC, EC, and sulfate concentrations. The source contributions to fine PM were determined on two-hour basis. $PM_{2.5}$ mass concentration measured by a 30 °C TEOM system with a Sample Equilibration System dryer was approximately 22 $\mu g/m^3$ (max.= 63 $\mu g/m^3$, min.= 6 $\mu g/m^3$). The 5-min. averaged sulfate concentration measured by a continuous sulfate analyzer (Harvard School of Public Health design) ranged from 2 to 32 $\mu g/m^3$. The continuous sulfate analyzer showed excellent agreement with daily filter-based analysis by Ion Chromatography with correlation coefficients of 0.98. However, the continuous analyzer measured approximately 40% less sulfate than the filter samples. The average continuous sulfate concentrations were strongly correlated with 1-hour averaged $PM_{2.5}$ mass (r^2 = 0.89). The correlation coefficient between $PM_{2.5}$ and OC was 0.64. However, $PM_{2.5}$ mass was poorly correlated with EC. The predominant chemical components of $PM_{2.5}$ mass at the monitoring site were sulfate and OC. On average, OC and EC measured using a semi-continuous OC/EC analyzer accounted for 21 % and 2 % of total $PM_{2.5}$, respectively. The sulfate mass was measured to comprise 39 % of total $PM_{2.5}$ mass concentration.

[P12-01] THE ASSOCIATION BETWEEN AIR POLLUTION AND CARDIOVASCULAR MORTALITY IN GREATER PHOENIX, 1995 TO 1997.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 12: Integrating Epidemiology, Toxicology, and Human Clinical Studies (4:00 PM-5:00 PM) Grand Ballroom 2-4

In a previous study on mortality and air pollution in Phoenix, AZ we found that cardiovascular mortality was associated with PM10, PM2.5, and coarse fraction (PMCF = PM10 - PM2.5). In that study mortality counts were restricted to zip codes that were considered most represented by the air pollution monitors. The goal of the current study is to assess the effect of various PM metrics, PM composition elements, and source contributions from a receptor model on cardiovascular mortality in the elderly (≥ 65 years) in a larger geographical area. Cardiovascular mortality counts were obtained for the greater Phoenix area: Phoenix, Glendale, Scottsdale, Mesa and Tempe. Daily PM10, PM2.5 and PM2.5 chemical composition elements were obtained from the EPA NERL platform in central Phoenix. Poisson regression models that controlled for time trends, day of week, temperature, relative humidity, and extreme temperatures were used to evaluate the association between air pollution and cardiovascular mortality. GLM, implemented in SPLUS, was used in order to avoid the convergence and standard error problems encountered with GAM. All results are reported for an interquartile range increase in air pollutant. We found that PM10 and PMCF were significantly associated with cardiovascular mortality (RR=1.04 [95% CI: 1.01, 1.08] and RR=1.04 [95% CI: 1.1, 1.07]) respectively at 1 day lag. The association with PM2.5 was similar to PM10 and PMCF with a RR=1.03 (95% CI: 1.00, 1.07). Cardiovascular mortality was also significantly associated with various composition elements ($p<0.05$): organic carbon, Cu, and Pb. The association with elemental carbon was marginal ($p<1.0$). No associations were found with the gaseous pollutants CO, NO2 and SO2. Soil components were found to have a negative association ($p<0.05$): Al, Si, Fe, Ca, and K. Analysis of source contribution data from the UNMIX receptor model indicated that cardiovascular mortality was marginally associated with diesel exhaust with a RR=1.03 (95% CI: 1.00, 1.07) and motor vehicle exhaust with a RR=1.06 (95% CI: 1.01, 1.11). Consistent with the negative association found with the soil components, the crustal source from the UNMIX model was also negatively associated with mortality ($p<0.05$). No associations were found with the vegetative burning source. This abstract has been subjected to EPA review and approved for publication. It does not necessarily reflect EPA policy. This research was supported by Grant # 5T32 ES07262 (NIEHS) and R827355 (EPA).

[P07-15] CHARACTERIZATION OF CHEMICAL COMPOSITIONS IN FINE PARTICULATE MATTER DURING THE ROCHESTER PARTICULATE MATTER STUDY.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

As a part of the summer intensive Rochester particulate matter (PM) study, highly time resolved measurements of $PM_{2.5}$ mass, organic carbon (OC), elemental carbon (EC), black carbon (BC), and particulate sulfate were conducted near University of Rochester PM Center at Rochester, NY. The continuous, semi-continuous, and daily filter-based methods were used during June 3 to 18, 2002 to characterize the composition of fine PM in urban ambient air. In order to minimize the loss of semi-volatile compounds in fine PM and condensation of water, TEOM system (R&P) was operated at a fixed temperature 30 °C with a Sample Equilibration System dryer. A Semi-continuous OC/EC analyzer (Sunset Lab) measured 2-hour averaged OC and EC mass concentrations of fine PM with an upstream OC denuder to prevent the positive artifacts of semi-volatile organic compounds. High resolution particulate sulfate concentrations were measured by a continuous sulfate analyzer (Harvard School of Public Health design). In addition, collocated daily filter samples were collected for filter-based OC, EC, and sulfate analysis. During the measurement period, the comparison of particulate sulfate concentration between the semi-continuous analyzer and filter-based ion chromatography analysis shows good agreement with a correlation coefficient of 0.85. While the continuous sulfate concentrations were highly correlated with TEOM $PM_{2.5}$ mass ($r^2 = 0.88$), the sulfate concentration was only 26 % of total $PM_{2.5}$ concentration. The average thermal OC and EC measured by a semi-continuous analyzer were approximately 6.6 $\mu g/m^3$ and 0.4 $\mu g/m^3$, respectively. The average TEOM $PM_{2.5}$ mass was 15.9 $\mu g/m^3$. The semi-continuous OC/EC measurements were lower than undenuded daily filter sample OC/EC. The average concentrations of semi-continuous total carbon (OC + EC) and the filter-based total carbon were approximately 43% and 63% of the TEOM $PM_{2.5}$ mass concentration, respectively.

-Supported by EPA PM Center grant R827354

[P07-27] CORRELATION OF VISIBILITY AND PM2.5 MASS CONCENTRATION AND RELATED PRECURSORS IN THE ADIRONDACK REGION OF UPSTATE NEW YORK DURING THE PMTACS-NY SUMMER INTENSIVE OF 2002.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

The physical and chemical characterization of fine particulate matter in ambient air is a major objective of the PMTACS-NY Supersite Program. As part of this program, a summer field intensive campaign operated from the ASRC's Whiteface Mountain base station (44° 22' N, 73° 54' W) located in the northern Adirondack region of upstate New York. The sampling site is within the canopy of a transition zone forest comprised mostly of white and yellow birch, sugar maple, beach and some red spruce and balsam fir. Routine gas and particulate matter measurements at this site include: NO, NO2, NOy, SO2, O3, air toxics, PM mass, and PM chemical speciation, and semi-continuous PM carbon. During the 2002 field campaign, additional instruments were deployed to measure semi-continuous PM mass, sulfate, nitrate, ammonium, and organics, gaseous formaldehyde, HONO, HNO3, and OH/HO2. In addition, a commercial nephelometer (OPTEC, NGN-3) was deployed at the start of the summer campaign. The nephelometer and R&P 8400S and 8400N semi-continuous PM sulfate and nitrate monitors, introduced during the summer 2002 campaign, were integrated into the routine measurement operation at the site. This presentation reports on preliminary analyses relating B_{scat} measurements and PM mass and chemical composition.

High correlations were observed between the PM2.5 particulate mass concentration measurements and the scattering coefficients (b_{scat}), with an r^2 value of 0.793 for the entire campaign. Several episodic pollution events as well as periodic influences of transported smoke across the northern US-Canada border from intense forest fires in southern Quebec were also observed during the campaign. During two such episodic events (07/09/02 and 07/21/02-07/24/02), PM mass and b_{scat} correlations reported r^2 values of 0.988 and 0.883 respectively. The effects of the forest fires were also observed in the PM organic carbon concentrations, which were as much as twenty times higher than typical mean concentrations during the smoke events.

The correlation of PM2.5 mass concentration and ozone mixing ratio data for the entire campaign was rather weak, with an r^2 value of 0.317. During the episodic period 07/21/02 - 07/24/02 a somewhat stronger correlation was indicated, with an r^2 value of 0.576. The chemical features of this episode are presented and the relationship of gaseous precursor species and PM2.5 mass concentrations explored.

[P07-26] MEASUREMENT OF ATMOSPHERIC VISIBILITY WITH A HIGH-QUALITY CAVITY.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

Visibility can be characterized by measurement of optical extinction through the Koschmieder relationship. Atmospheric extinction can be as low as a few Mm^{-1}, requiring large optical path lengths for its measurement. With the development of relatively inexpensive mirrors with ultra-low reflection losses, tens of kilometers of optical path length can be realized in practical, compact (1-m length) optical cavities. At the Desert Research Institute such cavities are being used for extinction measurements with sensitivities down to 0.1 Mm^{-1}.

Two pulsed laser techniques have been employed simultaneously to obtain highly sensitive extinction measurements with large dynamic range. The Cavity Ring Down (CRD) technique yields very sensitive detection, largely independent of laser power fluctuations, with a dynamic range from 0.1 Mm^{-1} to 1,000 Mm^{-1}. Cavity Enhanced Detection (CED) has a simpler experimental setup and data analysis algorithm than CRD, while yielding a dynamic range from 1 Mm^{-1} to about 5 10^6 Mm^{-1}. The CED sensitivity limit is due to power fluctuations of the pulsed laser and could be further improved by measuring and accounting for these fluctuations.

Capabilities of CRD and CED techniques including sensitivity, dynamic range, calibration, and complexity are further discussed and compared through simultaneous measurements.

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[P07-25] ANALYSIS OF AEROSOL LIGHT ABSORPTION MEASUREMENT CAPABILITIES: THE RENO AEROSOL OPTICS EXPERIMENT.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

Aerosol light absorption measurements are important for health, climate, and visibility applications. The Reno Aerosol Optics Experiment was conducted in June of 2002 with the main purpose of evaluating our capability to accurately measure aerosol light absorption. Most of the measurements were accomplished using well-characterized external mixtures of laboratory-generated ammonium sulfate and kerosene soot aerosol. A primary standard for measurement accuracy was provided by the difference of extinction and scattering measurements. Photoacoustic measurements of aerosol light absorption agreed well with the primary standard measurements.

Aerosol light absorption measurements have typically been accomplished using filter-based samplers. Here the attenuation of light across the filter is measured as a proxy for light absorption. This approach purposely overestimates the in-situ aerosol light absorption because these filters are multiple scattering substrates that amplify absorption as a means of improving instrument sensitivity. Various empirical approaches have been used to calibrate these instruments. For example, the calibration model used for the Particle Soot Absorption Photometer requires additional measurements of aerosol scattering to reduce the artifact it produces on the absorption measurements. It will be shown that the PSAP and 7 wavelength aethalometer data can be parameterized to provide reasonably good correlations with the photoacoustic instrument for time-averaged data. Comparisons of the time series data from the photoacoustic instrument and aethalometer for white and dark aerosol limiting cases reveal insight on filter-based artifacts. A theoretical analysis of the reduced aethalometer response upon filter loading by dark aerosol is presented based on the reduction of filter multiple scattering as it darkens.

[P07-24] A NEW INTEGRATING NEPHELOMETER FOR VISIBILITY STUDIES.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

Visibility impairment is mostly caused by particle scattering with important contributions from both fine particles (e.g., sulfate, carbonaceous particles) and coarse particles (e.g., entrained mineral dust). Scattering by fine particles can be characterized with good accuracy by commercial nephelometers. This is in contrast to scattering by coarse particles, which includes a large near-forward scattering component due to diffraction that is not easily included in the integrated measurement of particle scattering. Most existing nephelometers have a forward truncation angle of 7° or above, resulting in truncation losses of more than 25% for particles with a diameter larger than 2.5 μm. In locations where large particles contribute substantially to atmospheric scattering, such nephelometers are not adequate for characterizing the scattering component of visibility impairment.

The Integrating Sphere Integrating Nephelometer (ISIN) is a novel and unique reciprocal nephelometer that uses an integrating sphere with attached truncation-reduction tubes to contain the sample volume and to integrate the scattered light. Its main advantage over current integrating nephelometers is the seven-fold reduction in truncation angle to about 1° that reduces errors in measuring scattering from large particles. Truncation losses of more than 25% occur for the ISIN at particle diameters of larger than 16 μm. Additional features include the improved ability to sample large particles and the well-defined operating wavelength. Initial comparisons of the ISIN with two commercial nephelometers using sub-micron particles revealed excellent correlation and agreement within a few percent. Comparisons with one of the two commercial nephelometers during a study of dust entrainment by military off-road vehicles from an unpaved roadway, showed good agreement for ambient fine particles (no entrainment) while the ISIN readings were up to four-times higher than those of the commercial instrument for freshly entrained coarse particulate matter. This large discrepancy is attributed to the reduced truncation error (up to a factor of two) and the improved large particle sampling of the DRI-ISIN.

[P07-23] OPTICAL AND CHEMICAL LIGHT SCATTERING DETERMINATION IN THE SOUTHEAST: EXAMPLES FROM THE SEARCH NETWORK.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

The Southeastern Aerosol Research and Characterization network consists of eight aerosol monitoring stations -- 4 urban/rural pairs -- that are operating continuously in four states in the Southeast from 1998 to 2005. The chemical composition of fine and coarse particulate matter fractions is determined from 24-hr filter samples and, in some locations, also from semi-continuous measurements. Integrating nephelometers are used to make measurements of light scattering in ambient air samples that have been desiccated with Nafion diffusion dryers.

This paper provides a first, exploratory analysis of the nephelometer measurements and aerosol composition at some of the SEARCH sites. Conditions at urban and rural sites are compared and causes for differences are illuminated. Chemical light scattering (an estimate of light scattering from products of mass concentrations of chemical species and their scattering efficiencies) is compared with the direct measurements of light scattering by the nephelometers, using the formula that has been developed for Class I areas by IMPROVE. The appropriateness of using the IMPROVE light scattering efficiencies for representing chemical light scattering in Southeastern rural and urban area is explored. Benefits to the understanding of chemical light scattering that are provided by rapidly-improving semi-continuous chemical measurements are also addressed.

The SEARCH nephelometer measurements have recently been extended to all eight locations and have been enhanced to improve data quality, so this exploratory analysis will be used to guide more comprehensive analyses of the full regional data set after another year of data collection.

[P07-22] INTECOMPARISON OF SEMI-CONTINUOUS PARTICULATE SULFATE AND NITRATE MEASUREMENT TECHNOLOGIES AT A NEW YORK STATE URBAN AND RURAL LOCATION.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

Two intensive field measurement campaigns have been performed as part of the PM2.5 Technology Assessment and Characterization Study (PMTACS-NY). The first, an urban campaign, operated on the campus of Queens College, CUNY, Queens NY during the Summer 2001 and the second, a rural campaign at Whiteface Mountain, NY, a rural site located in the northern part of Adirondack Mountains during the Summer 2002.

One of the objectives of PMTACS-NY program is to study and evaluate semi-continuous PM-2.5 chemical speciation measurement technologies. To this end several semi-continuous PM2.5 sulfate and nitrate instruments were deployed and operated side-by-side during the field intensive campaigns. The instruments included a Rupprecht and Patashnick Ambient Particulate Sulfate and Nitrate Monitors (8400S and 8400N), an Aerodyne Research, Inc. Aerosol Mass Spectrometer (AMS), a Particle-into-Liquid Sampler with IC developed at Georgia Institute of Technology (PILS-IC) and a Continuous Ambient Sulfate Monitor developed by George Allen at Harvard School of Public Health (CASM).

The performances of these instruments are compared and contrasted for these two distinctly different environments, as are the semi-continuous particulate sulfate and nitrate mass concentration measurements. In addition, comparisons of the semi-continuous sulfate measurements with 24-hr filter based measurements are presented and assessed in terms of the effects of local environmental variables on observed instrument biases.

[P07-21] SEMI-CONTINUOUS $PM_{2.5}$ SULFATE AND NITRATE MEASUREMENTS IN NEW YORK CITY.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

Ambient $PM_{2.5}$ comprises various constituents including sulfate, nitrate, ammonium, organic and elemental carbon and various trace elements. Filter based methods are being used in EPA's national networks to provide measurements of average daily $PM_{2.5}$ mass and chemical composition. However, due to the sampling times employed, these methods cannot track concentration changes that occur on time scales of hours or less. In order to better understand the various source contributions, and to quantitatively track short-term variations in $PM_{2.5}$ mass and composition, semi-continuous methods for chemical composition have recently been developed and are currently being used in various field studies.

As part of the New York $PM_{2.5}$ Supersites Study semi-continuous $PM_{2.5}$ Sulfate and Nitrate Rupprecht and Patashnick instruments (R&P 8400S and 8400N) have been deployed in a site in the South Bronx, New York City. The instruments collect $PM_{2.5}$ particulate matter on a metal strip by a humidification and impaction process followed by flash vaporization and detection of the evolved gases. These instruments have provided 10 minute particulate sulfate and nitrate data since April 2002. Time resolved data shows that $PM_{2.5}$ can exhibit a large degree of variability over a period of a few hours with particulate sulfate typically varying by a factor of two to three and nitrate up to a factor of ten. In general sulfate concentrations are significantly higher than nitrate. To date the maximum hourly sulfate concentration has been 29.9 $\mu g/m^3$ which occurred on August 13, 2002 compared to a maximum hourly nitrate concentration of 10.5 $\mu g/m^3$ observed on June 20, 2002. On these days the 24-hr average sulfate and nitrate concentrations were 15.3 $\mu g/m^3$ and 3.39 $\mu g/m^3$ respectively, clearly indicating that 24 hr filter measurements can significantly underestimate maximum concentrations. Peak nitrate concentrations tended to occur in the early morning hours between 5 and 11 am coinciding with morning rush hour followed by a decrease in the afternoon and a gradual increase in the late evening around 8 pm. In contrast no diurnal trend was observed for particulate sulfate with peak concentrations occurring at various hours throughout any given day. Maximum sulfate occurred from June to August consistent with the period of highest SO_2 oxidation.

Other instruments at the site include an R&P 2300 Speciation Sampler, R&P 2025, R&P TEOMs $PM_{2.5}$ and PM_{10} and gas measurement SO_2, NO_x and O_3 instruments. Data from the semi-continuous Sulfate and Nitrate particulate instruments will be presented and compared with other collocated instruments.

[P07-20] CONTINUOUS MEASUREMENTS OF PM2.5 SULFATE, NITRATE AND AMMONIUM IN SEARCH.

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Filter-based measurements of fine particulate mass and composition are valuable for understanding bulk characteristics of atmospheric aerosols. They are, by definition, the basis for determining attainment status relative to National Ambent Air Quality Standards for PM2.5. Filter methods are also useful for calculating mass balance and extinction budgets, and for evaluation of spatial patterns and secular trends. On the other hand, long integration times for filter measurements (typically 12 to 24 hours on a sustained basis) limit insight into particle dynamics. Processes that govern particle concentration and composition do not take place over discrete 24-hour periods; rather, they occur over periods of minutes to hours to days. Continuous or semi-continuous methods are required to observe short-term processes and to challenge our understanding of particle formation and transformation, deposition, transport and accumulation. The SEARCH study uses continuous techniques to measure PM2.5 mass and composition at 8 sites in the southeastern U.S., on time scales ranging from 5-minutes to 1-hour. PM2.5 mass is measured with an R&P model 1400a/b TEOM maintained at 30C and equipped with a nafion drier. Carbon (organic, elemental, total) is measured with an R&P Model 5400 particulate carbon monitor and an Andersen aethelometer (elemental only). Sulfate is measured with a modified Harvard School of Public Health (HSPH) continuous sulfate analyzer. The HSPH technique involves reduction of sulfate to sulfur dioxide on a hot (875C, or higher) stainless steel converter, followed by pulsed UV-fluorescence detection of sulfur dioxide. Interfering species, sulfur dioxide and reduced sulfur gases, are scrubbed upstream of the converter. Ammonium and nitrate are measured using a multi-channel analyzer designed by ARA. In this approach, ammonium and nitrate are selectively converted to NO and detected via ozone chemiluminescence. This poster will present results of field measurements using the above continuous analyzers. Data will be compared with filter-based measurements for a several SEARCH sites and overall operating characteristics will be described. Observations for a number of settings (e.g., rural, urban and coastal) will be described and contrasted.

[P07-19] USE OF CONTINUOUS SO2 AND SULFATE MEASUREMENTS TO ESTIMATE SO2 OXIDATION RATES IN POWER PLANT PLUMES.

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This paper presents a novel approach for estimating SO2 oxidation rates in power plant plumes. The approach is based on continuous and simultaneous measurement of SO2, NOy and fine particulate sulfate at a surface site, under conditions when the site is impacted by a plume from a known point source. The research site, located approximately 55 km WNW of Atlanta, GA is instrumented with a high sensitivity pulsed UV-fluorescence SO2 analyzer, a high-sensitivity ozone-chemiluminescence NOy analyzer, a modified Harvard School of Public Health (HSPH) continuous sulfate analyzer, plus an array of instruments for continuous measurement of fine particulate matter, trace gases and surface meteorology. The measurement principle and overall performance of the HSPH sulfate analyzer, as deployed in the SEARCH network, are discussed in a companion paper. In practice, the ambient SO2 signal is used to determine if the site is influenced by one of five coal fired power plants (CFPPs) within an approximate 100 km radius. For this study, we arbitrarily define an event as one with a peak 1-minute SO2 concentration of at least 15 parts per billion. Once an event has been detected, the source contributing to that event is identified by two methods: 1) air mass trajectory analysis using the NOAA-HySplit model; and 2) comparison of the ambient SO2:NOy ratio with in-stack data from continuous emission monitors (CEMs). Events are assigned to a particular souce only if trajectory data indicate flow along a line (+/- 15 degrees) from the plant to the site, and if the ambient SO2:NOy agree with CEM data +/- 10 percent. Roughly 2 dozen events are successfully classified for the periods December 2001-March 2002 (winter) and June-September 2002 (summer). Linear regression of sulfate to SO2 is then used to estimate the fraction of oxidized sulfur in each plume event, and trajectory data are used to estimate time of flight (reaction time) from source to site. Fraction of oxidized sulfur divided by transit time represents the average oxidation rate during plume transit. Results show a wide range of apparent oxidation rates. Winter events exhibit oxidation rates on the order of 0.0 to 0.2 percent per hour, and, in general, little sulfate above estimated primary sulfate emissions. Summer events exhibit oxidation rates between 0.1 and 2.1 percent per hour. Nighttime events, both summer and winter, show virtually no oxidation. The population of events will be discussed and results will be compared with available oxidation rates from the literature.

[P07-18] ULTRAFINE PARTICLE EVENTS ASSOCIATED WITH NITRATE CHEMISTRY OBSERVED BY SINGLE PARTICLE MASS SPECTROMETRY.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

Single particle measurements in Baltimore from March to December 2002 were performed with the real-time single particle mass spectrometer RSMS III. Spectra were collected in both positive and negative ion modes over a particle size range of 40-1250 nm in diameter. For nitrate analysis, positive ion spectra were initially selected at m/z 30 on the basis of an above threshold signal. The spectra were further analyzed by the fast adaptive neural network algorithm Art-2a to confirm the presence of nitrate in these particles. From this analysis, nominally "pure" nitrate particles (defined as having a signal intensity at m/z 30 greater than 75% of the total ion signal) were identified. Examination of these data revealed numerous ultrafine particle events in which the number of "pure" nitrate particles in the 50-90 nm size range would quickly increase and then decrease. The increase in the number of "pure" nitrate particles during these events would either precede or coincide with an increase in particulate nitrate mass (measured coincidentally with an R&P 8400N ambient particulate nitrate monitor); the number concentration would then decrease as the particulate nitrate mass decreased. In a few instances, nitrate particles in the 50-90 nm size range were found to grow into larger 110-220 nm size particles over time. Correlations of these events with both meteorological variables and continuous particulate nitrate mass measurements have been explored. Mass concentrations calculated from "pure" nitrate particles identified with RSMS III agree well with particulate nitrate mass measurements. The occurrence of ultrafine nitrate particle events correlated well with high relative humidity and low temperature as expected by equilibrium considerations.

[P07-17] SULFATE DETECTION IN INDIVIDUAL FINE AND ULTRAFINE AMBIENT PARTICLES AT THE BALTIMORE SUPERSITE.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 7: Semi-Continuous Methods for Measuring PM (4:00 PM-5:00 PM) Grand Ballroom 2-4

Single particle measurements in Baltimore from March to December 2002 were performed with the real-time single particle mass spectrometer RSMS III. During this time period, spectra were obtained for over 350,000 particles across a size range of 40-1250 nm in diameter. Unlike previous versions of the instrument, RSMS III contains a dual drift tube configuration that permits both positive and negative ion spectra to be simultaneously recorded for each particle. Since sulfate is preferentially detected in negative ion spectra, this instrument offers for the first time the opportunity to study the distribution of sulfate in fine/ultrafine particles. Over 75% of the particles above 400 nm were found to contain sulfate. Many of these particles gave strong negative ion signals (from sulfate) with virtually no positive ion signal detected. These particles are thought to arise from nominally "pure" ammonium sulfate particles, most likely produced by cloud processing of CCN. If particles in the 50 to 100 nm range act as CCN, then by the time they have grown to 400 nm or larger, the initial core only comprises a very small faction of the total particle mass (i.e., a 50 nm CCN only comprises 1/1000 of the mass of a 500 nm particle). The low mass fraction, coupled with the difficulty in vaporizing an entire particle of this size, inhibits detection of the CCN core. "Pure" ammonium sulfate particles smaller than 200 nm in diameter are rarely detected, in part because negative ions are more difficult to produce from small particles and in part because the initial CCN can be detected since it is a larger fraction of the total particle mass. Mixed composition particles containing sulfate are observed in the smaller size ranges and constitute 10-50% of the total particles detected.

[P11-08] RELATIVE CONTRIBUTIONS OF PRIMARY AND SECONDARY (BIOGENIC AND ANTHROPOGENIC) ORGANIC AEROSOLS AT NASHVILLE: COMPARISONS OF OBSERVATIONS AND MODELING RESULTS.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 11: Air Quality Modeling (4:00 PM-5:00 PM) Grand Ballroom 2-4

The performance of EPA's Models-3/CMAQ (2002 release) on relative contribution of primary and secondary (biogenic and anthropogenic) organic aerosols was examined and evaluated, paired in time, against observational data from the SOS/Nashville'99 Experiment (June 15 to July 15, 1999). The 12-hour mean ratios of $^{14}C/^{13}C$ measured by radiocarbon analysis were used to determine the fractions of biogenic total carbon (BTC). Organic carbon (OC), elemental carbon (EC) and total carbon (TC) concentrations were measured by a thermo-optical transmission analyzer. The results show that the model captured the temporal variations of observed TC (correlation coefficient (r) =0.90) with slightly higher mean modeled TC concentration (5.4 $\mu g\ C\ m^{-3}$) than the observed TC (4.8 $\mu g\ C\ m^{-3}$). The model slightly overpredicted nighttime observed TC but underpredicted daytime observed TC. The modeled mean fraction of BTC (0.36) was ~44% lower than the observation (0.64). This is due to the fact that the modeled mean BTC concentration (2.0 $\mu g\ C\ m^{-3}$) was 39% lower than the observation (3.2 $\mu g\ C\ m^{-3}$). One of the reasons for the underprediction of BTC by the model is that the model did not include the contribution from the primary BTC. A close inspection of daytime and nighttime cases indicates that the model overpredicted the nighttime OC but underpredicted daytime OC.

[P12-02] AN ANALYSIS OF THE ASSOCIATION BETWEEN AIR POLLUTION AND PULSE OXIMETRY, HEART RATE, AND BLOOD PRESSURE IN ELDERLY SUBJECTS IN SEATTLE.

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Thursday, April 3, 2003, 4:00 PM, Poster Session 6: Workshop 12: Integrating Epidemiology, Toxicology, and Human Clinical Studies (4:00 PM-5:00 PM) Grand Ballroom 2-4

The objective of this intensive panel study was to recruit subjects from groups thought to be susceptible to particulate matter (PM) air pollution and study their exposures and health outcomes. Three groups of subjects were recruited: healthy subjects and subjects with chronic obstructive pulmonary disease (COPD) over the age of 65 and subjects with heart disease 50 years of age and older. Each subject participated for 10 consecutive days in a session for up to 3 sessions that required daily collection of PM and health outcomes. To determine whether PM influenced pulmonary or cardiac function, each subject underwent repeated daily measures of oxygen saturation of arterial blood, pulse rate, and blood pressure during each session. Associations between health outcomes and PM2.5 values measured indoors and outdoors at subjects' homes with Harvard impactors, personal PM2.5 measured with Harvard personal environmental monitors, and central site agency TEOM measurements were tested using mixed effects models with random intercepts. For a 10 μg/m3 increase in PM2.5 from personal monitors on the same day, we found a 2.5 (CI .31-4.62) mmHg increase in systolic blood pressure (SBP) and an increase of 1.6 (CI 0.36-2.84) beats per (bpm) in heart rate in subjects with heart disease. We also saw a 1.8 (0.39-3.26) bpm increase in heart rate associated with a one day lag in PM2.5 for the outdoor monitors and a 1.6 (CI 0.07-3.19) bpm increase in heart rate on the same day with the indoor monitor. We observed similar magnitude decreases in SBP (-2.8mmHg, CI -4.5 to -1.0) and heart rate (-2.2 bpm, CI -4.0 to -0.3) in subjects with respiratory disease for the personal and outdoor monitors respectively. These effects were not seen in healthy control subjects. No associations between PM2.5 and oxygen saturation were observed.

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