QUARTERLY PROGRESS REPORT

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Title: The Pittsburgh PM Supersite Program: A Multidisciplinary Consortium for Atmospheric Aerosol Research

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Institution: Carnegie Mellon University

Project Period: December 16, 2002 - March 15, 2003

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Objectives: Characterization of the atmospheric aerosol in the Pittsburgh region; development and evaluation of current and next generation atmospheric aerosol monitoring techniques; quantification of the impact of the various sources to the PM concentrations in the area; elucidation of the links between PM characteristics and their health impacts; study of the responses of the PM characteristics to changes in emissions.

Work Status: The chemical analysis of all the samples collected during the ambient sampling phase (Phase II) of the Pittsburgh Air Quality Study has been completed. Approximately sixteen months of data are available, including three intensive sampling periods (July 2001, January 2002, and July 2002) and several special experiments (instrument inter-comparison, nucleation, etc). We are continuing the QA/QC of the available data and we will be submitting the 2001 data to EPA by the end of spring of 2003.

We are currently in the third phase of the study (Source Characterization) and we have also started the modeling (Phase IV). We have completed the measurements in one of the biggest coke facilities in North America and in the Squirrel Hill tunnel in Pittsburgh.

The analysis of the data continues. The PAQS team submitted 6 papers to the second special issue in Atmospheric Environment in March. We also coauthored together with colleagues from other Supersites three chapters on semi-continuous inorganic PM, organic PM and mass concentration measurements to be published in the *Compendium of Methods of Air Sampling and Analysis*. The PAQS team contributed 16 papers to the Atmospheric Sciences, Exposure and the Fourth Colloquium on PM and Human Health. Details are provided in the publications and presentations section.

The Clarkson U. team has applied the PMF approach that they used for July 2001 to 10 months of PAQS data. They have developed an approach to identify nucleation and growth events so they can be removed from the data set and the resulting gap is then treated as missing data. It is necessary to remove such transient events before the factor analysis since these non-stationary events do not meet the assumptions of such an analysis. The results of the longer data set were not very satisfactory and it was recognized subsequently that it is not likely that the size distributions from a given source would be constant over an annual cycle. In the summer period, there is more photochemistry while in the winter nucleation of vapors in engine exhaust would be more efficient. Additional sources might be anticipated in winter such as wood smoke and thus, it is not reasonable to analyze these data on a long term basis. The particle size distribution data are being analyzed on a month-by-month basis. Since there is a size distribution measured every 15 minutes, there is sufficient data that analyses can be made on these shorter time blocks. We can then see how the size distributions evolve over the course of the year.

The Hopke team is also currently working on building the program to apply their model for analyzing data from instruments running on different sampling time intervals. We anticipate that we will be making our first trials of this model in June 2003 and hope to have a functioning model by the end of July. The model we are trying to build will permit us to extract source information on the same time scale as the data were obtained and thus, should provide close to optimum source identification and resolution.

Continuous meteorological measurements of wind speed, wind direction, UV radiation, total radiation, total rainfall, temperature, relative humidity, and barometric pressure made at the central site were finalized. Continuous gas-phase measurements of O_3, NO, NO_x, SO_2, and CO made at the central site were also finalized. The measurements were validated to Level 2 using measurements of the same species at nearby ACHD sites. These data will soon be available in the NARSTO format. Semi-continuous $PM_{2.5}$ mass measurements made at the central site using a 30 °C Rupprecht and Patashnick (R&P) TEOM with sample equilibration were also finalized. The measurements were validated to Level 2 using 24-hour FRM, Dichot, and MOUDI mass measurements collected at the central site. Semi-continuous $PM_{2.5}$ nitrate and sulfate measurements made using the Rupprecht and Patashnick (R&P) 8400 instruments were finalized. Comparisons with $PM_{2.5}$ nitrate and sulfate measurements collected from July 1, 2001 to March 1, 2002 using the CMU inorganic sampler revealed that the semi-continuous measurements were underestimates of the true concentrations. The comparison led to the development of a 'best estimate data set', which features the accuracy of the inorganic sampler measurements and the short temporal resolution (1-hour average) of the R&P measurements.

The entire RSMS-3 data set has been fully processed by the UC Davis and U. Delaware teams. Each single particle spectrum, consisting of both positive and negative polarities, has been individually time-to-mass calibrated, peak-integrated and inspected for quality and consistency. More than half of the data has been submitted to NARSTO for release to the public and the remainder will be submitted by the end of June 2003. The correlation of RSMS-3 data with that of coincident measurements, such as the nano-SMPS and high-vol sampler is underway. Currently, new analysis techniques and algorithms are being developed to better handle the extensive size of the data set and to improve single-particle classification schemes. A general overview of the complete data set will be finished by the end of August 2003 and submitted for publication.

The rapid single-particle mass spectrometer, has been modified to improve its performance. Upgrades included replacing plastic by metal tubing to reduce the background signal levels, introduction of a new cone-cap inlet system at the critical orifice to increase the particle transmission efficiency, replacing the single-port turbo pump by a

three-ports turbo pump enhancing pumping speed at the 3rd and 4th inlet stages, redesigning the steering mirror housing to improve stability, etc.

The CSU efforts over the past several months have focused on finalizing our fog and peroxide data and submitting the validated data to the NARSTO database. Fog data throughout the entire study period has been submitted in final form. Peroxide data has been submitted for the period of July-November 2001. We expect the rest of peroxide data to be submitted within the next several weeks. Ion concentrations for measured fog events were fairly consistent over the study period, with the exception of two relatively long-lived events in November 2001. These events showed elevated concentrations of nitrate, sulfate, chloride, and ammonium when compared with events for the rest of the study period. The sample pH, however, was within the range of values seen for other events. Peroxide concentrations were dominated by hydrogen peroxide during the July 2001 intensive, with organic peroxides contributing only about 18% of the total. Throughout the remainder of 2001, total peroxide concentrations fluctuated between 0 and 1.8 ppbv with a clear diurnal cycle and a mean value of 0.13 ppbv. Calculations indicate that H_2O_2 is the primary SO_2 oxidant for production of non-volatile sulfate in Pittsburgh fog drops.

Rutgers University made three kinds of measurements during the Pittsburgh Air Quality Study: 1) semicontinuous particulate organic and elemental carbon, 2) functional groups in size- and polarity-segregated particles, and 3) high volume filter samples for extraction and analysis by polarity. In addition, since the end of the ambient field study we have provided semicontinuous carbon measurements for the sampling of several sources. The semicontinuous carbon data has been finalized and the entire dataset is ready for NARSTO submission. The time-resolved nature of the measurements proved to be extremely useful during source sampling, particularly fenceline sampling, where the time resolution helped to identify times when the plume impacted the sampling site. Tunnel measurements were made during a very cold period. Some measurements (including semicontinuous carbon) were made at approximately 20-30 C, whereas other measurements (including integrated filter measurements) were made at ambient temperature, which was close to 0 C. Measured particulate organic carbon concentrations were considerably lower at the higher temperature. This is consistent with expectations based on gas-particle partitioning theory, and suggests 1) the presence of considerable

semivolatile organic material in motor vehicle exhaust and 2) that the relative amount of particulate organic to elemental carbon in motor vehicle emissions is likely to vary with atmospheric temperature. Recent data analysis efforts have focused on finalizing a strategy for estimating the amount of primary and secondary organic carbon annually. Primary organic carbon is emitted in particulate form and secondary organic carbon is formed in the atmosphere. First a subset of samples throughout the year for which secondary organic aerosol formation is unlikely must be identified. Second, these data are used to describe primary organic carbon as the sum of carbon from combustion (using elemental carbon as a tracer for combustion) and primary non-combustion carbon (e.g. primary biogenic). The data are broken down by season and then by time of day to determine whether the relationship between primary organic carbon and elemental carbon varies seasonally or diurnally (i.e. due to changes in emissions). Then primary organic carbon must be calculated using this/these relationships and secondary organic carbon is determined by difference. The sensitivity of results to reasonable changes in estimation strategy must be examined. We are in the middle of this process. We have written up the methods second for a publication on this topic, and are taking care to ensure that primary organics from all sources are included in the construction of a simple model for primary organic carbon.

Functional groups in size-resolved FTIR spectra, collected in the July and January intensives, have all been integrated to provide concentrations in units of absorbance per cubic meter. These data are being prepared for submission, and the spectra are being clustered to enable quantitative description of the variation in features across the study. Analysis of the high volume samples will begin June 1.

Results: The main findings of the PAQS papers submitted to the second PM Supersites special issue are summarized below.

Ambient sampling for the Pittsburgh Air Quality Study (PAQS) was conducted from July 2001 to September 2002. The study was designed (1) to characterize particulate matter (PM) by examination of size, surface area, and volume distribution, chemical composition as a function of size and on a single particle basis, morphology, and temporal and spatial variability in the Pittsburgh region; (2) to quantify the impact of the various sources (transportation, power plants, biogenic sources, etc.) to the aerosol concentrations

in the area; and (3) to develop and evaluate the next generation of atmospheric aerosol monitoring and modeling techniques. Recent findings of PAQS obtain closure of the Pittsburgh aerosol mass balance if water is included; recommend methods to obtain accurate high time resolution organic material and $PM_{2.5}$ nitrate, sulfate, and mass measurements; estimate the portion of the Pittsburgh organic carbon concentrations that are secondary in origin; describe the diurnal variations in aerosol sulfate and the partitioning of nitrate between the aerosol and gas phases; and quantify the impact of fine particle generation by nucleation. Monthly average and diurnal patterns in aerosol number concentration, and aerosol nitrate, sulfate, elemental carbon, and organic carbon concentrations, light scattering as well as gas-phase ozone, nitrogen oxides, and carbon monoxide are discussed with emphasis on the processes affecting them. **(Wittig et al., 2003a)**

A method for semi-continuous (10 minute time resolution) $PM_{2.5}$ nitrate and sulfate measurements, based on the humidified impaction with flash volatilization design of Stolzenburg and Hering (2000), was evaluated at the Pittsburgh Air Quality Study Supersite from July 2001 to August 2002. The semi-continuous measurements were corrected for several operating parameters. These corrections resulted in an improvement in the agreement of the measurements with the filter-based measurements, with a major axis regression relationship of y=0.83x+0.20 μg m^{-3} and R^2 of 0.84 for nitrate and y=0.71x+0.42 μg m^{-3} and R^2 of 0.83 for sulfate. The corrected semi-continuous measurements were calibrated over the entire year using collocated filter-based measurements. These calibrated semi-continuous measurements are used in conjunction with temporally resolved gas phase measurements of total (gas and aerosol phase) nitrate and meteorological measurements to investigate short-term phenomena at the Pittsburgh Supersite. The gas-to-particle partitioning of nitrate varied daily and seasonally, with a majority of the nitrate in the particle phase at night and during the winter months**. (Wittig et al., 2003b).**

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). The study measured $PM_{2.5}$ mass by the Federal Reference Method (FRM) and the $PM_{2.5}$ chemical composition by a variety of filter-based and continuous instruments. Monthly average $PM_{2.5}$ concentrations for July and August were 20 and 28 µg/m^3. During this period, there

were periods where the sum of the mass of the aerosol chemical components was almost 30% less than the mass measured by the FRM. Mass balance comparisons on a monthly basis revealed average discrepancies of 12 and 19% between the FRM-measured mass and the sum of the aerosol chemical components. In the winter months, monthly average $PM_{2.5}$ concentrations were approximately $12\mu g/m^3$, with the sum of the mass of the aerosol chemical components at or slightly below the FRM-measured mass. For those episodes where the FRM-measured mass is significantly greater than the sum of components, it appears that the dominant mechanism for the mass discrepancy is retention of aerosol water. The negative discrepancy observed on low $PM_{2.5}$ concentration days dominated by organic aerosol or winter days with relatively high nitrate concentration appears to correlate with estimated volatilization losses. The seasonal shift in the mass discrepancy observed from summer to winter cannot be explained by measurement uncertainty and other methods alone; instead these factors in combination with aerosol water and volatilization appear responsible. A method using aerosol thermodynamic models and estimates of volatilization is proposed for calculating FRM mass discrepancy effects from the ambient aerosol composition. **(Rees et al., 2003).**

Size resolved aerosol mass and chemical composition were measured during the Pittsburgh Air Quality Study (PAQS). Daily samples were collected for 12 months from July 2001 to June 2002. Micro-orifice uniform deposit impactors (MOUDIs) were used to collect aerosol samples of fine particulate matter smaller than 10 μm. Measurements of $PM_{0.056}$, $PM_{0.10}$, $PM_{0.18}$, $PM_{0.32}$, $PM_{0.56}$, $PM_{1.0}$, $PM_{1.8}$ and $PM_{2.5}$ with the MOUDI are available for the full study period. Seasonal variations in the concentrations are observed for all size cuts. Higher concentrations are observed during the summer and lower during the winter. Comparison between the $PM_{2.5}$ measurements by the MOUDI and other integrated PM samplers reveals good agreement. Good correlation is observed for PM_{10} between the MOUDI and an integrated sampler but the MOUDI underestimates PM_{10} by 20%. Bouncing of particles from higher stages of the MOUDI (>$PM_{2.5}$) is not a major problem because of the low concentrations of coarse particles in the area. The main cause of coarse particle losses appears to be losses to the wall of the MOUDI. Samples were collected on aluminum foils for analysis of carbonaceous material and on Teflon filters for analysis of particle mass and inorganic anions and cations. Daily samples were analyzed

during the summer (July 2001) and the winter intensives (January 2002). During the summer around 50% of the organic material is lost from the aluminum foils as compared to a filter-based sampler. These losses are due to volatilization and bounce-off from the MOUDI stages. High nitrate losses from the MOUDI are also observed during the summer (above 70%). Good agreement between the gravimetrically determined mass and the sum of the masses of the individual compounds is obtained, if the lost mass from organics and the aerosol water content are included for the summer. For the winter no significant losses of material are detected and there exists reasonable agreement between the gravimetrical mass and the sum of the concentrations of the individual compounds. Ultrafine particles (below 100 nm) account for less than 5% of the $PM_{2.5}$ mass, and show different composition for the summer and the winter intensive. During the summer the ultrafine mass is 50% carbonaceous material (organic material and elemental carbon) and 50% inorganic (mainly sulfate and ammonium); during the winter these percentages are 70% and 30% respectively. **(Cabada et al., 2003b).**

Twelve months of aerosol size distributions from 3 nm to 560 nm, measured using Scanning Mobility Particle Sizers (SMPS) are presented with an emphasis on average number, surface, and volume distributions, and seasonal and diurnal variation. The measurements were made at the main site of the Pittsburgh Air Quality Study from July 2001 to June 2002. These are supplemented with 5 months of size distribution data from 0.5-2.5 μm measured with a TSI Aerosol Particle Sizer and 2 months of size distributions measured at an upwind rural sampling site. Measurements at the main site were made continuously under both low and ambient relative humidity. The average Pittsburgh number concentration (3-500 nm) is 22,000 cm^{-3} with an average mode size of 40 nm. Strong diurnal patterns in number concentrations are evident as a direct effect of the sources of particles (atmospheric nucleation, traffic, and other combustion sources). Nucleation (involving sulfuric acid) is active on the 30-50% of study days over a wide area (at least a hundred kilometers). Rural number concentrations are a factor of 2-3 lower (on average) than the urban values. Average measured distributions are different than the model literature urban and rural size distributions. **(Stanier et al., 2003)**

Publications:

1. J. C. Cabada, S. N. Pandis, and A. L. Robinson (2002) Sources of atmospheric particulate matter in Pittsburgh, Pennsylvania, JAWMA, 52, 732-741.

2. C. O. Stanier, A. Khlystov, and S. N. Pandis (2002) Chemical processes and long-range transport of aerosols: Insights from the Pittsburgh Air Quality Study, in *Long Range Transport of Air Pollution,* Kluwer.

3. Subramanian R., A. Y. Khlystov, J. C. Cabada-Amaya, and A. L. Robinson (2003) Sampling artifacts during measurement of ambient carbonaceous aerosol, *Aerosol Sci. Technol.,* (in press).

4. Cabada J. C., S. N. Pandis, A. L. Robinson, R. Subramanian, A. Polidori, and B. Turpin (2003) Estimating the secondary organic aerosol contribution to PM2.5 using the EC tracer method, *Aerosol Sci. Technol.,* (in press).

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6. Stanier C. O., A. Khlystov, W. R. Chan, M. Mandiro, and S. N. Pandis (2003b) A method for the in-situ measurement of aerosol water content of ambient aerosols: The Dry Ambient Aerosol Size Spectrometer (DAASS), *Aerosol Sci. Technol.,* (in press).

7. A Khlystov, C. O. Stanier, and S. N. Pandis (2003) Aerosol size distribution measurements from 3 nm to 10 μm: Instrument performance and particle properties, *Aerosol Sci. Technol.,* (in press).

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12. Cabada J. C., S. Rees, S. Takahama, A. Y. Khlystov, W. Tang, C. Davidson, and S. N. Pandis (2003) Aerosol size-composition distributions during PAQS, *Atmos. Environ.,* (submitted).

13. Vayenas D., S. Takahama, and S. N. Pandis (2003) Formation and removal of ammonium nitrate and its precursors: System responses to emission changes, *Atmos. Environ.*, (in preparation).

14. Takahama S., D. Vayenas, S. N. Pandis, and C. Davidson (2003) Evaluating the aerosol equibrium assumption in an urban area in the Northeastern US, *Atmos. Environ.*, (in preparation).

15. Eatough D. and C. Davidson (2003) Meteorological influence on, and diurnal patterns in ambient fine particulate chemical composition at two sampling sites in metropolitan Pittsburgh: A 2001 intensive summer study, *Atmos. Environ.*, (in preparation).

17. Eatough D. and C. Davidson (2003) Source apportionment of $PM_{2.5}$, organic material and sulfate during the July 2001 summer intensive, *Atmos. Environ.*, (in preparation).

18. Gaffney J. et al. (2003) Natural radionuclides in fine aerosols in Pittsburgh, *Atmos. Environ.,* (in preparation).

19. Rogge W. et al. (2003) Organic PM2.5 at the Pittsburgh Supersite: Regional versus local concentrations and seasonal variations, *Atmos. Environ.,* (in preparation).

20. Cabada J. C., A. Khlystov, B. Wittig, and S. N. Pandis (2003) Fine particle light scattering reconstruction and measurements at PAQS, *Atmos. Environ.* (in preparation).

21. Subramanian R. , A. Y. Khlystov, B. J. Turpin, A. L. Robinson (2003) Measurement of Ambient Carbonaceous Aerosols During the Pittsburgh Air Quality Study, *J. Geophys. Res.* (in preparation).

22. Khlystov A. Y., C. O. Stanier, and S. N. Pandis (2003) In-situ continuous PM water concentrations measurements, *J. Geophys. Res.*, (in preparation).

23. Pandis S. N. (2003) Estimates of diesel and other emissions: Overview of the Supersite program, in *Improving Estimates of Diesel and Other Emissions for*

Epidemiological Studies, HEI Communication 10, Health Effects Institute, Boston, MA.

Presentations:

1. "Investigation of nucleation bursts in the Pittsburgh air quality study", 6th International Aerosol Conference, Taipei, Taiwan, September 2002 (C. O. Stanier, A. Y. Khlystov, and S. N. Pandis).

2. "Monitoring of water content of ambient aerosol during the Pittsburgh Air Quality Study" 6th International Aerosol Conference, Taipei, Taiwan, September 2002 (A. Y. Khlystov, C. O. Stanier, D. Vayenas, and S. N. Pandis).

3. Performance of the Aerodynamic Particle Sizer 3320 during the Pittsburgh Air Quality Study (PAQS)" 6th International Aerosol Conference, Taipei, Taiwan, September 2002 (A. Khlystov, C. Stanier, and S. N. Pandis).

4. "Sulfate-ammonia-nitric acid interactions in an urban area" 6th International Aerosol Conference, Taipei, Taiwan, September 2002 (S. Takahama, A. Khlystov, B. Wittig, S. V. Hering, C. Davidson, A. Robinson, and S. N. Pandis).

5. "Sampling artifacts during measurement of ambient carbonaceous aerosol" 6th International Aerosol Conference, Taipei, Taiwan, September 2002 (R. Subramanian, A. Y. Khlystov, J. C. Cabada, S. N. Pandis, and A. L. Robinson).

6. "Formation and properties of regional aerosol: Some insights from the Pittsburgh Air Quality Study", NASA-GSFC, Greenbelt MD, May 2002,(C. Stanier, A. Khlystov, S. Rees, J. Cabada, A. Robinson, C. Davidson, and S. N. Pandis)

7. "Seasonal composition of PM2.5 and performance of the Federal Reference Method in Pittsburgh", PM2.5 and Electric Power Generation, Pittsburgh, April 2002 (S. L. Rees, S. Takahama, A. L. Robinson, A. Khlystov, and S. N. Pandis).

8. "Continuous measurements of ammonia, sulfate, and nitrate in Pittsburgh: Implications for PM2.5 control strategies", PM2.5 and Electric Power Generation, Pittsburgh, April 2002 (B. Wittig, A. Khlystov, S. Takahama, C. Davidson, A. Robinson, S. Hering, and S. N. Pandis).

9. "The contribution of long-range transport and secondary organic aerosol to PM2.5 in Pittsburgh", PM2.5 and Electric Power Generation, Pittsburgh, April 2002 (J. C.

Cabada, R. Subramanian, S. N. Pandis, A. L. Robinson, W. Tang, N. J. Anderson, T. Raymond, and C. I. Davidson).

10. "The Dry-Ambient Size Spectrometer: A new technique for the automatic on-line measurement of the atmospheric aerosol water size distribution", Annual Meeting of American Geophysical Union, San Francisco, December 2001 (A. Khlystov, C. O. Stanier, S. N. Pandis).

11. "The July 2001 intensive of the Pittsburgh Air Quality Study", Annual Meeting of AAAR, Portland, Oregon, October 2001 (C. I. Davidson, A. L. Robinson, and A. Khlystov, S. N. Pandis).

12. "Sources of atmospheric carbonaceous particulate matter in Pittsburgh", Annual Meeting of AAAR, Portland, Oregon, October 2001 (J. Cabada, S. N. Pandis and A. L. Robinson).

13. "Automated measurements of dry and wet ambient aerosol distributions", Annual Meeting of AAAR, Portland, Oregon, October 2001 (A. Y. Klhystov, W. R. Chan, C. O. Stanier, M. Mandiro, and S. N. Pandis)

14. "Continuous measurements of ammonia and ammonium in ambient air", Annual Meeting of AAAR, Portland, Oregon, October 2001 (A. Khlystov, J. Sauser, R. Otjes, and S. N. Pandis).

15. The contribution of secondary organic aerosol to PM2.5 concentrations in Pittsburgh, AGU Fall Meeting 2002, San Francisco CA Dec. 2002 (J. C. Cabada, S. N. Pandis, A. L. Robinson, R. Subramanian, A. Polidori, and B. Turpin).

16. Preliminary results from the Pittsburgh Air Quality Study, AGU Fall Meeting 2002, San Francisco CA Dec. 2002 (S. N. Pandis, C. I. Davidson, A. L. Robinson, and A. Y. Khlystov)

17. Monitoring of water content of ambient aerosol during the Pittsburgh Air Quality Study, AGU Fall Meeting 2002, San Francisco CA Dec. 2002 (A. Y. Khlystov, C. O. Stanier, D. Vayenas, and S. N. Pandis)

18. Investigation of nucleation bursts during the Pittsburgh Air Quality Study, AGU Fall Meeting 2002, San Francisco CA Dec. 2002 (C. O. Stanier, A. Y. Klhystov, B. Wittig, S. N. Pandis, Y. Zhou, K. Bein, A. S. Wexler, C. Misra, and C. Sioutas)

19. Atmospheric particulate matter: Physics, chemistry, and Chemical Transport Models, PM AAAR 2003, Pittsburgh PA March 2003 (B. Koo, K. Fahey, T. Gaydos, and S. N. Pandis)

20. Secondary organic aerosol contribution to carbonaceous PM2.5 concentrations in Pittsburgh, PM AAAR 2003, Pittsburgh PA March 2003 (J. C. Cabada, S. N. Pandis, B. Wittig, A. Robinson, R. Subramanian, A. Polidori, and B. J. Turpin)

21. Using ultrafine concentrators to increase the hit rates of single particle mass spectrometers, PM AAAR 2003, Pittsburgh PA March 2003 (Y. Zhao, K. J. Bein, A. S. Wexler, C. Misra, P. M. Fine, and C. Sioutas)

22. PM$_{2.5}$ Federal Reference Method performance relative to mass balance closure, PM AAAR 2003, Pittsburgh PA March 2003 (S. L. Rees, A. L. Robinson, A. Khlystov, C. O. Stanier, and S. N. Pandis)

23. Examining the assumptions behind elemental carbon measurements using the thermal-optical transmittance technique, PM AAAR 2003, Pittsburgh PA March 2003 (R. Subramanian, A. Y. Khlystov, and A. L. Robinson)

24. Spatial variations of PM2.5 during intensive sampling of PAQS, PM AAAR 2003, Pittsburgh PA March 2003 (W. Tang, C. I. Davidson, T. R. Raymond, S. N. Pandis, B. Wittig, A. Khlystov, and A. L. Robinson)

25. Fenceline sampling adjacent to a large coke production facility in Pittsburgh, PM AAAR 2003, Pittsburgh PA March 2003 (E. A. Weitkamp, E. Lipsky, A. Robinson, N. Anderson, H. Leifeste, R. Subramanian, J. Cabada, A. Khlystov, C. Stanier, L. Lucas, S. Takahama, B. Wittig, C. Davidson, S. Pandis, A. Polidori, H. J. Lim, B. Turpin, P. Pancras, and J. Ondov)

26. In-use vehicle emissions source characterization study: Squirrel Hill tunnel Pittsburgh, PM AAAR 2003, Pittsburgh PA March 2003 (E. M. Lipsky, A. Robinson, N. Anderson, H. Leifeste, R. Subramanian, J. Cabada, S. Rees, A. Khlystov, C. Stanier, L. Lucas, S. Takahama, B. Wittig, C. Davidson, S. N. Pandis, A. Polidori, H. J. Lim, and B. Turpin)

27. Water content of ambient aerosol during PAQS, PM AAAR 2003, Pittsburgh PA March 2003 (A. Khlystov, C. Stanier, and S. N. Pandis)

28. Diurnal and seasonal trends in outdoor particle size distributions measured at urban and rural locations during PAQS (C. Stanier, A. Khlystov, and S. N. Pandis)

29. Mass and chemically resolved size compositions of fine particulate matter at the Pittsburgh Supersite, PM AAAR 2003, Pittsburgh PA March 2003, (J. C. Cabada, S. N. Pandis, S. Rees, S. Takahama, A. Khlystov, A. L. Robinson, and C. I. Davidson)

30. Simulation of the atmospheric aerosol size/composition distribution in a three-dimensional chemical transport model, PM AAAR 2003, Pittsburgh PA March 2003 (T. M. Gaydos, K. M. Fahey, B. Koo, and S. N. Pandis)

31. Application of PMCAMx to the South Coast Air Basin and the Eastern United States, PM AAAR 2003, Pittsburgh PA March 2003 (B. Koo, K. M. Fahey, T. M. Gaydos, and S. N. Pandis)

32. Principal component analysis of trace elements in $PM_{2.5}$ in Pittsburgh, PM AAAR 2003, Pittsburgh PA March 2003 (N. J. Anderson, C. I. Davidson, S. N. Pandis, A. Robinson, and A. Khlystov)

33. Source apportionment using particle size distribution data from PAQS, PM AAAR 2003, Pittsburgh PA March 2003 (L. Zhou, E. Kim, P. K. Hopke, C. Stanier, and S. N. Pandis)

34. Highly time-resolved measurements of elemental composition at the Baltimore, St. Louis, and Pittsburgh Supersites using the UM High Frequency Aerosol Slurry Sampler: Unprecedented resolution of the sources of primary atmospheric aerosol (J. M. Ondov, J. Pancras, S. Gazula, M. Yu, J. Turner, A. Robinson, S. N. Pandis, N. D. Poor, and R. K. Stevens)

Changes in Key Personnel Involved in the Project: None

Expenditures to Date: During the first twelve quarters of the project the Supersite team has used the entire budget for the corresponding period.

Planned Activity for the Subsequent Reporting Period: Major activities planned for the next quarter of the project include:

- Continued data analysis

- Continuation of the source sampling and characterization experiments

- Modeling of the July 2001 intensive using a three dimensional chemical transport model (PMCAMx).

- QA/QC of the data. Submission of the data files to EPA.

Supplemental Key Words: Airborne particulate matter, aerosol, size distribution, ultrafine, fine and coarse particles, atmospheric chemistry, source-receptor, measurement error, study design, regional modeling, source/receptor analysis, Pittsburgh, Ohio River Valley, Western Pennsylvania, photochemistry, meteorology, trajectory modeling, peroxides.

Relevant Web Sites: homer.cheme.cmu.edu