# QUARTERLY PROGRESS REPORT

**Cooperative Agreement Number** R 82806101-0

**Date of report:** September 15, 2002

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

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**Institution:** Carnegie Mellon University

**Project Period:** May 16, 2002 – September 15, 2002

**Investigators:** Spyros Pandis, Cliff Davidson, Allen Robinson, Neil Donahue, Andrey Khlystov (*Carnegie Mellon Univ*.), Anthony Wexler (UC Davis), Murray Johnston (*Univ. of Delaware*), Wolfgang Rogge (*Florida Intern. Univ*.), Mark Hernandez, Joze Jimenez (*Univ. of Colorado*), Jeff Collett (*Colorado State Univ*.), Susanne Hering (*Aerosol Dynamics*), Jonathan Kahl (*Univ. Wisconsin*), Barbara Turpin (*Rutgers Univ*.), Bruce Doddridge, John Ondov, Steven Buckley (*Univ. of Maryland*), *RJ Lee, Inc.,* Kevin Crist (*Ohio University*), Delbert Eatough (*Brigham Young University*), Urs Baltensperger (*Paul Scherrer Inst*.), Phil Hopke (Clarkson U.), Jonathan Samet (*Johns Hopkins*), Allen Goldstein (UC Berkeley), Doug Worsnop (Aerodyne), William Aljoe (*DOE-NETL*).

**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:** Baseline ambient monitoring in the central site was continued during these three months without any significant problems. During July 2002 we had the third intensive sampling period of the study. During the episode days of the second summer intensive the full suite of instruments were used. Additional daily $PM_{2.5}$ composition measurements were collected in the satellite sites (Hazelwood, Lawrenceville, Florence, Greensburg, and Athens, Ohio). A special nucleation experiment took place in September to investigate the chemical composition of the

ultrafine particles that are produced in situ during sunny relatively clean days. The third phase of the study (Source Characterization) has started with measurements in one of the biggest coke facilities in North America.

The $PM_{2.5}$ concentration levels during the summer of 2002 were significantly higher than during the first summer of the study. A number of multi-day episodes were captured (June 22-26, June 30-July 4, July 7-9, July 17-19) most of them during the July intensive. In all of these episodes the daily average $PM_{2.5}$ concentration exceeded 50 $\mu g\ m^{-3}$ for at least one day. The highest observed daily average $PM_{2.5}$ concentration during PAQS was around 62 $\mu g\ m^{-3}$ on July 1$^{st}$. This episode in the beginning of July covered a significant part of the Northeastern US. Our main objective during the second summer of the study was to obtain more data during days with relatively high $PM_{2.5}$ levels, and thanks to the help of nature we have been successful.

During September, the Aerodyne team (Doug Worsnop and colleagues) together with Jose Jimenez and his team brought the Aerodyne particle spectrometer to the central site. The major goal of the study was to learn more about the composition of the ultrafine particles during nucleation events. Secondary objectives were the inter-comparison of the two particle spectrometers and obtaining additional information about the evolution of the size/composition distribution of the particles. A number of nucleation bursts were observed during the two weeks of this mini-study. Preliminary results suggested that most of the ultrafine particles during these events contained sulfate. This provides significant support to our hypothesis that the initial nuclei consist of sulfate, ammonia, and water and that they grow because of condensation of sulfuric acid and organics. The results from these studies are currently analyzed from all the groups that participated.

The analysis of the collected samples during PAQS should be completed during the next project period. We are almost up-to-date in the analysis of the major inorganic ions (CMU Speciation Sampler, PC-BOSS), the OC and EC (three CMU samplers and PC-BOSS), the mass concentrations (FRM, Dichotomous Sampler, and MOUDI impactor). There is a small backlog only for the analysis of the metals, the bio-aerosols and the organic speciation (because of the labor-intensive nature of the analysis). Most of the data have been loaded to the PAQS database and are currently undergoing QA/QC. The data are in the NARSTO format.

The analysis of the data is also underway. The PAQS team gave 5 presentations in the International Aerosol Meeting (Taiwan, September 2002) and will give 14 presentations in the upcoming AAAR meeting in October. Two presentations were given during the International International Global Atmospheric Chemistry conference (Greece, September 2002). Seven papers have been submitted or are in preparation for the first PM Supersite special issue in the Aerosol Science and Technology issue. Details are provided in a subsequent section.

During the last quarter, the PAQS data management team has been working to submit data to the NARSTO archive and to Clarkson University. The NARSTO format on approximately 80% of July 2001 intensive data has been checked by the NARSTO Quality Systems Science Center; several data sets have been checked as many as three times. We are continuing to work on debugging the format. The goal is to have a large fraction of the July 2001 through September 2001 data submitted to the archive by the end of September 2002. We have initiated the transfer of data to Clarkson University for inclusion in the relational database.

We are in the middle of the source characterization phase of the study. The emissions from a major coke facility were characterized using fence monitoring techniques. A number of instruments with fast response were used for the study including: SMPS (size distributions), semi-continuous OC/EC, semi-continuous metals (SEAS by the Ondov group), major inorganic ions (steam sampler), gas-phase analyzers. Samples were brought to the central supersite and were analyzed with the single particle mass spectrometer to obtain the particle-by-particle signature of the source. The sampling site was dominated by the source especially during the night. During the night of August 22, 2002 the measured total carbon concentration exceeded 90 $\mu gC\ m^{-3}$ while the ambient levels were less than 5 $\mu gC\ m^{-3}$. Samples were collected for speciation of the organics during some of these nights. The source characterization phase of PAQS will continue for another six months.

**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. Rees S. L., A. L. Robinson, A. Khlystov, C. O. Stanier, and S. N. Pandis (2003) The $PM_{2.5}$ Federal Reference Method (FRM) and the chemical mass balance for fine particulate matter, *Aerosol Sci. Technol.,* (in preparation).
4. 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 preparation).
5. Cabada J. C., S. N. Pandis, A. L. Robinson, R. Subramanian, A. Polidori, and B. Turpin (2003) Estimating the secondary organic aerosol contribution to $PM_{2.5}$ using the EC tracer method, *Aerosol Sci. Technol.,* (submitted).
6. Stanier C. O., A. Y. Khlystov, and S. N. Pandis (2003) Nucleation events during the Pittsburgh Air Quality Study: Description and relation to key meteorological, gas phase, and aerosol parameters, *Aerosol Sci. Technol.,* (in preparation).
7. Stanier C. O., A. Khlystov, W. R. Chan, M. Mandiro, and S. N. Pandis (2003) A method for the in-situ measurement of aerosol water content of ambient aerosols: The Dry Ambient Aerosol Size Spectrometer (DAASS), *Aerosol Sci. Technol.,* (submitted).
8. 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 preparation).
9. Zhou L. and P. Hopke (2003) The Advanced Factor Analysis on Pittsburgh particle size distribution data, *Aerosol Sci. Technol.,* (in preparation).

**Presentations:**

1. "Investigation of nucleation bursts in the Pittsburgh air quality study", $6^{th}$ 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" $6^{th}$ 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)" $6^{th}$ 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" $6^{th}$ 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" $6^{th}$ 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 $PM_{2.5}$ and performance of the Federal Reference Method in Pittsburgh", $PM_{2.5}$ 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 $PM_{2.5}$ control strategies", $PM_{2.5}$ 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 $PM_{2.5}$ in Pittsburgh", $PM_{2.5}$ 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).

**Changes in Key Personnel Involved in the Project:** Doug Worsnop (Aerodyne) and Jose Jimenez (U. Colorado) have joined the PAQS team.

**Expenditures to Date:** During the first ten 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:

- Completion of the baseline measurements. September 30 will be the last day of the measurements. The sampling station will be removed in the end of October.
- Continued analysis of the collected samples by the CMU team and its collaborators.
- 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, epidemiology, regional modeling, source/receptor analysis, Pittsburgh, Ohio River Valley, Western Pennsylvania, photochemistry, meteorology, trajectory modeling, peroxides.

**Relevant Web Sites**: homer.cheme.cmu.edu