

COMPARATIVE EVALUATION OF AMBIENT FINE PARTICULATE MATTER (PM_{2.5}) DATA OBTAINED FROM URBAN AND RURAL MONITORING SITES ALONG THE UPPER OHIO RIVER VALLEY

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Summary

This presentation summarizes detailed findings and conclusions drawn from evaluations of data captured to date from the operation of ambient PM_{2.5} 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 (PM_{2.5}) 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.

A summary of the sampling activities, sample analysis and the correlation and interpretation of data acquired from February 1999 through October of 2001 will be presented. PM_{2.5} data acquired from both discrete filter samplers and continuous emission monitors will be presented and correlated. Mass and speciated data from urban and rural sources will be compared. Also, seasonal variations in PM_{2.5} distribution will be examined. Finally, preliminary correlations between wind trajectories and total PM_{2.5} mass will be presented.

Project Goal and Objectives. As stated above, the overall goal of this project was to investigate the nature and composition of fine particulate matter (PM_{2.5}) and its precursor gases in the Upper Ohio River Valley; however, in the process, the UORVP was intended to address the following four key scientific questions related to ambient fine particulate matter:

- Are sulfates a major or minor component of PM_{2.5} mass in the eastern half of the continental USA?
- Is there a correlation between O₃ and PM_{2.5} levels?
- Is there a significant variation in PM_{2.5} composition/concentration between urban and rural sites impacted by similar regional emission sources?
- Does the Federal Reference Method (FRM) performance provide an accurate/realistic measurement of PM_{2.5} mass? (What, if any, are the influences of artifacts on measurement?)

Two urban and two rural monitoring sites were included in the UORVP. The four sites selected were all part of existing local and/or state air quality programs. One urban site was located in the Lawrenceville section of Pittsburgh, Pennsylvania. This site is an air quality monitoring station operated by the Allegheny County Health Department. A second urban site was collocated at a West Virginia Division of Environmental Protection (WVDEP) monitoring station at the airport in Morgantown, West Virginia. One rural site was collocated with the Pennsylvania Department of Environmental Protection (PADEP) at a former NARSTO-Northeast site near Holbrook, Greene County, Pennsylvania. The other rural site was collocated at a site operated by the Ohio Environmental Protection Agency (OHEPA) and managed by the Ohio State Forestry Division in Gifford State Forest near Athens, Ohio.

Sampling Equipment. Sampling was conducted using Federal Reference Method (FRM) PM_{2.5} sequential and single filter-based samplers in order to provide comparability with stations set up as part of the national PM_{2.5} monitoring network. Similar PM_{2.5} sequential filter-based samplers (SFSSs) designed and built by the Desert Research Institute (DRI) were also deployed at the monitoring sites. In addition, PM₁₀ sequential filter-based samplers (DRI-SFSSs) were installed at the Lawrenceville and Holbrook sites along with DRI Sequential Gas Samplers (SGSs), designed to measure gaseous ammonia

and nitric acid, were also deployed. The two satellite sites were equipped only to monitor PM_{2.5}. A DRI-SFS was provided for the Morgantown, WV site, and a Met One Instruments Spiral Aerosol Speciation Sampler (SSAS) was utilized at the Athens, OH site.

The measurement of several gases that are relevant to characterizing photochemistry, or are precursors for particle formation, were also performed. Ozone (O₃), sulfur dioxide (SO₂) and nitric oxide (NO)/nitrogen dioxide (NO₂) were measured using ambient air monitors at the Holbrook and Lawrenceville sites collocated with the DRI-SGSs used to measure gaseous nitric acid (HNO₃) and ammonia (NH₃). Measurement of ambient mercury was also carried out using a “mercury deposition network” sampler, but solely at the Holbrook site.

Along with the discrete filter-based samplers used for intermittent sampling, continuous PM_{2.5} mass measuring instruments were in operation at the Lawrenceville and Holbrook sites. Tapered Element Oscillating Mass (TEOM) balances, manufactured by Rupprecht and Patashnick (R&P) Company, provided continuous mass measurements 24-hour per day and 7-day per week for PM_{2.5} and PM₁₀ at the Lawrenceville site and PM_{2.5} at the Holbrook site.

Surface meteorological data were collected at the Lawrenceville and Holbrook sites. Wind speed and direction, temperature, barometric pressure, relative humidity, precipitation and solar radiation sensors were operational at Lawrenceville while wind speed and direction, and temperature data were collected at Holbrook.

Sampling and Analysis Schedule. The UORVP was arranged to obtain a base level of intermittent samples on every sixth day at all the four sites. This allowed for estimates of monthly, seasonal and annual averages that could be compared with data obtained from other EPA/state programs and with other parallel research projects in the eastern United States. To investigate the daily differences, especially during months of high production of secondary particulates from atmospheric reactions, a daily “intensive sampling program” was performed for approximately one month in the summer, when PM_{2.5} material was obtained on a 6-hour schedule to evaluate episodic and diurnal variations in sample composition. For comparison with summer conditions, a similar one-month daily sampling period was performed in the winter months.

Sampling commenced with intensive sampling at the Lawrenceville and Holbrook sites on February 17, 1999 (Winter 1999 Session). Six-hour samples were collected daily at Lawrenceville and daily 24-hr integrated samples were acquired at Holbrook. Intermittent sampling (every sixth day) continued at these two sites subsequent to this intensive sampling and the Morgantown and Athens sites were added to this schedule on September 15, 1999. Intensive summer sampling occurred at all the four sites from August 3 through September 12, 1999 (Summer 1999 Session). Six-hour samples were collected daily at Lawrenceville, daily 24-hr integrated samples at Holbrook and 24-hr integrated samples every 3rd day at the Morgantown and Athens sites. The same sampling protocol was carried out at the four sites during the Winter 2000, the Summer 2000 and the Summer 2001 intensive sampling programs. Intermittent 6-day sampling ended on August 8, 2001 at the end of the Summer 2001 intensive; however, all continuous monitors including TEOMs have remained and are currently in operation. Also, a limited scope sampling intensive was performed for a three-week period beginning January 2, 2002 (Winter 2002 Session).

Results/Conclusions. 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 PM_{2.5} levels; however, the FRM-obtained data was consistently lower than the averages from the TEOM/DRI-SFS measurements;
- 2) The trending in the PM_{2.5} levels was similar for Lawrenceville and Holbrook, which represent an urban and a rural site sixty-five miles apart. This implies that the PM_{2.5} levels appear to be impacted more by regional than by local effects;
- 3) The absolute median PM_{2.5} levels were slightly higher for Lawrenceville than for Holbrook, implying that local urban environmental contributions had a minor but measurable effect on total PM_{2.5} mass concentration;
- 4) PM_{2.5} 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) The PM₁₀ fraction had a larger percentage of geological material and a smaller percentage of condensable material (ammonium bisulfate, ammonium sulfate, ammonium nitrate and total carbon species) than the PM_{2.5} fraction for samples collected in winter at Lawrenceville; and
 - 10) Most high PM_{2.5} episodes occurred when the predominating wind direction was from the South-West.

The analysis of the acquired data has so far addressed three of the four scientific questions originally posed. More data analysis is on-going including the correlation between O₃ and PM_{2.5} levels and the correlation of mass data with meteorological observations.