

Southern Fine Particulate Monitoring Project

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Summary

This presentation describes results from the first year of operation of the "Southern Fine Particulate Monitoring Project", funded by the DOE National Energy Technology Laboratory under cooperative agreement to Southern Research Institute. In this project we established and operate a research monitoring station in the Birmingham, AL metropolitan area in collaboration with existing regulatory and research efforts. The host site is the North Birmingham PM_{2.5} mass and chemical speciation monitoring station operated by the Jefferson County Health Department. The site is also one of eight sites in the EPRI / Southern Company Southeastern Aerosol Research and Characterization (SEARCH) project. These programs provide several replicate measurements relevant to ambient PM, including filter-based mass and species measurement of PM₁₀ and PM_{2.5}, and near-continuous measurements of meteorological data, reactive gases, total and black carbon, as well as 50°C TEOM measurements of PM₁₀ and PM_{2.5}. Our project supplements the existing projects at the site with an augmented set of near-continuous measurements of fine particulate mass (30°C dry TEOM), composition (R&P 8400S sulfate), particle size distribution (TSI APS/SMPS analyzers) and optical scattering (Radiance M903 Nephelometer). We are applying the measurements to time/transport properties of fine PM, source attribution, and implications for management strategies for PM_{2.5}.

Particulate concentrations show considerable short-term variability, with frequent excursions attributable to plume impacts from local stationary or mobile sources. Underlying these fluctuations are some persistent time-of-day trends, superimposed on a seasonal trend toward higher concentrations in warmer months. To depict PM_{2.5} time-of-day trends, the PM_{2.5} mass concentration averages over corresponding hours of the day were computed for each study month. Overnight steady high levels followed by rush hour peaks are seen to some extent during each month of data collection. After the morning peak, average concentrations drop to a lower level during daylight hours, followed by a steady rise from late afternoon to midnight. The steady daytime concentrations are in the 16 - 19 µg/m³ range during the spring and fall months, but trend to higher levels in the summer months with suggestions of a mid afternoon increase. The overnight concentrations and morning rush hour peak are more variable from month to month, even within seasons. Generally, concentrations in these hours are lower in the spring and fall months when the air was generally cleaner. The major mass-bearing size fractions (120 - 900 nm) show the same overall trends as the PM_{2.5} TEOM mass concentration, with the morning rush hour maximum slightly less pronounced. In contrast, the particle sulfate concentration shows very little sign of a morning rush hour peak, but for the summer months does show a broad maximum in the daytime hours. The markedly different time-of-day pattern of the sulfate mass fraction confirms an independent origin for this major mass fraction from the balance of the particle mass.

Some Source Attribution information was gained from Positive Matrix Factorization (PMF) calculations using daily chemically resolved PM_{2.5} data from the EPRI SEARCH program measurements at the site. Seven factors extracted by the PMF method account for more than 85% of the measured mass. In order of their calculated contribution, these factors are identified as secondary sulfate (35%), vehicle traffic (29%), crustal (9%), secondary nitrate (5%), biomass combustion (5%), non-ferrous metallurgical (2%), and ferrous metallurgical (1%). Significant associations were verified with time (seasonal and day of week) and meteorological variables (temperature, wind speed and direction). Application of the semicontinuous data allows improved resolution of several specific local sources and assessment of their impact on the measured ambient particulate loading.