The Regional Nature of $PM_{2.5}$ Episodes in Southwestern Pennsylvania

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Summary

The NETL-OST in-house $PM_{2.5}$ Site Sampling and Analysis program performs in-depth research to characterize ambient air concentrations of particulate matter with an aerodynamic diameter of 2.5 micrometers or less ($PM_{2.5}$). In particular this research program is directed toward determining the method and degree by which fossil-fuel-fired electric power generating stations contribute to the primary particulate matter load in ambient air. This program will develop high-quality scientific information for decision makers to implement effective, cost-efficient strategies to meet the stringent, revised, National Ambient Air Quality Standards (NAAQS) of 1997.

During the time period from October 1999 through September 2000, $PM_{2.5}$ mass and composition were measured daily with two batch samplers, a $PM_{2.5}$ R&P Partisol®- Plus FRM and a BYU PC-BOSS, and continuously with a TEOM® monitor. The composition and concentrations of $PM_{2.5}$ were both highly variable during this time period. This paper explores the chemical composition of the $PM_{2.5}$ at the NETL site. Changes in the composition associated with transport of pollutants to the site are discussed, and the probable sources of $PM_{2.5}$ at the site as a function of meteorological conditions are considered.

Relationships among various measured parameters and possible causes of the variations seen in concentration and composition of the fine particulate matter were explored. Correlation of the data with meteorological data and back-trajectory analyses suggested that episodes of high concentrations of $PM_{2.5}$ are associated with transport of pollutants from outside the NETL study site area during the passage of frontal systems. Pollutants that build up in other areas during high pressure regimes are transported to the site under these conditions. The main sources of these transported pollutants were from the general direction of the Ohio River Valley to the west and southwest of the site. The transport of this $PM_{2.5}$ occurred most frequently and resulted in the highest concentrations during the summer. Local sources, within a 20 Km radius of the NETL site, were minor contributors to elevated $PM_{2.5}$ concentrations. Likely sources of $PM_{2.5}$ during low concentration periods were transportation, coal-fired boiler and other emissions generated in the local area. For these periods, the average concentration of $PM_{2.5}$ was 13 $\mu g/m^3$ and 70% of the $PM_{2.5}$ mass was carbonaceous material, including semi-volatile organic material that was lost in varying degrees from both the TEOM® and FRM samplers. In contrast, much higher concentrations of $PM_{2.5}$ were associated with transport of pollutants to the site. Analysis of meteorological and back-trajectory data suggests that these pollutants were emitted elsewhere during a period of high atmospheric pressure and were subsequently transported to the site with the passage of a frontal system. The fine particulate matter present at the NETL site under these conditions was enriched in sulfate. For example, when the $PM_{2.5}$ collected at the site originated from the west or southwest during the summer, the concentrations averaged 31 $\mu g/m^3$ and ammonium sulfate averaged 54% of the $PM_{2.5}$ mass. During these episodes of high fine particulate material at the NETL site, concentrations measured with TEOM monitors at regionally located sites were highly correlated. Possible reasons for this regional nature of the fine particulate material will be introduced.