PROJECT facts

Environmental and Water Resources

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U.S. Department of Energy
Office of Fossil Energy
National Energy Technology Laboratory

Evaluation of the Emission, Transport, and Deposition of Mercury, Arsenic, and Fine Particulate Matter From Coal-Based Power Plants in the Ohio River Valley Region

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Background

The U.S. Department of Energy's National Energy Technology Laboratory (NETL) has established an aggressive research initiative to address the technical and scientific issues surrounding the impact of coal-based power systems on ambient levels of fine particulate matter ($PM_{2.5}$), nitrogen oxides (NO_X), mercury/air toxics, and acid gases. Regulatory drivers such as the 1990 Clean Air Act Amendments, the 1997 revised National Ambient Air Quality Standards, and the 2005 Clean Air Interstate Rule (CAIR) and Clean Air Mercury Rule (CAMR) are pushing coal-fired power plant owners to consider multi-pollutant control options. The overall goal of NETL's research effort is to ensure that the best science and technology are available for regulatory decision making related to the health and environmental impacts of ambient fine particulate matter, regional haze, and air toxics.

Primary Project Goal

The overall project goal is to quantitatively evaluate the emission, transport, and deposition of mercury, arsenic, and $PM_{2.5}$ from coal power plants in the Ohio River Valley region.

Objectives

Ohio University is conducting the work in collaboration with CONSOL Energy, ATS-Chester Engineers (ATS) and Atmospheric Environmental Research, Inc. (AER) as subcontractors. An existing air monitoring site in Athens, Ohio was upgraded to provide the capability to monitor $PM_{2.5}$ chemical composition, species of gaseous mercury in ambient air, and mercury in precipitation. Regional modeling studies are being conducted to develop a comprehensive inventory of arsenic, elemental mercury (Hg^0), reactive gaseous mercury (RGM), and $PM_{2.5}$, including

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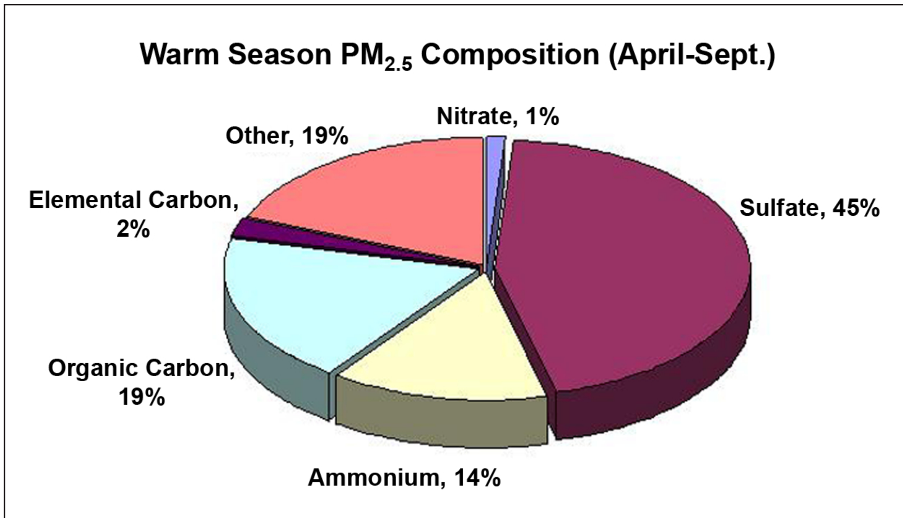
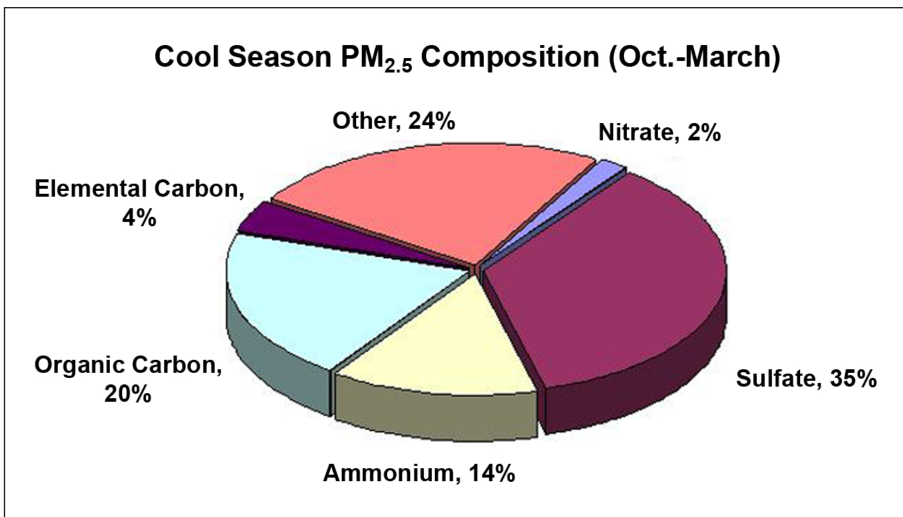
sources, sinks, atmospheric lifetimes, burdens, and air movement across the Ohio Valley Region. Updated emissions inventories for mercury and arsenic within the region are being developed to support this objective. Short-term and seasonal simulations with the refined model are being compared to field measurements from the monitoring site, and the results are being used to develop a decision-support tool for policy makers and other stakeholders.

The scope of work for the ambient air monitoring includes the deployment of a surface air monitoring (SAM) station in Athens, Ohio. The SAM station contains sampling equipment to collect and measure mercury (including speciated forms of mercury and wet and dry deposited mercury), arsenic, $PM_{2.5}$, and gaseous criteria pollutants (CO, NO_X, SO_2, O_3, etc.). Approximately 18 months of field data are being collected at the SAM site to validate the regional model simulations for episodic and seasonal model runs. The ambient air quality data provides qualitative information on $PM_{2.5}$ and gas composition that can be used by Ohio Valley industries to assess performance of multi-pollutant control systems.

Accomplishments

- Began operation of a surface air monitoring station in Athens, Ohio in March 2004 to collect and measure 18 months of mercury, arsenic, $PM_{2.5}$, pollutant gases, and weather data.
- Conducted a base case simulation for the year 1996 with the CMAQ (Community Multiscale Air Quality) 3-D regional-scale atmospheric chemical transport model.
- Refined and updated mercury and arsenic emission inventories for the 2004 base case.
- Performed short-term CMAQ modeling simulations for 2001 and compared model predictions to field measurements from the DOE-sponsored Pittsburgh Air Quality Study.
- Completed meteorological simulations for 2004 base case to support conducting seasonal-scale modeling simulations to identify sources contributing to the deposition of mercury, arsenic, and $PM_{2.5}$ in the Ohio Valley region.
- Initiated development of web-based model interface technologies to enable industry and government agencies to evaluate pollutant source-receptor relationships and performance of emission reduction strategies.





Results of $PM_{2.5}$ Speciation Monitoring by Season

PERIOD OF PERFORMANCE

April 2003 to
December 2006

COST

Total Project Value
$1,584,052

DOE/Non-DOE Share
$1,260,777 / $323,275

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Benefits

Mercury, arsenic, and associated fine particulate matter can be transported over large distances due to their limited rate of atmospheric deposition. Elemental mercury transport, for example, represents a global problem because it is believed to have a half-life of approximately one year in the atmosphere, and little is known about its cyclic transport between land, water, and air. Also, biogenic contributions, particularly those that involve plant respiration, are understood even less well. As a consequence, a regional approach must be adopted to adequately evaluate source-receptor relationships for mercury, arsenic, and associated fine particulate matter. Characterizing transport and deposition on a regional scale facilitates the design and implementation of emission control strategies to achieve maximum environmental benefit at an acceptable cost.

Planned Activities

Activities continue to focus on two important tasks. First, seasonal-scale simulations will continue to identify significant sources and source regions contributing to the deposition of mercury and ambient concentrations of arsenic and fine particulate matter over time periods of several months or more. The modeling will also examine the efficacy of emission reduction strategies specifically for coal-fired power plants. Second, web-based model interface technologies will continue to be developed to provide industry and government agencies with a user-friendly decision-support tool to facilitate the evaluation of source-receptor relationships and the efficacy of emission reduction strategies.