PROJECT UPDATE

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New York State Energy Research and Development Authority

Environmental Monitoring, Evaluation, and Protection Program

Source Apportionment of Fine Particles in New York City

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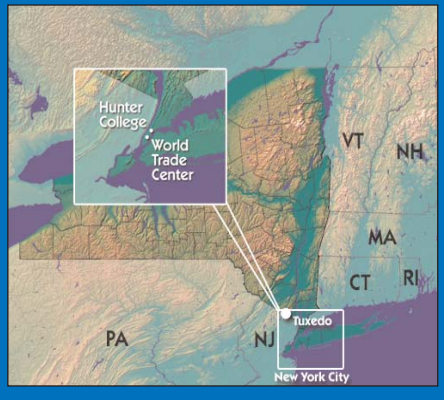
Project Location



Project Status

- Initiated 1999
- Project ongoing

Contact Information

For more information on this project see:
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Keywords

- Aerosol
- Elemental carbon
- Particulate matter ($PM_{2.5}$)
- Source apportionment
- State Implementation Plans

PROJECT FOCUS

This project monitored 2001 levels of fine particulate matter ($PM_{2.5}$) at two locations: Hunter College in Manhattan, New York City (NYC) and New York University's satellite campus in Sterling Forest, near Tuxedo, Orange County (SF). Beginning in January 2001, researchers collected daily $PM_{2.5}$ data from the two sites in order to measure $PM_{2.5}$ mass concentrations, to distinguish the relative contributions of local and regional sources to $PM_{2.5}$ pollution in NYC, and to determine the categories of responsible sources. Information from the SF site, which is located in a rural setting approximately 35 miles to the north and west of NYC, was used as reference data to indicate regional air quality, representing $PM_{2.5}$ mass concentrations transported from upwind sources.

CONTEXT

In 1997, the U.S. Environmental Protection Agency (EPA) set a new mass-based National Ambient Air Quality Standard (NAAQS) for airborne particles smaller than 2.5 microns in diameter, called $PM_{2.5}$, including a daily maximum (65 $\mu g/m^3$) and an annual daily average (15 $\mu g/m^3$). When these standards come into effect, they will likely be exceeded in New York State (NYS). Currently, the New York State Department of Environmental Conservation (NYS DEC) is conducting a three-year monitoring program to identify areas in New York State that may not meet the mass-based $PM_{2.5}$ NAAQS.

Airborne particulate matter (PM) is a broad class of materials of different composition and sizes that are transported in the air as solid particles or liquid droplets. PM is emitted from a variety of natural processes and human activities, including fossil fuel combustion, forest fires, wind erosion, agricultural practices, industrial processes, and construction. Particles may be emitted directly into the atmosphere (primary particles) or formed in the atmosphere from precursor gases (e.g., sulfur dioxide, nitrogen oxides, ammonia, and volatile organic compounds).

Epidemiological studies have found correlations between elevated ambient concentrations of $PM_{2.5}$ and increased morbidity and mortality. $PM_{2.5}$ constituents include carbon, metals, nitrates, sulfates, and semivolatile organics. As is the case with ozone and its precursors, $PM_{2.5}$ may be transported over regional scales. The selection and application of the most appropriate control regimes and policies require identification of the important sources and types of $PM_{2.5}$ that adversely affect human health.

METHODOLOGY

Instruments monitored $PM_{2.5}$ mass, elemental and organic carbon, ozone, and carbon monoxide in real time. Filter sampling was deployed for the analysis of metals. Both continuous $PM_{2.5}$ sampling and integrated 24-hour filter $PM_{2.5}$ sampling were conducted simultaneously at each site.

Researchers compared the daily mean $PM_{2.5}$ mass and carbon concentrations at the two sites. Plotting the NYC data against the SF data allowed an estimation of the relative amounts of $PM_{2.5}$ pollution caused by upwind sources and by local NYC sources. In addition, the difference between the two sites was compared to the NYC carbon concentrations for each day in order to test the assumption that it resulted from local NYC sources, as well as to test the hypothesis that elemental carbon can serve as a marker for the contribution of local sources.

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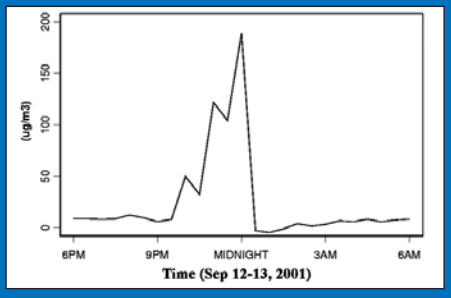
A researcher checks the elemental and organic carbon sampler system at the Sterling Forest site in Tuxedo, New York

The World Trade Center Plume Clearly Registered at the Hunter College Site



New York Energy $mart℠
Public Service Commission — NYSERDA

Since 1975, the New York State Energy Research and Development Authority (NYSERDA) has developed and implemented innovative products and processes to enhance the State's energy efficiency, economic growth, and environmental protection. One of NYSERDA's key efforts, the Environmental Monitoring, Evaluation, and Protection (EMEP) Program, supports energy-related environmental research. The EMEP Program is funded by a System Benefits Charge (SBC) collected by the State's investor-owned utilities. NYSERDA administers the SBC program under an agreement with the Public Service Commission.

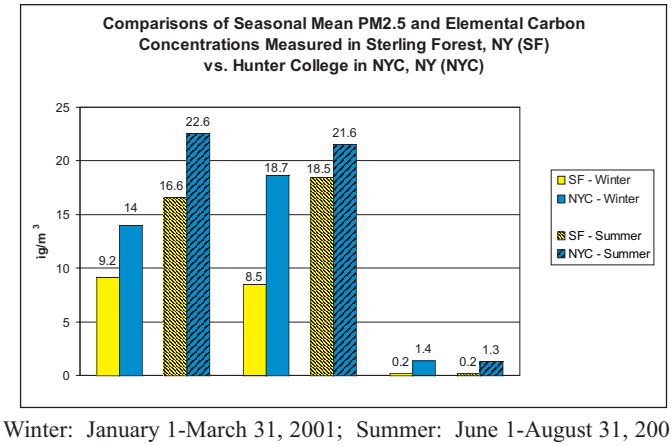
$PM_{2.5}$ sources are identified using different statistical approaches and modeling. Concentrations of various species (e.g., elements and ions) at the ambient sampling sites are analyzed in order to identify the major particle sources, to determine their appropriate source profiles, and to obtain their respective contributions to the total mass. Identification of the trajectory of the air masses, which can be determined from an analysis of meteorological information, allows for the assessment of regional influences.

RECENT FINDINGS

Preliminary data from 2001 indicate:

1. $PM_{2.5}$ concentrations were higher in summer than in winter (see graph).
2. $PM_{2.5}$ concentrations at the two sites are highly correlated: Regionally transported air pollution affects both sites similarly, while the NYC site is also affected by local transportation sources.
3. Since the elemental carbon concentrations in NYC are much higher than in SF, most of the elemental carbon in NYC is assumed to be more local in origin. The difference between the NYC and the SF $PM_{2.5}$ is proportional to the elemental carbon concentrations in NYC. This indicates that differences between the two sites result from local NYC pollution, and that the NYC elemental carbon level is a reasonable marker of the local air pollution.
4. Source apportionment work identified numerous sources, both local and non-local. Transported aerosols are estimated to be the major contributors to NYC $PM_{2.5}$ pollution. Sources identified in order of importance include the World Trade Center fires plume (see sidebar); soil; transported aerosols; dust, including that from the World Trade Center's collapse; traffic; and residual oil combustion.
5. A. *Summer*: Most (roughly 3/4) of the NYC $PM_{2.5}$ mass is accounted for by the upwind $PM_{2.5}$ mass (measured at SF), and only about 1/4 or less is local in origin.

   B. *Winter*: Most (roughly 2/3) of the NYC $PM_{2.5}$ mass is accounted for by the upwind $PM_{2.5}$ mass (measured at SF). Thus, data suggest that a majority of NYC $PM_{2.5}$ mass is transported into the City in this season, and that only ~1/3 is local.



Winter: January 1-March 31, 2001; Summer: June 1-August 31, 2001

PROJECT IMPLICATIONS

The development of state implementation plans (SIPs) to attain national ambient air quality standards will require the identification of the sources of ambient $PM_{2.5}$ pollution. These $PM_{2.5}$ mass analyses indicate that the mean NYC $PM_{2.5}$ levels through August 2001 averaged above the federal annual standard. Preliminary results from this study suggest that the majority of this pollution was transported into NYC from outside sources. A higher proportion of the total NYC $PM_{2.5}$ mass was transported into NYC from upwind sources in the summer than in the winter. The research team's future plans include further analysis of NYC samples for $PM_{2.5}$ mass, organic and chemical carbon, and trace elements. The project will continue to evaluate the relative roles of transported and local sources at the NYC site through the application of source apportionment methods and wind trajectory information to the NYC and SF $PM_{2.5}$ data.