PROJECT UPDATE

November 2003

New York State Energy Research and Development Authority

Environmental Monitoring, Evaluation, and Protection Program

Enhanced Measurements of Oxidants, Fine Particles and Precursors

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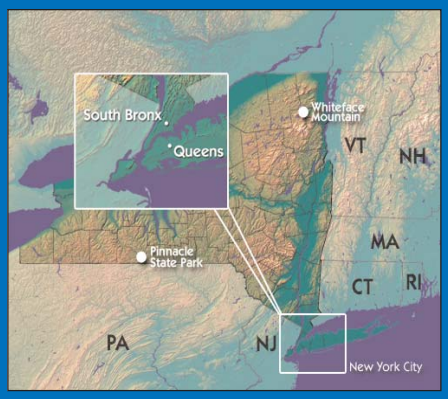
Project Location



Contact Information

For more information on this project see:
www.asrc.cestm.albany.edu/pmtacsny/index.html
and
www.nyserda.org/programs/environment/emep.asp

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Keywords

- Compressed Natural Gas (CNG)
- Continuous Regenerating Technology (CRT)
- Diurnal patterns
- $PM_{2.5}$/co-Pollutant complex
- Speciation
- U.S. EPA PMTACS-NY Supersite

PROJECT FOCUS

This NYSERDA project, begun in 1999, subsequently leveraged New York State funds with US EPA funds in 2000 to establish a "$PM_{2.5}$ Supersite" program in NYS. The NYS program is one of eight nationally, providing measurement data on the chemical and physical properties of fine particles smaller than 2.5 microns in diameter ($PM_{2.5}$) and associated precursors. These data will support the development of process science, observation-based analysis tools in atmospheric chemistry and source-receptor modeling, and health-related exposure assessments.

The objectives of the Joint Enhanced Ozone-$PM_{2.5}$ Technology Assessment and Characterization Study in New York (PMTACS-NY) are to:

- Measure the temporal and spatial distribution of $PM_{2.5}$ and its copollutants at five monitoring sites. These measurements will provide data needed to characterize the chemical composition of $PM_{2.5}$ within New York City and the regional background of upstate New York, which is affected by transported pollutants.
- Monitor the effectiveness of new emission-control technologies introduced for mobile sources in New York City, such as Compressed Natural Gas (CNG) buses, Continuously Regenerating Technology (CRT), and hybrid electric buses and their impact on ambient air quality.
- Test and evaluate new measurement technologies and provide technology transfer of robust technologies for use in the monitoring network. This will include mobile and fixed-site measurements of CO, NO_2, NO, SO_2, H_2CO, CH_4, HONO, CN, and aerosol chemical composition.

CONTEXT

In July 1997, the US Environmental Protection Agency (US EPA) set forth a new National Ambient Air Quality Standard (NAAQS) for ozone and particulate matter (PM). Airborne PM is a broad class of materials of different composition and sizes that are transported in the air as solid particles or liquid droplets (aerosols). Particles can be emitted directly into the atmosphere (primary particles) or formed in the atmosphere from precursor gases (secondary particles). Combustion processes are an important source of both ozone and $PM_{2.5}$ pollution. In addition, the production of ozone and $PM_{2.5}$ in the atmosphere is linked in complex ways. Both are associated with adverse health effects.

METHODOLOGY

This project conducts high-resolution measurements of oxidants, $PM_{2.5}$, and their precursors at three urban New York City (NYC) sites and two representative regional sites: Whiteface Mountain (WFM) in Wilmington, Essex County, and Pinnacle State Park (PSP) in Addison, Steuben County. In addition to collecting standard measurements of criteria pollutants and the mandated $PM_{2.5}$ mass and chemical speciation measurements, the research team also operates advanced instruments for improved chemical and temporal specification of the air quality. Factors affecting ozone and $PM_{2.5}$ on both regional and local scales are being analyzed.

The project's real-time "vehicle-chase" studies use a mobile platform equipped with instruments in order to characterize on-road emissions of Metropolitan Transit Authority (MTA) buses (standard diesel, CRT-equipped, CNG, and diesel hybrid technologies) and diesel trucks operating in New York City (see photograph). Analysis of the measurements includes correlating the exhaust emissions with speed, fuel grade, and ambient temperature.

New measurement technologies are tested at the Aerosol Generation and Calibration Facility, developed as part of the Supersite program at the Atmospheric Sciences Research Center, as well as at rural and urban monitoring sites. Field and laboratory tests have provided NYSDEC with advanced knowledge on performance and operational issues associated with these technologies.

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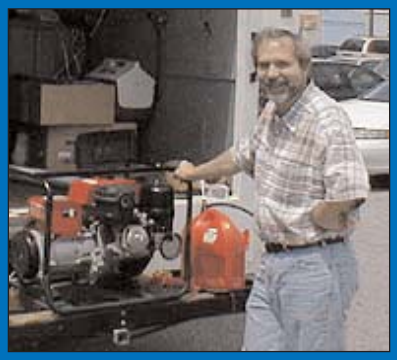


A researcher prepares for a vehicle chase using the Aerodyne Mobile Laboratory, which collects exhaust emission samples from moving buses and trucks.

Project Status

- Initiated 1999
- Project ongoing

New York Energy Smart℠
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.

RECENT FINDINGS

URBAN vs. RURAL $PM_{2.5}$: A study conducted at Queens College (NYC) and WFM (summers 2001 and 2002, respectively) characterized chemical and physical properties of the $PM_{2.5}$/co-pollutant complex and local photochemical production processes of $PM_{2.5}$ sulfate, nitrate, and organic carbon. The findings indicate that diurnal patterns in ambient air concentrations are:

- Mainly determined by primary source emissions in urban environments, where secondary production processes play a much less significant role.
- More noticeable with proximity to the source and owing to prevailing winds.
- Significantly less well defined in rural environments, where, to the extent that they are observed, they may be identified with local secondary production processes.

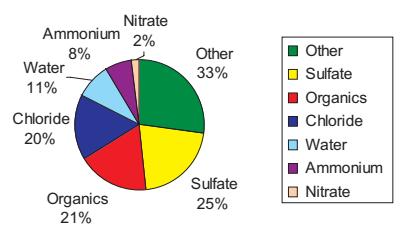
Findings also suggest that primary and secondary pollutant levels can vary significantly within 24-hour periods. Concentrations of long-lived species are predominantly affected by transport/meteorological conditions; concentrations of short-lived species are affected by emissions and chemical transformations.

ORGANIC PM (NYC): Studies using the Aerosol Mass Spectrometer (AMS) measurement technology indicate that a significant fraction of the observed organic PM mass comes from mobile sources. Observed organic particles with a diameter of ~70 nm are associated with condensed lube oil formed in the combustion exhaust not only of diesel sources, but also of poorly maintained, oil-burning, spark-ignition gasoline engines.

SULFATES (NYC): The observed levels and diurnal patterns of SO_2 concentrations in NYC suggest that fossil-fuel combustion from mobile and stationary sources contributes significantly to NYC sulfate levels. The local production of summertime sulfate from the reaction of SO_2 and OH can represent a significant fraction of the total observed sulfate concentration during high photochemical PM production periods.

VEHICLE EMISSIONS ON THE ROAD (NYC): Direct measurement of in-use vehicle emissions has provided an extensive database characterizing gaseous and PM emissions from a variety of standard diesel-powered trucks and buses as well as from CNG-fueled and retrofitted diesel-fueled CRT buses (DF-CRT). Real-world measurements show significantly more variation in emissions than observed in laboratory testing. These measurements indicate that both CNG and DF-CRT significantly reduce vehicle PM emissions in comparison with standard diesel buses (60–70% reduction). However, DF-CRT bus NO_2 emissions were 30% of total NO_x, compared to less than 5% of total NO_x in standard diesel buses. In another series of measurements, exhaust plumes of CNG buses showed ~5–10 times more formaldehyde than observed in standard diesel bus and truck plumes.

Species Mass Concentration Distributions



PROJECT IMPLICATIONS

Project findings suggest that the implementation of the federally mandated low-sulfur rules, which address on-road mobile sources, and the proposed inclusion of off-road mobile sources (e.g., construction, marine and farm equipment), would have significant benefits for PM mitigation. The NYS Acid Deposition Reduction Initiative, which could result in the decreased use of high-sulfur residual fuel in utilities in NYC and the region, may prove an additional effective measure. Results also indicate that tracking and reducing sulfur levels in distillate fuel burned for stationary applications, which is not currently being addressed by the proposed federal rules, could have significant benefits.

On-road tests show encouraging reductions in the PM emissions of CNG-fueled and retrofitted diesel-CRT vehicles. The higher formaldehyde emissions suggest that either combustion modification or possibly the addition of oxidative catalysis will likely be required if CNG-fueled vehicles are to become a significant portion of the mobile fleet.

The accumulated data and findings of this joint project will provide the scientific basis for the assessment of ambient ozone and $PM_{2.5}$ standards in NYS. They also allow us to determine the impact of recent and future emissions reductions in terms of emission-control effectiveness and air-quality response. Understanding the relative importance of local and regional sources will enable better evaluation of the effectiveness of different mitigation strategies for achieving air-quality standards.