EMISSIONS MONITORING FREEWAY MONITORING PERFORMING AEROSOL SCIENCE IN HARM'S WAY

APPLICATION NOTE EM-002

Measuring aerosol inside the traffic flow creates new challenges and insights. Photo: Dane Westerdahl

Just imagine yourself in the middle of a herd of bellowing, 70-foot-long, 40-ton, smoke-belching monsters, charging along at 70 miles per hour. Now imagine placing $400,000 worth of delicate aerosol-measurement instruments inside the herd. This may sound like a study of Jurassic-era dinosaur breath. But actually, it is an air monitoring study performed to evaluate the nature of ultrafine particles and other pollutants found on freeways and city streets and in the quiet community settings of Los Angeles.

Every day, hundreds of thousands of Los Angelinos spend an estimated 1½ hours commuting to and from work, with much of this time spent on freeways. They share the road with diesel trucks, buses, and a great many cars. Investigators from the California State Air Resources Board, the University of Southern California's Aerosol Science Laboratory, and the Southern California Particulate Matter Supersite and Center assembled a mobile air-monitoring platform to collect particle count and concentration data inside this challenging environment. The platform was capable of supporting and operating an array of state-of-the-art particle monitors.

Several TSI instruments were included on the mobile air-monitoring platform:

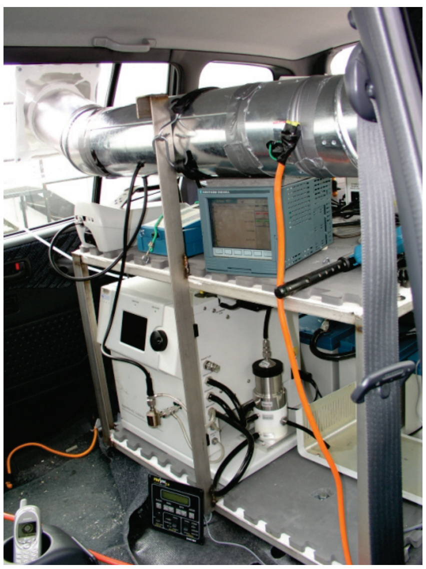
- Two Model 3936-series Scanning Mobility Particle Sizer™ (SMPS™) systems (one with a nano DMA)
- Model 3070A Electrical Aerosol Detector
- Model 3007 Hand-held Condensation Particle Counter (CPC)
- DustTrak™ Aerosol Monitor (used for PM 2.5)
- Two Q-Trak™ IAQ Monitors (used for CO/CO_2)

A Model 3022A CPC was installed in the platform for a short time. Also included were conventional nitrogen and carbon oxide analyzers, an Aethalometer to measure black carbon, and a polycyclic aromatic hydrocarbons (PAH) analyzer. Most of these instruments don't usually leave the safety of a laboratory. Yet all of this equipment, an operator, a power system, and computers for data logging were crammed into a Toyota RAV4 electric vehicle.

Ultrafine particles, their components, and co-pollutants are thought to be especially harmful to people and may account for health impacts ranging from discomfort to death of people already compromised by illness. To date, very little is known regarding the physical or chemical nature of these particles or the nature of their levels in complex urban environments. Some studies have been carried out under controlled conditions to test vehicles for ultrafine emissions. A few of these tests even took place on roadways, but they focused primarily on chasing diesel trucks and buses. However, exposures experienced by people who drive these roads, or live, work, or play near them, are very poorly understood.

The Los Angeles study found a surprisingly dynamic range of pollutant levels, with very great differences between on-road concentrations and those in communities no more than ¼ mile from the freeway edge. Several of the particulate phase pollutants track closely together, because they originate from the same traffic sources. A unique and challenging facet of this work was to determine the size distribution of ultrafine PM in these microenvironments. The SMPS systems were operated in a synchronized 60-second scan mode in hopes that they might capture the complexity of sources and operation conditions encountered. The researchers reported that indeed they were able to assemble robust, continuous size distributions over the size range of 6 to 600 nm. They also reported that ultrafine counts in excess of 4 million particles per cc were encountered during their studies. Counts on freeways are more typically in the range of 100,000 to 500,000 particles/cm^3. Exposure while driving in these highly polluted microenvironments may dominate daily levels for the driving population.

The mobile air-monitoring platform used by California researchers to monitor inside freeway traffic was installed in a Toyota RAV4 electric vehicle. This mobile laboratory provided exciting new data about aerosols in and around high-traffic areas. Photo: Dane Westerdahl



The platform, including duct work, power supplies, and computers for data logging, was jammed into the passenger and luggage compartments, leaving barely enough room for a driver and operator. Photo: Dane Westerdahl

What will the researchers do with this information? Work is underway to assess the nature of the observations in various kinds of traffic, to determine how the various pollutants interrelate, and to begin piecing together a picture of the spatial and temporal complexity that contributes to human exposure. Further, monitoring conducted in industrial and community locations away from freeways has identified previously uncharacterized sources of ultrafine PM. This work also provides initial data needed for anyone who might be considering the development of air standards or regulating levels of ultrafine PM in ambient air. It also demonstrates how variable community levels for this pollutant can be.

Mobile monitoring proved to be both challenging and rewarding. The high-tech equipment was incredibly robust and up to the task. Clearly, this application of aerosol monitoring technology holds promise for future applications. Operations are being considered that will build upon the lessons learned. Researchers plan to move to other microenvironments and ask questions about organic vapors in addition to particles. Improved time resolution is expected from new technologies, as well, allowing a more complete assessment of individual vehicular sources to roadway concentrations of ultrafine PM.

The researchers appreciate the help they received from TSI technical, sales, and marketing people. TSI thanks Dane Westerdahl of the California Air Resources Board for his assistance with this application note.

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