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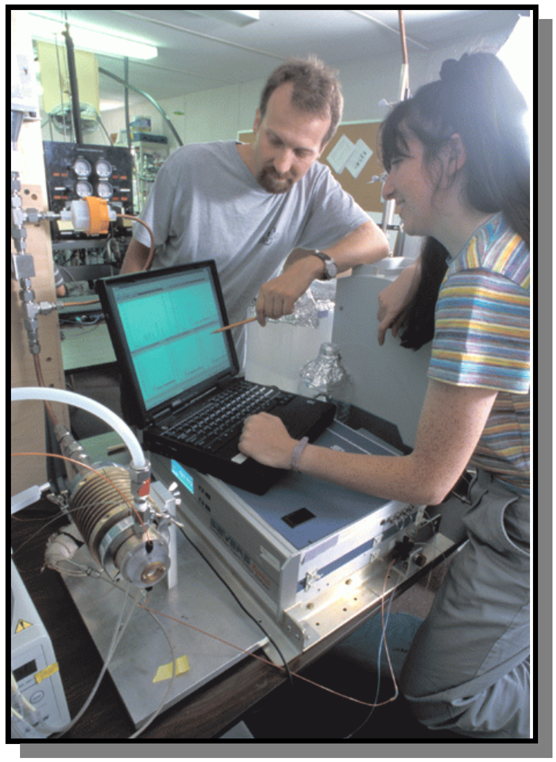
MEASURING ATMOSPHERIC POLLUTANTS: INSTRUMENT AUTOMATES SAMPLING OF AEROSOLS, PROVIDES MORE DETAILED DATA

Scientists studying a class of atmospheric pollutants known as aerosols now have a new tool at their disposal – an instrument that automates the collection of air samples for analysis with sensitive ion chromatography equipment. Fine-particulate aerosol pollutants have attracted considerable attention because of recent studies linking them to human health effects such as heart attacks and respiratory problems.

By automating the collection of data, the Particle-Into-Liquid-Sampler (PILS) developed at the Georgia Institute of Technology can measure particulate pollutants several times an hour, giving atmospheric scientists detailed time-dependent information not previously available. In a recent study, this ability to make frequent measurements revealed previously unknown morning and afternoon peaks in the levels of two key pollutants.



Rodney Weber and Amy Sullivan check measurements on a Particle-Into-Liquid-Sampler connected to an ion chromatograph.

"Chemists have made significant advances in measuring trace species," said Rodney Weber, assistant professor in Georgia Tech's School of Earth and Atmospheric Sciences. "We are applying those technologies to measure the composition of atmospheric particles. In combination with the ion chromatograph, this instrument provides some unique insights that could not be obtained before."

Weber presented information about the instrument's capabilities at the 224th

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national meeting of the American Chemical Society August 22 in Boston. The instrument is already in use around the world in studies conducted from aircraft, ships and ground stations.

Developed by Weber and colleague Douglas Orsini with help from Brookhaven National Laboratory, the PILS system uses small quantities of steam to form water droplets on individual aerosol particles. The water droplets containing the dissolved aerosols can then be captured and analyzed by ion chromatography techniques to detect as many as 15 different chemical species. The instrument can operate unattended for extended periods of time on the ground or in research aircraft, and can take samples as often as every four minutes

Scientists analyzing airborne particulates had previously relied on filters that collected the aerosol particles over a long period of time, usually 24 hours. The particles were then removed from the filters and dissolved in water for ion chromatograph analysis. It is these types of long time-intergrated measurements that have provided the air quality data to study the effects of aerosols on human health and that are the basis for current EPA particulate matter standards. This, however, is likely to change since the EPA is now moving toward more real-time measurements for assessing air quality.

The PILS system has shown 97 percent efficiency at collecting particles with diameters of between 0.03 and 10 microns – which includes the PM 2.5 particles of concern for their health effects. Joining the instrument to an ion chromatograph allows rapid analysis of aerosol ionic components of interest. Georgia tech has focused on nine major chemical species, including sodium, ammonium, potassium, calcium, magnesium, chloride, oxides, nitrates, and sulfates. With longer analysis times – approximately 15 minutes -- the combined system can also analyze acetate, formate and oxylate.

The limits of detection for the cation and anion species are, respectively, 50 nanograms per cubic millimeter and 10 nanograms per cubic millimeter. Testing against other measurement systems has validated the accuracy of the system, Weber noted.

"With the stock ion chromatograph, our instrument makes all of these measurements online and there is no manual labor involved," Weber noted. "We can make the measurements more quickly than with previous techniques, and with higher sensitivity. We no longer have to dissolve these particles in large volumes of water and don't have to be concerned with contamination during sample handling."

Because of its water-based process, the PILS system measures only aerosols that are soluble in water. But combined with other detection techniques that measure the size, volume and mass of particles, the instrument gives air quality researchers a better view of what's fouling the air – and clues about how to make it cleaner.

"When you put data from all of these techniques together, you can really get a meaningful data set," Weber said. "The various species that we measure change concentrations over time. Our instrument allows us to see a level of detail that we could not see before. There is structure in these changes that provides important information about the aerosol chemistry."

PILS was first tested during a 1999 Atlanta study that looked at particulates. Because it was able to make frequent and automated measurements during the day, data from the PILS system showed that particulates in Atlanta varied dramatically over time – and revealed a previously-unknown set of trends in pollutant levels: a morning peak of carbon-containing particles and an afternoon peak containing sulfates. The sources and meaning of the peaks remain under study.

"The older measurement system produced an average reading for Atlanta during the course of the day, but it turned out that there are times of the day when it is a lot more polluted than at other times," Weber noted. "Observing these transient events in Atlanta was a unique benefit of this instrument."

Since then, PILS has been used to study large particulate plumes in the Asian atmosphere, the composition of particles responsible for haze in Yosemite National Park and plumes from ships in the Atlantic Ocean.

In the China studies, known as ACE ASIA and TRACE-P, the instrument differentiated between plumes from dust and those arising from the burning of biomass by detecting trace elements that serve as markers. Potassium, Weber noted, indicates biomass burning, while calcium shows the particulates include dust particles.

"The instrument can pick up traces for those different sources," Weber explained. "You can see these layers in the atmosphere as the aircraft is flying through. In Asia, these plumes can be tens or hundreds of kilometers wide. The speed at which the instrument can do these measurements is very helpful in airborne studies."

Development of the PILS system began with work by researcher Sandy Dasgupta of Texas Tech University, who first suggested an automated system for capturing aerosols into water. With initial assistance from a Brookhaven chemist, Weber and Orsini, with the help of graduate students, improved on and refined the system over the past four years.

Development and testing of the instrument was supported by the U.S. Environmental Protection Agency, the National Science Foundation, the National Aeronautics and Space Administration, the Georgia Tech Foundation, and the Southern Company.

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URL: gtresearchnews.gatech.edu/ newsrelease/PILS.htm