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National Center For Environmental Research

Featured Story

Taking the Haze out of Air Quality Models

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Having a bad air day? Hard to breathe? The distant mountains are no longer visible and the stratospheric ozone hole has expanded? The probable cause -- it's likely due to aerosols, those pesky particles ranging in size from nanometers to tens of millimeters that are emitted from tailpipes, smokestacks, and forest fires. These aerosols, recognized by us as haze, smoke, smog, and dust, are made of liquid droplets or fine solid particles suspended in a gas. Because they are very small, aerosols can travel vast distances and have an enormous influence on visibility, the global radiation balance, and human and ecosystem health in areas remote from their sources. Aerosols influence cloud formation and rainfall and lead to illnesses, such as asthma, heart disease and lung cancer. Because of the importance of this area, EPA has funded many studies on the relationships between fine particulate matter, organic aerosols, and air quality. One of these studies is described below – future articles will discuss other studies and their integration with this work.

Aerosols are coated with thousands of different organic compounds which make them very complex. This complexity limits the ability of modelers to improve the accuracy of the climate and air quality models that are used to predict pollutant concentrations and the effectiveness of pollution control strategies. In a new study supported by the U.S. Environmental Protection Agency, National Science Foundation, and Department of Energy, a team of 60 researchers analyzed worldwide field observations and laboratory experiments to understand the chemical transformations and fate of organic aerosols as they are transported through the atmosphere.

"We're providing a key piece of machinery that is needed to make accurate predictions of air quality and climate and that is also relatively simple and practical to use," said Jimenez, lead-author of the study that appears in the Dec. 11, 2009, issue of Science.

Interestingly, the team found that through a series of reactions in the atmosphere, the initially widely different compounds become more similar in composition over time regardless of their origin. As they age, the organic aerosols become less volatile (evaporate less), increasingly oxidized (as measured by their oxygen to carbon ratio), and more hygroscopic (readily absorbing moisture and forming cloud droplets). The oxygen to carbon ratio is important because it reflects how the organic matter is aging and building up on airborne particulates.

"What surprised us is how similar the organic matter looked as we went from the heart of Mexico

City to an island in Japan to a forest in Finland or a mountain in the Swiss Alps", said Jimenez.

From the field data, laboratory experiments, and analyses with a unique mass spectrometer the researchers were able to "map" the aging process of the aerosols based on volatility and oxygen measurements. With this new understanding modelers can now "lump" species of similar volatility and oxidation state, greatly simplifying models and their computational requirements.

Understanding the reaction pathways of organic aerosols, as well as the ability to "lump" species, are tremendously important findings for improving the accuracy of air quality and climate model predictions. "These results should allow us to do a better job in predicting future climate and air quality," Jimenez said. "And we need good predictions in order to be able to do the right thing."

In 2008 Dr. Jimenez was awarded the prestigious Kenneth T. Whitby Award by the American Association for Aerosol Research at their annual meeting in Orlando, FL. The award "recognizes outstanding technical contributions in aerosol science and technology by a young scientist." As noted at the ceremony, Dr. Jimenez "is widely recognized as one of the premier aerosol scientists in the world and as a leader in Aerosol Mass Spectrometer analysis." Of his over more than 100 peer reviewed articles, over 30 are recognized as "highly cited" by the Institute of Scientific Information.

Dr. Jimenez's EPA STAR grant specifically focuses on developing techniques to determine the sources of specific submicron organic aerosols. By using an Aerosol Mass Spectrometer (AMS), researchers can track a mixed sample of aerosols of differing chemical compositions and sizes to specific sources, such as motor vehicles or fireplaces. This information is essential for regulators so they can make focused decisions when regulating polluters.

Learn more about Dr. Jimenez's research: http://cires.colorado.edu/jimenez/

Learn more about the Whitby award: http://www.aaar.org/index2.cfm?section=Awards&content=Kenneth_T_Whitby

Learn more about Dr. Jimenez's STAR grant: http://cfpub.epa.gov/ncer_abstracts/index.cfm/fuseaction/display.abstractDetail/abstract/7504/report/0