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Simulation Investigates Method To Improve Prediction Of Global Pollution

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For asthmatics and for anyone with respiratory problems, air pollution can significantly impair simple everyday activities. NASA is trying to tie together satellites and stations on the ground to develop a "sensor web" to track this pollution and improve air quality forecasts.

Understanding how tropospheric or near-surface-level ozone is produced, distributed and transported from city to city, region to region and continent to continent is an important step toward improving the complex mathematical computer models used to forecast air pollution as we do for weather. Such models can be used to provide alerts days in advance so that people sensitive to pollutants can modify planned outdoor activities to minimize their exposure.

The troposphere is where we all live, work, play and breathe! It's the region of the atmosphere where our weather occurs and it extends from the Earth's surface to roughly the cruising altitude of a passenger jet - about 40,000 feet. In some cases air pollutants have natural causes such as lightning induced wildfires that can emit large plumes of particulates into the troposphere.

Fossil fuel burning in industrial areas and vehicular traffic in metropolitan areas are also major pollutant sources. Complex chemical interactions and atmospheric processes can transport these pollutants across thousands of miles.

To improve our ability to track the transport of pollutants from their various sources to populated cities and towns around the globe, NASA technologists are exploring an innovative technology called the "sensor web."

This interconnected "web of sensors" coordinates observations by spacecraft, airborne instruments and ground-based data-collecting stations. Instead of operating independently, these sensors collect data as a collaborative group, sharing information about an event as it unfolds over time.

The sensor web system is able to react by making new, targeted measurements as a volcanic ash plume is transported to air traffic routes, or when smoke of a wildfire is carried aloft, then dispersed over large metropolitan areas.

The sensor web has the potential to improve the response time of our observing systems by reconfiguring their sensors to react to variable or short-lived events and then transmit that information to decision makers so that appropriate alerts can be issued to those people living in the impacted areas.

To test the value and benefit of using dynamic sensor web measurement techniques and adaptive observing strategies, NASA technologists have formulated experiments involving two NASA Earth observing satellites that fly in formation high above Earth. These consist of Aqua and the recently launched Aura, along with sophisticated atmospheric chemistry models that can forecast the global distribution and concentration of one particular pollutant - carbon monoxide (CO).

"The sensor web behaves as a search-and-rescue team," said Principal Investigator Stephen Talabac, lead technologist with the Science Data Systems Branch at NASA's Goddard Space Flight Center, Greenbelt, Md. "Each sensor collects data as part of a team of cooperating sensors.

It is able to respond to the needs of the team members.

The sensors on one satellite react to data and information sent to it from other sensors on other satellites that have different but complementary capabilities. The sensors then change their observing strategy accordingly, to target and then collect data for a particular event."

Talabac offered the analogy of a search-and-rescue team whereby the unique skills of firefighters, police officers, and paramedics are brought together to form and then implement a plan to find and rescue a person in need of help.

Computer forecast models can also help decide where the sensors should make observations. If a model forecasts high concentrations of CO, the sensor web's instruments can be commanded to make targeted observations of those locations.

The actual sensor measurements can then be fed back into the computer model to improve the accuracy of the forecast. Talabac's team hopes to illustrate how such a model-driven sensor web could be used to enhance current measurement techniques, and bring to bear multiple complementary instruments to respond to rapidly changing environmental conditions.

"These simulations fall into the category of 'proof of concept,' to assess the feasibility of what is also planned for the next generation observing systems to enable real, full-fledged sensor web measurements," explained Talabac. "We hope to demonstrate that such an approach, or 'targeted intelligent data collection techniques,' can bring about more efficient use of our Earth observation satellites and their sensors."

In September 2005, Talabac's team will use an atmospheric chemistry computer model to predict global CO distribution. The team will also make measurements using Aura's Tropospheric Emission Spectrometer (TES), at key locations to improve the model prediction. In the future the team hopes to be able to use their prototype software to recommend regions where the TES instrument could be commanded to look and make real measurements at key locations predicted by the model.

"Our goal here is improve our ability to monitor and assess the Earth's environment," Talabac added. "With the sensor web, policy and decision makers will have access to the most useful and timely information available to help maintain a high quality of life and to potentially save lives."