Three-Dimensional Air Quality System (3D-AQS)

Using NASA Satellite Data to Improve Air Quality & Public Health

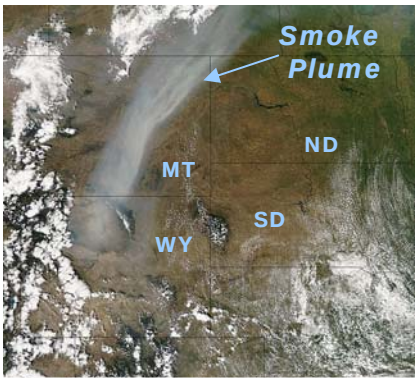

Figure 1: MODIS Aqua true color image of smoke plume from wildfires in Montana on July 30, 2007, taken at approximately 2 PM local time.

Because smoke has a very high concentration of particulates, it can be a public health hazard.

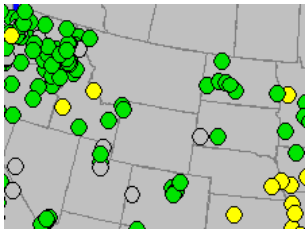

Figure 2: July 30 AIRNow 24-hr air quality index (AQI) values for the region affected by the Montana wildfires. Colored dots correspond to ground-based monitors; green and yellow indicate good and moderate air quality, respectively.

There is a large gap in the monitor network in the vicinity of the wildfire, so an alternate means of tracking the impact of the plume, such as satellite data, is required.

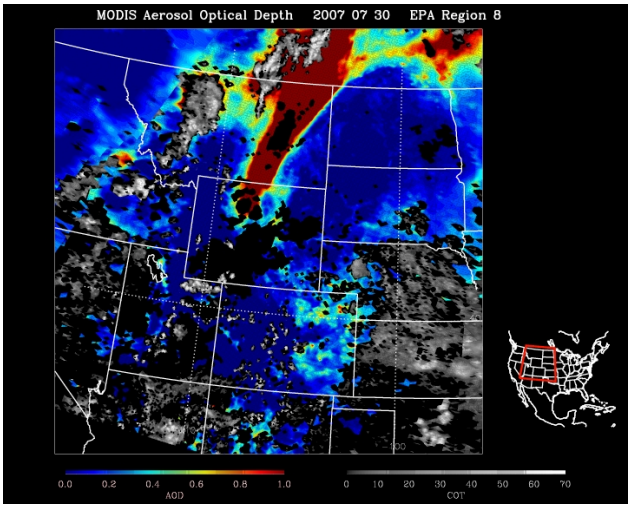

Figure 3: MODIS aerosol optical depth (AOD) of smoke plume from wildfires in Montana on July 30, 2007.

Note the swath of high AOD (colored red) in eastern Montana that corresponds to the visible smoke plume in *Figure 1*. AOD correlates to $PM_{2.5}$ concentrations, so analysts and forecasters can use the satellite data to predict the transport and distribution of particulates from the fire in areas where there are no ground-based monitors in Montana and Wyoming.

Project Overview

In order to assess airborne particulate levels, make air quality forecasts, and implement measures to meet ambient air quality standards, U.S municipalities and states use information from the U.S. Environmental Protection Agency's (EPA) Air Quality System (AQS) and AIRNow continuous monitoring system. Currently, these systems are ground-based and thus only provide the distribution of pollutants at the surface of the Earth in locations where in-situ monitors exist. However, during poor air quality events, it is often imperative to know the concentration and transport of pollutants aloft in the atmosphere, as well as in locations where no ground-based monitors are present.

To bridge these gaps, the 3D-AQS project is using a range of remote sensing instruments, listed in Table 1, to expand EPA's AQS into a three-dimensional system of nation-wide coverage, with the goal of providing information on the vertical and horizontal distribution of pollutants, particularly aerosols and particulates.

The project also supports the Centers for Disease Control and Prevention's (CDC) environmental public health tracking network and National Oceanographic and Atmospheric Administration's (NOAA) air quality mapping system. The University of Maryland, Baltimore County (UMBC) leads the project with co-investigators at Battelle Memorial Institute, University of Wisconsin-Madison, CDC, EPA, and NOAA.

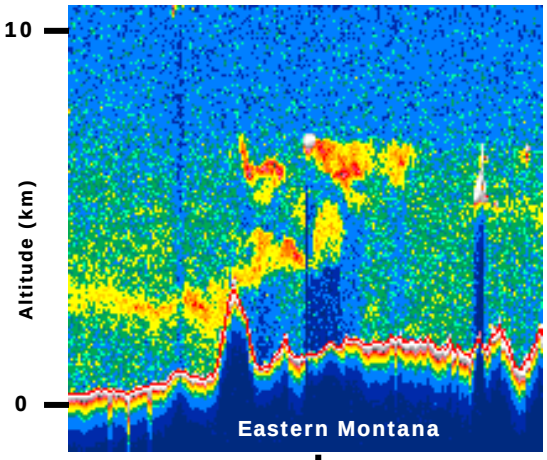

Figure 4: 532 nm backscatter return signal from the CALIPSO lidar, taken at 3:20 AM local time on July 31, 2007. The satellite data show the vertical distribution of fine particles over eastern Montana from the wildfires on July 30, 2007. The red and yellow areas indicate elevated particulate concentrations.

The CALIPSO data show that smoke from the wildfires rose high into the troposphere; smoke was in contact with the ground only at high altitude locations.

Table 1: Instruments used in 3D-AQS Project		
Sensor	**Platform**	**Product / Data**
Ground-Based LIDAR (Light Detection and Ranging)	REALM MPLNet	Extinction profiles; PBL Height; AOD (Aerosol Optical Depth)
MODIS (Moderate Resolution Imaging Spectroradiometer)	Terra Aqua	True Color Images AOD
GOES (Geostationary Operational Environmental Satellites)	GOES-East GOES-West	GASP AOD (GOES Aerosol & Smoke Product)
CALIOP (Cloud-Aerosol LIDAR with Orthogonal Polarization)	CALIPSO	Aerosol Extinction Profile; Layer Heights; Aerosol Type Estimate
OMI (Ozone Monitoring Instrument)	Aura	AOD, Absorption OD, Tropospheric O_3, NO_2, SO_2
AIRS (Atmospheric Infra-Red Sounder)	Aqua	Total Column CO

Project Details

Satellite images and data, such as aerosol optical depth (AOD), provide a 3D-profile of pollutant concentrations and transport, as shown in Figures 1-4. This information can greatly enhance air quality forecasts and regulatory analysis, which rely primarily on ground-based pollutant monitors. NASA satellite data are available for use by air quality forecasters and analysts, but the data can be difficult for them to manipulate and interpret.

To make satellite data more accessible to the air quality community, the 3D-AQS project combines NASA satellite data and imagery with ground-based light detection and ranging (LIDAR) data to provide a three-dimensional profile of pollutant concentrations, with an emphasis on aerosol and particulates.

The 3D-AQS project has three key initiatives. First, the project is improving existing data and visualization methods by developing finer resolution products, quantitative analysis of the satellite data with ground-based data, and creating new visualizations of 3D air quality information. Second, the project will integrate satellite and lidar data into EPA's AirQuest system, a database that merges AQS and AIRNow data with other monitor, model, and socioeconomic data, making the NASA data easily accessible. Third, the Integrating satellite Data from Environmental Applications (IDEA) product, which unites a range of satellite data in near real time, will be migrated to an operational environment within NOAA's National Environmental Satellite, Data, and Information Service (NESDIS). IDEA will be enhanced to include data from GASP and the ground-based LIDAR sensors.

An end user advisory committee comprised of air quality forecasters and analysts is providing input and advice at each stage of the project.

For more information about 3D-AQS:

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Project at a Glance

Three-Dimensional Air Quality System (3D-AQS) for Air Quality & Public Health

- Creating advanced three-dimensional tools for air quality forecasters and analysts using NASA's satellite data and training students in their use.
- Integrating NASA satellite data into EPA's core decision support systems (AQS/AIRQuest).
- Migrating the current IDEA product to an operational environment within NOAA NESDIS.

Goals of the Project

- Increase the accuracy of air quality forecasts, thereby reducing health impacts arising from poor air quality.
- Enhance knowledge of the causes of poor air quality, which will increase the accountability of government regulators and help improve air quality.
- Improve understanding of tropospheric transport.

Key Websites for Data and Images

3D-AQS Project
http://alg.umbc.edu/3D-AQS

U.S. Air Quality (The Smog Blog)
http://alg.umbc.edu/usaq/

Infusing satellite Data into Environmental Applications (IDEA)
http://idea.ssec.wisc.edu/

Regional East Atmospheric Lidar Mesonet (REALM)
http://alg.umbc.edu/REALM/

EPA Air Quality System (AQS)
http://www.epa.gov/ttn/airs/airsaqs/

NASA Applied Sciences Program & Air Quality

The NASA Applied Sciences Program supports innovative approaches to integrate Earth science research results (e.g., satellite observations and models) in decision-making tools that organizations use to benefit the nation and society.

The Air Quality applications program supports activities to apply Earth science research results to air quality management, policy, and decision making. The Air Quality program focuses its activities according to four themes: Air Quality Planning, Forecasting, Emissions Inventories, and Compliance.

For more information, contact:
Lawrence Friedl at 202-358-1599
http://science.hq.nasa.gov/earth-sun/applications/index.html