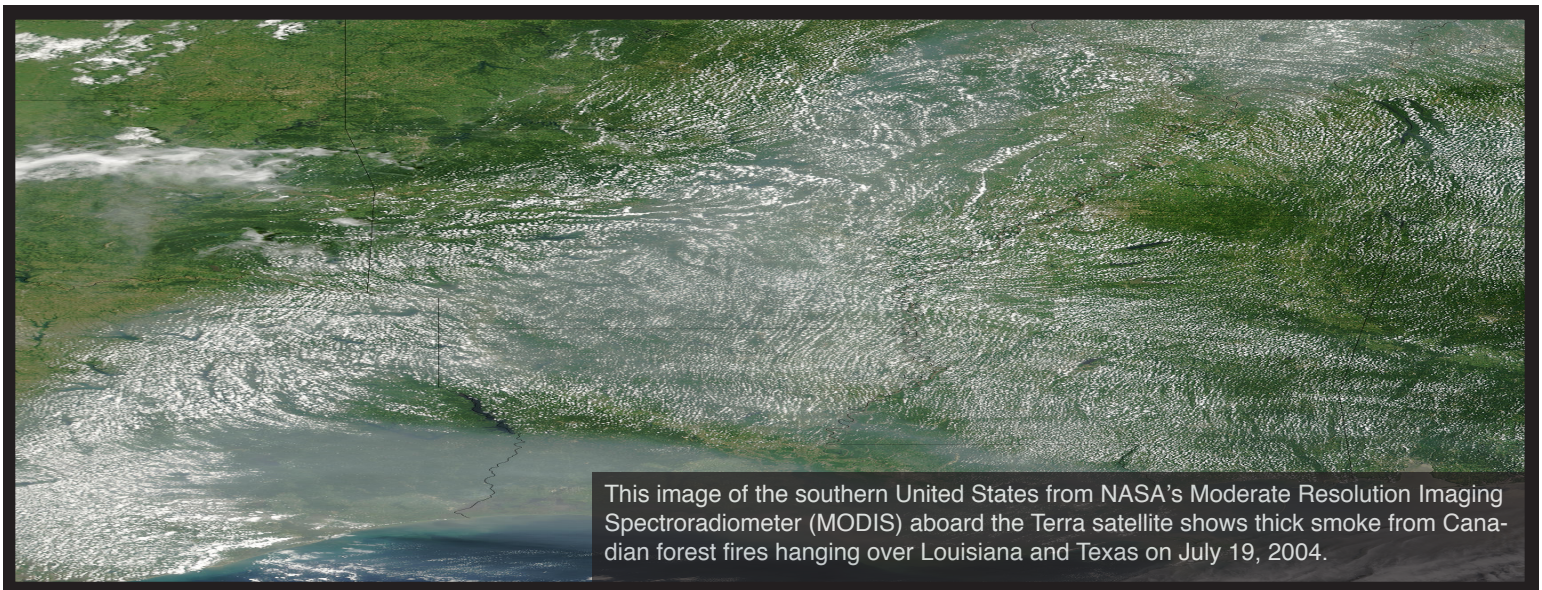
National Aeronautics and Space Administration

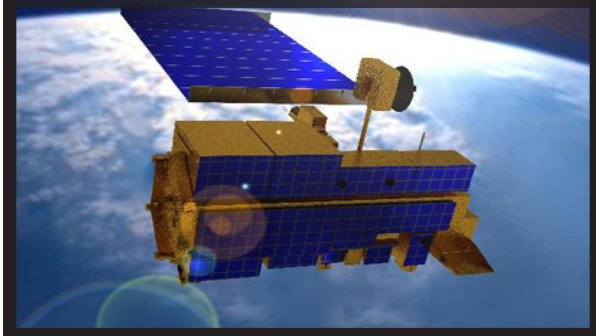
Dynamic Updating of Emissions to Support Air Quality Forecasting and Analysis

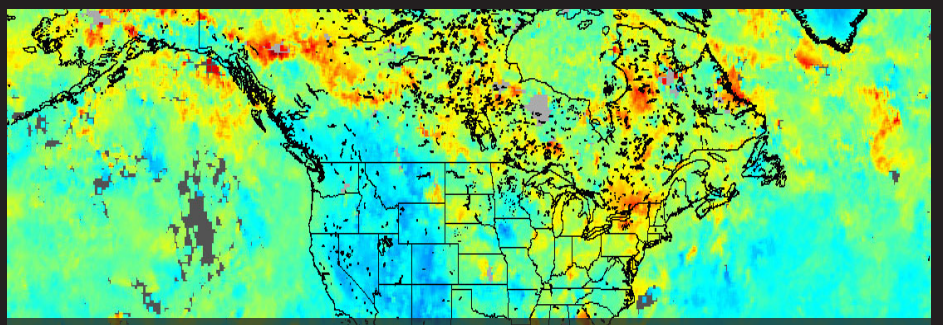
A Methodology for Satellite-Based Rapid Emission Inventory Development



This image of the southern United States from NASA's Moderate Resolution Imaging Spectroradiometer (MODIS) aboard the Terra satellite shows thick smoke from Canadian forest fires hanging over Louisiana and Texas on July 19, 2004.

Terra satellite, flying the Measurements of Pollution in the Troposphere (MOPITT) instrument.





Carbon monoxide as measured by MOPITT aboard NASA's Terra satellite. Smoke from Canadian forest fires contributed to the high pollution in this image from 2004.

Project Goals

Improved emission estimates used in decision support assessments and management actions, including:

U.S. EPA CMAQ model to demonstrate compliance with U.S. National Ambient Air Quality Standards

UNECE Task Force on Hemispheric Transport of Air Pollution

Modeling studies to determine background concentrations of long-lived air pollutants in the Northern Hemisphere

Real-time emissions inventory update capability to aid planners of such events as the 2008 Beijing Olympic Games

Project Outcomes

Provide for the first time a real-time update capability for emission inventories that will improve the precision of air quality forecasts

Quantification of pollution transport from Asia to the U.S. and its effect on background air quality and NAAQS compliance

A more reliable understanding of pollutant releases in remote parts of the Northern Hemisphere, especially where energy development is occurring now—and a general knowledge of intercontinental contributions to ozone formation and fine particulate matter

Dynamic Updating of Emissions to Support Air Quality Forecasting and Analysis

A Methodology for Satellite-Based Rapid Emission Inventory Development

Summary

This project assesses the potential uses of NASA remote sensing data (from MODIS, OMI, and other instruments) and advanced modeling tools in the Argonne National Laboratory Emission Inventory Model System and the U.S. Environmental Protection Agency's (EPA) Community Multiscale Air Quality (CMAQ) model, two integrated decision support systems that are used to make predictive models for nitrogen oxide (NOx) emissions. The resulting models are critical tools in air quality management and provide key inputs into decision-making and policy development. For example, air quality models are used to evaluate various emission control strategies and to inform the general public regarding air quality conditions.

Accurate emission records are necessary for timely air quality forecasts. A significant component of the uncertainty in emissions can be attributed to the fact that emission inventories are often out of date. Through this study, a systematic analysis framework to provide rapid updates of emission inventories will be developed, demonstrated and transitioned to operations. Improved inventories will support more accurate assessments of human and ecosystem health.

Project Details

This project will develop a unique integration of emission inventory development, modeling and satellite observations to provide top-down constraints on emissions and to enable rapid updating of emission estimates.

The integration of these efforts requires the use of chemical transport models to provide inverse modeling analyses. Top-down emissions data have been combined with a bottom-up emission inventory to develop an improved estimate of global and regional NOx emissions in basic research applications. These individual components were not initially designed as a systematic framework to provide an operational approach to rapid update of emissions, nor did they contain an active bottom-up emission estimate component, which is necessary to reflect and interpret emission changes. These modeling activities, enhanced by closer interactions with the satellite community and informed by more recent participation in NASA field experiments (including INTEX A and B), will be utilized to develop and test a systematic analysis framework to provide rapid updates of emission inventories. The impact of these improved inventories will be tested in air quality forecasting and human health assessment applications in both the U.S. and Asia. The framework will also support several important international activities, including the UNECE Task Force on Hemispheric Transport of Air Pollution.

The ability to apply satellite observations to air quality issues stems from decades of investments by NASA and the atmospheric research community in aerosol retrieval methods, sensor technology, validation efforts, and other scientific research. The work done by Streets, D.G., et al. in "Revisiting China's CO Emissions after TRACE-P: Synthesis of Inventories, Atmospheric Modeling, and Observations (2006)" was particularly influential on this project.

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 about this project
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202-358-1599
http://science.hq.nasa.gov/earth-sun/applications/index.html

Key Web sites

Univeraity of Iowa, ACESS
www.cgrer.uiowa.edu/ACESS/acess_index.htm

Aura Satellite
http://aura.gsfc.nasa.gov/

EPA CMAQ
http://www.epa.gov/asmdnerl/CMAQ/

Argonne National Laboratory
http://www.transportation.anl.gov/research/engine/index.html