

ENVIRONMENTAL PROTECTION AGENCY WEATHER PROGRAMS

Environmental Protection Agency (EPA) is responsible for working with state, local, and other Federal government agencies to provide user-appropriate and scientifically-credible air quality and meteorological programs to support regulatory applications. Applied research and meteorological support are furnished primarily by EPA's National Exposure Research Laboratory and EPA's Office of Air Quality Planning and Standards, both located in Research Triangle Park, North Carolina. This activity is provided through interagency agreements with the National Oceanic and Atmospheric Administration (NOAA), which assigns approximately 50 research meteorologists to the EPA.



Meteorological support to EPA's Office of Research and Development, EPA's Office of Air and Radiation, EPA Regional Offices, and to state and local agencies includes:

- Development and application of multi-scale and multipollutant air quality models for pollution control, direct and indirect exposure assessments, and emission control strategy assessment;
- Preparation and performance of dispersion studies and air quality model evaluations;
- Review of meteorological aspects of environmental impact statements, state implementation plans, and pollution variance requests;
- Understanding the interactions of global climate change and air quality; and
- Emergency response planning in support of homeland security.

Meteorological expertise and guidance are also provided for the national air quality standards, modeling guideline, and policy development activities of the EPA.

In light of the 1990 Amendments to the Clean Air Act and the recent national rules, air quality models and the manner in which they are used are expected to continue to grow over the next few years. In the area of pollutant deposition, the evaluation of nitrogen, oxidant, sulfur and aerosol chemistries will help to clarify the roles of model formulation, cloud processes, aerosols, radiative transfer, and air/surface exchanges in air quality model predictions, leading to a better understanding of model predictions relative to control strategy assessments. Further development and evaluation of existing air quality models will take place to accommodate the inter-pollutant effects resulting from the variety of control

programs that are now or may be in place, such as the new National Ambient Air Quality Standards for ozone and particulate pollution. These inter-pollutant effects include trade-offs among controls on ozone, sulfur oxides, nitrogen oxides, and volatile organic compounds, as well as developing predictable methods of forecasting the impacts on various measures of air quality.

With respect to the fine particulate model development, air quality models are being enhanced to accurately predict aerosol growth from precursors over local and regional-scale transport distances. To assist in the evaluation of the contribution of various sources to regional air degradation, inert tracer and tagged species numerical models have been developed. These models will introduce separate calculations for inert or reactive chemical species emitted from a particular source or region. The calculations will proceed to simulate transport and transformation to a receptor point, where the contribution of emission sources can be discerned.

Atmospheric research is the area of the effects of climate change on regional air quality involves both analytical and statistical climatology as well as linking global climate models with regional chemical transport models, and the development of coupled models to better simulate the interactions between meteorology and atmospheric chemistry.

Research in human exposure modeling includes micro-environmental monitoring and modeling, and development of exposure assessment tools. This research entails linking air quality models to exposure models to understand the relationships between air quality and human health. Micro-environmental algorithms are being developed based on field data to predict air quality in buildings, attached

garages, and street canyons. These improved algorithms are then incorporated into micro-environmental simulation models for conducting human exposure assessments within enclosed spaces in which specific human activities occur.

In addition to the above major areas, dispersion models for inert, reactive and toxic pollutants are under development and evaluation on all temporal and spatial scales, e.g., indoor, urban, complex terrain, mesoscale, regional, and global. Other efforts include modeling nutrient deposition to Chesapeake Bay and mercury deposition to the Florida Everglades; and determination of meteorological effects on air quality. Atmospheric flow and dispersion experimental data obtained from wind tunnel and convection tank experiments in the EPA Fluid Modeling Facility will be used to continue development and evaluation of these models along with providing researchers with insight into the basic physical processes that affect pollutant dispersion around natural and man-made obstacles. For example, the transport and dispersion of airborne agents in the Manhattan, New York area were simulated in the wind tunnel to evaluate Computational Fluid Dynamics modeling systems in an effort to help build confidence in modeling assessment source-receptor relationships for horrific events such as the one that occurred on September 11, 2001. A similar study was conducted for the Pentagon and will be conducted for the Washington, DC area. The impacts of noise barriers and vegetation on air quality near roadways are being assessed and improvements are being made to better simulate the transport and dispersion of pollutants released from roadways.

Over the past twenty-five years, numerous air quality simulation models have been developed to estimate reductions in ambient air pollutant concentrations resulting from potential emission control strategies. Separate models were developed, for example, for tropospheric ozone and photochemical smog, for acid deposition, and for fine particles. Distinct models also existed for addressing urban scale problems and the larger regional scale problems. It has been recognized, however, that the various pollutant regimes are closely linked chemically, spatially/temporally in the atmosphere. The principal purpose of the Community Multi-scale Air Quality (CMAQ) modeling project was to develop a "one at-

mosphere" flexible environmental modeling tool that integrates the major atmospheric pollution regimes in a multi-scale, multi-pollutant modeling system. This system will enable high-level computational access to both scientific and air quality management users for socio-economic applications in community health assessments and ecosystem sustainability studies.

After seven years of development, the CMAQ model was first released in June 1998, and is being updated periodically, reflecting the state-of-science, for use by Federal and state agencies, industry, and academia. The latest version of CMAQ, which includes science enhancements and computational efficiencies, will be released in September 2008. It is also intended to serve as a community framework for continual advancement and use of environmental assessment tools. CMAQ, configured for the Windows-NT computer system, is available on tapes from the National Technical Information Service (NTIS). It is accompanied by an Installation and Operations Manual, a User Manual, a Science Document, and a tutorial providing step by step instructions for use of the modeling capabilities. Additional information is available at the Division web site at <http://www.epa.gov/asmdnerl/models3/>.

In FY 2005, EPA worked closely with the National Center for Environmental Prediction of the National Weather Service (NWS) in the continued development, evaluation, and use of a coupled meteorological-chemical transport model (WRF-CMAQ) for predicting ambient air quality over the Continental United States. This capability is built on years of research in air quality, exemplified by the NOAA-led New England Pilot Air Quality Study in 2002 and 2004. In the first phase of the forecasting project, NWS implemented the Eta-CMAQ modeling system, to provide daily forecast guidance for ozone for the northeastern United States starting from September 2004. In 2007, the forecast system for ozone was deployed nationwide. In the next few years, the operational forecast capability is projected to be able to forecast fine particulate matter. State and local air quality management agencies will continue to forecast local air quality, assisted in their efforts by the addition of national forecast guidance for the concentrations of ozone and fine particles.

EPA participation in the interagency Information Technology Research and Development (IT

R&D) Program is developing a modeling framework that supports integration of diverse models (e.g., atmospheric, land surface, and watershed). EPA's IT R&D work also enables increased efficiency in air quality-meteorological modeling through research on parallel implementation of the CMAQ modeling system. The evolving research seeks to improve the environmental management community's ability to evaluate the impact of air quality and watershed management practices, at multiple scales, on stream and estuarine conditions. Toward this goal the primary objectives include:

- Developing a prototype multiscale integrated modeling system with predictive meteorological capability for transport and fate of nutrients and chemical stressors;
- Enabling the use of remotely sensed meteorological data; and
- Developing a computer-based problem solving environment with ready access to data, models,

and integrated visualization and analysis tools for water and air quality management, local and regional development planning, and exposure-risk assessments. A variety of research areas are being pursued such as the integration of the National Weather Service Next Generation Radar (NEXRAD) Stage IV data into watershed modeling applications; enhanced atmospheric dry deposition models; multi-scale and spatially-explicit watershed modeling tools; and model-coupling technology for integrating media and scale-specific models.

EPA also maintains good working relationships with foreign countries to facilitate exchange of research meteorologists and research results pertaining to meteorological aspects of air pollution. For example, agreements are currently in place with Canada, UK, Greece, Japan, Korea, China, India, and Mexico, and with several European countries under the NATO Committee for Science for Peace (SPS).

