

## Modeling for Use in Sustainability Studies

A new air modeling system is available to help Department of Defense (DoD) personnel maintain compliance with Clean Air Act (CAA) requirements. It's called the Air Quality Modeling System (AQMS).

DoD personnel conduct a variety of missions to maintain combat readiness. Critical to sustaining the combat readiness of the United States armed forces is access to training ranges. However, environmental protection and encroachment issues can significantly restrict range operations.

To sustain military training ranges, compliance measures must be taken and best management practices implemented using credible scientific information and proactively addressing public concerns. To assist DoD activities in complying with CAA requirements, the Naval Air Systems Command (NAVAIR) and the Naval Facilities Engineering Service Center (NFESC) jointly developed and implemented AQMS. The AQMS modeling team consists of specialized experts in meteorological, emission, and chemical transport modeling for air shed analysis.

AQMS provides assistance and guidance to DoD environmental professionals in assessing needs and implementing air pollution control methods. It features state-of-the-science modules recommended by the Environmental Protection Agency (EPA), simulation of multiple air pollutants (including ozone, Particulate Matter (PM) 2.5, toxics, acid deposition, and visibility degradation) and multi-scale applications with the ability to determine both local and regional air pollution impacts.

### System Description

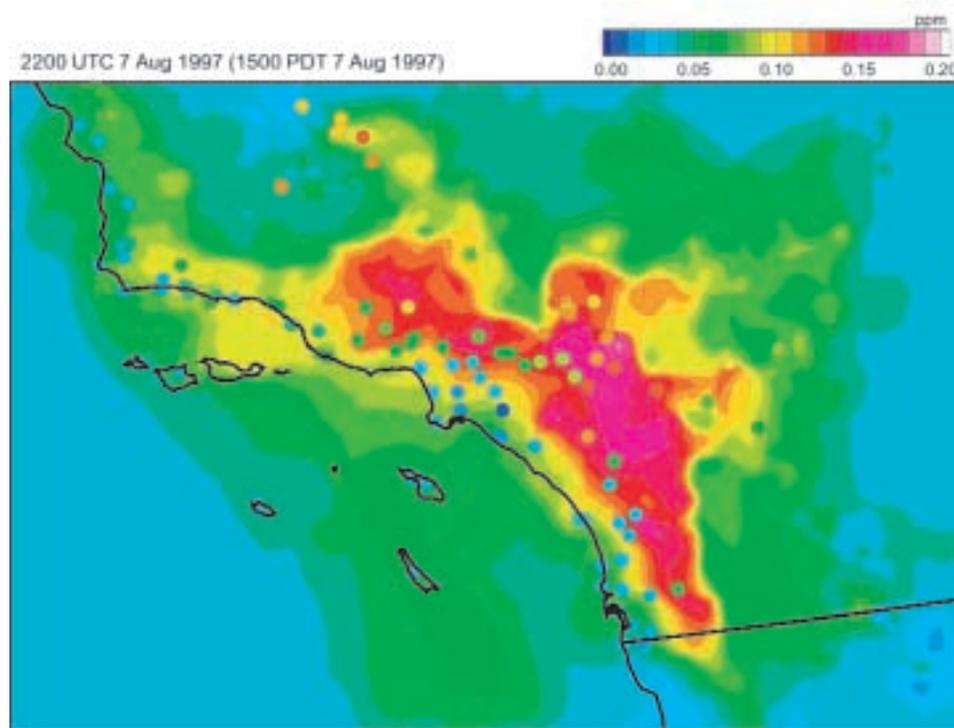
AQMS is capable of treating multiple pollutants simultaneously. The features include modeling gaseous and particulate species, atmospheric aqueous chemistry, and domain sizes from urban to continental scales. The AQMS is customized for DoD operations and performs the following functions:

- Rapidly and inexpensively sets model domains using public databases;
- Performs baseline studies without expensive emission inventory gathering;
- Provides a credible, EPA-approved scientific approach that shows the impact of adding personnel, aircraft and vehicles to individual air sheds;
- Provides a capability for rapidly responding to proposed air quality regulations that may impact DoD operations; and
- Predicts whether base consolidations will result in non-attainment classifications.

The models used in the AQMS include:

### *Mesoscale Model 5 (MM5)*

The MM5 is a modeling system for simulating mesoscale atmospheric meteorological circulations. It provides for the input of the meteorological data needed for emission and chemical transport calculations to Community Multi-Scale Air Quality (CMAQ).



AQMS Simulation Results with Ambient Measurements

### *Sparse Matrix Operator Kernel Emissions (SMOKE)*

SMOKE converts emission inventories normally provided as annual or daily average emissions and grouped by counties or air districts, to hourly, gridded emissions useful as input to CMAQ. Input for all model chemical species is provided. Emission source types considered are:

- Area emissions (gas stations),
- Point source emissions (stacks),
- Mobile source emissions (on-road vehicles),
- Non-road mobile emission sources (ships, jets),
- Biogenic emission sources, and
- Air emissions from fires.

Large border areas (including Mexico) are treated as area sources.

### *Community Multi-Scale Air Quality (CMAQ) Model*

CMAQ simulates species transport, chemical transformations and the fate of multiple air pollutants. CMAQ includes modules for:

- Meteorology-chemistry interface processor,
- Photolytic rate processor,
- Initial condition processor, and
- Boundary condition processor.

### *Chemical-Transport Model Processor*

The chemical-transport model processor consists of features that can be combined in any manner to accurately reflect the air shed being modeled including:

- Horizontal advection,
- Vertical advection,
- Mass conservation adjustments for advection processes,
- Horizontal diffusion,
- Vertical diffusion,
- Gas-phase chemical reaction solver,
- Atmospheric aqueous-phase reactions and cloud mixing,
- Aerosol dynamics and size distributions,
- Plume chemistry effects,
- Aerosol deposition velocity estimation, and
- Photolytic rate computation.

Future add-ons for AQMS include plume dispersion models such as the California Puff Model (CALPUFF) and the adaptive grid modeling function embedded within CMAQ to provide outputs useful at scales less than 100 meters.

The AQMS incorporates the most advanced approach now available to modelers (adaptive grid modeling) for extending the capability of CMAQ calculations to scales on the order of ten to 100 meters—as opposed to the normal lower limit of kilometers.

### The Benefits of Modeling

Modeling air sheds provides DoD personnel with the capability to respond to proposed changes in air quality regulations and to deal with concerns with regional transport and transformation of pollutants. Determining the impact of adding additional personnel, aircraft and/or vehicles to a particular air shed and predicting whether additional consolidation may cause an activity to reach a non-attainment status can be addressed. The EPA accepts the results of calculations performed using EPA-approved models, such as the suite of models used in the AQMS, and with which they have developed expertise to run and to adapt them to specific air shed requirements.

AQMS offers the following benefits to DoD ranges:

- Uses state-of-the-science, EPA-approved models for multi-source, multi-scale simulation of ozone and PM 2.5 formation and regional transport.
- Evaluates air quality impact as a result of activity growth and operational changes.
- Provides results to assist DoD environmental personnel in planning, assessing, and selecting the best control measures and management practices.
- Provides a regulatory-approved method for projecting attainment of compliance requirements for new and existing sources.
- Permits easy DoD access to a skilled and experienced modeling team. [↕](#)

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*If you would like to share your pollution prevention success stories, or would like additional information on the Navy's technology transfer program, contact Kurt Buehler at 805-982-4886, DSN: 551-4886, or [kurt.buehler@navy.mil](mailto:kurt.buehler@navy.mil).*