Community Multiscale Air Quality (CMAQ) Modeling System

What is CMAQ?

The Community Multiscale Air Quality (CMAQ) Modeling System is EPA's premier modeling system for studying air pollution from global to local scales. For over a quarter century, EPA and states have used CMAQ—a powerful computational tool for translating fundamental atmospheric science principles to policy scenarios—to support air quality management. CMAQ is continually updated to incorporate new knowledge on the state-of-the science and use high performance computing power to characterize air quality more accurately and efficiently and to protect human health and the environment.

States use CMAQ to develop and assess implementation actions needed to attain National Ambient Air Quality Standards (NAAQS) defined under the Clean Air Act. CMAQ simulates air pollutants of concern—including ozone, particulate matter (PM), and the most prevalent air toxics—to optimize air quality management. Deposition values from CMAQ are used to assess ecosystem impacts such as eutrophication and acidification from air pollutants. In addition, the National Weather Service uses CMAQ to produce twice-daily forecast guidance for ozone air quality across the U.S.

CMAQ—when coupled with a meteorology model such as the Weather Research and Forecasting (WRF) model—unites the modeling of meteorology, emissions, and chemistry to simulate the fate of air pollutants under varying atmospheric conditions. Other kinds of models—including crop management and hydrology models—can be linked with the CMAQ simulations, as needed, to describe pollution more holistically across environmental media.

CMAQ can be configured to simulate meteorology and atmospheric chemistry in a sequential fashion (i.e., one model at a time), or it can be "coupled," where CMAQ is embedded in the meteorology model. In the latter case, the impacts of atmospheric chemistry can be reflected actively in the clouds and radiation simulated by the meteorology model. There are options to connect CMAQ with meteorology models for coupled simulations across local to hemispheric scales.

CMAQ is a sophisticated numerical modeling system that runs on multi-processor Linux computing systems. CMAQ requires tens of gigabytes to tens of terabytes of disk space to accommodate input and output files. CMAQ can also be operated in a cloud computing environment.

What's new in CMAQ?

CMAQ version 6.0 includes the following new features:

- The release of the Community Regional Atmospheric Chemistry Multiphase Mechanism (CRACMM) version 3. CRACMM3 adds updated reactions, heterogeneous sulfur chemistry, and particulate nitrate photolysis. It expands capabilities to include versions for hazardous air pollutants and marine chemistry. These updates improve model performance when simulating ozone and PM2.5.

- The Carbon Bond mechanism (CB6r5) has also been updated to include heterogeneous sulfur chemistry and particle nitrate photolysis.

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- Major advancements in windblown dust module, including support for new vegetation inputs, and dramatically reduced bias over North America.
- Improvements to the Integrated Source Apportionment Method (CMAQ-ISAM) and Decoupled Direct Method-3D (CMAQ-DDM3D) tools. DDM3D is now more robust and stable, with new support for the Surface Tiled Aerosol and Gaseous Exchange (STAGE) dry deposition module.
- New customization options, simplified user experience, and the Explicit and Lumped air quality Model Output module (ELMO) version 2.
- New Soil Emissions of Gases to the Atmosphere (SEGA) module provides a simple, meteorological dependent method to calculate soil NO and HONO emissions for regional to global applications.
- Updated dry deposition of volatile carbon-containing compounds.
- Boundary-layer mixing dynamics in stable conditions have been made consistent with upstream meteorological models.

Community Engagement

The CMAQ community includes state, local, and tribal air agencies across the 50 states and US territories as well as industry, academics and environmental organizations throughout the US and the globe. These users include scientists and air quality managers across government, academia, and the private sector. Their input has contributed to developing a more robust model.

To support the CMAQ user community, EPA contracts with the University of North Carolina at Chapel Hill to host the Community Modeling and Analysis System (CMAS) Center, which provides user training and support for the CMAQ modeling system. CMAS hosts an online user forum to connect users with model developers and the international user community to collaborate on using CMAQ and to share feedback for science and feature improvements.

For more information, visit:

EPA's CMAQ website: **www.epa.gov/cmaq**

CMAQ source code and documentation on GitHub

FAQ for upgrading to CMAQv6.0

Test data for CMAQv6.0

CMAS Center at UNC-Chapel Hill

CMAS User Forum

October 2026