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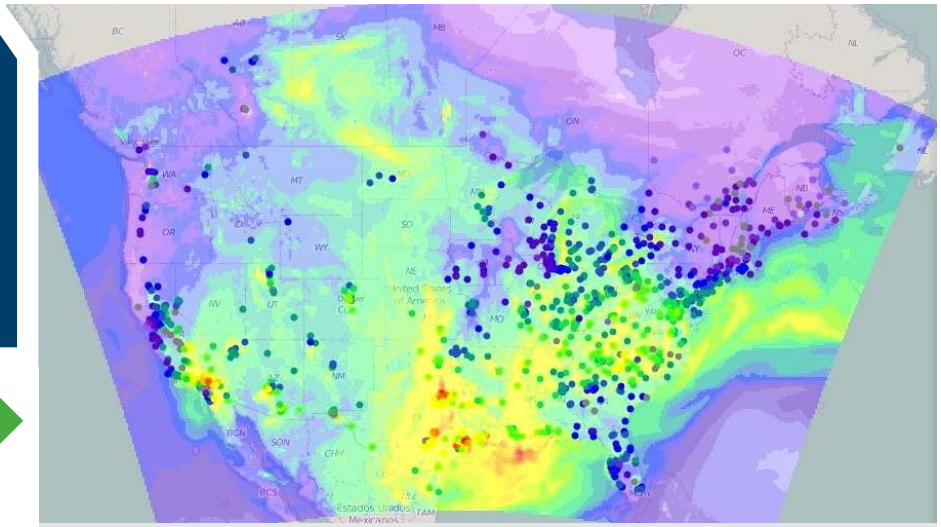
INNOVATIVE RESEARCH FOR A SUSTAINABLE FUTURE

EPA's Community Multi-scale Air Quality Modeling System (CMAQ)

Tools for controlling air pollution; studying climate change



CMAQ predicted surface-level 8-hour maximum ozone across the United States. Color coded circles indicate observations.

What is CMAQ?

For more than a decade, EPA and states have used EPA's Community Multi-scale Air Quality (CMAQ) Modeling System, a powerful computational tool for air quality management. The National Weather Service also uses the model to produce daily U.S. forecasts for ozone air quality.

States use CMAQ to develop and assess implementation actions needed to attain National Ambient Air Quality Standards. The system simultaneously models multiple air pollutants, including ozone, particulate matter, and a variety of air toxics, to help regulators determine the best air quality management scenarios for their communities, states, and countries.

CMAQ brings together three kinds of models:

- Meteorological models to represent atmospheric and weather activities.
- Emission models to represent man-made and naturally-occurring contributions to the atmosphere.
- An air chemistry-transport model to predict the atmospheric fate of air pollutants under varying conditions.

In fall 2015, EPA is releasing the newest version of the modeling system — CMAQ 5.1, which includes the following new features:

- Improved fine-scale capabilities, allowing users to simulate air quality at smaller settings, like metropolitan areas.
- Expanded spatial scale that includes the entire Northern Hemisphere, enabling users to study the intercontinental movement of air pollution and how it may affect air quality and climate change. Earlier versions were typically applied at regional to continental levels.
- Updated representation of physical and chemical atmospheric processes that provide a more realistic portrayal of atmospheric chemistry over a broader range of conditions including man-made and natural emissions.
- Improved capacity to identify air pollution hot spots that can inform remediation strategies for protecting public health.
- Computational efficiency improvements that will allow users to apply it to larger problems, and to more

efficiently investigate alternate scenarios.

The ability to use CMAQ 5.1 at the hemispheric scale will allow scientists to better understand the ways that air pollution moves around the globe and how much pollution in the U.S. is attributed to other countries. The information will help air quality managers determine what portion of air pollution can be managed locally and nationally and what needs international solutions.

A Little History

Using data about land use, meteorology, and emissions, CMAQ provides detailed information about the concentrations of air pollutants in a given area for any specified emissions or climate scenario. Since 1998, when the first version was released, CMAQ has been used to evaluate potential air quality policy management decisions. The model provides reliable information for decision makers about the estimated impacts of different air quality policies.

Since its inception, CMAQ has been able to incorporate data from related models that have alternate mathematical processes. This has allowed inclusion of new science in the model to address increasingly complex air pollution issues.

Community Based Development

CMAQ stands out from other air quality models because it incorporates input from a large, world-wide user community. To support the CMAQ user community, EPA and the University of North Carolina at Chapel Hill host the Community Modeling and Analysis System (CMAS) Center, which distributes CMAQ software, hosts user email exchanges, and provides new user training on the CMAQ modeling system.

This growing community, which includes thousands of users in more than 50 countries, has helped assess and improve the model's functionality. Users include scientists, researchers and air quality modelers, as well as governmental air quality managers who apply the modeling system in their environmental management programs. Their input has helped EPA scientists prioritize modeling research to improve CMAQ's capabilities.

CMAQ Model Application

CMAQ has been used to address several major air pollution issues in recent years. New fuel and car standards finalized by EPA in 2014 were developed with input from CMAQ. The new fuel standards require the amount of sulfur in gasoline to be reduced by more than 60 percent starting January 1, 2017. Under the new rule, motor vehicle particulate-matter emissions are to be reduced by 70 percent and nitrogen-oxides emissions by 80 percent. Once fully in place, the standards will help avoid up to 2,000 premature deaths per year and 50,000 cases of respiratory ailments in children.

In developing the rule, CMAQ was used to calculate 8-hour ozone concentrations; daily and annual $PM_{2.5}$ concentrations; annual nitrogen dioxide (NO_2) concentrations; annual and seasonal (summer and winter) air toxics concentrations; visibility levels, and annual nitrogen and sulfur deposition total levels. These factors were calculated for the years 2018 and 2030, with and without the rule. CMAQ results were used in combination with other tools to determine how the new standards would impact various health outcomes.

For more information, visit:

EPA's CMAQ resource page:
http://bit.ly/EPA-CMAQ

CMAS at UNC-Chapel Hill:
www.cmascenter.org

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