The Community Multiscale Air Quality (CMAQ) Modeling System

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Background

Drivers for Air Quality Models

Air quality models have evolved over the past several decades to address increasingly complex application and assessment needs.

The CMAQ Modeling System: A “Numerical Laboratory”

CMAQ is a comprehensive state-of-the-science atmospheric modeling system that integrates and synthesizes our evolving knowledge of the various atmospheric processes regulating the fate of atmospheric pollutants.

CMAQ Formulation

The theoretical basis for model formulation is the conservation of mass for atmospheric trace species transport, chemistry, and deposition:

Characterizing Long-term Trends in Air Pollution Exposure

1990-2010 Trends: Impact of the Clean Air Act

95th Percentile O₃

Summer mean PM₂.₅

Regulatory actions over the past two decades have resulted in substantial reductions in levels of criteria pollutants across the Nation and in reducing the exposure of sensitive populations to harmful levels of air pollution.

CMAQ Applications

Policy Analysis

Assessing effectiveness of emission control strategies for National Rules, State Implementation Plans

Nutrient Loading to Sensitive Ecosystems

Ammonium Ion Wet Deposition

Wet and dry deposition are key removal processes for airborne pollutants, but also the pathway for atmospheric input to terrestrial and aquatic ecosystems

Help Design Monitoring Network

Modeled spatial trends vs. CASTNET locations

Current coverage of sites may not be sufficient to capture hot-spots. Thus budgets based solely on observations will be misleading

Improving Public Health: Air Quality Forecast Guidance

CMAQ deployed at NOAA-NWS to develop next day air quality forecast

Developing accurate short-term air quality forecasts enables state and local agencies to alert the public of the onset, severity and duration of unhealthy air, and to encourage public and industry to reduce emission producing activities.

Emerging Application Needs

Informing Human Exposure & Health Studies

Accounting for spatial variation in air concentrations & population density, enables a more accurate estimate of the average exposure across metropolitan areas

Air Pollution–Meteorology–Climate Interactions

Many air pollutants (PM₂.₅, O₃) are radiatively active and are also short-lived climate forcers. In regions of high PM₂.₅, feedback effects on atmospheric dynamics can be significant and can impact air pollutant levels. The consideration of such interactions could be important for examining air quality-climate co-benefits of various policy options.

Integrated Approaches to Address Multiple Problems

CMAQ science and capabilities are continuously being extended to link with other models to enable integrated assessments of multiple issues:

- air quality-climate
- air quality-human health
- air quality-ecosystem health
- air quality-agriculture

Dissemination and User Community

- CMAQ is publicly available through the Community Modeling & Analysis (CMAQ) center: www.epa.gov/cmaq
- Periodic scientific updates to CMAQ have led to creation of a dynamic and diverse user community
- Annual Conference and training
- EPA’s CMAQ modeling system is widely used by a growing international community for a variety of research and regulatory applications

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