

Community Multiscale Air Quality Model

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The Community Multiscale Air Quality (CMAQ) modeling system is rapidly becoming a major and widely used air quality model. Some investigators have tested CMAQ's prediction of aerosol mass concentrations, but little is known about model prediction of aerosol size, chemical properties, and vertical distribution. It is difficult to trust the model's prediction of future aerosol mass without an understanding of how it captures the underlying aerosol size distribution, especially in an urban area heavily influenced by ultrafine particles.

To evaluate CMAQ's ability to model aerosol size distributions, CMAQ version 4.3 at 4 km resolution simulated a period of August 2001 when extensive chemical and aerosol observations were available from Pacific Northwest 2001 (PNW2001) near Seattle, Washington, USA and from its larger sister field campaign, Pacific 2001, in metropolitan Vancouver, British Columbia, CA. The CMAQ simulation attempts to capture all the important processes affecting gaseous and aerosol pollution.

Airborne and surface size distribution measurements show an underprediction of aerosol number by typically a factor of 10 to 100. The underprediction persists at all hours and is greater for smaller size ranges. This result cannot simply be explained by errors in gas-phase constituents. Errors in gaseous precursors exist, but the aerosol number underprediction is relatively constant while the gas-phase errors fluctuate in time and location. Surface PM_{2.5} measurements demonstrate that the number underprediction occurs in spite of mass performance similar to other published CMAQ results. Errors in aerosol mass are not consistent or large enough to explain the negative bias factor of 5-10 in accumulation mode particle number concentration and of 10-100 in total particle concentration. Size-resolved, speciated aerosol measurements reveal that the underprediction is consistent for sulfate, organics, and nitrate species.

Few studies have investigated aerosol size distribution performance with CMAQ. If this study performs similarly to other CMAQ PM_{2.5} evaluations, then it is likely these other studies are also having difficulties with the underlying size distribution.