CMAQ Aerosol Number and Mass Evaluation for Pacific Northwest

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Although several investigators have tested CMAQ's prediction of aerosol mass (for example: Mebust et al., 2003; Eder et al., 2004; Tonnesen, 2003), little is known about CMAQ's ability to reproduce aerosol number concentrations. In addition, most studies are focused on eastern North America and the Southwest U.S. Only a few studies (e.g., O'Neill, 2004) have examined CMAQ aerosol performance in the unique Pacific Northwest emission and meteorological conditions. Therefore as part of the NW-AIRQUEST's continuing evaluation of CMAQ for the Pacific Northwest, this project evaluates 4-km CMAQ aerosol number and mass concentrations against detailed airborne and surface measurements from the coordinated Pacific Northwest 2001 (PNW2001) and Pacific 2001 field campaigns.

Airborne measurements show an under-prediction of aerosol number by a factor of 10 to 100, especially in the Aitken mode (i.e., ultrafine or less than 100 nm diameter). This result cannot simply be explained by errors in gas-phase constituents. Errors in ozone, NO/NO_y, and SO_2 performance 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. At the time of aircraft measurements, the surface $PM_{2.5}$ Normalized Mean Bias Factor is 4%, -56%, and -74%. Errors in aerosol mass are not consistent or large enough to explain the negative bias factor of 5-10 in accumulation mode particle concentration and of 10-100 in total particle concentration. Speciated aerosol measurements reveal a large but intermittent positive bias in aerosol nitrate and organic mass. Few studies have investigated number concentration 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 predicting number concentrations. The root cause may lie in the treatment of aerosols as three lognormal modes or may be due to inadequate processing of the aerosol size distribution.

References:

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