Performance Evaluation of CMAQ for Summer 1999 Southern Oxidants Study Episode

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A comprehensive model evaluation has been conducted with the 2004 version of CMAQ for its application to the period 29 June - 10 July 1999 of the Southern Oxidants Study episode with two nested horizontal grid sizes: a coarse resolution of 32 km and a fine resolution of 8 km. The coarse grid domain covers the contiguous U.S. and the fine grid domain covers an area of the southeastern U.S. Simulated meteorological variables (e.g., temperature, relative humidity, wind direction and speed) and chemical species (e.g., O_3, $PM_{2.5}$, PM_{10}, sulfate, nitrate, ammonium, black carbon and organic carbon) and their precursors (e.g., SO_2, NO_x, HNO_3) for both grids are compared to observations from both routine monitoring networks (e.g., the Clean Air Status and Trends Network (CASTNet), Interagency Monitoring of Protected Visual Environments (IMPROVE)) and special studies (e.g., 1999 Southern Oxidants Study (SOS), the Southeastern Aerosol Research and Characterization study (SEARCH)).

Our evaluation has shown that the model performance for O_3 generally meets EPA's criteria and that for PM is generally consistent with the performance currently expected from PM models. The O_3 statistical values were calculated using two cut-off values, 40 and 60 ppb. Mean normalized gross error (MNGE) and mean normalized bias (MNB) for O_3 predictions are 17% and 7% for 32-km grid and 16% and -0.1% for 8-km grid for a cut-off value of 60 ppb. The MNGE and MNB) for O_3 predictions are higher for the lower cut-off value of 40 ppb (33% and 28% for 32-km grid and 27% and 17% for 8-km grid), indicating that the model has worse predictions for the O_3 mixing ratio ranges of 40-60 ppb. For PM_{10} and $PM_{2.5}$ predictions over the southeastern U.S. domain, the ranges of MNGE and MNB are 39-42% and -38 to -22% for 32-km grid and 42-46% and -36 to -24% for 8-km grid. The MNGE and MNB of nitrate and organic matter are the largest and the second largest among all PM compositions. Underestimation in emissions of NH_3 and primary OM is likely a major factor causing large underpredictions in nitrate and OM. Other possible causes are being analyzed through further diagnostic analyses/sensitivity simulations.

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