# EVALUATING TEMPORAL AND SPATIAL $O_3$ AND $PM_{2.5}$ PATTERNS SIMULATED DURING AN ANNUAL CMAQ APPLICATION OVER THE CONTINENTAL U.S.

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Over the next several years, grid-based photochemical models such as the Community Multiscale Air Quality (CMAQ) model and REMSAD will be used by regulatory agencies to design emission control strategies aimed at meeting and maintaining the NAAQS for $O_3$ and $PM_{2.5}$. The evaluation of these models for a simulation of current conditions is a necessary prerequisite for using them to simulate future conditions. In this study, we present evaluation results of an annual simulation for 2001 over the continental U.S. with the CMAQ and REMSAD air quality models driven by meteorological fields generated by MM5 and emissions processed by SMOKE. The evaluation focuses on determining the temporal and spatial patterns in all components of the modeling system (meteorology, emissions and air quality) and comparing them against available observations. In summary, we find that the models exhibit greatest skills at capturing longer-term (seasonal) fluctuations for temperature, wind speed, ozone, sulfate and nitrate. For total $PM_{2.5}$, ammonium, EC, OC and crustal $PM_{2.5}$, correlations are highest for the synoptic time scale, implying problems with factors other than meteorology in capturing the baseline (seasonal) fluctuations. For the variables for which hourly measurements were available, correlations were insignificant on the intraday time scale, suggesting that these models in their current setup were not skillful in simulating the shorter-term variations in pollutant levels. We also compared average observed and predicted diurnal cycles for total PM2.5 mass at TEOM monitors. Although the time of occurrence of maxima was simulated well, there is a large difference in the amplitude of the diurnal forcing; both models overestimated observations during nighttime and severely underestimate observations during daytime hours. By comparing the observed and predicted spatial correlation structures for the different temporal components, it was found that the observed intra-day component shows more spatial variability than the predicted one for temperature, wind speed, $O_3$ and $PM_{2.5}$. The correlation structures for the synoptic and baseline components are generally well-captured by the modeling system for all variables.

In a second thrust of our model evaluation, we briefly investigated the weekday/weekend differences in the observed and predicted pollutant concentrations and outlined steps for future research. Since anthropogenic emissions are known to have a distinct weekly cycle, such analyses would help us in evaluating the modeling system's ability to accurately reproduce the observed response to emission changes. We generated a scatter plot of the average CMAQ predicted difference between weekend daily maximum 1-hr ozone concentrations and weekday daily maximum 1-hr ozone concentrations versus the corresponding difference computed from observations at the same location. This analysis showed that a weekday/weekend cycle of comparable magnitude is indeed present in observed and CMAQ-predicted ozone concentrations during the summer of 2001. However, it is important to ascertain whether the weekday versus weekend differences in ozone concentrations are caused by emission fluctuations or might be largely explained by meteorological effects when analysis is restricted to a single summer season only. Indeed, we show that for the summer of 2001 there was a distinct weekday/weekend fluctuation in temperature at most monitors in the eastern U.S. Most monitors show lower daily maximum temperatures on weekends than on weekdays, and MM5 captures this behavior. Because temperature both directly influences the rate of ozone formation and serves as a proxy for other meteorological parameters conducive to ozone formation, this illustrates that the existence of a weekday/weekend cycle in ozone concentrations for the summer of 2001 can not unequivocally be attributed to cyclical changes in precursor emissions.

## ACKNOWLEDGMENTS

The Department of Commerce partially funded the research described here under contracts with Dr. E. Gego (EA133R-03-SE-0710), with the University of Idaho to Dr. P. S. Porter (EA133R-03-SE-0372), and with the State University of New York to Dr. C. Hogrefe (EA133R-03-SE-0650).

## DISCLAIMER

The research presented here was performed under the Memorandum of Understanding between the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) and under agreement number DW13921548. Although this work was reviewed by EPA and approved for publication, it may not necessarily reflect official Agency policy.

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