8.5 APPLICATION OF THE MODELS-3 COMMUNITY MULTI-SCALE AIR QUALITY (CMAQ) MODEL SYSTEM TO SOS/NASHVILLE 1999

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1. INTRODUCTION

The Models-3 Community Multi-scale Air Quality (CMAQ) model, first released by the USEPA in 1999 (Byun and Ching 1999), continues to be developed and evaluated. The principal components of the CMAQ system include a comprehensive emission processor known as the Sparse Matrix Operator Kernel for Emissions (SMOKE), a Chemical Transport Model (CTM), and a meteorology model, the Penn State/NCAR Mesoscale Model (MM5). Evaluation of the CMAQ modeling system includes simulation of a series of air quality field studies such as NARSTO and SOS. This paper describes many upgrades to the next release (June 2002) of the CMAQ system and our initial model application to the SOS/Nashville 1999 field experiment.

2. MODEL DESCRIPTION AND UPDATES

The 2002 release of the CMAQ modeling system will include many additional and improved components and better consistency between chemistry and meterology models. The SOS/Nashville 1999 model runs represent our initial testing and evaluation of several combinations of new features in the meteorology, emissions, and chemical components of the system. The meteorology runs feature the Pleim-Xiu land-surface model (PX-LSM) (Pleim and Xiu 1995; Xiu and Pleim 2001) with indirect soil moisture data assimilation and the Asymmetric Convective Model (ACM) (Pleim and Chang 1992) for PBL processes. A new dry deposition model (M3dry) has been developed as an adjunct to the PX-LSM that uses the same stomatal and aerodynamic resistances computed for evapotranspiration (Pleim et al. 2001). New features of the CMAQ CTM include the SAPRC-99 chemical mechanism (Carter 2000), the Modified Euler Backward Iterative (MEBI) chemical solver (Huang and Chang 2001, Hertel et al, 1993), and a new version of the aerosol model (AE3). The aerosol model represents size spectra by three log-normal modes with variable geometric standard deviation. AE3 adds gas-aerosol partitioning for organic reaction products (Schell et al. 2001) and a heterogeneous reaction for N_2O_5 to HNO_3. CMAQ also includes Plume-in-Grid (PinG) which has been updated to include aerosols (Godowitch 2002). The ACM has been added to the CMAQ CTM as a new PBL option so that PBL vertical trasport is consistent for meteorological and chemical species.

The new release of CMAQ is designed to operate with a new emission processor (SMOKE) (Coats 1996). SMOKE includes the latest version of the Biogenic Emissions Inventory System (BEIS3) (Pierce et al, 2002).

The 2002 release includes a new version of the Meteorology-Chemistry Interface Processor (MCIP) for CMAQ. The new MCIP enables CTM to exact PBL and surface parameters calculated by the MM5. Previously, many of these parameters, including PBL height, friction velocity, and Monin-Obukhov length, were re-diagnosed from meteorological state variables. This feature is critical for maintaining consistency between meteorology and chemistry models.

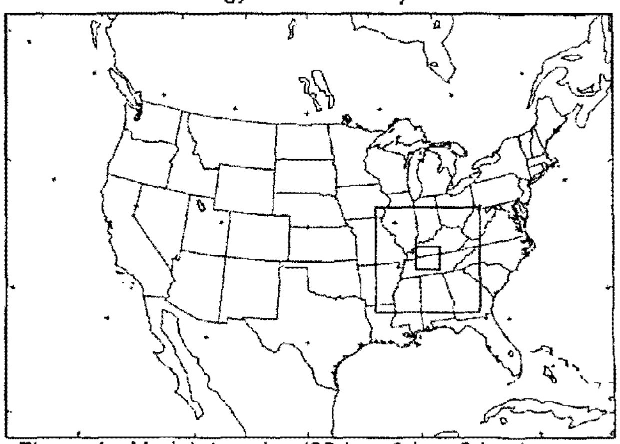

Figure 1. Model domains (32 km, 8 km, 2 km)

3. MODEL SIMULATIONS

We are running a series of one-way nests for both MM5 and CMAQ starting with a continental 32 km resolution domain, progressing through an intermediate 8 km domain centered on Nashville, to a 2 km domain covering central Tennessee (Figure 1). The MM5 32 km domain has been run for June15 - July 26, 1999 with a continuous simulation of soil moisture and temperature. The 8 km and 2 km nests are initialized by interpolation and run for selected periods. Several forms of FDDA were used for the MM5 runs including analysis nudging for winds at the

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surface and aloft, and temperature and humidity above the PBL for the 32 km and 8 km domains. Surface temperature and humidity analyses are used for indirect nudging of the soil moisture. Observation nudging is used for the 8 km and 2 km grids. In addition to routine rawinsonde and surface measurements, special surface and radar wind profiler measurements from the SOS/Nashville experiment are included.

Initial CMAQ runs at all three resolutions are being made for June 30 - July 14. Several variations of modeling components and features will be run for testing and sensitivity studies. The base runs use a preliminary version of BEIS3 which updates emission estimates of isoprene, terpenes and soil NO_X. The more complete BEIS3, which includes estimates of methanol emissions, will also be tested. Inclusion of biogenic methanol emissions may have a profound effect on the modeled photochemistry and require new capability from the dry deposition model. The base runs do not include the Plume-in-Grid option, but sensitivity tests will be run using PinG for the 32 and 8 km grids. The base runs use a bulk eddy diffusion scheme based on surface layer and boundary layer scaling. Sensitivity tests will include the ACM which is a non-local closure scheme for convective conditions and a local eddy diffusion scheme for all other conditions. With the use of ACM in CMAQ the PBL mixing of chemical species is identical to the mixing of heat, moisture, and momentum in MM5.

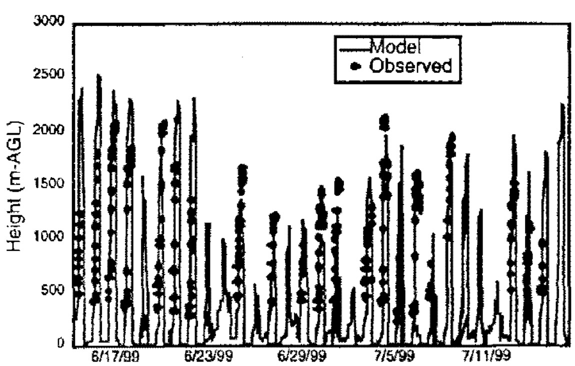

Figure 2. PBL height at Cornelia Fort, TN, Modeled by MM5 and measured by radar wind profiler

4. EVALUATION STATUS AND PLANS

At the time of submission of this extended abstract we have made most of the MM5 runs along with some evaluation but the CMAQ runs are at a very early stage. Some results of CMAQ evaluation will be presented at the conference.

MM5 evaluation involves simple statistics of model results compared to routine surface measurements as well as comparisons to special field study measurements such as PBL height from radar profilers, surface fluxes of sensible and latent heat, and surface radiation components. As an example of MM5 evaluation relevant to air quality modeling, Figure 2 shows time series of modeled and measured PBL heights at the Cornelia Fort radar wind profiler.

CMAQ evaluation will involve both routine measurement networks such as AIRS, for O_3 and SO_2, IMPROVE, for speciated aerosol mass, and CASTNet for inorganic aerosols, and special field study measurements from SOS/Nashville1999. The Nashville study has sophisticated gas and aerosol measurements at several surface sites as well as gas and aerosol measurements from 3 research aircraft.

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16. ABSTRACT

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