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Results of Coupling the WRF-Chemistry model w/ the SMOKE Emissions Processing/Modeling System

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1. INTRODUCTION

During the mid-1990's, the Sparse-Matrix Operator Kernel Emissions System (SMOKE, Coats, was designed to provide efficiently computed meteorology-modulated atmospheric chemistry emissions for EPA's "Models-3 CMAQ" and other air quality modeling systems, including MAQSIP-RT, UAM-IV, and UAM-V, using a wide-variety of speciations common to current and future-generation chemical mechanisms.

The authors have recently completed a first-generation coupling of the SMOKE emissions modeling system with the WRF-Chemistry model. WRF-Chem features chemical calculations online in an integrated code with the WRF meteorology model using the Eulerian mass-based vertical coordinate. The coupling involved a three-phase code modification and testing approach followed by a case study comparing the standard “typical” emissions file provided with the model (Grell et al., 2005).

2. COUPLING APPROACH

A generic diagram depicting the coupling approach used is shown in Figure 1. In the first phase of the work, both WRF and the WRF-Chemistry (Version 2.03.1) were modified enabling the EPA/MCNC/BaronAMS Models-3 I/O API (M3IO, http://www.baronams.com/products/ioapi/) to be called as an I/O subsystem within the “external” I/O sub-layer of the WRF model. This work proved significantly more challenging than had been originally envisioned because—at times—the design approaches used in the software engineering of the WRF model were at odds with fundamental notions built into M3IO.

The second phase of the work involved modifications to the SMOKE emissions processing system needed to enable the various SMOKE sub-models to efficiently couple with WRF-Chem. These modifications included:

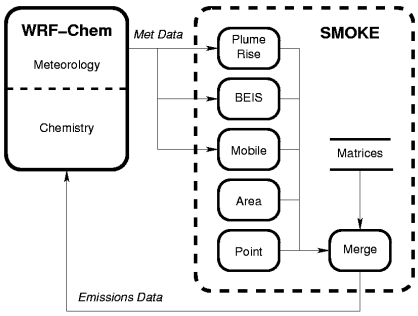

Figure 1. *Approach used in coupling SMOKE with WRF-Chem*

(1) Revisions to handle time-steps other than the formerly hard-coded hourly time-step for input meteorology data from WRF-Chem.

(2) Parallelization of relevant SMOKE sub-models It was unrealistic to expect a single-processor implementation of SMOKE to efficiently cooperate with a WRF-Chem that may be running on hundreds of processors.

(3) Re-coding so that proper attention was paid to failure-status returns for library calls that evaluate I/O status, environment-variables, etc.

(4) Restructuring of the SMOKE build (make) system so that it is compatible with the above mentioned M3IO build system, for compatibility with the WRF build system.

The third phase of the work involved testing such that the newly revised SMOKE was able to properly read and process WRF-Chem-based meteorological variables supplied in M3IO format and that WRF-Chem was properly able to read and process SMOKE-based emissions inputs supplied in M3IO format. Significant attention had to be paid to the distributed memory implications within the WRF model as these tests proceeded.

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3. CASE STUDY AND RESULTS

A late July 2004 case study was chosen in order to compare the “vanilla” version of WRF-Chem (V2.03.1) and WRF-Chem-SM. Results will be presented at the conference.

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