Multiscale Meteorological Modeling for Air Quality Modeling Applications (1.5)

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Air quality models require accurate representations of air flow and dispersion, cloud properties, radiative fluxes, temperature and humidity fields, boundary layer evolution and mixing, and surface fluxes of both meteorological quantities (heat, moisture, and momentum) and chemical species (dry deposition and evasion). Thus, meteorological models are critical components of the air quality modeling systems that evolve with the state of science. Because of this evolution, there is a need to frequently challenge our established models and configurations; this includes examining not only new physics schemes but also data assimilation strategies, which serve to lower uncertainty in model output. It is also necessary to develop and refine physical process components in the models to address new and emerging research issues. Each of these research objectives has the overarching goal to improve meteorological model simulations to ultimately reduce uncertainty in air quality simulations. Our meteorology modeling research program involves several key projects that have led to improved meteorological fields. The first is the transition from the MM5 mesoscale model system to the Weather Research and Forecasting (WRF) model that represents the current state of science. Part of this effort was to implement in WRF the land-surface (Pleim-Xiu; PX), surface-layer (Pleim), and planetary boundary layer (Asymmetric Convective Model version 2; ACM2) schemes that had been used in MM5 and are designed for retrospective air quality simulations. Part of this effort included improving the PX land-surface physics that included a deep soil nudging algorithm and snow cover physics that dramatically improved temperature estimations in the winter simulations and in areas with less vegetation coverage. An additional effort was to work toward implementing in WRF the nudging-based four-dimensional data assimilation (FDDA) capability that had been available in MM5. Another effort has been a re-examination of FDDA techniques, including the use of a developmental analysis package for WRF ("OBSGRID") to lower the error of analyses that are used to nudge the model toward the observed state.

Current results of the implementation of new physics in WRF show that our configuration is comparable to or exceeds the level of MM5 in terms of the uncertainty or error in near-surface variables like 2-m temperature, 2-m moisture, and 10-m wind. This is true only when the new analysis package is used to improve analyses used for FDDA and soil moisture and temperature nudging in WRF. A new evaluation method that utilizes both wind profiler and aircraft profile measurements provides a routine method to examine not only the uncertainty of simulated wind in the planetary boundary layer, but also the less examined temperature structure. The WRF model has low error in temperature (median absolute error of 1.0 to 1.5 K or less) in the planetary boundary layer, which is generally less than the error near the surface. The model also simulates the evolution of the wind structure, including features like nocturnal jets and the convective mixed layer, with low error (<2.0 m s-1). Our current configuration of WRF has met the requirements for the transition from MM5.

<u>Acronyms</u>

Sensitivity simulations are identified on the poster by mesoscale model, land-surface and planetary boundary layer options, and in one case, the tool used to generate analyses for FDDA. The run identifications include: WRF PXACM, WRF PXACM OG, MM5 PXACM and WRF NOAHYSU. PXACM indicates the Pleim-Xiu LSM (PX) and Asymmetric Convective Model Version 2 (ACM2). OG indicates OBSGRID was used.

NOAH – **N**ational Centers for Environmental Prediction, **O**regon State University, **A**ir Force and **H**ydrologic Research Lab land surface model

YSU – Yonsei University PBL scheme implemented in WRF