COMPARISONS OF OFFLINE AND ONLINE AIR QUALITY SIMULATIONS IN CALIFORNIA'S CENTRAL VALLEY

E.D. Grell[1,2] J.-W. Bao[1] G.A. Grell[1,2]

[1]NOAA/Earth System Research Laboratory, Boulder, CO

[2]CIRES, University of Colorado

(email contact: evelyn.grell@noaa.gov)

INTRODUCTION

Operational air quality modeling in California has long been conducted using the offline approach, in which the meteorological fields are saved at specified time intervals and later used to drive a chemical model. The advent of online coupled meteorology and chemistry modeling systems, such as WRF-CHEM, makes it possible for operational air quality modeling to be conducted with two-way interaction between the meteorological and chemical variables (see e.g., Grell et al. 2005). This can be important because not only can the meteorology affect the chemistry through transport, precipitation and radiation processes at each time step of the model integration, but the chemical fields can also impact the meteorological variables.

In this study, the WRF-CHEM model is used to investigate how intermittent sampling of meteorological fields in the offline approach affects the accuracy of chemical modeling in the complex terrain of California, where winds and temperature in the lower troposphere often change rapidly due to localized surface forcing.

ONLINE-OFFLINE MODEL DESCRIPTION

The offline WRF-CHEM model was developed in 2007 by Mohit Dalvi and Georg Grell (Dalvi et al. 2007) in order to facilitate multiple chemistry simulations with a minimal cost of the meteorological model. It requires that an online run is performed first and the necessary meteorological variables are time-averaged and written to an auxiliary history file at a specified time interval. Chemical species in both the online and offline versions are advected with an improved forward-in-time, positive definite advection algorithm called *solve_em_fit* (Skamarock, 2006).

During an offline run, two time periods are read from the auxiliary file, and the input meteorological variables are interpolated in time. These time-interpolated values are used to advect the chemical variables.

MODEL CONFIGURATION

WRF-CHEMv3.1.1

12km: 101 x 111 x 51

4km: 301 x 331 x 51

YSU boundary layer scheme

NOAH land surface model

RADM2 chemical mechanism

Offline output frequency: 60mins, 30mins, 10 mins

Simulation period: 48h beginning 12 UTC 29 July 2000

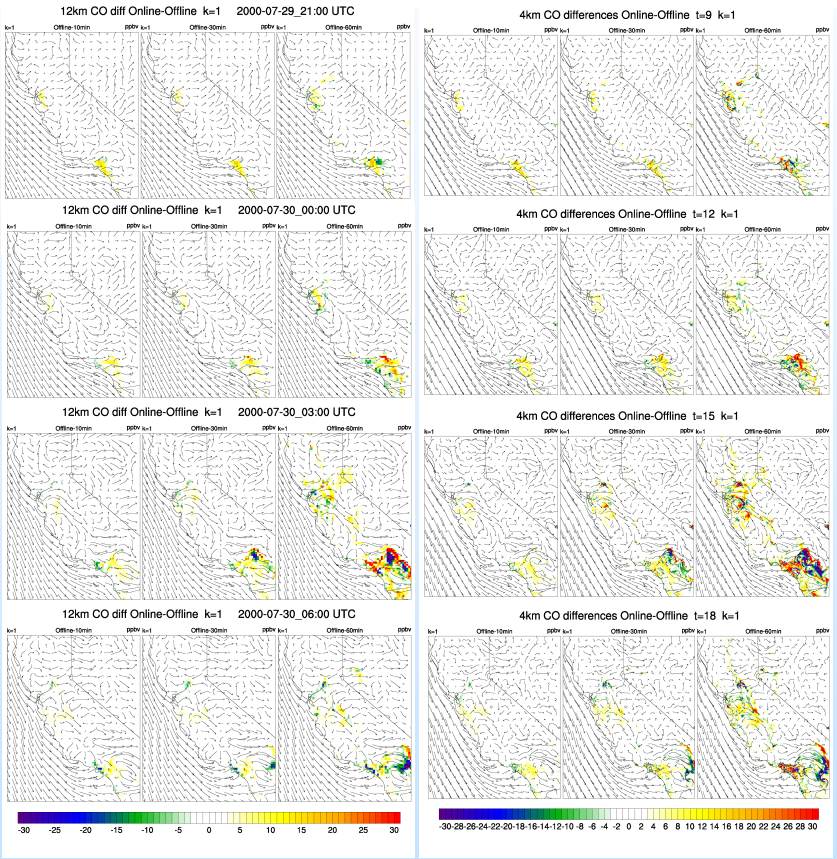

Figure 1. Online-offline differences in carbon monoxide at the lowest model level for 12km horizontal resolution (left panels) and 4km resolution (right panels) for the simulation times 9, 12, 15 and 18h, corresponding to the period 2100 UTC 29 July 2000 to 0600 UTC 30 July 2000.

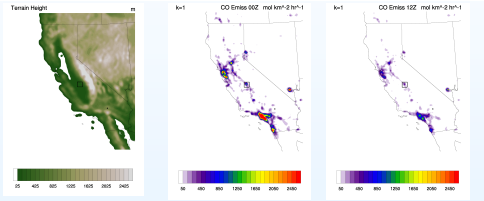

Figure 2. Terrain heights and CO emissions at 00 and 12 UTC for the model domain.

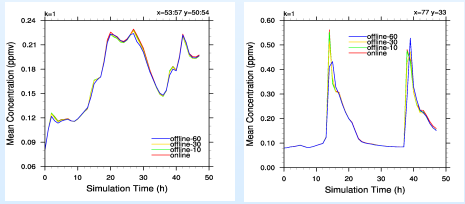

Figure 3. Time series of CO concentrations for the 12km simulation at the lowest model level for the period 29 July 2000 1200 UTC to 31 July 2000 1200 UTC. On the left is a box average, and above right is a time series for a single point. Box and point locations are shown in Fig 2.

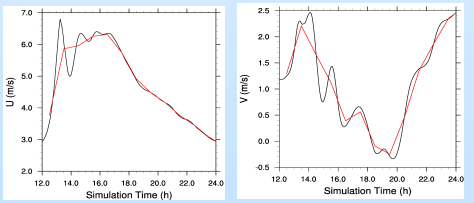

Figure 4. Time series for U and V wind components at the lowest model level for the point shown in Fig. 3, hrs 12-24. Black lines are from model output saved at every time step, and red lines are hourly averages. Differences between the lines indicate errors in winds due to the 60-minute average.

PRELIMINARY RESULTS

The preliminary results indicate that the offline air quality simulations in the Central Valley of California may produce significant errors when the sampling frequency of meteorological fields is hourly. More frequent sampling improves the results, but increases the model overhead in terms of computing time and disk space required. Orographically induced flows in California exert important influences on the temporal and spatial distributions of pollutants, and the time-scale of the variability of these flows may not be resolved with a 60-minute sampling interval. Higher horizontal resolution serves to better simulate the meteorological and orographic features, but is not sufficient to reduce chemical concentration errors. Although areal averaged differences are small, errors in simulated concentrations at particular points, especially near or downwind of emissions sources, may be more than 30 ppbv.

REFERENCES

Dalvi, M., G.A.Grell and S.Peckham, 2007: Development of an Offline WRF/Chemistry Model. Preprints, 2007 WRF Workshop.

Grell,G.A., S.Peckham, R.Schmitz, S.A.McKeen,G.Frost, W.C.Skamarock and B. Eder, 2005: Fully coupled "online" chemistry within the WRF model, *Atmospheric Environment*, 39(37), 6957-6975.

Skamarock, W.C. 2006: Positive-definite and monotonic limiters for unrestricted-time-step transport schemes, *Mon. Wea. Rev.*, **134**, 2241-2250.