P1.28 A COMPARISON OF METEOROLOGICAL OBSERVATIONS WITH THE OUTPUT OF A REAL-TIME WEATHER-CHEMISTRY FORECASTING MODEL DURING THE TEXAS AQS 2000 FIELD EXPERIMENT

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1. INTRODUCTION

The quality of meteorological forecasts is critical to that of air-quality forecasts. There are many atmospheric processes that control or strongly affect the evolution of emissions, chemical species, aerosols and particulates. Current meteorological models have a variety of parameterizations of these processes that were designed for weather forecasts. Since a combination of parameterizations that provide acceptable skills of weather forecasts (e.g., quantitative precipitation forecasts) may have poor skills of predicting meteorological conditions during high-pollution episodes, it is very important to use observations to evaluate the skills of physics parameterizations of meteorological forecasting models used in air-quality forecasts. Such an exercise is critical to the recommendation of appropriate physics parameterizations suitable for operational air-quality forecasts for a given geographical area.

To improve the understanding of the processes that control the formation and transport of air pollutants along the Gulf coast of southeastern Texas, a field experiment (i.e., The Texas Air Quality Study 2000) was carried out in August and September of 2000 around the Houston area by a team of researchers from federal and Texas state agencies, and universities. This experiment was the largest air quality study ever carried out in the state of Texas. Measurements of meteorological conditions, gaseous, particulate, and hazardous air pollutants were made by an observational network to make it possible to study the formation, composition, and day-night cycles of ozone and its precursors, as well as how these pollutants are controlled or affected by weather. These measurements are also valuable for the assessment and improvement of numerical chemistry models for air-quality forecasts.

In this study, meteorological observations taken during the Texas Air Quality Study 2000 are compared with the forecasts of a real-timecoupled weather-chemistry forecasting model. The comparison is carried out in terms of the evolution of the land-sea breeze front and the planetary boundary layer (PBL) structure, as well as the sensitivity of the evolution to the resolution of the coupled model.

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2. NUMERICAL MODEL

The coupled weather-chemistry forecasting model combines a modified version of the fifth-generation Penn State/NCAR Mesoscale Model (MM5) and the chemical mechanism of the Regional Acid Deposition Model Version 2 (details about the coupled model can be found in Grell *et al.* 2002). The transport of chemical species (grid-scale and sub-grid scale) is treated simultaneously with meteorology. Photolysis, biogenic emissions, and deposition are also calculated "online". To help the planning of daily observational operations during the Texas Air Quality Study 2000 field experiment, the model was run twice a day on multiple 1-way nested meshes of 60 km, 15 km, 5 km, and 1.7 km The 60-km mesh was initialized at 00 Z and 12 Z, respectively, using the Forecast System Laboratory/Rapid Update Cycle (FSL/RUC) analyses. The boundary conditions are provided by NCEP's Eta model forecasts. The chemical fields are initialized with the previous forecast to take into account the accumulation effect. The emission inventory was compiled with databases from EPA and TNRCC (see McKeen *et al.* 2002 and Grell *et al.* 2002).

The configuration of MM5 physics includes the mixed-phase cloud physics (Reisner1), the revised Grell scheme (only for 60 km, 15 km and 5 km meshes), the Burk-Thompson 1.5 order PBL scheme, the FSL/RUC land-surface parameterization, and the MM5 simple short-wave and long-wave radiation parameterization schemes.

3. PRELIMINARY RESULTS

An important indicator of the air quality is surface ozone concentration. In the event of high surface ozone concentration in the Houston area, the large-scale winds are weak, and the transport of ozone and its precursors is driven by local circulations, the most prominent one being the land-sea breeze. Observations have indicated that the re-circulation of ozone and its precursors by the land-sea breeze cycle are associated with the heaviest pollution episodes in the Houston area. Therefore, the first step of this study is to compare the model forecasted evolution of the PBL structure and the land-sea breeze front with wind-profiler measurements.

Figure1 presents the time-height sections of model forecast and wind-profiler observations of the horizontal winds for a 24-h period at southwest Houston (29.54□N, 95.47□W) within the first 4 km above the surface. The land-sea breeze cycle is clearly seen in the forecast (Fig. 1b), while the forecasted time-height distribution of the winds is, in general, smoother than the observations (Fig. 1a). The forecasted near-surface wind shows a clear diurnal cycle that agrees well with the observations although the prevailing direction and magnitude of the forecasted nocturnal low-level jet are different than those shown by the observations. It is also interesting to note that the forecasted day-time mixing layer height (denoted by the circles) agrees well at its peak time with the observations, but its growth rate is greater than that indicated by the observations. The sensitivity of the forecasted land-sea breeze to the model resolution is illustrated in Fig. 2 in which the winds from the model forecast at about 450 m above the surface are compared with the observations. It is seen that as the resolution of the model increases, the forecasted timing of the propagation of the land-sea breeze front is in better agreement with the observations. Moreover, the low-level winds ahead of the land-sea breeze front agree with the observations better when the resolution is higher.

4. CONCLUDING REMARKS

The preliminary results of this study indicate that the forecasted land-sea breeze cycle is in good agreement with the wind-profiler observations, but differences do exist in the wind direction and speed. The forecasted nocturnal flow within the lowest 4 km is smoother than that shown by the observations. The comparison with the observations also shows that the forecast of the low-level winds ahead the sea-breeze front is improved when the model=s resolution increases. As for the PBL structure, the forecasted PBL mixing layer grows faster comparing with the observations although its on-set and maximum height agree very well with the observations. It will be shown at the conference that the skills of meteorological forecasts have a profound impact on the skills of chemical forecasts. The next step of the study will be focused on how to improve the current skills of the coupled weather-chemistry model.

5. REFERENCES

Grell, G. A., S. A. McKeen, J. Michalakes, J.-W. Bao, M. Trainer, and E.-Y. Hsie, 2002: Real-time simultaneous prediction of air pollution and weather during Houston 2000 Field Experiment. *Preprints of the 4th Conference on Atmospheric Chemistry,* AMS, 13-17 January 2002, Orlando, Florida.

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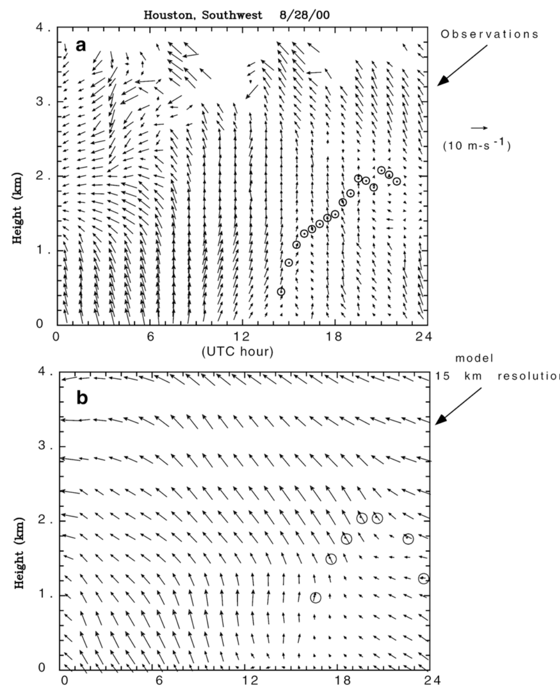

Figure 1. Time-height sections of model forecast and wind-profiler observations of the horizontal winds: (a) observations and (b) forecast. Circles denote the PBL height.

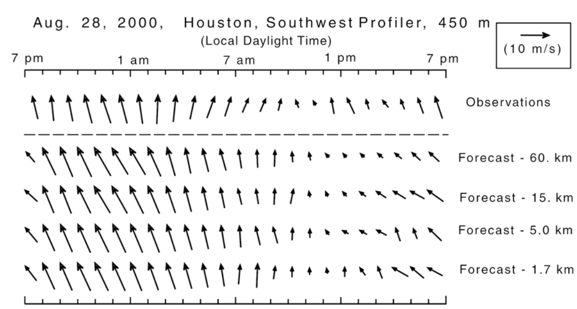

Figure 2. Comparison of the observed horizontal winds at about 450 m above the surface with the forecasts of different horizontal resolutions.