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A case study comparison of 10-km WRFRUC and RUC model forecasts from the IHOP experiment

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1. INTRODUCTION

The goal in development of the Weather Research and Forecast (WRF) modeling system is a non-hydrostatic mesoscale model applicable both to research and operational forecasting. One of the operational applications planned for the WRF model is within the Rapid Update Cycle (RUC) now running at the National Centers for Environmental Prediction (NCEP). The eventual replacement of the current hydrostatic RUC model by a WRF model will result in a WRF-based version of the RUC.

2. IHOP COMPARISONS

Toward this more specific goal of using the WRF within the RUC application, FSL is planning to conduct a comparison of 10-km real-time forecasts from the RUC and WRF models during the latter part of the IHOP (International H_2O Project) field experiment. Both of these models will be run with initial conditions from a developmental 20-km RUC cycle run at FSL, including assimilation of radar reflectivity (Kim et al., 2002, this volume). The intent of this comparison is to conduct an initial assessment of the suitability for replacement of the hydrostatic RUC model with the nonhydrostatic mass-coordinate WRF model in a future version of the Rapid Update Cycle. Accordingly, we designate this model as WRFRUC for this application and set of experiments.

A new version of the Rapid Update Cycle (RUC) was implemented into operations at NCEP on 17 April 2002 (Benjamin et al 2002b). This new version includes a doubling of horizontal resolution (40-km to 20-km), an increased number of computational levels (40 to 50), and improvements in the analysis and model physical parameterizations. A 10-km RUC has already been run successfully for 24-h forecasts during early 2001 and early 2002 over the western U.S. as part of the PACJET experiment. (Weygandt et al. 2002).

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For the spring 2002 IHOP, the 10-km RUC is being run in real-time over the southern Plains (see Fig. 1) to provide operational support for its field operations (Szoke et al. 2002). From these forecasts, a case considered to be representative of the IHOP forecast challenges (evolution of water vapor field, convective initiation, convective rainfall prediction) will be selected for a model intercomparison between the RUC and WRFRUC. Results from this comparison case study will be presented at the conference. The case study will include a detailed examination of successful and unsuccessful aspects of the model forecasts. An investigation will be made to determine specific model or initial condition issues responsible for performance.

3. MODEL CONFIGURATIONS

The RUC and WRFRUC models for these IHOP tests are run on the same 10-km domain over the central United States with a 249 x 241 grid (Fig. 1).

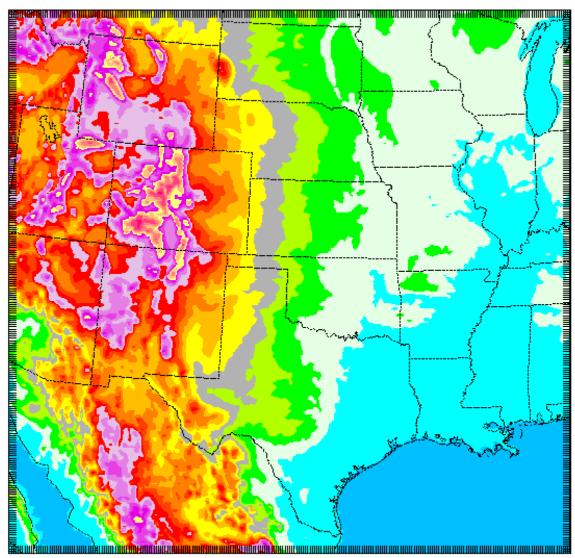

Figure 1. Terrain elevation for 10-km IHOP RUC. Contour interval is 200 m. Terrain elevation for 10-km WRFRUC is similar and covers same domain at same resolution.

Forecast runs out to 36 h are produced every 12 h for IHOP RUC10 and WRFRUC10 runs, using lateral boundary conditions from the FSL development RUC20 runs, also run out to 36 h.

3.1 *RUC10 model*

The RUC model running for IHOP is approximately equal, except for horizontal resolution and domain, to that implemented into operations at NCEP in April 2002 (Benjamin et al., 2002b, this volume). It is run at a 10-km horizontal resolution with 50 isentropic/sigma levels. The model is initialized by remapping the hybrid-coordinate (native) analysis from the RUC20 developmental cycle at FSL to the RUC10 grid, including consistency with the RUC10 topography (Fig. 1). The RUC20 and RUC10 models include the RUC/MM5 mixed-phase cloud microphysics scheme, and the RUC land-surface model (Smirnova et al. 2000) including a 6-level soil model, vegetation, 2-level snow, and treatment of frozen soil processes. They also both use the ensemble-closure convection parameterization developed by Grell and Devenyi (2001,2002).

3.2 *WRFRUC10 model*

The WRF model version used for this experiment is the NCAR mass-coordinate model (Skamarock et al. 2001), run with 35 levels and 10-km horizontal resolution on the same grid as shown in Fig. 1. This WRF model version was modified for two new physics options already present in the operational RUC20 model at NCEP: the RUC land-surface model (Smirnova et al. 2000) and the Grell/Devenyi (2001, 2002) ensemble-closure convective parameterization. Otherwise , the model is the same as in release version 1.2 beta.

The WRF model is initialized by running an advanced version of the WRF Standard Initialization (SI) which accepts RUC20 native data as a source. This source is advantageous in that it includes the GOES/radar cloud/hydrometeor initialization in the RUC20 development runs at FSL, as well as the RUC20 cycled land-surface fields (soil moisture, temperature, snow cover).

The RUC post-processor has been adapted to produce GRIB output files from the WRF in the same format as produced by the RUC. Thus, the RUC post-processing diagnostics for isobaric fields and 2-D fields such as sea-level pressure, tropopause levels, freezing levels, precipitation type, are applied to WRF output data.

3.3 *RUC20 development cycle analysis*

The data assimilation system used to initialize both RUC10 and WRFRUC10 forecasts for IHOP is a RUC national-scale 20-km hourly cycle run at FSL, with assimilation of special observations including a national mesonet collection, GPS precipitable water observations, 915 MHz profilers, and hourly radar reflectivity (Kim et al. 2002). It also includes hourly assimilation of other observations used in the NCEP RUC20, including rawinsondes (also special launches), profilers, VAD wind profiles, aircraft observations, surface observations, satellite cloud-drift winds, satellite precipitable water, and GOES cloud-top pressure (Benjamin et al 2002a).

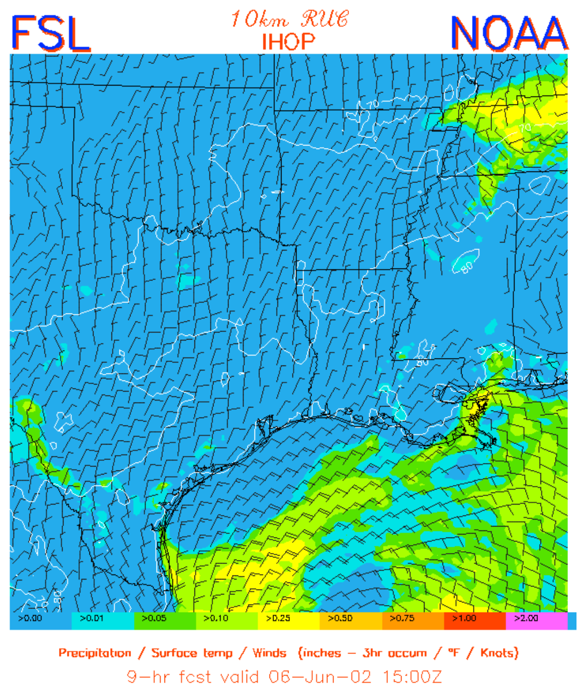

Figure 2. A 9-h forecast of precipitation, surface wind, and temperature from IHOP RUC10 initialized at 0600 UTC 6 June 2002. Precipitation forecast is 3-h total for 1200-1500 UTC.

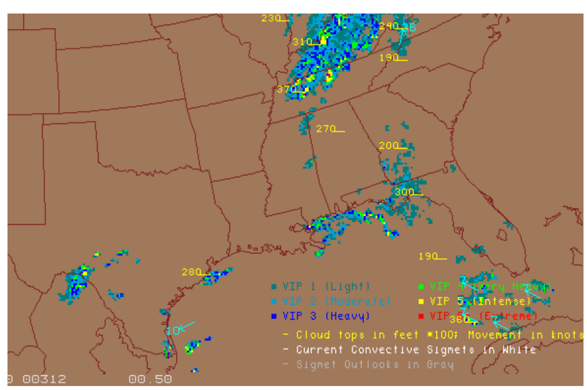

Figure 3. Radar summary valid 1245 UTC 6 June 2002 (from National Weather Service NEXRAD radar coded message data).

4. RESULTS

RUC10 forecasts for IHOP have been running since early May. These runs have shown considerable accuracy for surface wind and precipitation forecasts. An example is shown for a 9-h precipitation forecast (Figs. 2 and 3). In this example, the IHOP RUC10 forecast has accurately forecast the position of convection in western Tennessee and Kentucky, as well as areas of convection on the Mississippi Gulf Coast and in the Rio Grande valley northwest of Del Rio.

As of this writing (6 June), WRFRUC10 runs initialized from the RUC native analysis have been made for a few cases but not yet for real-time cases. Comparisons will be presented at the conference.

5. ACKNOWLEDGMENTS

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