Performance of the FSL RUC-initialized WRF over the CONUS Domain

Tanya G. Smirnova[2], John M. Brown[1], Stanley G. Benjamin[1]

[1] NOAA Research – Forecast Systems Laboratory, Boulder, Colorado
[2] in collaboration with the Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, Boulder, CO

In preparation for replacement of the Rapid Update Cycle (RUC) model by the WRF model in the "Rapid Refresh" (RR) slot at NCEP, the Eulerian Mass version of the WRF model was set up in spring 2003 at FSL to run on the CONUS domain of the operational RUC. The WRF model is initialized from the RUC three-dimensional variational (3DVAR, Devenyi et al. 2004) scheme, and runs in real time with 20-km horizontal resolution to 48-h. At this writing the just-released version 2 of WRF is being set up to run on CONUS with 13-km horizontal resolution, again initialized from a parallel RUC cycle at FSL running on the identical domain. Improved efficiency of WRF Standard Initialization (SI) would allow WRF to run with even higher horizontal resolution over the CONUS in compliance with the current plans to implement the initial operational RR version of WRF at NCEP at a horizontal grid spacing of 8-10 km beginning in 2007.

Of the physics parameterizations provided in WRF as officially supported options, only land-surface parameterization – the RUC Land-Surface Model (LSM, Smirnova et al. 1997, 2000), and shortwave radiation – Dudhia shortwave radiation scheme are identical to the RUC (Dudhia 1989). Other physics options used in WRF at FSL include the Grell-Devenyi convective scheme (Grell and Devenyi 2004), which is an advanced version of the ensemble scheme implemented in RUC. Surface and boundary layer physics follow from the Eta model parameterizations, and the NCEP 5-class scheme is used for microphysics. This difference in configuration affects the performance of RUC LSM in RUC and WRF environments. Also, in version 1 several inconsistencies between the variables in boundary layer and surface physics packages degraded the WRF performance in simulation of the diurnal cycle of temperature and dew point at the surface. For example, erroneous treatment of moisture feedback from the surface caused excessively dry conditions in WRF. These inconsistencies are eliminated in version 2 of the WRF code released in May 2004.

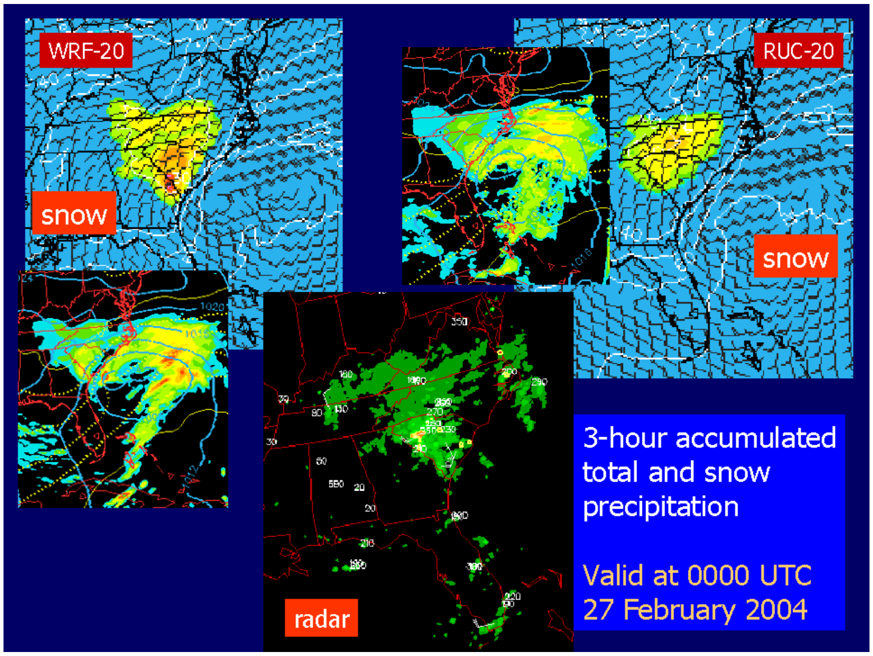

Figure 1. Comparisons of 3-h accumulated total and snow precipitation from 12-h forecasts of 20-km WRF and RUC to 88D radar reflectivity valid at 0000 UTC 27 February 2004.

The performance of the WRF model is routinely compared against the RUC model for such variables as precipitation, cloud, surface wind, temperature and dew point. One clear result of these comparisons is that the WRF runs consistently forecast more precipitation. This is illustrated on Figure 1, which shows a comparison of 3-h accumulated total precipitation and snow precipitation from WRF20-km forecasts and RUC 20-km forecasts for the South Atlantic states. More recent results from similar comparisons will be presented at the WRF Workshop. In addition, WRF and RUC statistics of surface temperature and dew point verification averaged over the CONUS domain will be presented.

Both WRF and RUC with 20-km and 13-km horizontal resolution will provide 48-h forecast grids for the New England High Resolution Temperature Program (NEHRTP). This will give a good opportunity to evaluate and compare the models' performance using the data from a special network of boundary-layer wind profilers and from surface meteorological stations in the New England area. An example of such verification is presented on Figure 2.

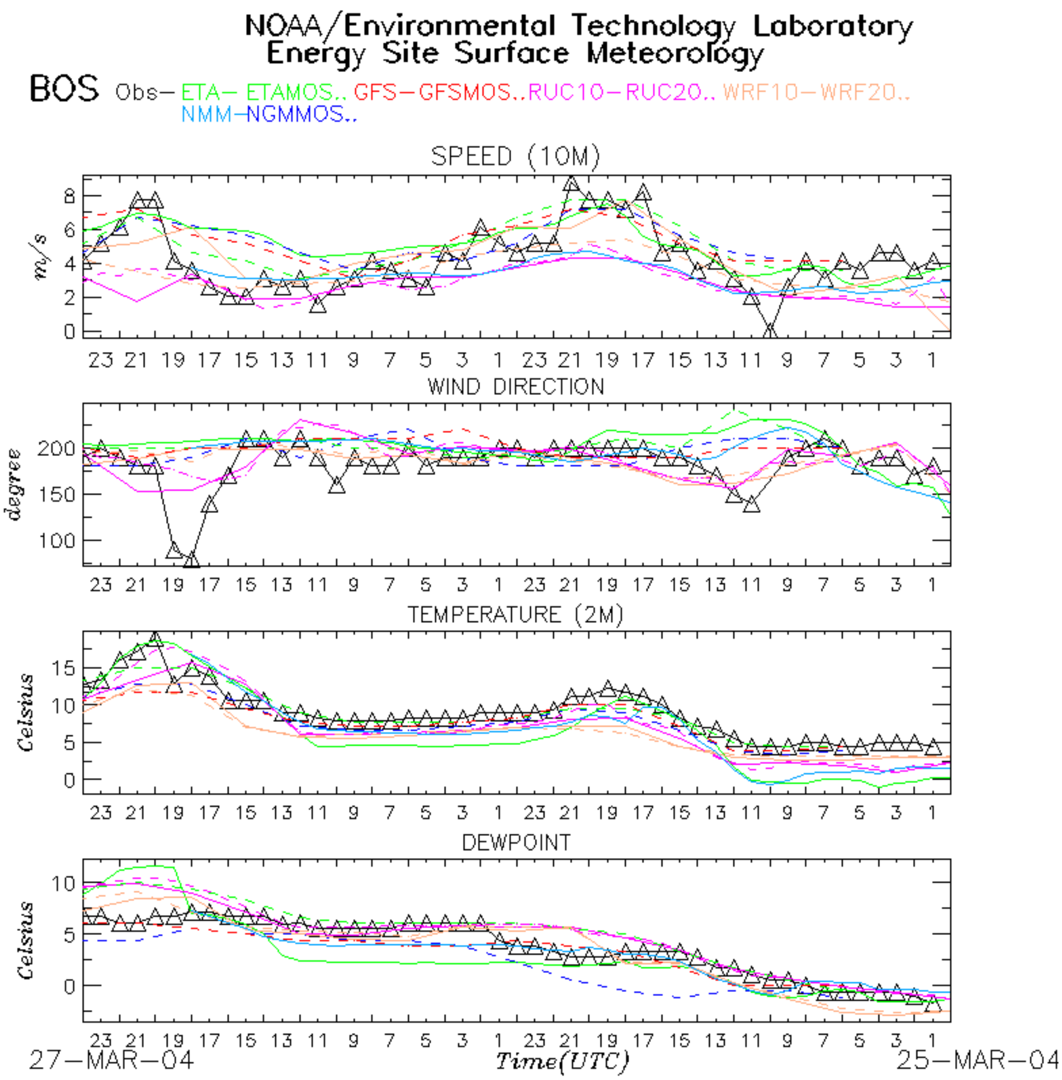

Figure 2. Verification of the diurnal cycles of wind, temperature and dew point for Boston, MA, 25 - 27 March 2004.

Future work in preparation for implementing WRF in RR will include setting up a fully cycling WRF run at FSL, using either the RUC 3DVAR adapted to the WRF vertical grid configuration, or the NCEP Gridded Statistical Interpolation (GSI) procedure modified for the RR frequent-updating application. In addition, evaluation of the time evolution of the noise level in WRF relative to RUC during the first several hours of the forecast indicates higher levels of noise (as measured by the domain average of the time step by time step change in surface pressure) in WRF than in RUC (Fig. 3). This points to the necessity of introducing a digital filter initialization into WRF.

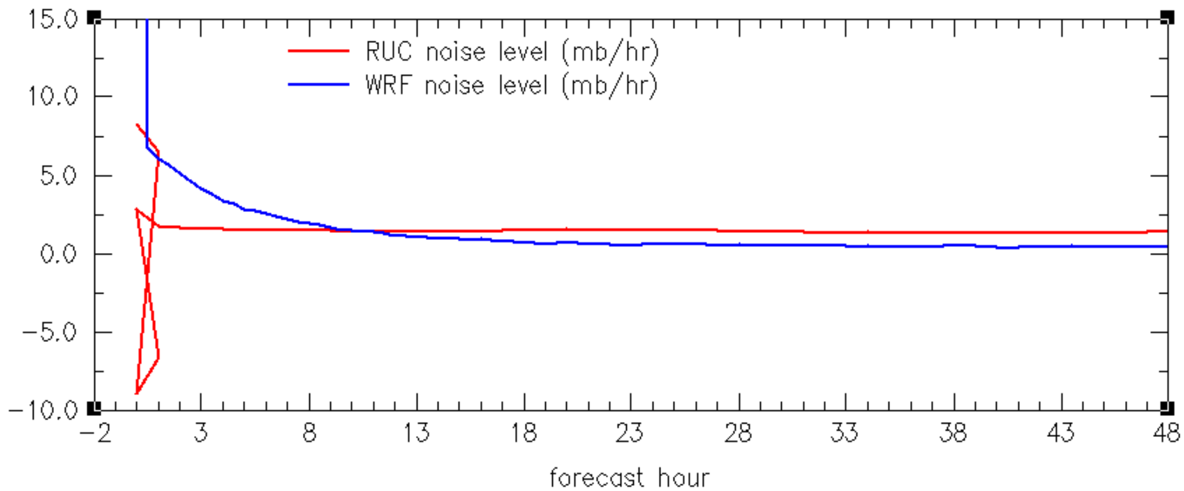

Figure 3. Time evolution of the domain average change in surface pressure (in millibars per hour) obtained from RUC and WRF 48-h forecasts initialized at 1200 UTC 30 March 2004. Note that the RUC reaches an equilibrium value of about 2-3 mb/h by the end of the first hour of the forecast. It takes the WRF without initialization 9h to settle down to this value

References

Devenyi, D., S.G. Benjamin, and S.S. Weygandt, 2004: The RUC 3DVAR: Operational performance and recent improvements. *20th Conf. on Weather Analysis and Forecasting*, Seattle, WA, Amer. Meteor. Soc., CD-ROM, P1.20.

Dudhia, J., 1989: Numerical study of convection observed during the winter monsoon experiment using a mesoscale two-dimensional model. *J. Atmos. Sci.*, **46**, 3077-3107.

Grell, G.A., and D. Devenyi, 2002: A generalized approach to parameterizing convection combining ensemble and data assimilation techniques. *Geophys. Res. Lett.*, **29**, 38-1-4.

Smirnova, T.G., J.M. Brown, and S.G. Benjamin, 1997: Performance of different soil model configurations in simulating ground surface temperature and surface fluxes. *Mon. Wea. Rev.*, **125**, 1870-1884.

Smirnova, T.G., J.M. Brown, S.G. Benjamin, and D. Kim, 2000a: Parameterization of cold season processes in the MAPS land-surface scheme. *J. Geoph. Res,* **105** (D3), 4077-4086.