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Ongoing experiments to improve cloud and precipitation forecasts from the WRF NMM modeling system

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1. INTRODUCTION

Two models within the Weather Research and Forecasting (WRF) system have been producing 48-h forecasts operationally at NCEP since 21 September 2004 in High Resolution Windows, namely the 8-km/60L Nonhydrostatic Mesoscale Model (NMM) and the 10-km/50L Advanced Research WRF (ARW). These HiResWindow forecasts are made over a set of three subdomains within CONUS, in addition to small domains that cover Alaska, Hawaii, and Puerto (see http://www.emc.ncep.noaa.gov/mmb/mmbpll/nestpage/overlays.wrfnmm.jpg). On 28 June 2005, explicit HiResWindow runs without parameterized convection were implemented into operations of the NMM and the ARW at resolutions of 5.8 km/35L and 5.8 km/35L, respectively. Further details are described in this conference by Black *et al*. (2005) and Rogers *et al*. (2005). A week's worth of forecasts are available at http://wwwt.emc.ncep.noaa.gov/mmb/mmbpll/nestpage/.

At NCEP we are currently in transition from version 1.3 of the WRF framework to version 2. Although most of the real-time parallel runs are currently based on version 1.3 codes, almost all of the model developments over recent months have been made with respect to the version 2 infrastructure. A series of sensitivity experiments using version 2 of the WRF NMM (hereafter referred to as NMMv2) will be presented as part of the ongoing effort at the Environmental Modeling Center (EMC) to replace the Eta model with the WRF model as the operational North American Mesoscale (NAM) model. These experiments are designed to gain a better understanding of how physical parameterizations (esp. cloud microphysics, convection, and surface-boundary layer) affect the fidelity of the temperature, moisture, and wind fields, particularly in regions of strong ascent where the potential for rapid destabilization can produce moist absolutely unstable layers (Bryan and Fritsch, 2000). Since the time that the conference abstract was submitted, we have not had time to make much progress on this investigation. Although most of what will be shown is based on early results from model simulations made in March and April, this investigation will resume in the next month or two in preparation for pre-implementation testing of the NMMv2 later this year.

2. RESULTS

A series of 8km/60L WRF NMM runs in the eastern HiResWindow were made using initial and lateral boundary conditions from the 12Z 27 February 2005 NAM. This case was selected because it was associated with a high-profile forecast of heavy snow over the mid Atlantic and New England by the NAM. The forecast track of the storm was too close to the coast, producing bands of precipitation to the north that were much heavier than observed. Unfortunately the WRF NMM forecasts were not much better. It was determined that the primary factor responsible for the missed forecast was due to the initial conditions (ICs). When the model was initialized from the GFS ICs, the forecast track was further off the coast, much improved over the operational NAM and NMM runs. A small low-pressure center was present over the northeast Gulf of Mexico west of Florida in the GFS ICs, which was absent in the Eta.

This case also proved to be a good example for looking at the treatment of moisture, both from a modeling and from a data assimilation perspective. The NAM data assimilation system (NDAS) starts 12 h prior to the initial forecast time, and analysis updates are applied at 3-h intervals. Since this same approach will be adopted when the WRF NMM becomes the NAM next year, we decided to look more closely at the 3-h forecasts of moisture, clouds, and precipitation from the 8-km WRF NMM. Figure 1 shows the relative humidity with respect to water at a particular model level, in

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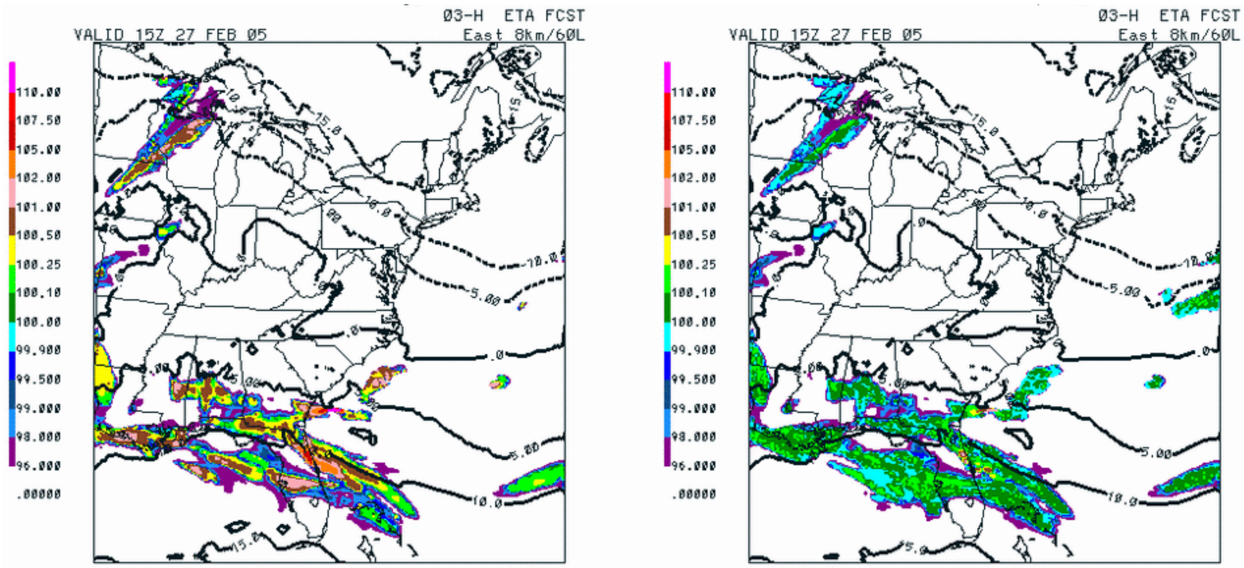

Figure 1. Three-hour forecasts valid at 2005022715 of relative humidity with respect to water (color fill) and temperature (contour lines at 5°C intervals, supercooled temperatures are dashed) from the operational WRF NMM (left) and the run with physics called more frequently (right). The fields are associated the model level 37, which corresponds roughly to the 800-700 hPa layer.

which there are no limits applied to the posted relative humidity (they are normally bounded to be within a range of 1% to 100%). Because the 8-km NMM calls physics (MYJ PBL, BMJ convection, and Ferrier microphysics) once every 3 min, or once every 10 model time steps (18 s), supersaturations with respect to water can form as a result of cloud microphysical updates occurring less frequently than the fundamental advection time step (Fig. 1, left panel). The largest supersaturations, which are in excess of 5%, occur in areas of ascent exceeding 25 cm s^{-1}. (not shown). Increasing the frequency of the physics calls to match the frequency that moisture is advected (once every other time step, or 36 s) substantially improves the prediction of in-cloud relative humidity (Fig. 1, right panel).

A strategy will be employed in which cloud condensation and vapor deposition from the microphysics will be calculated at the same frequency that moisture variables are advected in the model.

3. REFERENCES

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