14.1 NCEP's NONHYDROSTATIC MESOSCALE MODEL: FORECAST GUIDANCE AND TRANSITION TO WRF

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1. INTRODUCTION

Forecasts of NCEP's Nonhydrostatic Mesoscale Model (Janjić, 2002; Janjić et al., 2001) or NMM are running daily over six subdomains nested within the operational 12 km Eta Model. The Eta provides the boundary conditions as well as the initial conditions for the nests since the NMM does not yet have its own data assimilation system. Three of these nests cover the western, central, and eastern parts of the CONUS. Another domain covers Alaska and two smaller ones cover Hawaii and Puerto Rico. Each subdomain uses 8 km gridpoint spacing except Alaska's which uses 10 km. All the nests have 60 layers in the vertical. The start times are: Alaska at 0000 UTC, the western CONUS nest at 0600 UTC, the central nest at 1200 UTC, the eastern nest at 1800 UTC, the Hawaiian nest at 0000 and 1200 UTC, and the Puerto Rican nest at 0600 and 1800 UTC. A full complement of graphics of the daily NMM runs alongside those of the Eta Model and the NCEP runs of the WRF Eulerian Mass (EM) model can be found at http://wwwt.emc.ncep.noaa.gov/mmb/mmbpll/nestpage/. With its higher spatial resolution, the NMM is expected to augment the guidance of the Eta Model in describing finer scale features and circulations. Examples of this enhanced detail are shown below.

NCEP embraces the notion of a common modeling infrastructure that can be shared between operational centers and the research community because it will significantly speed the exchange of model codes and their improvements among all users who participate. A fundamental reason for the creation of the Weather Research and Forecast system (WRF) was to provide this opportunity (http://www.wrf-model.org). The NMM dynamic core and its physics packages have been placed within the WRF infrastructure and it is undergoing early testing in that form. NCEP's immediate plans regarding the NMM in WRF are described below.

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2. EXAMPLE OF NMM GUIDANCE

The NMM is being developed to give the forecasters detailed guidance that is as valuable as possible to them as the horizontal resolution of operational numerical models continues to increase and the gridpoint spacing moves below 10 km. On a daily basis the differences between the Eta and NMM forecasts on the synoptic scale are relatively small. Even at the mesoscale the differences in details of the forecasts can be small. However with a horizontal resolution 1/3 finer than the Eta Model and with many algorithms that were incorporated into it with the goal of improving upon those in the Eta, the NMM is demonstrating that it can provide additional skill in describing specific fine scale details in its forecasts.

Figure 1 shows observed and 42-hour forecast 10-meter wind fields for the Eta and NMM over Arizona where vector lengths are proportional to wind speed. Since topographic forcing plays a major role in circulations in the western U.S., especially in the lower levels, the accuracy of a model's description of that topography is very important and higher spatial resolution in both the horizontal and vertical is naturally necessary for more orographic detail. This case involves very weak synoptic forcing which can often provide a greater challenge to numerical models' ability to predict small scale details accurately than do those with strong synoptic forcing. While much of the low level flow is similar between the two models' forecasts in Fig. 1, numerous differences are also present. The three green circles highlight observation locations where the wind direction in the NMM is notably better than in the Eta while the red circle shows a location where the direction is somewhat worse.

In order to see more details of the types of improvements seen in the NMM predictions, Figures 2 and 3 show meteograms for the 42 hours from the forecast start time for the Eta and NMM respectively at the Winslow, AZ site. The top panels show the 2-m temperature traces where some improvement is seen from the NMM. The bottom two panels in each figure consist of the wind observations and the forecast winds. The observations indicate a general diurnal oscillation with very light southeasterly winds between 1100 UTC and 1800 UTC 26 Sep 2003 followed by a switch to light northerly winds until about 0200 UTC 27 Sep. Southerly and southeasterly winds return for several hours after 1100 UTC 27 Sep with northerly winds again appearing near the end of the period. The Eta 10-m winds remain northerly or northwesterly throughout the entire forecast period with only a hint of the oscillation visible. In contrast the NMM forecast winds clearly portray regular wind shifts at approximately the correct times. During the times of observed southeasterly winds, the NMM's are generally from the south southwest. The NMM's wind speeds are often too low over mountainous areas and this is seen in both Fig. 1 and Fig. 3. Modifications to address this low bias as well as various other refinements are ready and waiting for incorporation into the model. During the NMM's conversion to WRF, its code has been frozen and no changes have been allowed to be made.

3. NMM IN WRF

Currently the NMM runs in the so-called Hi-Res Window forecast slot in the operational suite at NCEP. Plans call for this slot to be the first to transition to WRF in operations. Specifically an ensemble of WRF runs will comprise the new Hi-Res Window which is to become operational in Fall 2004. There will be equal numbers of NMM members and EM members. Given the demands on the current NCEP computing system, the number of ensemble members will have to be reduced when the operational runs of GFDL's hurricane model are executing due to the latter's having the highest priority access to system resources. In the worst case there will be a single member each of the NMM and EM in the ensemble.

The NMM dynamic core has been placed into the WRF infrastructure and its physics modules have been translated to the requisite WRF form. The forecasts of the NMM in WRF cannot be identical to those from the NMM production runs due to several relatively minor differences. The differences that are being seen in the forecasts are considered to be acceptably small. At the time of this writing changes are being made to decrease the clocktime of the NMM WRF on the NCEP systems due to the time restrictions in place for all operational runs.

4. SUMMARY

Forecasts from daily runs of the NMM indicate the model's potential for providing improved accuracy in the description of details of mesoscale circulations. Development of the model continues in order to provide forecasters with the most useful guidance possible at all relevant scales. The NMM has now been incorporated into the WRF infrastructure as a prelude to the Hi-Res Window forecast slot being the first to transition to WRF in NCEP operations. That slot will consist of an ensemble of runs produced by both the NMM and the Eulerian Mass model developed at NCAR.

REFERENCES

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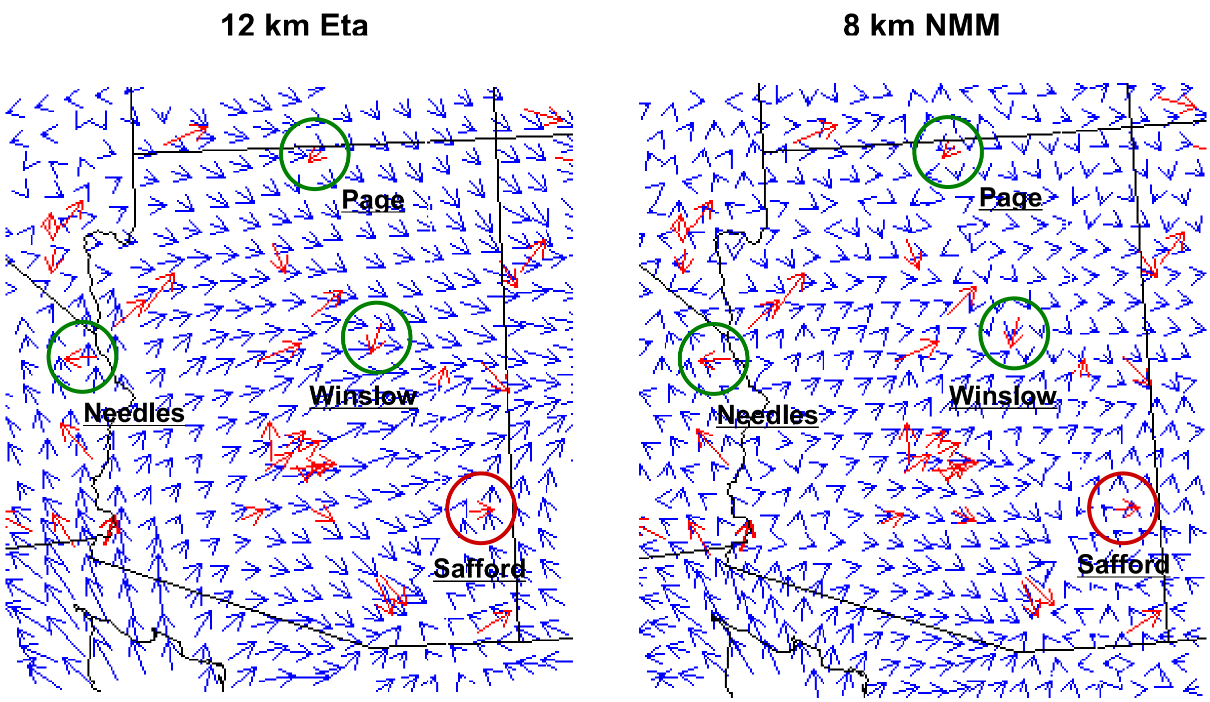

Fig.1 Observed (red) and 42-hour forecast (blue) 10-m winds valid at 0000 UTC 28 Sep 2003.

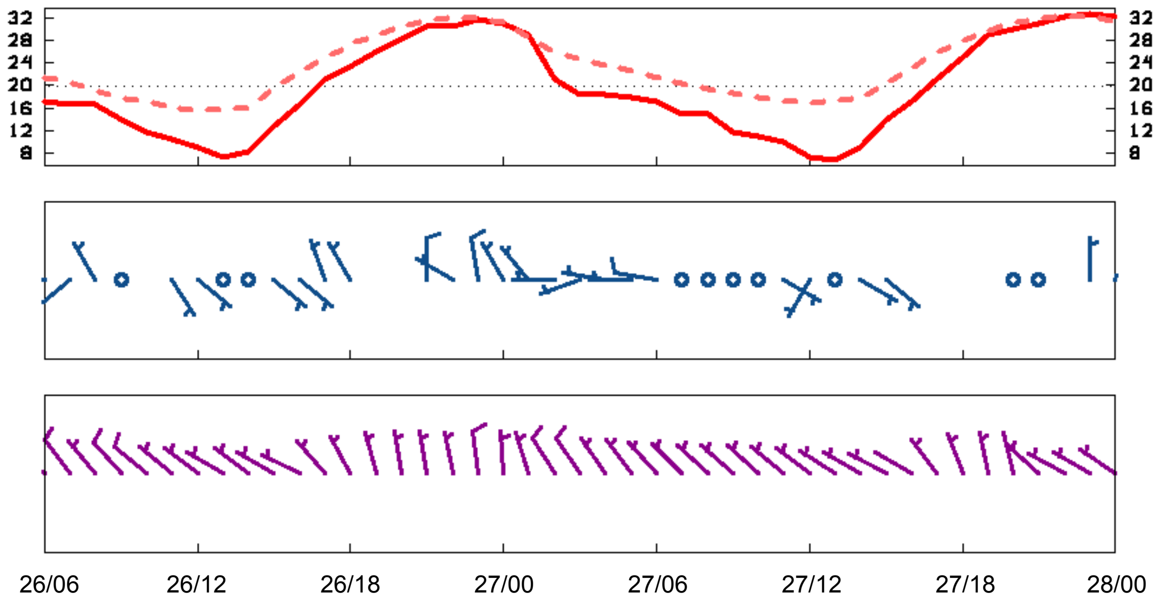

Fig. 2. Eta meteogram from 0600 UTC 26 Sep 2003 to 0000 UTC 28 Sep 2003. Top trace shows 2-m temperature (C) (observed solid; forecast dashed). Center trace shows observed 10-m winds (knots). Bottom trace shows forecast 10-m winds.

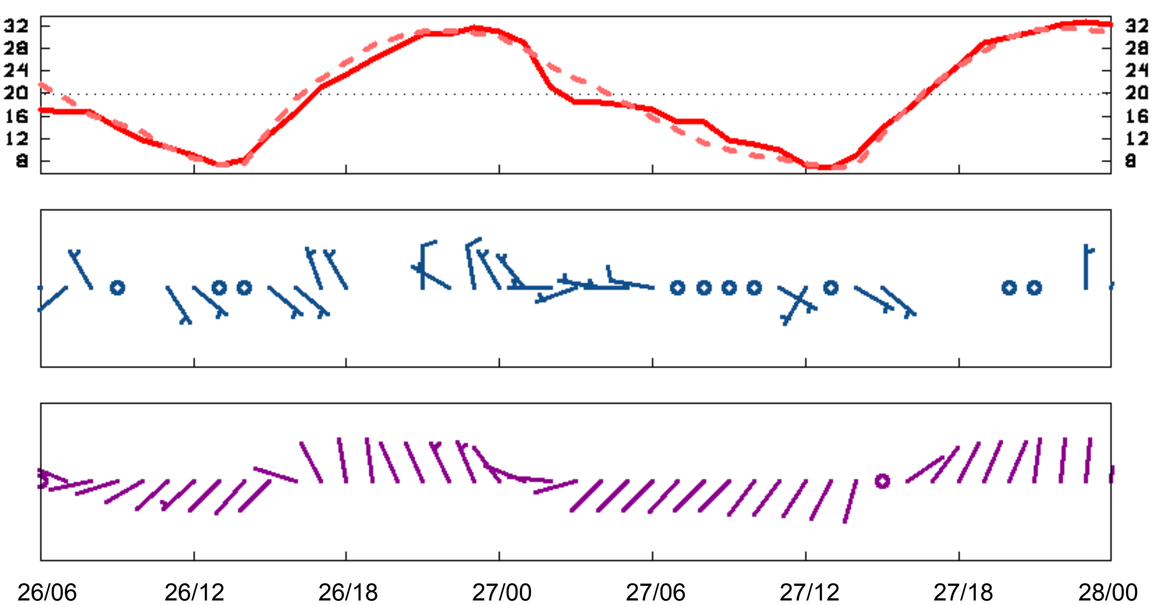

Fig. 3. Same as Fig. 2 except for NMM.