Geophysical Research Abstracts, Vol. 7, 05548, 2005
SRef-ID: 1607-7962/gra/EGU05-A-05548

Hazardous weather prediction using the WRF NMM

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The Nonhydrostatic Mesoscale Model (NMM) has been developed at NCEP within the WRF effort building on NWP experience. In very high-resolution tests the model successfully reproduced the classical two-dimensional nonhydrostatic solutions. The model dynamics demonstrated the ability to develop the observed –3 and –5/3 spectral slopes that are not induced by computational noise. In a decaying turbulence case on the cloud scales, the model dynamics developed the –5/3 spectrum consistent with the 3D turbulence theory. The computational efficiency of the model has been very high, and significantly higher than the computational efficiency of most nonhydrostatic models. The NMM dynamics is one of the two currently existing model cores within the Weather Research and Forecasting Model (WRF) infrastructure.

The NMM has been run operationally in NCEP High Resolution windows in six nested domains (West, Central, East, Alaska, Hawaii, Puerto Rico). The horizontal resolution is 8 km for all domains. The model has 60 unequally spaced levels in the vertical. The forecasts are computed up to 48 hours. In addition, the model is used for fire weather forecasting and other purposes on call. In terms of performance, statistical scores and numerous examples indicate that the NMM adds value to the forecasts of the driving regional model. This applies particularly to the details of flow over complex terrain.

In addition to operational forecasting the model has been tested in many case studies and several validation campaigns. The NMM model demonstrated the ability to predict tropical storms realistically, and efforts are under way to implement it as the Hurricane WRF. However, particularly interesting results were obtained in a carefully controlled field experiment (Weiss et al., 2004) in which the model was run at near-cloud resolving resolution of 4.5 km without parameterized convection. The model demonstrated the ability to spin-up severe convective systems more frequently, and with stronger signal, than if this was happening only by chance. This was reflected in

the verification scores (Weiss et al., 2004) that showed that the NMM with near-cloud resolving resolution for the first time clearly outperformed the forecasts of the NCEP mesoscale Eta model with parameterized convection. This result also suggests that further improvements in deterministic forecasting of severe weather phenomena may be achieved with increased resolution.

Weiss, S. J., J. S. Kain, J. J. Levit, M. E. Baldwin, and D. R. Bright, 2004: Examination of several different versions of the WRF model for the prediction of severe convective weather: The SPC/NSSL Spring Program 2004. Extended abstract, 22nd Conference on Severe Local Storms, AMS, 3-8 October 2004, Hyannis, MA. http://ams.confex.com/ams/pdfpapers/82052.pdf