The Promise and Challenge of Explicit Convective Forecasting with the WRF Model

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1. Introduction

Convective weather remains a significant challenge for numerical weather prediction systems, and is recognized as a major contributor to poor warm season quantitative precipitation forecasting (QPF). During the recent Bow Echo and MCV Experiment (BAMEX; Davis et al., 2004), 36h realtime forecasts were conducted daily with the NCAR version 1.3 of WRF, using a 4 km horizontal grid resolution and explicit convection over the central US (2000x2000 km). In the vertical, 35 levels were specified, spaced roughly 250 m apart in the lowest km with monotonic stretching to about 1 km spacing near and above 14 km. The model top was at 50 hPa. The basic physics packages included the Yonsai University (YSU) boundary layer scheme (Noh et al. 2001), the Oregon State University (OSU) land surface model (Chen and Dudhia 2001), and the Lin Microphysics scheme (derived from the original scheme described in Lin et al. 1983). The model was initialized at 00 UTC using the 40 km ETA analysis, with the boundary conditions updated on a 3 hourly interval using the ETA model forecasts. Output was generally available by 8:00 AM each morning. These 4 km forecasts were also compared to equivalent 10 km WRF forecasts as well as to other operational models, which all employed convective parameterization. An updated version of the Kain-Fritsch convection scheme (Kain 2004) was included in the 10 km WRF runs.

2. Results

We found that the 4km simulations did a surprisingly good job at forecasting timing, location, and number of significant convective systems, and did a much better job at predicting convective system mode and propagational characteristics, as compared to the coarser resolution simulations. Examples of some of the better forecasts are presented in Figs. 1 and 2, which depict the ability of WRF to predict an intense bow echo system over Iowa and Nebraska 30 h in advance, as well as a line of supercells over Illinois 23 h in advance. These improvements in convective forecast guidance were found to be extremely useful for operations planning each day, and were also highly praised by NWS forecasters, who used the WRF output for their daily severe weather outlooks. Challenges remain, however, as the 4 km simulations did not show corresponding improvements in overall QPF. The 4 km and 10 km WRF forecasts for the BAMEX experiment along with radar images can be found at http://www.joss.ucar.edu/bamex/catalog/. Further discussion of these BAMEX simulation results can be found in Done et. al. (2004).

Based on last year's experience and success, we are again running explicit convective forecasts this spring and summer in collaboration with the Storm Prediction Center, CAPS, and NWS forecasters, using the updated version 2.0 of the WRF code, and covering even a larger region of the US. The daily WRF forecasts for this year's real-time experiment, which extends from May 1 through July 31, can be viewed at http://rain.mmm.ucar.edu/mm5/, and are also being archived at http://www.joss.ucar.edu/wrf-2004/catalog/. Results from an NWS forecaster's questionnaire can also be viewed at the above JOSS site. Comparisons between the NCAR WRF simulations, a CAPS WRF simulation using an advanced data assimilation system (ADAS), and the NCEP NMM WRF core are also available for this year's experiment from roughly May 1 through June 4, and can be viewed at
http://www.nssl.noaa.gov/etakf/compare/wrf/

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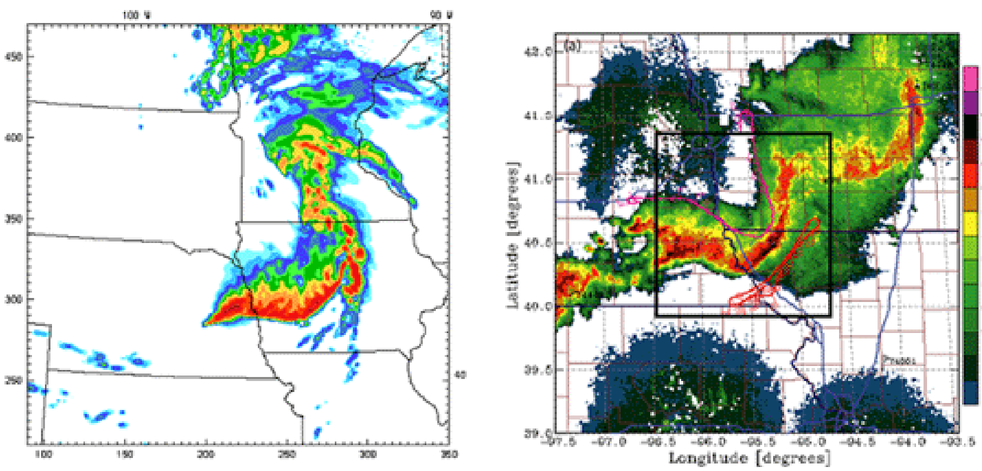

Fig. 1: 30h WRF forecast (left) and NEXRAD radar observations (right) of maximum reflectivity for June 10, 2003 at 06 UTC, during the BAMEX field program

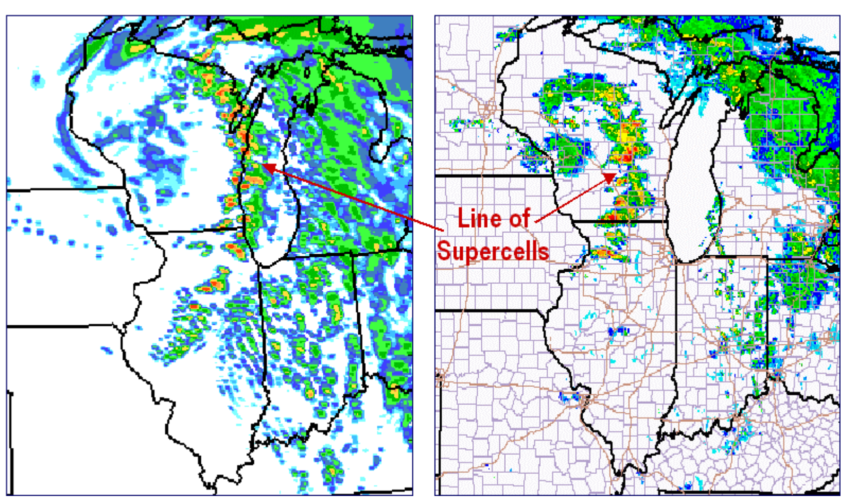

Fig. 2: 23h WRF forecast (left) and NEXRAD radar composite (right) of the maximum reflectivity for May 30, 2003 at 23 UTC, during the BAMEX field program