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MESOSCALE ENSEMBLE PREDICTION OF WINTER PRECIPITATION IN A SEVERE WINTER STORM

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1. INTRODUCTION

Forecasting of winter precipitation remains a challenging problem. Diagnosing the onset and duration of precipitation, as well as precipitation type and amount, is complicated by uncertainty in cyclone track and in the evolving local thermodynamic environment. Models utilizing high vertical and horizontal resolution offer much detail and realistic precipitation structures. However, uncertainty in model physics and initial data complicate the forecast problem. In cool-season forecasting, the result may be incorrect placement and timing of the mesoscale regions of mixed precipitation and of heavy snowfall and blizzard conditions.

Researchers at the University of Illinois Department of Atmospheric Sciences (DAS) and forecasters at the National Weather Service Forecast Office in Lincoln, IL (ILX) have undertaken a collaborative research effort to better understand and improve forecasting of Midwest cool-season precipitation. New diagnostic products are being developed to allow thorough interrogation of model output for prediction of winter precipitation onset, duration, type and amount. In addition, uncertainties in initial data and physical parameterizations are addressed through local ensemble modeling efforts. As part of a COMET Partners Project, new forecasting tools and techniques will be developed, shared and evaluated by DAS and ILX personnel, and utilized in ILX operations in the winter of 2002-2003. In this paper, preliminary tools are applied to a significant winter storm which struck the Midwest in January, 2002.

2. METHODOLOGY

In support of this collaborative research study, an ensemble of high-resolution numerical models is run daily at the University of Illinois Department of Atmospheric Sciences. The ensemble consists of the Penn. State/NCAR mesoscale model (MM5; Grell et al. 1995), the Weather Research and Forecasting model (WRF; Michalakes et al. 2001), the NCEP workstation Eta (e.g. Gallus 1999), and the NCEP Regional Spectral Model (Juang et al. 1997). The MM5, WRF and workstation Eta are currently initialized with NCEP operational Eta analyses. The RSM, and a second run of the Eta, use the NCEP Aviation model initial fields. All simulations are run for 36 hours from 0000 UTC, for an approximately 10-state region covering much of the Midwest. The MM5 simulations utilize nested grids; the Eta, RSM and WRF runs do not. Nesting capability is expected for WRF in 3-9 months.

In addition to the multi-model (and, for the Eta, multi-analysis) components of the ensemble, model physics perturbations are also incorporated. Our MM5 forecasts make use of two planetary boundary layer (PBL) and two cumulus parameterization (CUPA) schemes. The result is a suite of eight high-resolution simulations run daily[3] on local workstations (Table 1). Model data is being utilized for traditional and new diagnostic tools for cool-season forecasting, developed and evaluated at the Atmospheric Sciences Department and the Lincoln, IL National Weather Service.

Table 1: Ensemble Member Composition

Run	Model	Physics	Init.	Grid
1	MM5	Blackadar, Grell	Eta	12 km
2	MM5	Blackadar, KF	Eta	12
3	MM5	MY, Grell	Eta	12
4	MM5	MY, KF	Eta	12
5	Eta	MY, BMJ	Eta	12
6	Eta	MY, BMJ	Avn	12
7	RSM	Kanamitsu, Kuo	Avn	25
8	WRF	Hong-Pan, NCEP	Eta	25

KF: Kain-Fritsch CUPA *Kuo: Anthes-Kuo PBL*
MY: Mellor-Yamada PBL *NCEP: 3-class ice*
Kanamitsu PBL: 1989 WAF ***B**etts-**M**iller-**J**anjic: CUPA*

3. CASE DESCRIPTION

Work is underway to apply the ensemble modeling results to a significant winter storm which struck parts of the Plains, Midwest and Great Lakes from January 29-

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31, 2002. 6-18" of snow and up to 3" of ice affected these areas, leaving hundreds of thousands of homes and businesses without power (CIMSS, NWS reports, 2002). Application of a simple precipitation-type algorithm to regional model simulations made during the event predicted the evolution of significant snowfall, as well as a narrow northeast-southwest band of mixed precipitation from northern Illinois into Michigan (Fig. 1).

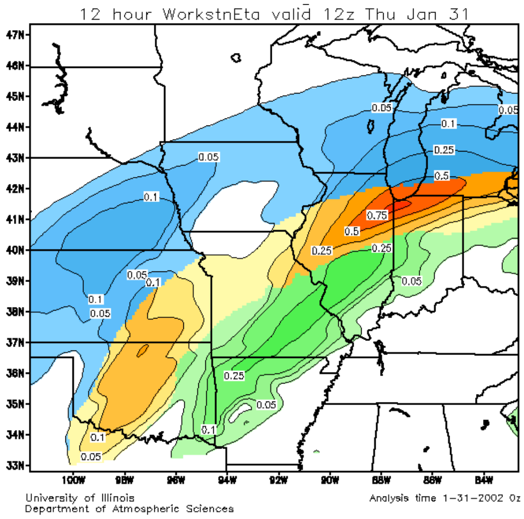

Fig. 1: 12-km workstation Eta precipitation type (coloring) and amount (contours/shading).

Differences in cyclone structure, intensity and associated precipitation distribution were also noted (Fig. 2). Examples of individual and ensemble prediction products from the suite of model simulations, the verification of these products, and operational forecasts will be presented at the Conference.

4. ACKNOWLEDGEMENTS

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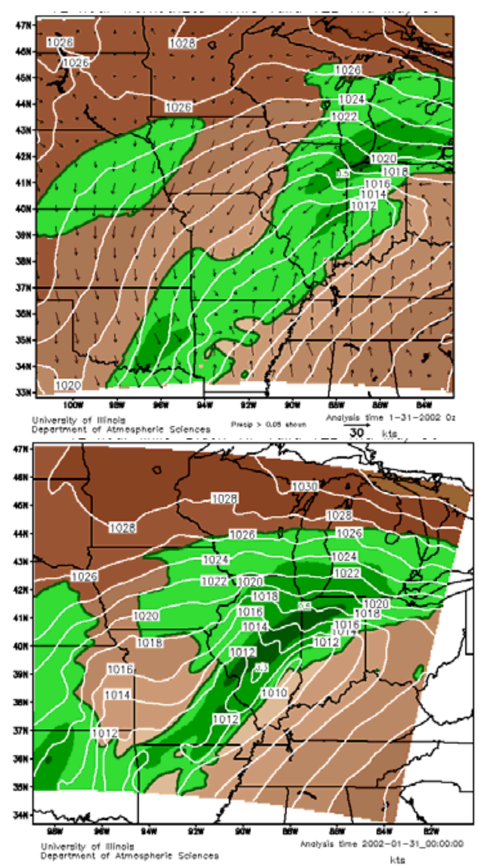

Fig. 2: 12-km workstation Eta (top) and MM5 (bottom) forecasts of MSL pressure (contours) and 12h precipitation (shading) valid 1200 UTC 31 Jan.