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THE UTILITY OF SHORT-RANGE ENSEMBLE FORECASTS IN THE REAL-TIME PREDICTION OF SEVERE CONVECTIVE WEATHER AT THE STORM PREDICTION CENTER

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1. INTRODUCTION

A collaborative experiment aimed at developing, testing, and evaluating the operational utility of short-range ensemble forecasts (SREFs) as guidance for the prediction of severe convective weather was conducted as part of the 2003 annual Spring Program at the Storm Prediction Center (SPC) and National Severe Storms Laboratory (NSSL). Additional participants included the Cooperative Institute for Mesoscale Meteorological Studies (CIMMS), as well as scientists and forecasters from other government and academic institutions. A primary goal of the Spring Program is to facilitate interaction between researchers and forecasters by conducting a multi-week experiment in severe convective forecasting. Kain et al. (2003) describe the objectives of the SPC/NSSL Spring Program as well as its tangible and intangible benefits to both operations and research.

2. THE 2003 SPRING PROGRAM

The 2003 Spring Program was conducted from 14 April through 6 June. One of the primary objectives of the 2003 Spring Program was to conduct a forecast experiment designed to evaluate SREFs and their usefulness in the prediction of severe convective weather. An advantage of the SPC/NSSL Spring Program is that positive results are migrated immediately into SPC real-time operations. Additional information on the 2003 Spring Program, including the operations plan, can be found at *http://www.spc.noaa.gov/exper/Spring_2003*.

2.1. *The NCEP EMC and NSSL Adjoint SREF Systems*

The National Centers for Environmental Prediction (NCEP) Environmental Modeling Center (EMC) SREF system was evaluated during the Spring Program. The current EMC SREF consists of 15 members and is designed to account for both initial condition and model uncertainty (Du and Tracton 2001). The SPC also evaluated EMC's new, experimental SREF which includes additional model physics diversity and a decrease in horizontal grid separation from 48 km to 32 km.

A second SREF available for the Spring Program was developed at the NSSL and executed daily on the University of Oklahoma supercomputer. This 32 member SREF employed only a single version of NCAR's MM5 (i.e., no model physics diversity); however, initial perturbations were constructed via forecaster determined regions of uncertainty and the MM5 adjoint. Using a WEB-based interface, 16 parameters of concern were identified during the forecast period, allowing the MM5 adjoint to produce reasonably scaled perturbations in the initial conditions sensitive to the forecaster diagnosed

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uncertainty. For details concerning this approach see Xu et al. (2001).

2.2 *The Experimental Forecast Exercise and Evaluation*

Both the MM5 and EMC ensembles were available to forecast teams via the meteorological display and interrogation system used in SPC real-time operations (known as N-AWIPS, or the National-center Advanced Weather Interactive Processing System). Statistical (e.g., mean, spread), probabilistic, and individual member fields were available via NAWIPS. Fig. 1 shows the basic meteorological and ensemble fields available in real-time during the experiment. Because the forecast is for severe convective weather, parameters concerning instability and shear are emphasized. Just about any derived ensemble product could be calculated through on-demand interrogation of the ensemble database via a simple GUI.

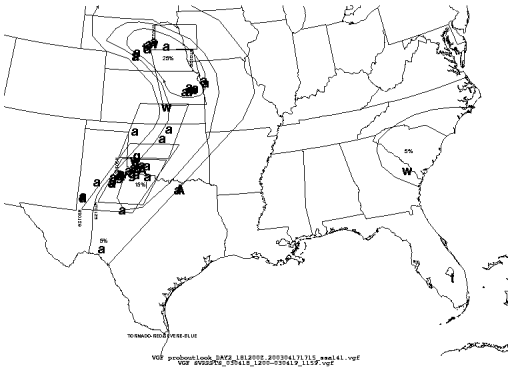
Every day during the experiment, forecast teams issued two Day 2 (i.e., 12 UTC to 12 UTC tomorrow) probabilistic outlooks of severe convection. During the late morning, the initial outlook was constructed based on a "traditional" approach using all available models except the ensemble forecasts (Fig. 2a). During the afternoon, forecasters examined exclusively the EMC SREF and MM5 SREF (forecasters produced perturbations during the morning). An updated probabilistic outlook of severe convection was issued during the late afternoon based on the additional ensemble information (Fig. 2b). In the example in Fig. 2, the area delineated by the 15% probability contours over the central U.S. was divided into two regions. Fig. 3 simply shows an example of output from the EMC SREF and MM5 SREF.

3. SUMMARY

Evaluation of the Spring Program forecasts is both statistical and feature based. Results of the experiment are not yet available, but preliminary statistical results and feature-based examples will be presented. A rigorous, quantitative comparison of the MM5 adjoint SREF will be conducted as a separate project.

Figure 1. All meteorological fields (top panel) and possible ensemble manipulations (bottom panel) available to forecasters during the 2003 Spring Program.

(a)



(b)

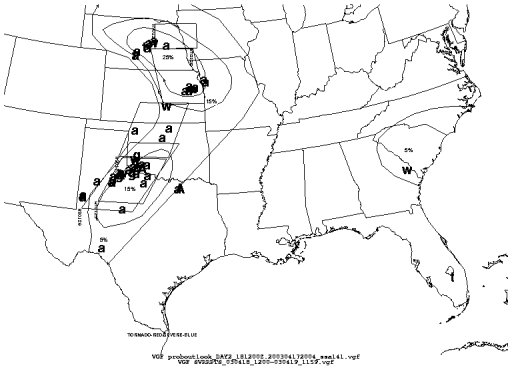
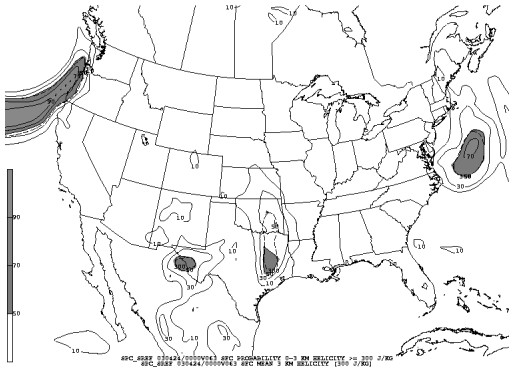


Figure 2. (a) The preliminary Day 2 severe weather probabilistic outlook based on deterministic model analysis, and (b) the modified Day 2 probabilistic outlook after incorporating the EMC SREF and NSSL MM5 SREF into the forecast process. These outlooks were issued 18 April 2003. Incorporation of the ensemble information led to a split in the 15% area over the central United States (contour intervals drawn at 5%, 15%, and 25% and reflect the probability of severe weather within 25 miles of a point). Verifying reports (a=hail; w=wind; t=tornado) and severe weather watches are overlaid.

(a)



(b)

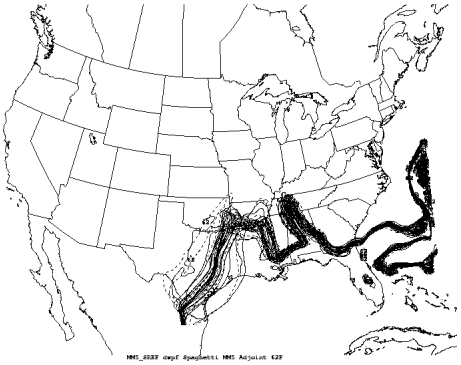


Figure 3. Examples of ensemble output in NAWIPS. (a) The probability of storm-relative helicity exceeding 300 m^2s^{-2} using the 15 member EMC SREF. Contour interval is 20% and shading begins at 50%. (b) A spaghetti plot of 62 F near-surface dew point from the 32 member MM5 adjoint ensemble.

4. REFERENCES

Du, J., and M. S. Tracton, 2001: Implementation of a real-time short range ensemble forecasting system at NCEP: An update. Preprints, *Ninth Conf. On Mesoscale Processes*, Fort Lauderdale, FL, Amer. Meteor. Soc., 355-356.

Kain, J. S., P. R. Janish, S. J. Weiss, M. E. Baldwin, R. S. Schneider, and H. E. Brooks, 2003: Collaboration between forecasters and research scientists at the NSSL and SPC: The Spring Program. Submitted to *Bull. Amer. Meteor. Soc*.

Xu, M., D. J. Stensrud, J-W Bao, and T. T. Warner, 2001: Applications of the adjoint technique to short-range ensemble forecasting of mesoscale convective systems. *Mon. Wea. Rev.*, **129**, 1395-1418.