JP2.2 NCEP SHORT-RANGE ENSEMBLE FORECAST OF THE 6–7 JANUARY 2002 NORTHEAST SNOWSTORM: ROLE OF INITIAL CONDITIONS

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1. INTRODUCTION

As part of the suite of training materials on Numerical Weather Prediction (NWP), the Cooperative Program for Operational Meteorology, Education and Training (COMET) has developed a series of small cases illustrating intelligent use of NWP products in the forecasting process. Discussion of the philosophy and methodology for development of these cases can be found in a separate presentation at this conference (see references). The subject case presents training on using a new model forecast tool developed at the National Centers for Environmental Prediction (NCEP); the short-range ensemble forecast (SREF) system.

2. DISCUSSION OF WINTER WEATHER EVENT

The case represented a failure of the SREF forecast to predict a heavy snowfall in interior PA. Total snowfall amounts are shown in Figure 1 (after NWS WFO State College, PA graphic). Water equivalents in central PA

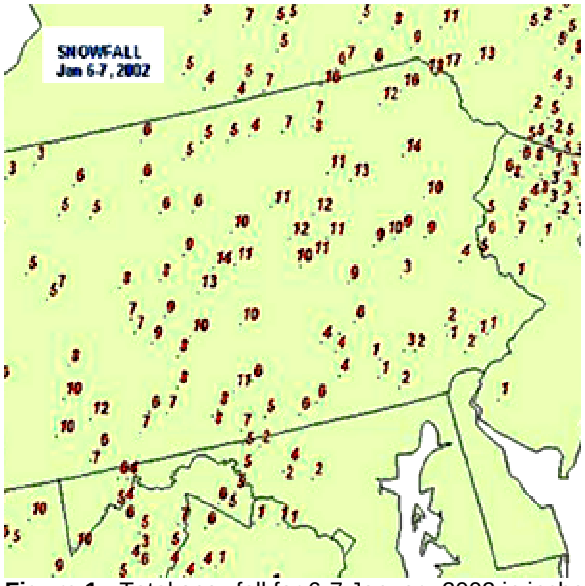

Figure 1: Total snowfall for 6-7 January 2002 in inches.

exceeded 1 inch. Until the morning of 6 January, the operational models **and** the SREF were all indicating low probabilities for heavy snowfall in the area where the maximum snowfall actually occurred. No winter storm watches were issued, and winter storm warnings did not go out in central PA until a few hours before the heavy snow began.

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3. TRAINING ON INTERPRETATION AND USE OF ENSEMBLE FORECASTS

3.1 NWP operational and ensemble forecasts for 6-7 January 2002 over central PA.

An overview of the operational forecasts from 00, 06, and 12Z 6 January, and SREF forecasts from 09Z and 21Z of 5 January and 09Z 6 January is presented first, concentrating on forecasts of surface pressure, precipitation, and precipitation type. Spaghetti diagrams are used to illustrate the use of ensemble tools. We used animated graphics with control widgets throughout, so that both the forecast evolution and specific frames could be examined in detail.

It can be seen in the case graphics (not shown) that the operational and ensemble forecasts (especially the AVN and the ensemble means) were slowly being nudged toward the correct solution over consecutive forecast cycles. In fact, by 12z 6 January 2002, the operational Eta forecast was quite good over central PA. However, the 09z SREF did not support the Eta, and the 12z forecast represented a significant change from the operational Eta previous cycle at 06z. These factors, combined with Eta forecast problems during the 2000-01 winter season, resulted in the Eta getting little weight in the forecast process.

The balance of the case examines why the ensemble forecasts prior to 12z 6 January 2002 failed, and how the operational forecaster can discern and correct for such failures.

3.2 Comparison of operational and ensemble forecasts for 12z 6 January 2002 to observations

It is demonstrated that the poor performance of the ensemble and operational forecasts was foreseeable by using observations. The forecasts were compared to 500-hPa radiosonde height and wind observations for 12 UTC on 6 January, about 6 hours before the storm began in central PA. Comparison is facilitated with an animated gif interface where the student can “flip” through all the ensemble member forecast comparisons with the radiosondes. The best-forecast 500-hPa short-wave position relative to radiosondes was found in the 12z 6 January **operational Eta** analysis (the forecast that subsequently gave the best QPF and indicated winter storm criteria snowfall over central PA).

The three-hour forecasts from the 09z 6 January SREF ensemble members were **all** too weak and too fast with the short-wave trough. This is consistent with the use of the relatively poor 06z 6 January 2002 three-hour

forecast as a first guess for its initial conditions. The two earlier ensemble runs from 5 January 2002, while tending to be slower, were even weaker with the 500-hPa short-wave trough than the 09z 6 January ensemble members. No ensemble members produced a combination of precipitation and temperature that indicated heavy snowfall in central PA. An example frame from the animated graphic interface is shown in Figure 2 below.

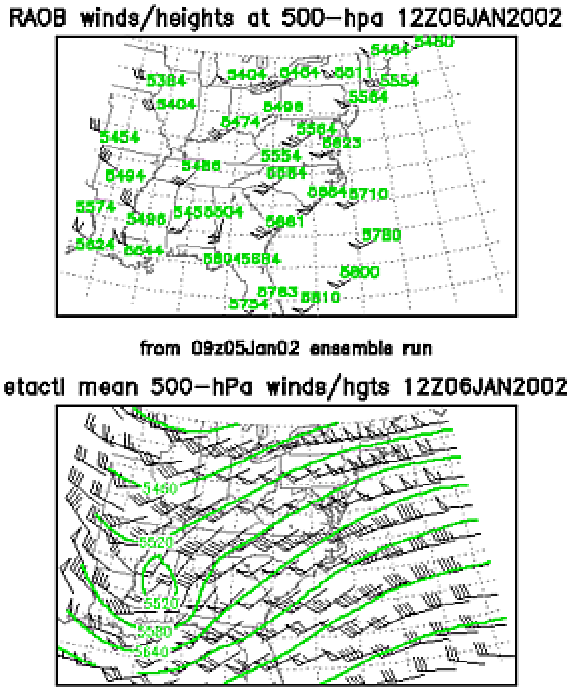

Figure 2: Radiosonde height (in meters) and winds (in kts) at 12z 6 January 2002 versus SREF Eta control forecast from 09z 5 January 2002.

We then compare a series of satellite IR and satellite wind observations from around **00z** 6 January 2002 to the three-hour ensemble member forecasts of winds from 500-400 hPa from 21z 5 January, using animated satellite cloud and wind graphics from a University of Wisconsin/Madison Web site (see references for URL). From the animated IR and wind graphics, we can see that the horizontal shear and cyclonic curvature of the disturbance that gave rise to the heavy snowfall in central PA is not adequately depicted in any of the 21z 5 January NWP ensemble member forecasts.

3.3 Adjusting the NWP forecasts

When dealing with ensembles to make a forecast, if the ensemble mean is expected (as is most typical) to be the best estimate of the outcome, forecasters can take the ensemble member closest in appearance to the ensemble mean and make use of its data. However, what should be done when the ensemble is not expected to verify well, as is true in this case?

An application similar in philosophy to that used when the ensemble mean is expected to verify is presented. The 09z 6 January 2002 SREF ensemble member that most resembles the initial condition at 12z 6 January 2002 is used to demonstrate the procedure. This procedure can also be used with individual ensemble members from the two ensemble forecasts from 5 January 2002, along with adjustments based on physical and dynamical reasoning.

4. CONCLUSIONS

The case presented here demonstrates the use (and potential **mis**use) of a new NWP forecast tool, the SREF system. Misuse in this case resulted from not properly checking the ensemble forecast evolution (and the current ensemble forecast range of initial states) against the observations. One important lesson is that initial condition errors can be just as damaging to ensemble forecasts as to operational forecasts.

When the SREF system fails to capture the range of uncertainty in the atmospheric initial state (and thus misses the forecast outcome), adjustments can be made. One possible method involves use of the ensemble member most resembling the actual forecast evolution, along with physical and dynamical reasoning, to improve on the forecast of that ensemble member.

5. ACKNOWLEDGEMENTS

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