P3.12 MODEL TRENDS AND SATELLITE IMAGERY IN FORECASTING

*Brian Motta **
Colorado State University/CIRA
Fort Collins CO 80523

Richard H. Grumm
National Weather Service
State College PA 16803

Anthony Mostek
National Weather Service
Boulder CO 80306

1. INTRODUCTION

The Virtual Institute for Satellite Integration Training (VISIT) has developed training aimed at improving the winter storm forecasting process as part of the Integrated Sensor Training Professional Development Series. During the past three winter seasons, real-time collaborations with National Weather Service (NWS) Warning and Forecast Offices about the use of the Geostationary Operational Environmental Satellite (GOES) imagery in winter forecasting has resulted in several case studies. Strategies required for the improvement of winter storm forecasts focus on two critical factors. The first factor is the need for effective evaluation of model initial-hour forecasts and errors. The second factor is the evaluation of run-to-run model trends (Grumm, 2001).

In this paper, a snowstorm with a significant model initialization problem led to erroneous forecasts. Select images will be used to show how model trends and satellite imagery could have been used to improve upon the forecast and identify potential errors.

2. METHOD

The Advanced Weather Interactive Processing System (AWIPS) gridded model data from the National Centers for Environmental Prediction Centers (NCEP) aviation run (AVN) of the global spectral model and Eta model were used. The data were examined using the AWIPS and were provided by the Cooperative program for Operational Meteorological Education and Training (COMET).

Model initial-hour guidance often has characteristics reflecting both the model first guess and the assimilated data sets. The first guess is usually heavily weighted in the initialization process and has a significant impact on the characteristics of important meteorological features. Remotely sensed data/imagery typically have lower weights than other data during the data assimilation step (Zapotocny, 2000). These weights can impact the model initial hour analysis/forecast fields.

After examining the satellite imagery and observed data for the case, one objective was to uncover which combinations of observed data and NWP could be used together most effectively. Satellite and other remotely sensed data can be useful in evaluating where a model is having difficulty initializing a feature. There are good examples of why parameters typically used by forecasters should be examined over a layer for effective comparison with satellite imagery. Bader (1995) shows a variety of expected types/configurations for cyclogenesis based on satellite interpretation and analysis. Before using a model "forecast", a thorough evaluation of the initial-hour fields should be done using remotely sensed imagery/data.

Model trends, referred to as ***dProg/dt***, are used to compare differences between model runs of the position and intensity of key features or parameters. In situations where cyclogenesis occurs rapidly, different trends from models can make forecast decisions very difficult. One approach is to combine the complementary capabilities of satellite image interpretation with modern Numerical Weather Prediction (NWP) guidance to do the best possible evaluation of model forecasts and trends to validate model solutions as rapidly as possible in the operational environment.

In circumstances where forecasts, watches, or warnings are issued well in advance (many hours

*corresponding author address: Brian Motta, Colorado State University, Fort Collins, CO 80523-1375; email: motta@cira.colostate.edu

or up to a few days) of the weather event, it is very important to find model errors and trends as early in the event as possible.

One of the capabilities for loading data in AWIPS is dProg/dt. This strategy of loading data allows a forecaster to compare previous runs of model guidance with the latest run valid at each time. Another way of loading the model guidance in AWIPS is using the latest run and previous run load modes. Either way, this technique is very useful but then must be related back to observed data trends to either a) develop/increase confidence in one or more model solutions or b) show observed pre-cursors or observations that would cause a forecast solution to differ from model guidance.

3. East Coast Storm of 24/25 January 2000

During the late evening and early morning hours of 24 and 25 January 2000, a major East Coast cyclone developed off the South Carolina Coast spreading heavy, and in many cases, record snowfall from South Carolina to New England. Particularly hard hit areas included a swath from near Raleigh, North Carolina through the Baltimore, MD and Washington, DC areas. At these latter two locations, the heavy snow arrived shortly before the onset of the morning commute. Seemingly surprised cities in Virginia and Maryland were nearly paralyzed by the snowstorm. This surprise could be attributed to relatively poor model guidance.

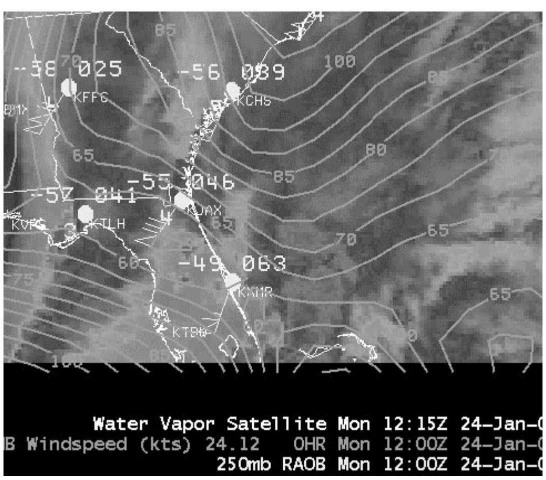


Figure 1. AWIPS Display of 250 mb Eta Isotachs and observed RAOB winds with water vapor image as background. Note that dark shades in the image indicate both cloud and dry regions. The upper-left part of the image shows a 50 kt wind error between the observed wind and the Eta 00-hour analysis/forecast.

Given the Eta versus observation error shown in Figure 1 at Atlanta (FFC), the question of how that error would affect the model guidance was a key to the forecast. Previous consecutive Eta runs indicated that the model runs were under-analyzing the intensification of the short-wave as shown Figs 3 and 4. This trend in the model guidance was a second key to correctly forecasting the rapid cyclogenesis.

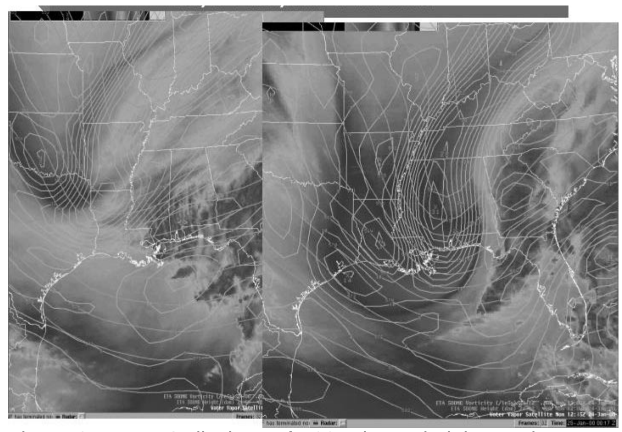


Figure 2. AWIPS displays of 500 mb Eta heights and vorticity at 0600 and 1200 UTC on 24 Jan 2000 with GOES water vapor imagery showing the intensifying shortwave.

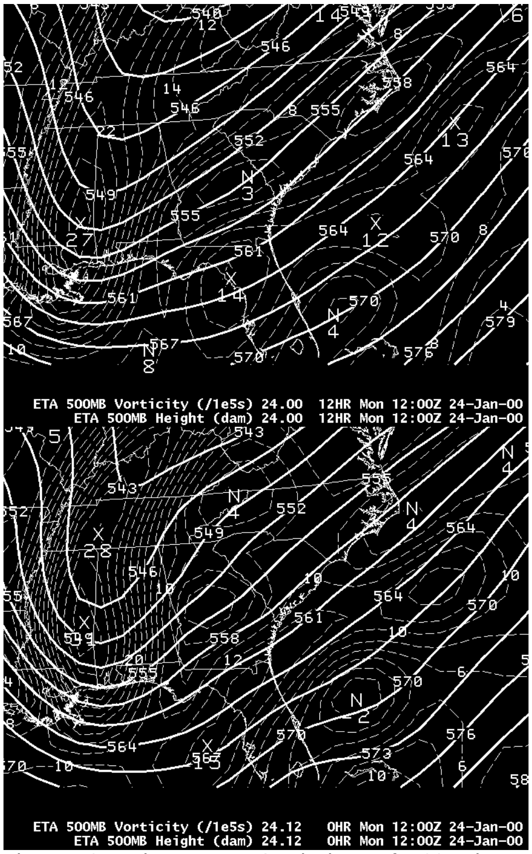
Example Eta analyses are shown in Figures 3 and 4 to show the dProg/dt concept. Both models showed a trend toward a deeper 500 mb trough farther west. Other dProg/dt images showed that subsequent model runs produced a deeper surface cyclone west of earlier runs. The combination of the deeper cyclone and the more westward position became apparent in the real-time satellite imagery before the new 0000 UTC model runs were available. The AVN showed a similar dProg/dt (not shown).

The trends toward a stronger cyclone, closer to the coast appeared to be related to a poorly initialized/forecast short wave. Successive model runs showed a stronger wave than forecast by each the previous ones (Figures 3 and 4). This trend implies some impact of the first guess on the initialization (Grumm, 2001).

4. DISCUSSION

The 25 January case showed similar trends in both the AVN and Eta. This implied a similar feature in the analyses used by both models was responsible for the errors.

When assessing model trends, it's also important to examine the role of the first guess in a model's performance. Without the initial and careful examination as described above, it is very difficult to recognize features which may "exist" in the



Figures 3 and 4. AWIPS Displays of 500 mb Eta Heights and Vorticity. Figure 3 shows the Eta 12-hour forecast valid at 12:00 UTC on Monday 24 Jan 2000. Figure 4 is the Eta 00-hour forecast valid at 1200 UTC on Monday 24 Jan 2000. Note the differences in the intensity of the vorticity maximum centered in southern Mississippi and the indication of a short wave ridge forming in eastern TN.

model but not in the real atmosphere (and vice versa). The importance of evaluating forecast trends of models using the AWIPS capability called dProg/dt in concert with real-time data becomes an important approach. When models disagree, it provides a better forecast approach than interpreting only the latest run. Large run-to-run differences may be indications of a low-confidence forecast.

In the case shown, the dProg/dt images from both models showed a deeper surface cyclone and upper-level trough tracking farther to the west with each successive forecast. Using this information, we were able to find an error in the model's initialization of an upper-level short wave which contributed to the errors in both models.

The AWIPS dProg/dt load mode is a tool that can assist the forecaster in locating potential problems. Using this technique on different models can be more instructive then using them on a single model. In the case shown, the dProg/dt revealed that both models had difficulty initializing the intensity of the same short wave feature. Relying on a single model or the trends in a single model may produce a singularly bad forecast. Therefore, it is important to note that dProg/dt may not always lead the forecaster to find the correct solution if the reasons for the trends cannot be identified. Ultimately, using dProg/dt to evaluate an ensemble may help forecasters determine what features have low predictability (Fritsch, 2000).

Current and future VISIT training in these areas will be shown in the poster. Forecaster response to the model initialization training has been very positive. Additional training on the integration and use of model output with observed data in the forecast process has or will include ensembles, medium-range, and large-scale analysis for winter forecast decision making.

5. Acknowledgements

Part of this research was performed under NOAA Grant No.NA67RJ0152.

6. References

Bader, M.J., G.S. Forbes, J.R. Grant, R.B.E. Lilley, and A.J. Waters, 1995: Images in Weather Forecasting. University Press, Cambridge, Great Britain, 499 pp.

Grumm, R.H., Robert Hart, 2001: Using Lagged Average Forecasts and Model Trends to Identify Initialization Errors. Preprints, AMS 18th Conference on Weather Analysis and Forecasting.

Fritsch, J.M, J.Hilliker, J.Ross, and R.L. Vislocky, 2000: Model Consensus, *Weather and Forecasting*, **15**, 571-582.

Zapotocny, Tom H., Steven J. Nieman, W. Paul Menzel, James P. Nelson III, James A. Jung, Eric Rogers, David F. Parrish, Geoffrey J. DiMego, Michael Baldwin, Timothy J. Schmit, 2000: A Case Study of the Sensitivity of the Eta Data Assimilation System. Weather and Forecasting, **15**, 603–622.