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VERIFICATION AND EVALUATION OF NOGAPS AND COAMPS ANALYSES AND FORECASTS FOR THE 24-26 JANUARY 2000 EAST COAST CYCLONE

Carlyle H. Wash and LCDR Greg Schmeiser, USN
Naval Postgraduate School, Monterey, CA
and
Patricia Pauley
Naval Research Laboratory, Monterey, Monterey, CA

1. INTRODUCTION

On 25 January 2000, a rapidly developing cyclone tracked up the East Coast of the United States. Associated with this system, 12 to 18 inches of snow fell on major cities from North Carolina to Washington DC. While it is not uncommon for several of these storms to occur in any given year, this snowstorm deserves special consideration because of the poor numerical and human forecasts.

Numerical model forecasts had difficulty handling the track of the storm, with most positioning it further east in the western Atlantic, not close to the coast. Twenty-four to 48 h model forecasts misplaced the position of the storm and the major areas of precipitation for the 25th. Related to the poor guidance from the numerical models, local forecasters failed to predict the heavy snowfall until late in the evening on the 24th. In fact, the National Centers for Environmental Prediction (NCEP) overview of the storm points out that local forecasts issued at 4 PM on the 24th reported only a 40% chance of light snow in Washington. Only six hours later, heavy snow was falling in southern Virginia and moving north. The first indication many people had that a heavy snowfall was imminent was when they woke up on the 25th and saw the snow on the ground.

The Navy models, Navy Operational Global Atmospheric Prediction System (NOGAPS) (Bayler, et al., 1992) and Coupled Ocean Atmosphere Mesoscale Prediction System (COAMPS) (Hodur, 1997), also had difficulty predicting the storm track and precipitation. The purpose of this research is to investigate the performance of the Navy models in predicting this storm. Identifying performance error is the first part of the work. Determining reasons for the model performance is the second. Various model fields were investigated to determine where the errors occurred and how they impacted the track of the storm.

The timing of this study was fortunate to coincide with the testing phase of the Naval Research Laboratory Atmospheric Variational Data Assimilation System (NAVDAS) with the NOGAPS model (Daley and Barker, 2000). Analyses and forecasts were rerun using the NAVDAS data assimilation scheme and were available for this study. Comparisons were made to the operational NOGAPS, which uses the Multi-Variate Optimum Interpolation (MVOI) system (Barker, 1992). These findings and the effect of an advanced data assimilation system on the global model will be discussed in the presentation.

2. RESULTS

Upper-level processes and low-level mesoscale effects were critical in the storm development similar to the rapid cyclogenesis overview by Uccellini (1990). Upper-level height patterns, jet streaks, vorticity, and divergence were all very crucial to the development. Low-level features such as cold air damming and a coastal front also played a large role in the storm track. The ability of each model to analyze these fields, and in turn, forecast their development is presented in a Master Thesis by LCDR Greg Schmeiser (2001) and summarized here.

NOGAPS cyclone forecast errors for this cyclogenesis event, even in the short-range 24-h or 36-h interval, were large. This global model moved the cyclone too fast and did not forecast the sharp curve in the storm track as the system moved up the East Coast. For example, the 36-h forecast verifying at 1200 UTC, 25 January misplaced the cyclone center by 500 km. The higher resolution COAMPS model performed considerable better. COAMPS, run at a horizontal resolution of 27 km at FNMOC, successfully forecasts the cyclone's turn to the north and is typically within 100 to 200 km of the actual surface

Corresponding author address: Carlyle H. Wash, Naval Postgraduate School, Department of Meteorology, 589 Dyer Rd., Room 254, Monterey, CA 93943-5114 e-mail: wash@nps.navy.mil

position. The operational COAMPS forecast also resolves some of the mesoscale structure of the forecast precipitation fields as well. However, the COAMPS forecast track is seaward of the actual track and the intense precipitation bands are predicted too far to the east.

A number of mesoscale features are of particular interest during this cyclogenesis event. Two strong jet streaks, the coastal front along the Carolina coast, and the amplification of the downstream ridge over the New England coast played important roles. The wind analyses of these jet streaks were often deficient, particularly in the global analyses. The intense deceleration and acceleration exit and entrance zones of the jets streaks are too smooth in the analysis and the associated ageostrophic and divergence flow too weak.

A manual analysis of surface temperatures reveals a strong coastal front along the Carolina coast preceding the cyclogenesis. The high horizontal resolution of COAMPS resolves the low-level coastal front, while it is not captured well by NOGAPS. This impacts NOGAPS ability to analyze and forecast the strength of the low-level baroclinic zone. COAMPS is able to analyze, and to a certain extent, forecast the low-level baroclinic zone. The better storm track with COAMPS is influenced by the model's ability to capture the coastal front.

Several precipitation zones play a major role in this case. Radar and satellite data describe a baroclinic leaf over Georgia and Florida at 1200 UTC 24 January with moderate to heavy precipitation. This intense precipitation area evolves into the intense heavy snow band on 25 January to the west and northwest of the deepening cyclone. Both models' 24/00 run failed to predict the heavy precipitation associated with the baroclinic leaf and provide poor precipitation forecasts for 25/00 and 25/12 associated with this feature. The NOGAPS 24/12 run had similar results. However, the 12 h forecast from the COAMPS 24/12 run did partially resolve the precipitation from the baroclinic leaf, and the heavy precipitation band feature in the 24 h forecast. There are positional errors, but the feature is resolved. The inability to handle this baroclinic leaf, and its associated moisture, led to poor short-range precipitation forecasts and upper-level height forecasts.

Another aspect of this case is the poor forecasts of the building of the downstream ridge in advance of the cyclone. Satellite data suggests model precipitation forecasts over the coastal Western Atlantic were deficient. The consequence of height errors in this ridge was the prediction of upper-level flow without a diffluent pattern and negative (southeast to northwest) tilt of the rapidly intensifying short wave trough. Without the strong ridge in the forecast, the upper-level trough propagated too fast and the diffluent flow did not develop. The forecast upper level flow was too easterly leading to the poor forecast cyclone tracks.

Results from the NAVDAS forecast runs are encouraging. Improvements in the forecast track and 250 mb isotach analyses are evident. Unfortunately little or no improvements are observed in the precipitation and 500 mb height forecasts for this case.

3. REFERENCES

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