7A.6 Verification of Gridded Morning Temperatures at NWS Miami, FL

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ABSTRACT

Grid-based comparisons of official NWS forecasts with numerical model guidance and objective analyses of observed weather can enable forecasters to assess the accuracy of their forecasts. This paper describes a technique developed to compare forecasts from the National Weather Service (NWS)'s National Digital Forecast Database (NDFD) with gridded Model Output Statistics (GMOS) from the National Digital Guidance Database (NDGD) and analyses from the Real Time Mesoscale Analysis (RTMA). The parameter assessed was the 1200 UTC (morning) temperature forecast. All processing and image generation were completed using a Geographic Information System (GIS). Example graphics will be shown at a state (Florida) and a local (south Florida) scale.

1. INTRODUCTION

The NWS' Southern Region Headquarters Science and Technology Services Division (STSD) collects 5km grids from the NDFD, RTMA and GMOS. These grids are input into a regularly-scheduled GIS process that creates near-real-time, grid-based graphical verification. Difference grids are produced to show human forecast (NDFD) and model (GMOS) errors relative to "observed" 1200 UTC temperatures from the RTMA. The 1200 UTC data was chosen as a proxy estimate for minimum temperature since minimum temperatures are not natively available from the RTMA. These grids are processed using a GIS. The GIS processing provides a simple way to automatically calculate and display forecast errors over any user-selected geographic area within the conterminous United States (CONUS).

The authors have been collaborating to implement a local version of this scheme at the NWS forecast office in Miami, FL. This paper will describe the motivations for expanding this project, catalog the methods for implementation at the local office level, and provide examples illustrating the utility of the project at the local level.

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2. MOTIVATION

The motivation for this project stems from the need to create forecast verification that is available to forecasters in near-real-time and is grid-based. Current NWS temperature verification methods are outdated in that they use observations from certain points within the forecast domain. In today's NWS operational environment, forecasts are made for a grid that covers a much larger area. To avoid a misrepresentation of the accuracy or inaccuracy of a given forecast, it is important to verify using forecasts and observations of similar format. Additionally, legacy point-based verification statistics are not available in real-time, and are only available in tabular format which differs from the graphical nature of today's modern NWS forecast process.

Since GIS software can perform numerous calculations on gridded data (rasters), and since NDFD, RTMA, and GMOS data are all available in gridded format, the marriage of GIS and this gridded data makes it the most efficient way to display forecast verification data graphically. One advantage of graphical verification is that model biases over certain regions in given weather patterns is much more discernable; that is, forecasters and researchers can identify where and when models or forecasters perform a certain way, and make adjustments accordingly to future forecasts. Identifying regimes or scenarios of poor model performance can lead to identification of a "forecast opportunity" where the forecaster has a greater chance of improving over a model's forecast. Additionally, this scheme highlights the important role GIS now plays within the NWS, and provides further evidence of its potential to become an integrated, everyday analysis tool in NWS operations.

3. DATA AND METHODOLOGY

As previously mentioned, 5km CONUS grids from the NDFD, GMOS (via the NDGD) and RTMA are automatically downloaded at NWS SR Headquarters. Basic difference grids (NDFD minus RTMA (forecaster's error) and GMOS minus RTMA (model's error) back 7 days are created using geoprocessing tools (python scripts) once a given days' observation is available. This leaves one with a graphical representation of both the amount of error in the forecasts, and any bias for that day's forecast made from each of the previous 7 days. Geoprocessing within GIS then makes a subset domain of data (as shown in Fig 3) for the state of Florida available for automatic download at NWS Miami.

Locally at NWS Miami, additional processing of the data takes place again with the use of GIS and python scripting. Several additional difference grids are produced, with one such grid showing the average error for the previous 7 days' forecasts ending on the valid day. Other grids calculate the running errors for all D-1 (where D is the valid day), D-2, etc. forecasts made in the prior 7 days. All graphics are produced automatically, using ArcObjects and Visual Basic for Applications (VBA) scripting within the GIS application, on a dedicated machine that writes to an internal webpage for display. The images and data are also archived for use in future calculations or publications.

4. SAMPLE GRAPHICS AND CASE STUDIES

Figures 1 and 2 show a suite of images depicting temperature forecast errors, model and human, applicable to the observed 1200 UTC temperature on 18 February 2009. Figure 1 shows a complete set of graphics depicting model (GMOS) errors, while Fig 2 is the same but for human forecasts (NDFD). These summary graphics are available to forecasters in near real-time after the date of the observation is reached.

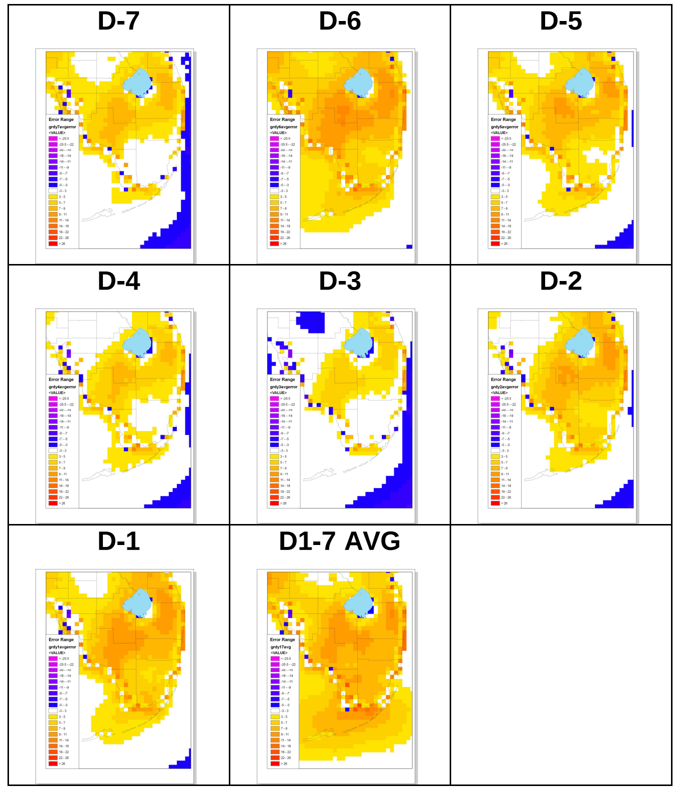

Figure 1: GMOS-RTMA (model) errors from D-7 through D-1 forecasts valid 18 February 2009. White areas denote errors within three degrees Fahrenheit of observed Min Temp. Warm (cool) colors denote too-warm (too-cool) forecast temperature errors, respectively.

Figure 1 clearly shows that during the 7 days preceding 18 February, the model (GMOS) had a warm bias in its forecasts of the observed conditions over south Florida. The largest warm biases were generally in the region just southwest of Lake Okeechobee, which is typically a region of warm model bias on fully decoupled/ideal radiational cooling nights. Indeed, the model forecast was nine to twelve degrees too high in these areas, even on D-1. It is also interesting to note that the most accurate model forecasts were D-3 and D-4, with the model errors increasing once again thereafter. These are the types of error patterns and biases that this project provides forecasters so they can account for them and adjust their forecasts accordingly. Fig. 2, however, shows a larger area of white

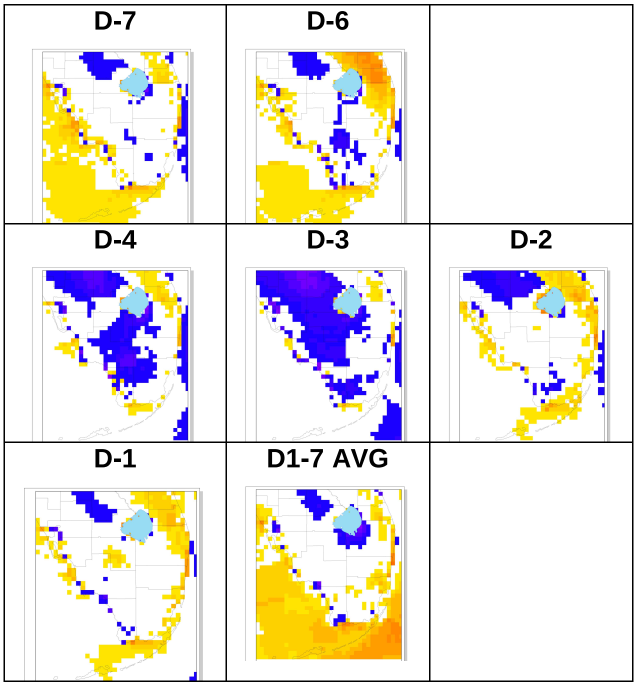

Figure 2: As in Figure 1, except showing forecast's (NDFD-RTMA) errors valid 18 February 2009. Color scale is identical to Figure 1. The D-5 error image was not available for inclusion.

across south Florida, which is indicative of generally more accurate forecasts from the NWS forecasters in this case. An exception to overall low-error forecasts is for the D-3 and D-4 forecasts, where the NWS forecasts were too cool by six to nine degrees southwest of Lake Okeechobee, coincident with model forecasts that had been too warm.

A very strong cold front passed south through the Florida peninsula during mid January 2009, leading to one of the most widespread and severe cold weather episode in several years. The forecast error trends were captured well by this GIS-based gridded verification scheme (Fig. 3). This event led to temperatures dropping as low as the lower 20's across the Lake Okeechobee region, with a reading in the mid teens recorded at an agricultural site in Highlands County, just northwest of Lake Okeechobee.

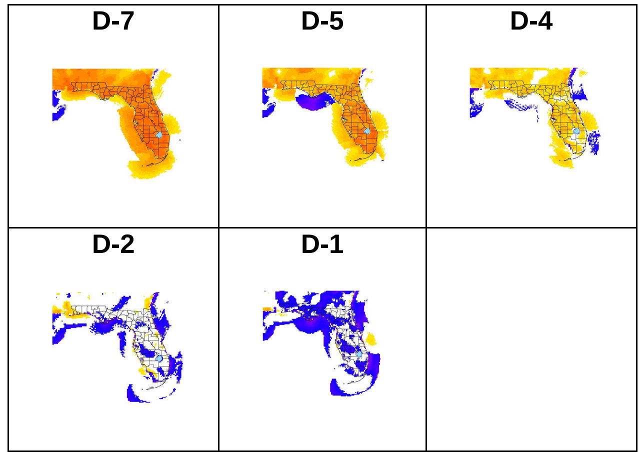

Figure 3: As in Figures 1 and 2, except showing forecast's (NDFD-RTMA) errors valid 22 January 2009. Color scale is identical to Figure 1. Several days' images were not available for inclusion.

Beginning on D-7, large warm forecast errors are exhibited. The possible reasons for such a widespread, large error could be that either the model at this time was not yet predicting such cold temperatures or forecasters chose a more cautious approach so far in the extended given the sensitivity to a cold weather forecast on local agriculture in the state of Florida. By D-5 and D-4, there is a definite improving trend in forecast error statewide, and although warm errors remain by D-4, most of the errors are within six degrees, and there are even areas of less than three degree error observed. The most accurate forecast was made on D-2, where the largest amount of "white" area, denoting minus to plus three degree errors was observed. Note that forecasts across parts of the state actually trended too much in the cooler direction, with some three to six degree cool errors noted especially in the west central part of the state. This "too cool" trend continued into D-1, where forecaster temperatures were too cool by three to six degrees across much of the Florida panhandle region and in other sporadic areas.

The first significant cold front of the 2009-2010 dry season passed through south Florida overnight between 17 and 18 October. Temperatures dropped from record highs in the lower 90s on 17 October across the Miami to West Palm Beach metro areas to lows in the 50s to around 60 the following morning. It can be useful to examine forecast versus model error trends graphically during this period (Fig. 4).

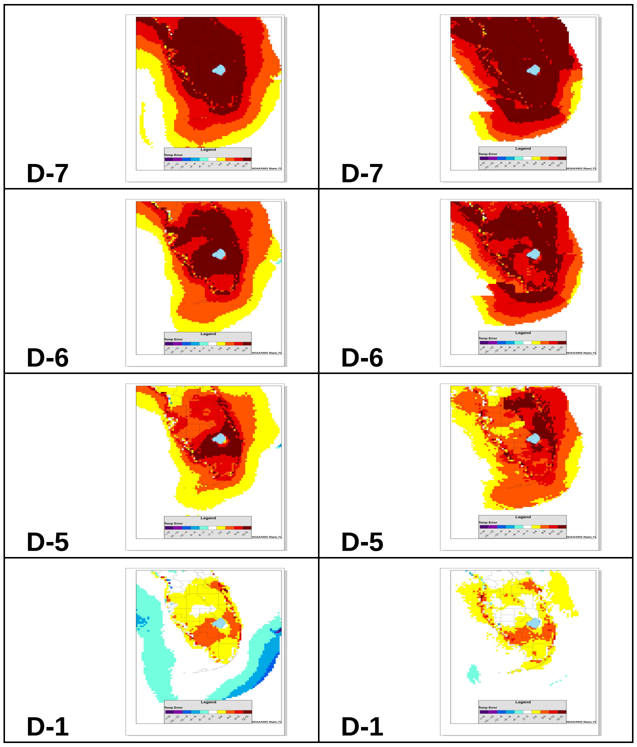

Figure 4: Model Error (left column) versus Forecaster Error (right column) for forecasts valid 18 October 2009. Color scale is at bottom of each image, but ranges are as in previous images.

Several things become readily apparent in examining this case. The D-7 through D-5 model and forecaster errors were quite warm: up to fifteen degrees too warm over a large area on D-7 and D-6. This could again be due in part to model and forecast uncertainty as to the exact day of the frontal passage as well as the magnitude of the cool air behind it. By D-5, some forecast improvement by the model as well as the forecaster is noted, though model errors were still in excess of twelve degrees too warm in the Lake Okeechobee region; forecaster errors still exceeded nine degrees too warm over a large area. By D-1, despite being too warm both model and forecasters showed an improving trend, with a larger area of minus to plus three degree errors just north of Lake Okeechobee.

5. CONCLUSIONS

Using a GIS to calculate and display forecaster and model errors is very advantageous and practical for NWS operations. This combination of technology and data can more easily enable forecasters to identify trends in model and forecast error; researchers can identify synoptic-scale patterns that models or forecasters handle poorly and can improve on, creating a "forecast opportunity." This can be especially useful to forecasters in that they can easily identify productive changes to their forecasts in near real-time in order to improve short-term forecasts. If implementation can be achieved agency-wide, overall improvement in temperature verification scores is anticipated.