JP2.10 RECENT GRID VERIFICATION ACTIVITIES IN THE NWS EASTERN REGION

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1. INTRODUCTION

Grid verification is in its infancy across the NWS, and 2008 marked an important beginning for the verification of public weather grids in Eastern Region (ER). Starting in the spring, all ER weather forecast offices (WFOs, Fig. 1) were briefed on the need, philosophy, and techniques behind the verification of gridded weather

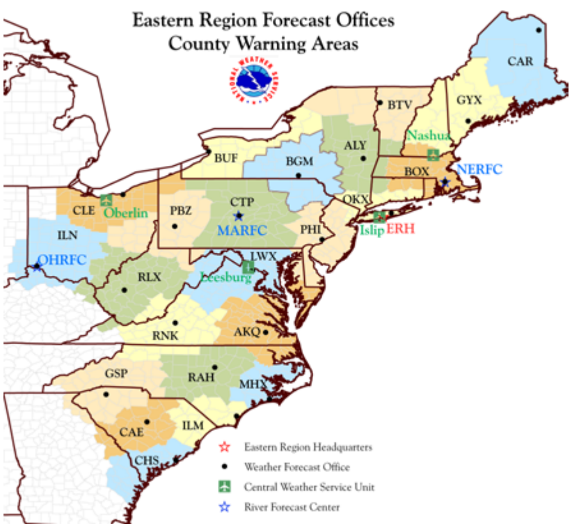

FIGURE 1. NWS/Eastern Region forecast office county warning areas (CWAs) of responsibility. Public weather forecast grids are routinely produced by each office for their entire CWA.

forecasts. The overall purpose of the verification is to provide timely, flexible feedback to forecasters on the quality of gridded forecasts, both spatially and temporally, and to serve as a complement to the existing national verification products produced by the NWS. For forecast operations, short latency of grid verification products is important for WFOs creating one- or three-hourly grid forecast updates in support of decision-making activities.

The ER grid verification implementation approach was phased in with a series of steps, which focused predominately on forecaster training. The initial emphasis was clear: establish a structured learning approach for forecasters to become familiar with the concept of grid verification; gain proficiency in the use of the software to generate meaningful statistical output; and become comfortable with interpretation of this output. All ER WFOs use the Graphical Forecast Editor (GFE) program BOIVerify (Version 2.02, developed at WFO Boise) in combination with forecast grids and NCEP's Real Time Mesoscale Analysis (RTMA, Pondeca et al., 2007) as the software program and analysis grid used for verification, respectively. Statistical output generated with BOIVerify focused on the temperature, dewpoint, and wind speed element grids of the public forecast. In addition to the focus on developing verification techniques and familiarization with the software, the verification feedback has been used by various ER WFOs for: identifying forecast "busts" of public weather elements, examining case studies in highly localized areas, monitoring forecast guidance trends, and highlighting local office grid production practices and evolution. In addition, some WFOs also experimented with a regression-based grid bias correction technique and verification of ensembles. The grid verification techniques can also be used by forecasters for verifying local model output though use of BOIVerify or other software, such as the Model Evaluation Tools (MET) package (DTC 2008). Over time, the routine verification of the public forecast grids should be fully integrated into the daily forecast process.

2. THE REAL TIME MESOSCALE ANALYSIS (RTMA)

The RTMA is an hourly, 5-km gridded analysis that provides an estimate of near-surface weather conditions for CONUS (Pondeca et al. 2007). The RTMA surface parameters include a surface (2-m) temperature, dewpoint and pressure, 10-m wind speed and direction, cloud cover, and precipitation. The hourly RTMA analysis is generated from a downscaled 13-km RUC 1-hr forecast and updated using available surface

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observations, centered around the top of each hour (Benjamin et al. 2007). The 13-km RUC forecast output serves as the first guess for the RTMA analysis, and is downscaled to a 5-km National Digital Forecast Database (NDFD) grid.

The RUC downscaling process to a 5-km grid allows for the analysis to be consistent with the NDFD operational public weather gridded database. As such, the gridded analysis is used by all Eastern Region NWS offices for verification activities. This state-of-the art objective analysis is thus easily integrated into the Graphical Forecast Editor (GFE) portion of the AWIPS platform, for routine use by operational forecasters.

3. IMPLEMENTATION

Given the emphasis on training and familiarity with grid verification concepts, specialized job sheets were developed by ER Scientific Services Division (SSD) to provide forecasters a “hands-on” approach to generate simple plots and interpret the statistical output produced by BOIVerify. These training materials were designed to give forecasters practical experience using BOIVerify to produce common plots and maps with a known result. The goal of this strategy was to effectively eliminate the “black box” mentality sometimes associated with the use of new software and accompanying methods, whereby users simply check boxes and turn knobs on the software display without giving critical thought to the input parameters, potentially leading to misinterpretation of the result.

Given the nature of this implementation approach, a monthly report was submitted by each WFO from a template produced by SSD, focusing on the generation of plots of varying statistical measures over different space and time scales. There was also ample opportunity for individual WFOs to experiment with forecast problems specific to their area. This approach allowed for all WFOs to be on a similar page with respect to training, provide feedback on their experience with the BOIVerify software, offer suggestions for improvement, and yet examine interesting forecast challenges specific to their CWA. Individual feedback from ER was provided via a monthly phone call to each WFO to discuss the report’s contents, answer questions, and solicit feedback. In addition, a monthly regional summary was produced and provided to the offices, informing all parties of regional progress, training issues, and other noteworthy items related to the grid verification initiative.

Most recently, conference calls focused solely on grid verification have allowed individual WFOs to share experiences, practices and lessons learned from examining cases for the monthly reports with the entire region. While the intention of the monthly reports was to familiarize forecasters with the concept of grid verification, the use of BOIVerify, and the interpretation of its output, interesting forecast insights resulted as well. For instance, many offices found that during the warm season, cloud cover from upstream convection (including cirrostratus shields) affected the temperature forecast over large parts of the CWA, which wasn’t always well forecasted or easily verified using traditional point-based methods. In addition, WFOs with large forecast responsibilities over coastal waters, significant topography, or unique land use determined local forecast biases with temperatures, winds and dewpoints over certain parts of the diurnal cycle. Some offices took a “phenomenon-based” approach, and used the grid verification output to examine forecasts challenges associated with local sea breezes, freeze warnings, or winds associated with tropical cyclone remnants. Finally, an examination of errors associated with existing diurnal temperature “Smart Tools” were emphasized by many WFOs, further highlighting the diverse nature of information gleaned from grid verification. Overall, the grid verification training and associated exercises provided an opportunity for WFOs to examine local grid production and identify biases and trends.

4. FORECASTING EXAMPLES

Grid verification at the WFO-level allows forecasters to more routinely assess the quality of the forecasts. As a result of the regional training effort and exposure to grid verification, several trends and insights into the grid production process and associated forecast process have emerged.

a. Spatial impact of cloud cover/convection

One common theme noted among many WFOs was the significant impact of cloud cover and fog on the forecasted temperature grids. Generally, WFOs noted that cloud cover and associated precipitation, or even a thin cirrus deck, was often unanticipated or unaccounted for in the grids to the spatial extent observed. This often resulted in temperature overforecasts (Fig. 2) as cloud cover and/or precipitation suppressed air temperatures. Conversely, early cloud dissipation or a quick-moving system where cloud cover cleared out earlier than expected led to a quick warm up and temperature underforecasts, particularly during the early morning hours. Forecast "busts" on the order of 4°F and greater at the 6-hr (Fig. 2b) and 12-hr (Fig. 2c) forecast projection have been noted by forecasters to be associated with widespread cloud cover and precipitation. In the example shown, it appears as though the WFOs in the Mid-Atlantic states cooled forecasted temperatures between the 6- and 12-hour forecast periods (Fig. 2d), but were too conservative in the adjustment.

b. Guidance comparisons

WFOs also found it useful to use the new verification techniques to compare gridded model guidance output over land and water areas over a variety of time intervals (Fig. 3). Guidance trends were noted for different meteorological regimes and geographic areas within individual CWAs, such as areas influenced by a sea/lake breeze or downsloping mountain winds. Forecasters found that identifying sub-regions within the CWA and using GFE and BOIVerify to compare guidance verification output trends at these locations yielded insight into which guidance performed consistently well, and which did not, under certain meteorological regimes, forecast projection, or time of day. For example, examining statistics over only the land points (Fig. 3a) of the CWA, or only the marine zones (Fig. 3b) using preselected "edit areas" in GFE were common practice. The results of such comparisons, over time, can provide forecasters additional confidence in selecting a favored guidance package to initialize the production of the public forecast grids in these specialized areas or under certain weather regimes.

c. Frontal placement and advection

The timing of frontal passages and incipient warm or cold air advection was also noted by the WFOs as a particular challenge to account for in the forecast grids. Often, the magnitude of warming (cooling) ahead (behind) of a cold front resulted in underforecasted (overforecasted) temperatures (Fig. 4). Forecasters noted that missed forecasts of the timing and movement of such features resulted in large errors in the forecasts grids of temperature, winds and dewpoint. In some cases, forecasters noted a tendency to "stick" with a preferred guidance solution when producing the grid forecasts, and were slow to deviate or make large changes to the forecast if subsequent model runs indicated large changes. It should be noted, however, that there are additional challenges to the forecaster in producing and updating grid forecasts, including inter-office collaboration, and software tool limitations. Nonetheless, verification of the gridded forecasts under these meteorological regimes raises forecaster awareness of the importance of the evolution of the grids, and the need to use sound forecast practices in producing the public grid forecasts.

5. SUMMARY

Grid verification training and exposure to new techniques continues in Eastern Region. Some office have begun to integrate grid verification practices into their daily weather breifings or held special office training sessions to expose additional staff to the techniques and software. A Region-wide iniative is currently underway to further develop techniques and tools to examine and verify quanititative precipitation forecasts, which will continue throughout the summer of 2009. Development is also underway to integrate elements of analysis (RTMA) uncertainty into the grid verification process. Over time, the lessons learned from grid verification will ultimately result in improved gridded forecasts, which is of benefit to the entire weather enterprise.

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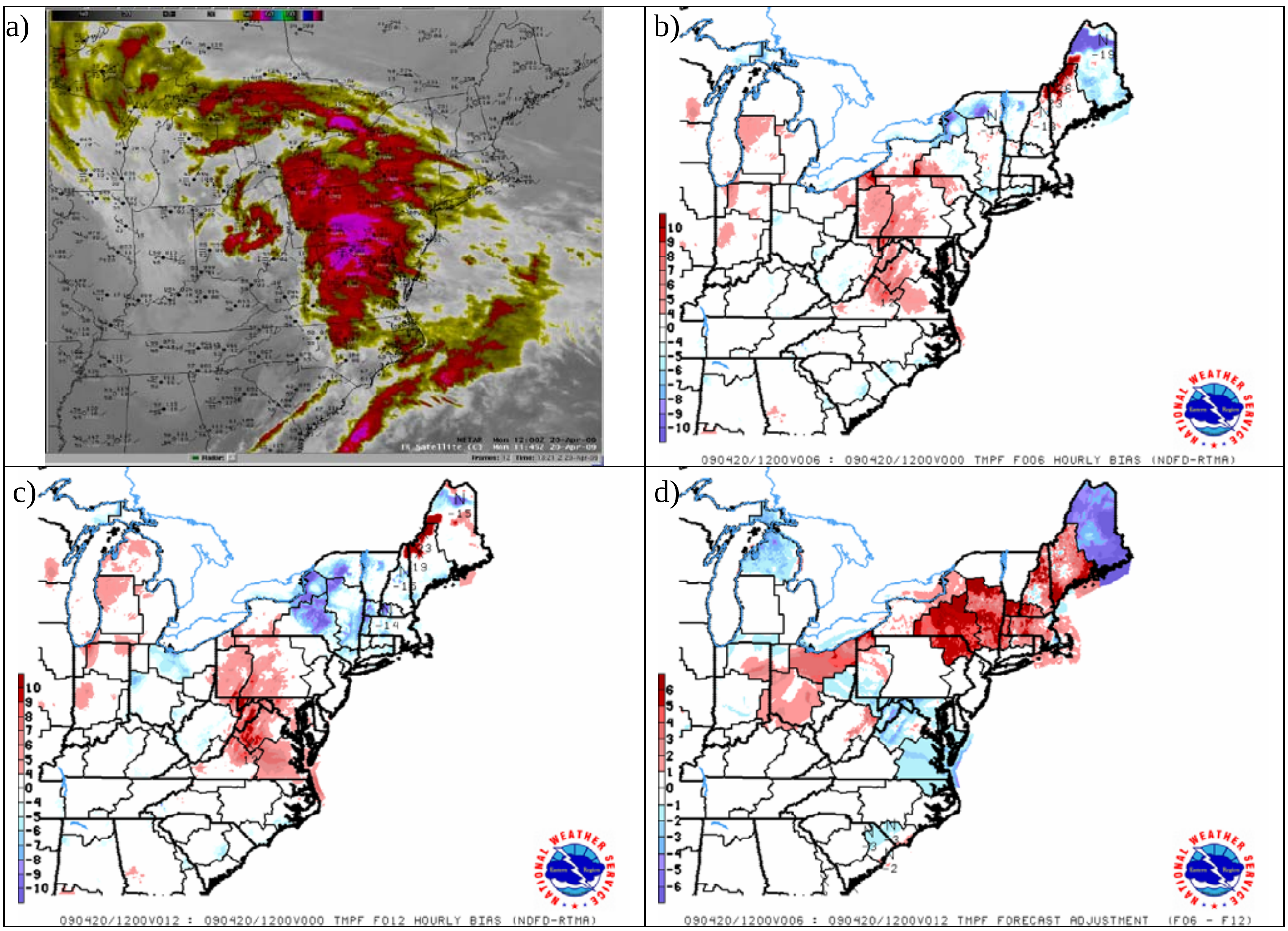

Figure 2. Regional views of (a) GOES IR imagery valid at 1145 UTC 20 April 2009. (b) NDFD Bias (°F) of the 6-hr temperature forecast valid at 1200 UTC 20 April 2009 verified with the RTMA. (c) Same as in (b) except for a 12-hr forecast. (d) Forecast difference (6-hr – 12-hr forecast projections) valid at 1200 UTC 20 April 2009. Warmer colors indicate an increase in the temperature from the previous forecast.

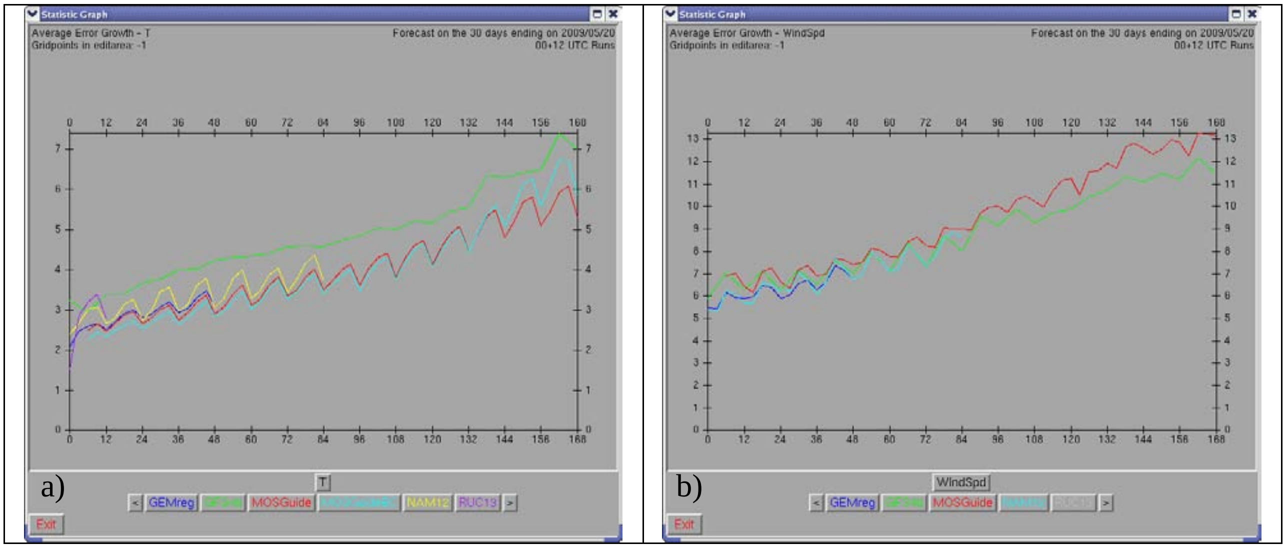

Figure 3. Example WFO views of the 30-day (a) mean absolute temperature error (°F) as a function of forecast projection for common model guidance output used in forecast operations. The forecast grids are verified with the RTMA. The statistics are computed over all land points in the Eastern Region grid domain (Fig. 1). (b) Same as in (a) but for wind speeds (kt.) over all Great Lakes marine points in Eastern Region. For clarity, the dark blue curve is the regional 15-km GEM, green the 40-km GFS, red gridded MOS, light blue a bias-corrected gridded MOS, yellow the 12-km NAM, and purple the 13-km RUC.

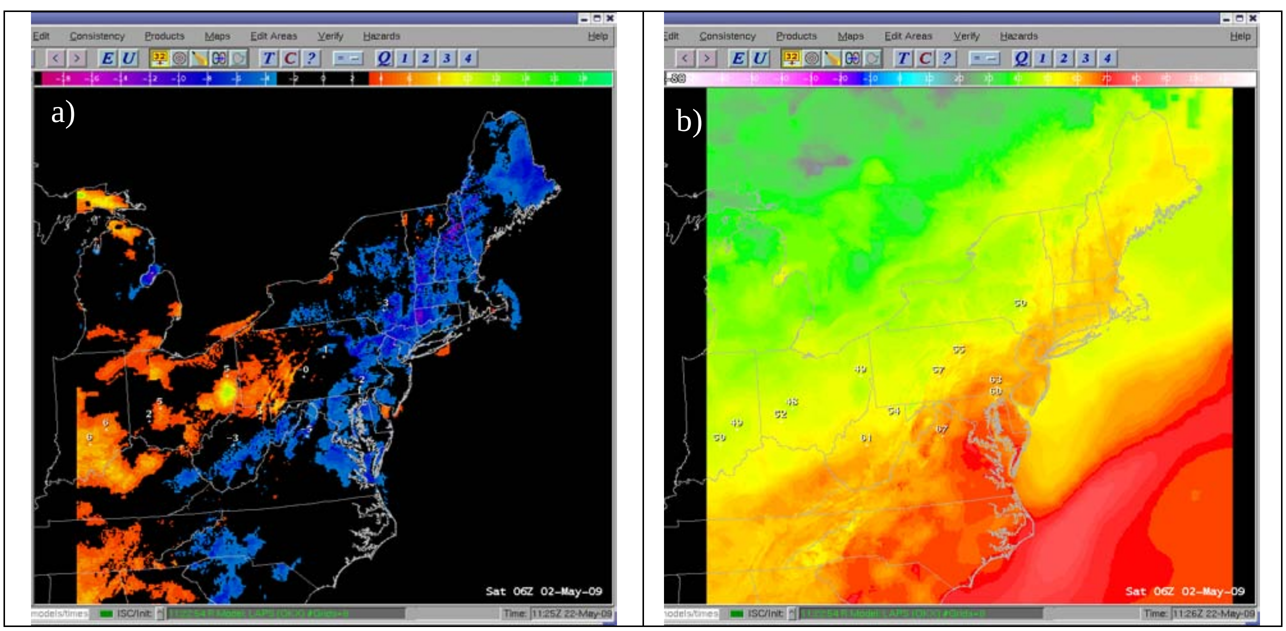

Figure 4. (a) Mean absolute temperature error (°F) for a cold front event on 2 May 2009. Cooler colors indicate an underforecast, warmer colors an overforecast. This is a 6-hour forecast projection from the 0000 UTC cycle on 20 May 2009. (b) RTMA surface temperatures valid 0600 UTC 2 May 2009.