P4.4 THE SECOND GENERATION OF ETA MOS PRECIPITATION GUIDANCE – DOES A FINER-RESOLUTION PREDICTOR DATASET HAVE AN IMPACT?

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1. INTRODUCTION

In the spring of 2002, the Meteorological Development Laboratory (MDL) implemented the Eta-based Model Output Statistics (MOS) guidance package. The Eta MOS guidance runs twice daily, following the 0000 and 1200 UTC runs of the Eta model, and provides forecasts for over 1200 stations in the conterminous United States (CONUS). Included in this package are forecasts for probability of precipitation (PoP) and quantitative precipitation (QPF) covering 6-, 12-, and 24-h periods valid at projections out to 60 hours after initialization. This first-generation Eta MOS development utilized data from a relatively coarse Eta model archive, both temporally (two cycles daily, forecasts every 6 hours out to 48 hours) and spatially (~90-km grid spacing). While our predictor data set was limited, verifications showed a significant improvement over the Nested Grid Model (NGM) MOS and some improvement over the Global Forecast System (GFS) MOS (Dallavalle et al. 2004) in the early projections (out to about 36-48 hours) (Maloney 2002).

The current Eta MOS system is not without its deficiencies, however. Because of the limitations of the predictor data available, no forecasts are available for U.S. sites outside the CONUS–Alaska, Hawaii, Puerto Rico, and the Virgin Islands (OCONUS). Additionally, no guidance is available beyond the 60-h projection. After the initial Eta MOS implementation, an effort was undertaken at MDL to secure a new Eta model archive to correct these shortcomings. While data were only available starting in April 2000, the new model archive grid covers a much larger area than the previous one, including all of Alaska, Hawaii, and the Caribbean Islands. The new Eta model archive also features finer spatial (32 km) and temporal (4 cycles daily, forecasts every 3 hours out to 84 hours) resolution than the original archive. Equations to predict PoP and probabilistic QPF have been developed from the new Eta model archive and will be implemented in the upcoming cool season.

This paper discusses details from the recent Eta MOS equation developments, including verification scores. Comparisons are made between MOS and direct model output (DMO), the new and existing Eta MOS PoP and QPF systems, as well as the GFS and NGM PoP/QPF systems. In addition, we look at the use of a higher-resolution model archive to determine what impact, if any, its use had on the skill of the guidance.

2. DEVELOPMENT DETAILS

Many of the details of this new Eta MOS development are identical to the previous development described by Maloney (2002). Therefore, only the major differences will be highlighted here.

The MOS technique (Glahn and Lowry 1972) was once again used with multiple linear regression to develop predictive equations. Developmental data were available from April 1, 2000, through September 30, 2003. Forecasts out to 84 hours were first available on April 18, 2001 (previously, 60 hours was the maximum projection). This meant we had 3 cool seasons of data available for development (2000-01, 2001-02, and 2002-03), with just the latter two seasons having forecasts out to 84 hours.

The data were archived on a 32-km Lambert Conformal grid (Fig. 1) which included not only the CONUS, but also Alaska, Hawaii, Puerto Rico, and the Virgin Islands. Thus, development for OCONUS sites was now possible. In later verification diagrams, MOS guidance derived from this archive is denoted as Eta32.

Many of the predictors offered to the regression were the same as the previous development; however, a new predictor–upslope wind–was also

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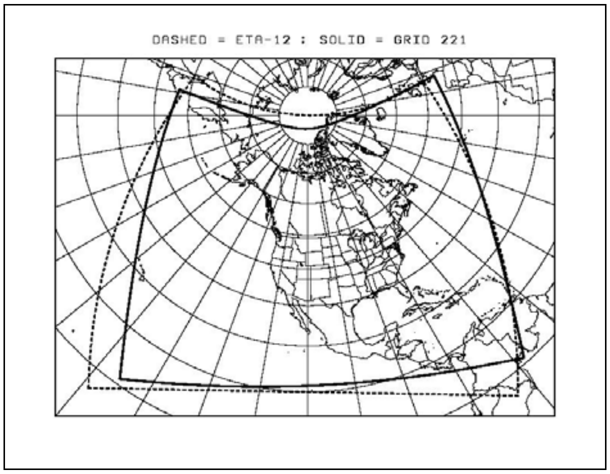

Figure 1. Grid domain of 32-km Eta archive (dark solid line). From http://wwwt.emc.ncep.noaa.gov/mmb/etagrids/g221.12km.jpg

introduced. This predictor interacts the horizontal wind at a given vertical level (850 hPa, 700 hPa, and 10 m) with terrain slopes calculated from a 5-km resolution terrain dataset to generate terrain-induced vertical velocities.

3. TEST VERIFICATION

Prior to the generation of the final regression equations, a test development was performed. In this test, a portion of the data sample was withheld from the regression and was used for forecast verification. For this test, the latest cool season (October 1, 2002 – March 31, 2003) was held out for use as an independent sample for projections out to 60 hours. Because of the limited data available beyond 60 hours, for these projections only, the last half of each month in the latest cool season (e.g., October 16-31, November 16-30, etc.) was withheld. The remaining data were used as a developmental sample from which test equations were produced. The test equations were evaluated on the aforementioned independent test sample, the output was post-processed (Maloney 2002), and the resulting forecasts were compared to the DMO and the various MOS products. For all verifications, MOS and DMO forecasts were compared to observations at 335 CONUS and OCONUS sites. PoP accuracy is measured with the Brier score (Brier 1950), with lower scores indicating more accurate forecasts. Categorical QPF skill is measured by calculating the Heidke skill score (HSS) (Wilks 1995).

3.1 *Versus Direct Model Output*

Since the Eta model only forecasts precipitation amount, and not the probability of precipitation, only the Eta MOS categorical QPF guidance was compared to the corresponding DMO, binned into the appropriate category (Table 1). These seven categories are used in determining the HSS. Note that both the DMO and MOS QPFs (and PoPs) do not forecast precipitation at a given forecast projection, but rather over a period of time ending at that projection. The HSS of these 12-h categorical forecasts are plotted in Fig. 2 for the cool season test sample. While the 6-h and 24-h verifications are not shown, all three show similar results. The HSS of each system, as expected, decreases with increasing forecast hour. Additionally, the Eta MOS shows more skill than the Eta DMO for all projections. Interestingly, as Fig. 2 shows, the percentage improvement of skill for the Eta MOS relative to the DMO is rather consistent for every forecast projection—about 10 to 12%.

Table 1. Eta MOS QPF categories

Category	Forecast Precipitation Amount (in)
0	No measurable precipitation
1	0.01 – 0.09
2	0.10 – 0.24
3	0.25 – 0.49
4	0.50 – 0.99
5	1.00 or more (6-h forecasts)
	1.00 – 1.99 (12-h & 24-h forecasts)
6	2.00 or more (12-h & 24-h forecasts)

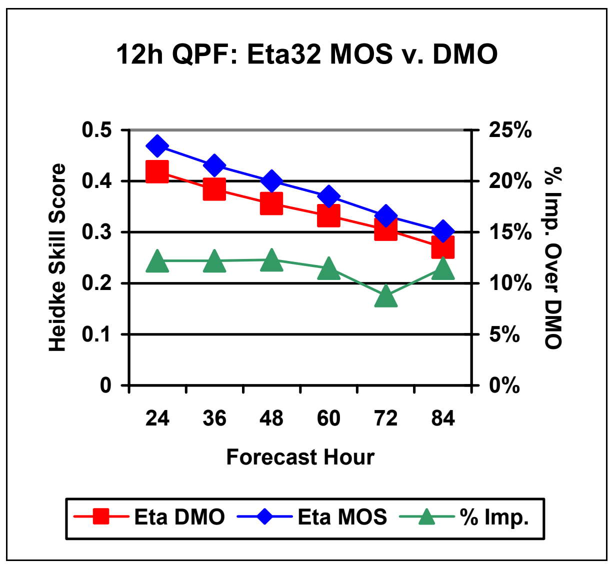

Figure 2. Heidke skill score for 0000 UTC cycle 12-h Eta32 MOS and Eta32 DMO; and Eta32 MOS improvement over DMO.

3.2 *Versus Other Operational MOS Systems*

Figures 3 and 4 show the Brier scores for the new Eta and NGM MOS PoPs, and the HSS for the new Eta and NGM MOS QPFs, respectively. It is quite obvious that the new Eta MOS precipitation guidance is much more skillful than the older NGM guidance, showing generally a 15% improvement across the board.

The improvement in skill of the new Eta MOS over the AVN MOS is not nearly as noticeable, as

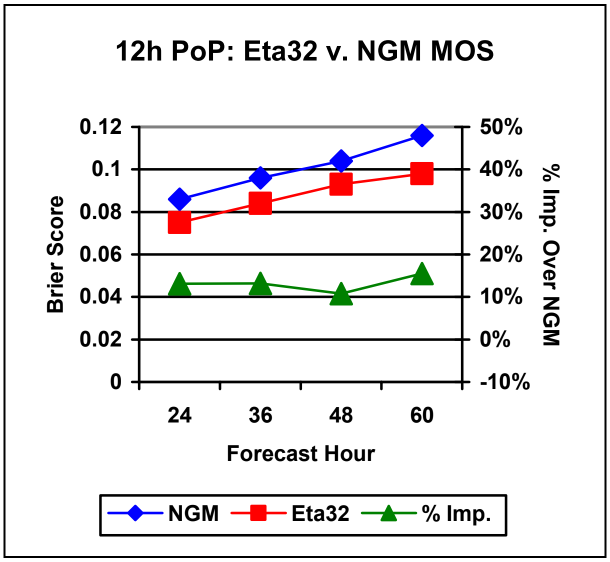

Figure 3. Brier score for 0000 UTC cycle 12-h PoP from Eta32 MOS and NGM MOS; and Eta32 MOS improvement over NGM MOS.

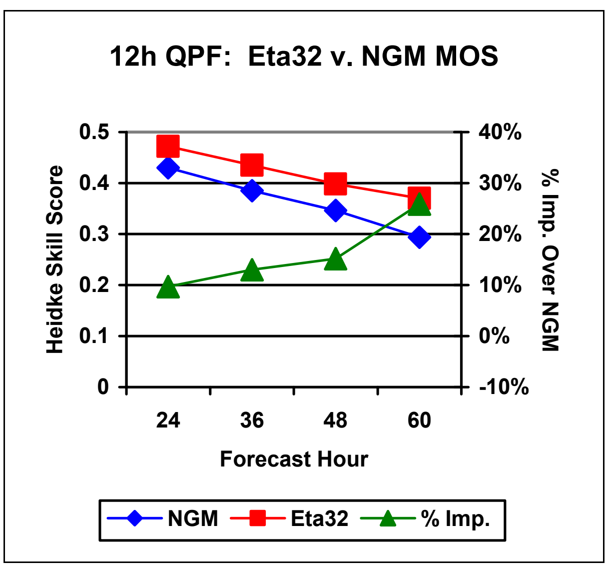

Figure 4. Heidke skill score for 0000 UTC cycle 12-h QPF from Eta32 MOS and NGM MOS; and Eta32 MOS improvement over NGM MOS.

suggested by Figs. 5 and 6. There are some gains evident for the early projection PoPs, but generally, the two systems are about equally accurate and skillful.

4. IMPACT OF HIGHER RESOLUTION DATA

With this new Eta MOS development, two high-resolution datasets were employed: 5-km terrain (via the upslope predictor), and the 32-km Eta model archive. The goal of using these high-resolution datasets was to better handle more of the mesoscale precipitation events. However,

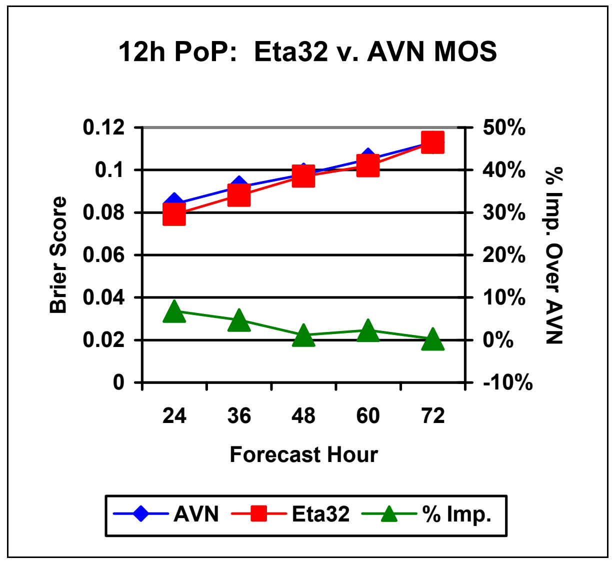

Figure 5. Same as Fig. 3, but for AVN MOS in place of NGM MOS.

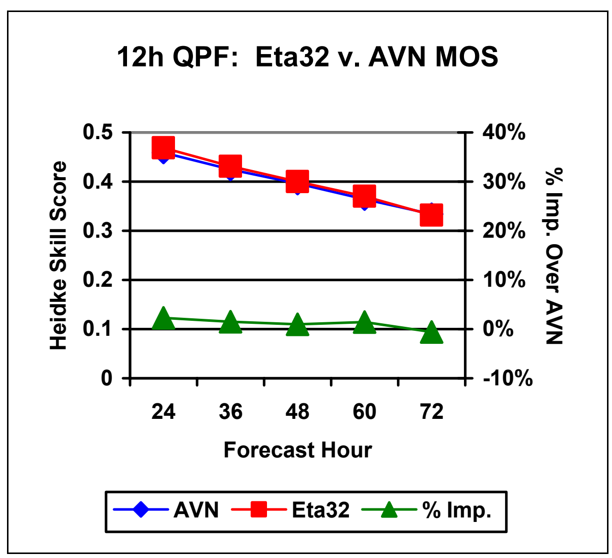

Figure 6. Same as Fig. 4, but for AVN MOS in place of NGM MOS.

based upon verification scores of the new Eta MOS against the currently operational Eta MOS, it appears that little has been gained—at least for the short-range projections. As Figs. 7 and 8 show, there is little to no improvement in skill through 48 hours with the higher resolution data. A significant increase in skill is evident at 60 hours, but recall that in the original Eta MOS development, model fields were available only through 48 hours (Maloney 2002).

There are a few reasons which may explain this lack of improvement in overall skill. First, the new Eta MOS used a somewhat shorter archive than the currently operational system. A longer sample would likely improve the guidance's skill. Also, in the cool season, precipitation is due more to synoptic-scale forcing than mesoscale forcing. Warm season regressions have not been completed yet, but perhaps the higher resolution datasets will improve the skill of forecasting warm season convective precipitation. This work is currently underway and preliminary results will be shown at the conference. Implementation of the new Eta MOS guidance will occur in early 2004.

5. REFERENCES

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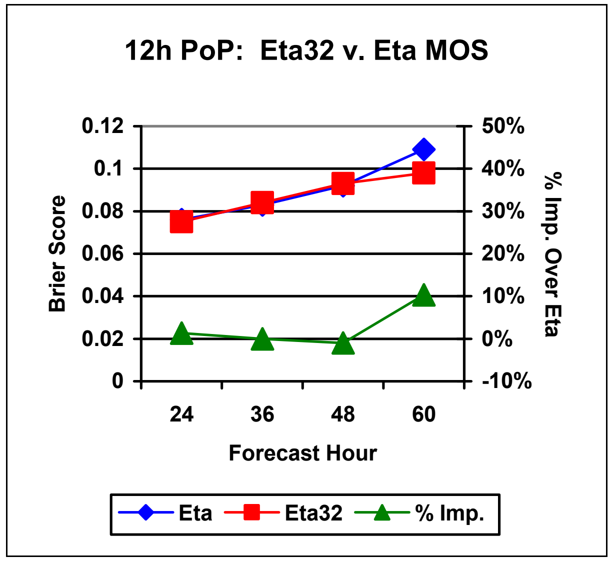

Figure 7. Same as Fig. 3, but for Eta MOS in place of NGM MOS.

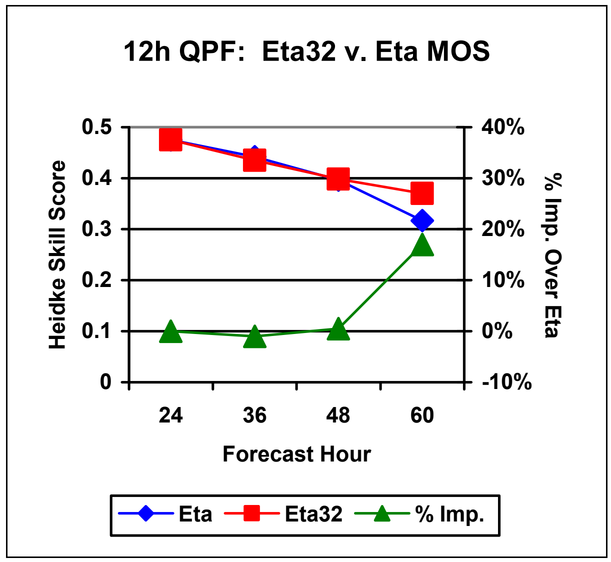

Figure 8. Same as Fig. 4, but for Eta MOS in place of NGM MOS.