

## **Proposal: Replacement of Eta-Based MOS with new NAM-based MOS Products**

### **1. Introduction**

On June 20, 2006, the National Weather Service (NWS) replaced components of the data assimilation, forecast model, and model output statistics used in the North American Mesoscale (NAM) portion of the NWS operational forecasting suite. The 3DVAR data assimilation system was replaced by Gridpoint Statistical Interpolation data assimilation and the Eta model was replaced by the Non-hydrostatic Mesoscale version of the Weather Research Forecast model. For further information about these changes, please see the following Technical Implementation Notice:

[http://www.nws.noaa.gov/om/notification/tin05-68aaa\\_eta\\_replacement.txt](http://www.nws.noaa.gov/om/notification/tin05-68aaa_eta_replacement.txt) .

Tests at the NWS Meteorological Development Laboratory (MDL) showed that output from the non-hydrostatic mesoscale model (NMM) could not be substituted for Eta model output in the operational Eta-based Model Output Statistics (MOS) forecast equations without degrading the accuracy of the guidance. Consequently, at the time the NAM changes were implemented, the NWS began running an interim 32-km Eta model with NAM initial conditions at 0000 and 1200 UTC expressly to support production of the eta MOS guidance. Please see the following notice for further details:

[http://www.nws.noaa.gov/mdl/synop/tin/txt/tin06-40eta\\_mos\\_nmm\\_final.txt](http://www.nws.noaa.gov/mdl/synop/tin/txt/tin06-40eta_mos_nmm_final.txt).

Later, in August 2006, the NWS released a proposal to terminate the production of Eta-based MOS guidance for public comment:

[http://www.weather.gov/om/notification/pns\\_eta\\_mos.txt](http://www.weather.gov/om/notification/pns_eta_mos.txt). Following the public comment period, an analysis of user responses underscored the need to develop a suitable statistically post-processed replacement product from the NAM output before removing the Eta MOS guidance. The NWS has now developed such a replacement product.

### **2. Motivation**

One of the underlying principles of the MOS approach is that the operational forecast equations need to be applied to the same (or nearly the same) analysis and prediction system from which they were developed. The June, 2006 modifications to the data assimilation and model components of the NAM were so extensive that this underlying principle is violated. Verifications performed at MDL for the period of March 1, 2006, through May 31, 2006, support this hypothesis. During that period, test guidance was generated by applying the Eta-based MOS equations to output from the NAM running in a real-time parallel mode at NCEP. Comparisons between the MOS guidance generated by this test method and the operational Eta MOS guidance showed significant degradation in skill when this alternative approach was used. Details of this verification can be found at: <http://www.weather.gov/mdl/synop/wrfmoseval.htm>.

Consequently, in mid-2007, MDL set out to develop a suitable replacement for the Eta MOS system that would be based on output from the NAM suite in a configura-

tion which more closely resembles its current operational state. Initial emphasis was placed on developing replacement equations for forecasting 2-m temperature and dew-point, local maximum/minimum temperature, probability of precipitation (PoP), and wind speed and direction. This strategy was chosen because MOS guidance for these elements appeared to be the most affected by the June, 2006 NCEP model changes.

Experience has shown that two, 6-month seasons of dependent data from a stable NWP model are the minimum required to produce stable statistical relationships when developing MOS equations. However, the development process for the new NAM MOS guidance was further complicated by ongoing changes to the underlying NAM suite during collection of even this minimal amount of data. Not only was the Eta-coordinate model replaced by the NMM in mid-2006, but at least one major change to the operational configuration of the NMM also was made during the dependent data sample. (For more information, please see [http://www.nws.noaa.gov/om/notification/tin06-92nam\\_crisis\\_chg.txt](http://www.nws.noaa.gov/om/notification/tin06-92nam_crisis_chg.txt)) Therefore, since the NAM had been running in its current WRF-NMM configuration for only a few months prior to system development, dependent samples for the NAM MOS contain a mixture of data from the older, Eta-coordinate model and the WRF-NMM in its latest two operational configurations. Despite this, verifications indicate that these new NAM-based MOS guidance products generally are more skillful than either their Eta MOS counterparts or products generated by applying the original Eta-based equations to output from the current configuration of the NMM (i.e. in the same manner as the 2006 tests). For more information on these verifications, please see <http://www.nws.noaa.gov/mdl/synop/nmmoseval.php>.

MOS guidance for other, less frequently observed weather elements is generally developed using a regionalized operator approach, since a short sample of NWP model output generally is not sufficient to develop robust statistical relationships. In this method, data are pooled from a number of climatologically similar observing sites in order to increase the effective sample size for MOS equation development. Because of this, regionalized equations are less finely “tuned” to individual forecast locations and thus are less sensitive to local changes in NWP model biases. This behavior also was seen to hold true in the 2006 verifications performed at the time of the operational NAM changes. Therefore, for these regional MOS elements, the older, Eta-based equations may be applied to the NAM WRF-NMM output with little or no degradation in skill until a sufficient sample of data from the newer version of the model can be collected for redevelopment. MDL expects to complete the redevelopment of equations for all remaining weather elements by early 2010.

Thus, the NAM MOS products described above appear to provide a suitable replacement for the Eta-based guidance. Furthermore, transitioning to the new NAM MOS products will allow NCEP to terminate running of the interim 32-km Eta model in support of the Eta MOS system, thus freeing up these computational resources for other modeling tasks. Therefore, **it is proposed that dissemination of Eta-based MOS products be terminated following the approval of this proposal (after public comment and review), or no later than October 1, 2008. All Eta-based products will be replaced by identical NAM-based MOS products generated by using either new equa-**

tions developed from samples of dependent data which specifically include NMM output or by application of existing Eta-based equations to NMM output. The latter technique will be used only where tests indicate that there will be no adverse effects resulting from the substitution of NMM output.

### 3. List of Eta MOS Products affected/Proposed NAM MOS Replacements

All Eta-based MOS products proposed for replacement have equivalent products available from the new NAM MOS as described in the following sections on alphanumeric products, alphanumeric marine products, BUFR products, graphics products and GRIB products.

#### i. Alphanumeric Messages

The NAM MOS text messages will replace the current operational Eta MOS text products and be available for use by forecasters in a similar manner. NAM MOS text messages will have the same parameters and format as the current Eta MOS. Guidance will continue to be disseminated twice daily (0000 and 1200 UTC) at T+3 hours, and alphanumeric forecasts will continue to be valid for +06 to +72 forecast hours (even though the NAM model runs out to the 84-h forecast projection). Prototype NAM MOS messages are available for viewing at: <http://www.weather.gov/mdl/forecast/text/nmmhybrid.txt>.

The interested user also can find a description of the Eta-based MOS guidance at: <http://www.nws.noaa.gov/mdl/synop/smbpublications.php> or by downloading MDL Technical Procedures Bulletin 05-06 from the following address: <http://www.nws.noaa.gov/mdl/synop/tpb/mdltpb05-06.pdf>.

This proposal should result in few, if any, impacts on AWIPS for the text-based products; new WMO headers will not have to be assigned. However, products will continue to carry the “Eta MOS” labels until the labeling can be updated as part of a future AWIPS build. For all proposed NAM MOS text products, the communication headers and identifiers in the AWIPS database are identical to those currently being used for the corresponding Eta MOS products:

<b>Eta MOS WMO Header</b>	<b>Eta MOS AWIPS Identifier</b>	<b>Guidance Area</b>	<b>NAM MOS WMO Header</b>	<b>NAM MOS AWIPS Identifier</b>
FOAK47 KWNO	METAJK	Southeast Alaska	FOAK47 KWNO	METAJK
FOAK48 KWNO	METAFC	Central Alaska	FOAK48 KWNO	METAFC
FOAK49 KWNO	METAFG	Northern Alaska	FOAK49 KWNO	METAFG
FOPA40 KWNO	METPA0	Hawaiian Islands	FOPA40 KWNO	METPA0
FOUS44 KWNO	METNE1	Northeast Contiguous U.S.	FOUS44 KWNO	METNE1
FOUS45 KWNO	METSE1	Southeast Contiguous U.S.	FOUS45 KWNO	METSE1
FOUS46 KWNO	METNC1	North Central Contiguous U.S.	FOUS46 KWNO	METNC1

FOUS47 KWNO	METSC1	South Central Contiguous U.S.	FOUS47 KWNO	METSC1
FOUS48 KWNO	METRM1	Rocky Mountains -- Contiguous U.S.	FOUS48 KWNO	METRM1
FOUS49 KWNO	METWC1	West Coast -- Contiguous U.S.	FOUS49 KWNO	METWC1

A slight increase in the size of the NAM MOS alphanumeric bulletin is possible because the METAR observations that were available in 2002 (during Eta MOS development), are not the same observations available in 2007 when the bulk of the NAM data sample was collected. A few METAR stations have closed and been dropped from the message, while a greater number of new stations were commissioned and included in the NAM MOS development.

ii. Alphanumeric Marine Messages:

Note that, for NWS forecasters, the proposed replacement will result in all MME messages now in the AWIPS database becoming based on NAM (WRF-NMM) output. Unlike the MOS messages for traditional land-based observing sites, messages for these marine locations contain guidance for only a few weather elements, namely, wind direction, wind speed, temperature, and, at selected sites, dew point:

<b>Eta MOS WMO Header</b>	<b>Eta MOS AWIPS Identifier</b>	<b>Guidance Area</b>	<b>NAM MOS WMO Header</b>	<b>NAM MOS AWIPS Identifier</b>
FQAK47 KWNO	MMEAK1	Alaska	FQAK47 KWNO	MMEAK1
FQPA40 KWNO	MMEHI1	Hawaiian Islands	FQPA40 KWNO	MMEHI1
FQUS41 KWNO	MMENE1	Northeast U.S. Coast	FQUS41 KWNO	MMENE1
FQUS42 KWNO	MMESE1	Southeast U.S. Coast	FQUS42 KWNO	MMESE1
FQUS43 KWNO	MMEGL1	Great Lakes	FQUS43 KWNO	MMEGL1
FQUS44 KWNO	MMEGF1	Gulf of Mexico	FQUS44 KWNO	MMEGF1
FQUS45 KWNO	MMENW1	Northwest U.S. Coast	FQUS45 KWNO	MMENW1
FQUS46 KWNO	MMESW1	Southwest U.S. Coast	FQUS46 KWNO	MMESW1

The interested user can find a description of the MOS marine guidance at:  
<http://www.nws.noaa.gov/mdl/synop/marinedesc.php>.

iii. BUFR Messages:

These products contain all of the MOS guidance available in the alphanumeric products as well as guidance for additional weather elements and projections. As with the NAM MOS alphanumeric products, the communications headers will not change:

<b>Eta MOS WMO Header</b>	<b>Guidance Area</b>	<b>NAM MOS WMO Header</b>
JSML10 KWNO	Hawaiian Islands	JSML10 KWNO

JSML11 KWNO	Northeast Contiguous U.S.	JSML11 KWNO
JSML12 KWNO	Southeast Contiguous U.S.	JSML12 KWNO
JSML13 KWNO	North Central Contiguous U.S.	JSML13 KWNO
JSML14 KWNO	South Central Contiguous U.S.	JSML14 KWNO
JSML15 KWNO	Rocky Mountains – Contiguous U.S.	JSML15 KWNO
JSML16 KWNO	West Coast -- Contiguous U.S.	JSML16 KWNO
JSML17 KWNO	Alaska	JSML17 KWNO

More information about the BUFR messages can be found at the following: <http://www.nws.noaa.gov/mdl/synop/bufr.html>. The interested user can also find detailed information about the stations contained in both the alphanumeric and BUFR messages at the following address: <http://www.nws.noaa.gov/mdl/synop/stadrg.php>.

iv. Graphics Products:

No graphics products based on the Eta MOS guidance are disseminated via the traditional communications networks. However, on the following web page: <http://www.nws.noaa.gov/mdl/forecast/graphics/MET/> a large number of Eta-based MOS graphics are available. These will continue to be available but will be based on NAM output once this proposal has been adopted.

v. Gridded Products:

A large number of gridded Eta MOS products are available in GRIB format on the NWS tgftp server. All of these products, with the exception of the thunderstorm probabilities, are available on a 95.25-km grid (AWIPS grid 213) covering the contiguous U.S. The thunderstorm probabilities are available on AWIPS grid 212 (a resolution of approximately 40 km). All of these Eta-based GRIB products will become NAM-based at the same time as the alphanumeric and BUFR messages.

Users also should be aware that gridded MOS products are available at much higher resolution as part of the National Digital Guidance Database (NDGD). These products are expressly intended to support the NWS National Digital Forecast Database (NDFD), and are currently valid for a 5-km NDFD grid over the contiguous U.S. (CONUS) and at 3-km resolution for Alaska. However, these products are currently based on NCEP's medium-range Global Forecast System (GFS). As the GFS-based gridded MOS system continues to be expanded, additional sets of MOS products encoded in GRIB2 and available over the CONUS will be disseminated on the Satellite Broadcast Network. Additional information on the gridded MOS system and the attendant products may be found at: <http://www.nws.noaa.gov/mdl/synop/gmos.php>.

At this time, GFS-based gridded MOS products for a number of weather elements are available on the NWS tgftp server. See: <ftp://tgftp.nws.noaa.gov/SL.us008001/ST.opnl/DF.gr2/DC.ndgd/GT.mosgfs/AR.conus/> for the data or [http://www.nws.noaa.gov/mdl/synop/gmos/griddedmos\\_ftp.htm](http://www.nws.noaa.gov/mdl/synop/gmos/griddedmos_ftp.htm) for further details. Future plans call for a companion set of similar gridded MOS products to be based on NAM output. Development of these NAM-based gridded MOS products will

begin once equation redevelopment for all observed weather elements has been completed as described above in Section 2.

#### **4. Important Dates**

The period for comment on this proposal will be 30 days from the date that this request for comments is issued.

The proposed date for the termination of the Eta MOS guidance and implementation of the NAM MOS replacement product is at least 75 days after a final decision to replace is made (following review of comments received). If this replacement proposal is accepted, we propose to have the replacement product supported operationally by October 1, 2008.

#### **5. Notification**

The replacement of the Eta MOS guidance will be announced by issuance of a formal Technical Implementation Notice and Request for Change Notice, as well as by a mail message sent to subscribers of the MOS mailing list. See the following web page for the status on upcoming changes to the MOS system or for information on signing up to receive notices of those changes: <http://www.nws.noaa.gov/mdl/synop/changes.php>.

#### **6. Points of Contact**

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