13B.5

AN OVERVIEW OF THE REDEVELOPED LOCALIZED AVIATION MOS PROGRAM (LAMP) FOR SHORT-RANGE FORECASTING

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1. INTRODUCTION

The National Weather Service's (NWS) Meteorological Development Laboratory (MDL) provides objective guidance to NWS Weather Forecast Offices (WFO) to assist in forecasting sensible weather. LAMP, previously called the Local AWIPS MOS Program and now renamed the Localized Aviation MOS Program, is one such objective guidance product developed by MDL. LAMP was designed to run locally at WFOs within the Advanced Weather Interactive Processing System (AWIPS), produce forecast guidance relevant to the WFO's regional area, and serve as an update to Nested Grid Model (NGM) MOS guidance. This NGM-based LAMP system produces guidance for the contiguous United States (CONUS) and provides forecasts at hourly projections out to 20 hours. It has been running locally in AWIPS at WFOs in the CONUS since 1997 and runs every three hours, at 0200, 0500, 0800, …, 2300 UTC (Kelly and Ghirardelli 1998).

MDL is in the process of redeveloping LAMP. The new LAMP product will be run centrally, at every hour eventually, go out 25 hours, and will be valid over the CONUS, Hawaii, Alaska, and Puerto Rico.

In this paper, the reasons for redevelopment are presented, as is an overview of the new LAMP system. The statistical approach used to develop LAMP is discussed, and the specific LAMP forecast elements are detailed. Future LAMP products are discussed, and a sample of verification results are presented. Finally, dates for both experimental and operation implementation, and the dissemination format, are outlined.

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2. RATIONALE FOR REDEVELOPMENT

The most obvious need for a redevelopment of LAMP is that LAMP acts as an update for the NGM MOS, which is no longer the most accurate (Dallavalle et al. 2004), nor the most frequently updated, MOS product. Moreover, the current NGM MOS-based LAMP system provides guidance for less than 1000 stations. The Global Forecast System (GFS) MOS provides guidance for 1500-1600 stations. Also, MDL is updating the GFS MOS when and where necessary, and the NGM MOS is not being updated. Therefore, MDL is redeveloping LAMP to act as an update for the more modern GFS MOS.

In addition, it has been difficult to maintain a local application such as LAMP within the AWIPS environment. Statistical guidance development at MDL is done on the National Centers of Environmental Prediction (NCEP) supercomputers, and not on the AWIPS platforms. In addition, all current MDL MOS products are produced operationally on NCEP computers and centrally disseminated. Since LAMP is a MOS-like statistical guidance product and uses much of the same software as the MOS products do, it will be more efficient to run the new LAMP system on the NCEP computers, and disseminate the product centrally, rather than to continue LAMP as a local application. It is therefore our plan to run the new LAMP on the NCEP supercomputers.

3. LAMP STATISTICAL APPROACH

The traditional MOS approach consists of developing multiple linear regression equations, where the predictors are selected by a forward selection screening process (Glahn and Lowry 1972). This approach is used in developing LAMP to derive statistical relationships between sensible weather and the following kinds of predictor inputs: MOS guidance, the most recent surface observations, and simple models run hourly (Kelly and Ghirardelli 1998). In addition, the new LAMP system uses some direct GFS model output, 10-km Radar Coded Message (RCM) Mosaic data (Kitzmiller et al. 2002), and climatological and geoclimatic variables for selected elements.

LAMP elements require an additional development step beyond the regression equation development if a best category forecast needs to be made from the probability forecasts. For such elements, statistically derived thresholds are developed to facilitate the best category decision.

4. PREDICTORS

Development has shown that the most useful predictors are recent surface observations and GFS MOS guidance. Since observations used in LAMP are more recent than those that were available when GFS MOS ran, LAMP is in essence using the more recent observation to update GFS MOS. This update is especially useful in times of rapidly changing surface conditions, such as frontal passages or lowering aviation conditions.

As mentioned above, LAMP relies on various kinds of inputs as predictors in the regression equations. The various types of predictors are detailed here. In general, predictor data are from April 1997 to October 2004.

4.1 *Observations*

The main premise of the LAMP system is that the most recent surface observations can have strong predictive value in updating the MOS forecasts. By including the most recent observation, LAMP is taking advantage of the strong predictive value of the observation, and using it at those projections at which it can help to update the MOS.

The majority of observations used are hourly METAR reports. These observations are used as they are reported at the station after undergoing some quality control checks.

In addition, radar data are used as predictors for thunderstorm development. The 10-km radar data used in the development of the statistical equations is from two sources: the 16-level 2-km WSI radar archive available from NASA's Global Hydrology Resource Center (GHRC), and the 7-level 10-km RCM radar mosaic available from the NWS (Kitzmiller et al. 2002). The 10-km RCM radar mosaic from the NWS is used as the predictor in real-time.

Finally, observed lightning data from the National Lightning Detection Network (NDLN; Cummins et al. 1998) are used in the development of thunderstorm probabilities. These data were obtained from GHRC.

LAMP uses two types of equations, which we call “primary” and “backup” equations. Primary LAMP equations use observations as predictors. There are times when the observation is missing at the station, which means the primary equation cannot be evaluated. Backup LAMP equations do not use observations as predictors, and are developed so that a forecast can still be made if the observation is missing. Backup equations use as predictors “analyzed observations” which are hourly observations analyzed to a grid and interpolated back to the station. For a full description of the objective analysis technique, see Glahn et al. (1985). These analyzed observations act as a surrogate for the missing observation in the backup equation. If MOS is missing, no forecast can be made since MOS is used as a predictor in both the primary and backup equations.

The strategy for primary and backup thunderstorm equations, neither of which use station observations, is slightly different. Radar observations, which are useful in the thunderstorm development, are included as predictors in the primary equations. However, radar observations may be missing at times, so backup equations are developed which do not include radar as predictors. If the MOS or lightning observations are missing, no thunderstorm guidance can be made since these predictors are in both primary and backup equations.

4.2 *LAMP Models*

Output data from very simple models run hourly are used as predictors in the LAMP system. These LAMP models consist of a Sea Level Pressure model (Unger 1982), a Moisture model (Unger 1985), and an advective model called the Cloud Advection Model (CLAM; Glahn and Unger 1986), which advects the analyzed observations. Output from the advective model is used to give an indication of upstream surface conditions. These models are driven by fields from the GFS model.

CLAM provides advective forecasts for a number of surface fields. Testing to date has found that the advected fields of temperature, dewpoint, ceiling heights, and occurrence of precipitation have been useful predictors, although their overall contributions to the equations are small.

4.3 *Model Output Statistics*

The goal of the redeveloped LAMP is to provide an update to GFS MOS guidance. GFS MOS has been operational since May of 2000 (Dallavalle et al. 2004), and has undergone updates and revisions since then. To ensure the MOS data used in LAMP represents the most up to date MOS forecasts, the most recent MOS equations and thresholds were run retrospectively back to April of 1997 for MOS thunderstorm guidance, and October of 1998 for all other MOS guidance. This affords LAMP with several years of data for a stable development.

New GFS MOS is run four times daily off the 0000, 0600, 1200, and 1800 UTC GFS model runs. The guidance is typically available no sooner than 4 hours after the nominal time of the model run. When deciding which cycle of GFS MOS to use as an input to LAMP in development, the operational availability of the MOS was considered. It was decided to use whichever MOS cycle would be the most recent at the time the LAMP cycle was to start running. For the 0900 UTC LAMP development discussed here, the MOS used is from the 0000 UTC GFS cycle.

MOS elements are in general valid at 3-hourly projections, with some exceptions such as 6- and 12-h probability of precipitation. Since LAMP establishes statistical relationships with predictands and predictors valid hourly, it is desirable to have MOS valid at hourly projections. To achieve this, software was written to provide MOS guidance valid at the hours between the standard projections. In most cases, this "off-hour" MOS is merely a linear interpolation of the MOS valid at the 3-hourly projections. However, in some cases, a more complicated interpolation scheme is used to obtain a meaningful representation of the MOS at all hours, especially when the MOS predictand represents a forecast valid over a time period.

5. PREDICTAND DEFINITIONS

Predictands are obtained from observations taken from METAR reports for all elements except for LAMP thunderstorms, whose predictand is obtained from observations of lightning strikes from the NLDN. The predictand data archive extends from April 1997 through October 2004 for thunderstorm development, and from October 1998 through October 2004 for all other predictands.

Four LAMP predictands--temperature, dewpoint, wind components, and wind speed--are developed in such a way that each station has its own equation. Only data specific to the station go into the development of that station's equation. This was done this way because a sufficient sample of predictand data existed for each station. The remaining LAMP elements are developed regionally, meaning that the data from stations within a defined "region" were pooled to increase the sample size for that region. An equation for that region was then developed from the pooled data. For those elements developed regionally, stations within a region share a common equation for each predictand, although the inputs into the equation are station specific.

The equations and thresholds are developed from data stratified by two seasons, where the seasons were defined to be a warm season (April – September), and a cool season (October – March). The thunderstorm development uses data stratified into three seasons: Summer (July 1 - October 15), cool (October 16 – March 31), and spring (April 1 – June 30) (Charba and Liang 2005). Wherever possible, 15 additional days of data on either side of the season are included in the development to assist in the transition between the seasons, and also to increase the data sample size slightly.

LAMP predictand definitions match up consistently with MOS predictand definitions, with limited exceptions. The LAMP predictand definitions follow. Unless otherwise noted, all predictands are provided hourly out to 25 hours.

5.1 *Hourly Temperature and Dewpoint*

Temperature (TMP) and dewpoint (DPT) guidance are derived from hourly observations at 2 meters above the ground.

5.2 *Wind Speed and Direction*

The wind speed (WSP) and direction (WDR) forecasts have the same definition as the observed wind speed and direction. The predictand data represent the observations 10 meters above the ground. The wind direction is given in tens of degrees. On a technical note, the actual LAMP equations predict the u- and v-wind components of the wind, and the wind speed. The direction is computed from the u- and v-wind components. This is comparable to how wind was done in the NGM LAMP system (Glahn 1984) and in the GFS MOS system (Dallavalle et al. 2004).

5.3 *Wind Gusts*

There is no wind gust guidance available from any MOS guidance, and yet it is an important element, especially for the purposes of aviation forecasting. With the LAMP redevelopment, wind gust guidance (WGS) will be provided. This offers a new and exciting objective guidance element.

The definition of a forecasted wind gust is the same as an observed wind gust-–it is the highest instantaneous wind speed in the 10-minute period before the observation is taken, provided that the difference in the wind speeds between the highest (peak) and lowest (lull) in the 10-minute period is at least 10 knots (OFCM 1995). The LAMP wind gust guidance is unlike other elements that always provide a numerical forecast. The gust is determined via a two-tiered decision which results in either a wind gust speed or a forecast of "no gust." If the LAMP wind gust probability for a gust occurring is not high enough, "no gust" is forecast. If the probability for a gust occurring is high enough, then the LAMP wind gust speed is checked to see if it meets certain criteria. If so, a wind gust speed is forecast. Therefore, the user might see a forecasted gust value only at some projections, with "no gust" forecast at the remainder of the projections. See Wiedenfeld (2005) for a more detailed discussion of the wind gust development.

5.4 *Probability of Precipitation Occurring*

LAMP forecasts a probability of precipitation occurring on the hour (PPO) valid hourly out 25 hours. The precipitation need not be measurable. The predictand data come from the METAR observations of present weather. There is no comparable forecast element in MOS, but this element is forecast by the NGM LAMP system (Kelly and Ghirardelli 1998). From this probability, thresholds are calculated and used to make a best category forecast of "yes" or "no" for precipitation occurring (PCO). The idea behind this unique predictand is that it would be useful to forecasters in determining precipitation onset and stop.

5.5 *Probability of Precipitation*

The probability of 0.01 inches of precipitation or more in a 6-h period (P06) and a 12-h period (P12) are provided in LAMP. These forecasts are valid for either the 6- or the 12-h period ending at the times of 0000, 0600, 1200, and 1800 UTC.

5.6 *Precipitation Type*

LAMP provides forecasts for precipitation type. Probabilities of freezing (POZ), snow (POS), and liquid precipitation types are provided. The probabilities are post-processed to develop thresholds. The thresholds are then used to forecast a best category of precipitation type (TYP), which is one of the three types listed above. Note that this development is done only using events when precipitation was reported. Therefore, the probabilities and best category forecasts are conditional on precipitation occurring. In other words, the precipitation type best category might indicate snow, and that means that if there *were* precipitation at that hour, LAMP is forecasting that the precipitation type would be snow.

The definitions of the precipitation types are as follows: "Snow" consists of pure snow or snow grains; "freezing" consists of freezing rain or drizzle, ice pellets, or any combination of another precipitation type with freezing; and "rain" which consists of pure rain or drizzle, or rain mixed with snow.

The equations and thresholds are being developed from data from September 1 through May 31. This is different from the other LAMP elements which have different equations for the warm and cool seasons. This is done because there are typically none or very few non-liquid precipitation type observations in the typically defined "warm season," so the cool season was extended slightly, and no warm season equations are developed. However, we plan to provide summer precipitation type forecasts valid in June, July, and August for Alaska, but this development is contingent on there being enough cases of non-liquid events to allow for a skillful forecast.

5.7 *Ceiling Height and Total Sky Cover*

Ceiling height is defined to be the lowest level of clouds aloft that is either broken or overcast, or the vertical visibility into an indefinite ceiling (OFCM 1995). LAMP provides probabilities for ceiling heights in categories. Thresholds are derived from the probabilities. The thresholds and probabilities are used in post-processing to arrive at a best category forecast (CIG). The best category definitions are shown in Table 1.

In addition, LAMP will also provide probabilities and a best category forecast for “conditional” ceiling (CCG). To develop this element, only events when precipitation was reported are included in the developmental sample. In this way, the forecasted ceiling is conditional on precipitation occurring. An aviation forecaster could use this guidance in a Terminal Aerodrome Forecast (TAF) to indicate what level the ceiling might lower to during precipitation. The best category definitions for conditional ceiling are consistent with the definitions for ceiling, as shown in Table 1.

Table 1. LAMP Ceiling Height Best Category Definitions

Category	Ceiling Height
1	< 200 feet
2	200 – 400 feet
3	500 – 900 feet
4	1000 – 1900 feet
5	2000 – 3000 feet
6	3100 – 6500 feet
7	6600 – 12,000 feet
8	> 12,000 feet or unlimited

Total sky cover is forecast by LAMP, and is developed together with ceiling height to ensure that the same predictors are included in the equations for both elements. This is done to reduce inconsistencies between the forecasts. The probabilities of each total sky cover category are post-processed to obtain thresholds used in determining the best category forecast (CLD). The best category definitions are listed in Table 2. See Weiss and Ghirardelli (2005) for a discussion of the ceiling and sky cover development.

Table 2. LAMP total sky cover best category definitions

Category	Total Sky Cover
CL	Clear
FW	Few: > 0 - 2 octas
SC	Scattered: > 2 – 4 octas
BK	Broken: > 4 - < 8 octas
OV	Overcast

5.8 *Visibility and Obstruction to Vision*

Probabilities of visibilities are provided by LAMP. As with ceiling, the visibility probabilities are post-processed to obtain thresholds which are used to select best category forecasts (VIS). The best category definitions are shown in Table 3.

As with ceiling, LAMP provides a conditional visibility (CVS) for the same aviation purpose: to provide guidance to the forecaster regarding what the visibility would be if precipitation were to occur. Again, only cases when precipitation occurred are used in the development, and the probabilities and best category forecasts are therefore conditional on precipitation occurring. The categories are consistent with those shown in Table 3.

Table 3. LAMP visibility best category definitions

Category	Visibility
1	< ½ mile
2	½ - < 1 miles
3	1 - < 2 miles
4	2 - < 3 miles
5	3 – 5 miles
6	6 miles
7	> 6 miles

Obstruction to vision was developed together with visibility to reduce inconsistencies between the forecasts. Probabilities of obstruction to vision are computed for five possible categories, and thresholds are also computed to arrive at a best category forecast (OBV) from the probabilities. Best category definitions are shown in Table 4. See Rudack (2005) for a more detailed discussion of both the visibility and obstruction to vision development.

Table 4. LAMP obstruction to vision definitions

Category	Obstruction to Vision
N	None of the following
HZ	Haze, smoke, or dust
BR	Mist (fog with visibility >= 5/8 mile)
FG	Fog or ground fog (fog with visibility < 5/8 mile)
BL	Blowing dust, sand, snow

5.9 *Precipitation Characteristics*

Although not currently done, our plan is for LAMP to provide forecasts of precipitation characteristics. These forecasts will be conditional on precipitation occurring. The best category definitions will most likely be the same as for the GFS MOS: Drizzle, continuous precipitation, or showers (Dallavalle et al. 2004).

5.10 *Cloud Layers*

The old LAMP system provided for cloud layer forecasts of cloud amounts and heights for up to three layers (Kelly and Ghirardelli 1998). At present, work has not been completed on the new LAMP cloud layers. Until cloud layers are developed, users can use categorical ceiling forecasts from LAMP for cloud guidance.

5.11 *Thunderstorms*

LAMP provides forecasts of the probability of one or more lightning strikes in a 2-h period in a 20-km grid box (TP2). This product differs from the GFS MOS thunderstorm probabilities in that the MOS probabilities are valid over a 3-h period. We use a Lambert conformal grid that covers the CONUS and the waters just off-shore. Unlike the other LAMP predictands, this predictand is gridded, and is not provided for Alaska, Puerto Rica, or Hawaii since there is not a sufficient lightning database over those areas. Also unlike other LAMP elements, observations used for the thunderstorm predictand are from the NLDN observations of lightning strikes, and not from METAR reports. Lastly, the predictand is stratified into three seasons rather than the two seasons used by the other LAMP elements (Charba and Liang 2005).

Thunderstorm probability forecasts are valid for 2-h periods ending 3, 5, 7, …, 23, and 25 hours after the LAMP start time. From these probabilities, thresholds are calculated to provide for best category forecasts of "yes" or "no" if a thunderstorm is forecast to occur during the 2-h period (TC2).

6. VERIFICATION RESULTS

In general, the verification over an independent sample for 0900 UTC warm season LAMP shows that LAMP is improving on both persistence and the MOS out 9 to 15 hours, depending on the element. After that period, the LAMP is generally comparable to or better than MOS. An exception here is that the LAMP ceiling forecasts show an improvement over MOS for the entire 25-h period. This improvement is greater for lower ceilings. It is believed that the observations of low ceiling persist greatly, and maintain some predictive value even out 25 hours. The cool season results are comparable. A sample representative of our findings from verification of the 2004 warm season is presented here.

Verification results for the 0900 UTC warm season for temperature are shown in Fig. 1. This shows the Mean Absolute Error (MAE) of the forecasts of LAMP compared to that of MOS and persistence. A lower MAE indicates a more accurate system. It can be seen that LAMP is more accurate than persistence for the entire 25-h period, and more accurate than MOS through the first 12 hours. LAMP is comparable to MOS from hours 13 – 25.

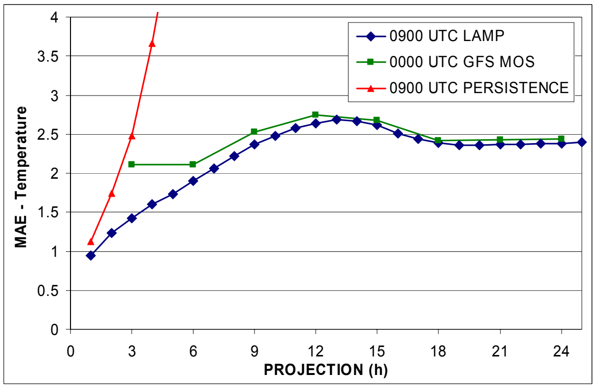

Figure 1. Temperature MAE in degrees Fahrenheit for 0900 UTC warm season 2004.

Figs. 2 shows threat scores for visibility less than 3 miles. A higher threat score is a better score. LAMP improves on persistence throughout the period, and on MOS through about the 9-h projection, with a slight improvement over MOS in the end period of 18 – 25 hours. LAMP is comparable in accuracy to MOS for projections 10 – 17.

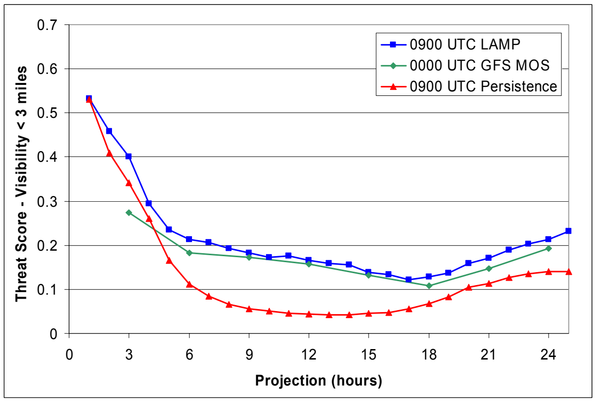

Figure 2. Threat score for visibility < 3 miles for 0900 UTC warm season 2004.

Fig. 3 shows threat scores for ceilings less than 1,000 feet, and shows that LAMP is as accurate as persistence in the first 2 or 3 hours, and improves on persistence thereafter. LAMP is more accurate than MOS for the entire 25 hours.

We believe this improvement over MOS throughout the period is due to the strong predictive value of the observation for lower ceilings.

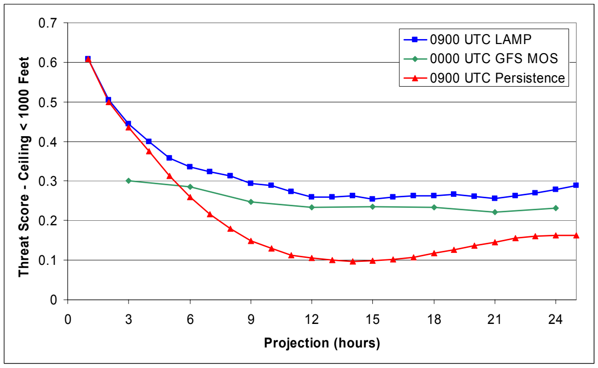

Figure 3. Threat score for ceiling height < 1,000 feet for 0900 UTC warm season 2004.

In addition to verifying visibility and ceiling separately, we verify LAMP for conditions of Instrument Flight Rules (IFR) or lower. IFR is a flight category defined to be when the visibility is greater than or equal to 1 mile, and less than 3 miles, and/or the ceiling is greater than or equal to 500 feet, and less than 1000 feet (NWS 2005). Fig. 4 shows the threat score for flight categories of IFR conditions or worse. It can be seen from this that LAMP is as accurate as persistence at the first hour, and improves on persistence beginning with the second hour. LAMP is more accurate than MOS for the entire 25-h period, which is most likely an artifact of LAMP being more accurate than MOS for ceiling forecasts less than 1,000 feet.

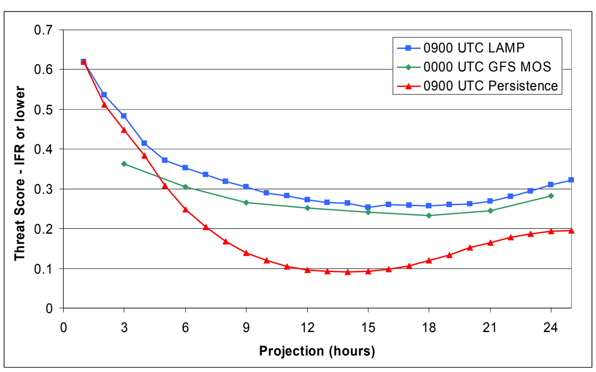

Figure 4. Threat score for IFR conditions for 0900 UTC warm season 2004.

Fig. 5 shows the Heidke Skill Score of our new guidance element of wind gusts. A higher Heidke Skill Score indicates more skill. The eight categories verified were a category for no gusts or gusts less than 18 knots, and seven discrete categories of gusts from 18 knots to greater than 48 knots. There is currently no GFS MOS wind gust guidance, so it was not possible to verify the LAMP gusts directly against the MOS gusts. However, to get a flavor of the skill that might be contained in the GFS MOS wind <u>speed</u> forecasts, a MOS pseudo gust was derived, which was simply the GFS MOS wind speed multiplied by 1.5. This pseudo MOS gust has to exceed 13.5 knots for it to be considered as a gust for the purposes of this verification. Any observed wind gust was persisted as a gust. It can be seen here that LAMP provides skillful guidance over both persistence and the pseudo wind gust derived from the GFS MOS wind speed for the whole 25-h period.

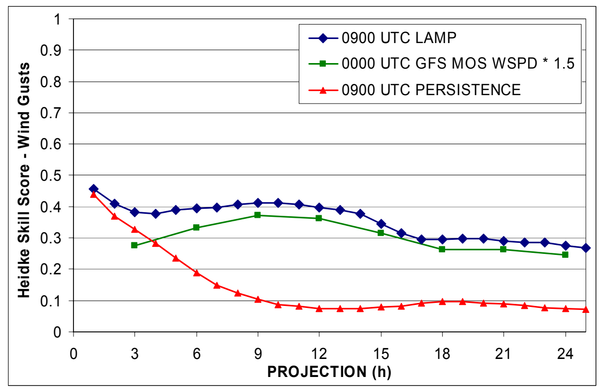

Figure 5. Wind Gust Heidke Skill Score for 0900 UTC warm season for 2004.

7. CURRENT STATUS

At the time of this writing, the first cycle of LAMP, 0900 UTC, was under development and nearing completion. 0900 UTC was chosen as the first LAMP cycle to be developed because it is believed that this cycle will be available in good time for consideration in making the TAFs issued at 1200 UTC. The warm season equations, and thresholds where applicable, for temperature, dewpoint, u- and v-wind components, wind speed, wind gusts, visibility, conditional visibility, obstruction to vision, ceiling heights, probability of precipitation occurring, and probabilities of precipitation occurring in both 6- and 12-h periods have been completed. Cool season equations for many of these elements were also completed, with all cool season development for these elements to be completed shortly.

Equations and thresholds for warm season conditional ceiling guidance and precipitation type will be completed soon, as will the thunderstorm equations for the season beginning in July.

Precipitation characteristic development will begin shortly. Cloud layer development is not currently in progress.

We are running the completed warm season equations and thresholds on the NCEP supercomputers once a day. The forecasts are run through simple quality control programs to check for unreasonable or questionable forecasts. Graphical depictions of the LAMP forecasts, MOS forecasts, and verifying observations are produced for all 1523 stations, and posted to an internal web site for viewing by the LAMP developers for checkout purposes. In addition to the meteograms, we are also creating a test alphanumerical text bulletin for all of the stations; see Fig. 6 for a sample of the LAMP bulletin.

8. FORECAST PRODUCTS

The old LAMP system's products are not officially disseminated. They are created within AWIPS, and are not transmitted from there. However, we are running the old LAMP system in a non-official capacity on the NCEP computers. We put products generated from these runs to our web site, http://www.nws.noaa.gov/mdl/lamp/. This web site offers LAMP analyses, forecasts in bulletin format, gridded images for LAMP Quantitative Precipitation Forecasts (QPF), and station meteograms. We will likewise send the new LAMP products in similar formats to our internet site. Of special note is that there is no provision for continuing the QPF forecasts in the new LAMP system, so the gridded QPF forecasts will be discontinued at some point.

We plan to disseminate the new official LAMP products similarly to how MOS products are disseminated. Alphanumeric guidance will be provided. Fig. 6 shows an example of our new LAMP bulletin, with the abbreviated guidance elements consistent with those indicated previously in the text. The thunderstorm guidance is a gridded product, but is interpolated to the station for the purposes of the bulletin. It is not our intent to show probabilities in the bulletin other than the precipitation type probabilities of snow and freezing, nor do we intend to show the guidance for precipitation characteristics or 12-h probabilities of precipitation in the bulletin.

In addition to the alphanumeric guidance, we plan to disseminate all the station guidance, including all probabilities as well as guidance for precipitation characteristics and 12-h probabilities of precipitation, in bufr format. The gridded thunderstorm guidance will be disseminated in GRIB2 format.

The plan is for the new LAMP forecasts to be available in AWIPS similarly to how MOS is, with AWIPS receipt and processing of the alphanumeric message and the bufr data. In addition, our plan is that the thunderstorm gridded data will be available in AWIPS via the Volume Browser.

KBWI GFS LAMP GUIDANCE 5/10/2005 0900 UTC

UTC	10	11	12	13	14	15	16	17	18	19	20	21	22	23	00	01	02	03	04	05	06	07	08	09	10
TMP	58	60	64	68	71	72	75	76	77	78	78	78	77	76	73	70	67	65	63	61	60	59	58	58	57
DPT	52	53	54	53	53	53	52	51	51	51	51	50	51	51	51	52	53	54	53	54	54	53	53	54	54
WDR	25	25	26	27	29	29	29	29	29	29	29	29	29	29	30	30	30	31	30	30	33	01	34	35	36
WSP	04	04	05	08	08	09	10	09	10	10	10	09	09	07	04	01	01	01	01	01	01	02	01	01	02
WGS	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG	NG
PPO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	2	3	3
PCO	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
P06									2						2						4				
TP2			1		0		0		0		1		2		0		2		2		0		0		0
TC2			N		N		N		N		N		N		N		N		N		N		N		N
POZ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
POS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TYP	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
CLD	SC	SC	SC	SC	SC	SC	SC	SC	FW	FW	FW	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	CL	SC	SC
CIG	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
CCG	8	7	7	7	7	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
VIS	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
CVS	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
OBV	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N

Figure 6. LAMP alphanumeric message.

We plan to begin running the new LAMP system in a job stream parallel to operations at NCEP beginning in September 2005. At this time, all elements except for cloud layers, and possibly precipitation type and precipitation characteristics, should be running. The 0900 UTC LAMP products should become fully operational during 2006. When the 0900 UTC LAMP development and implementation are completed, we will begin work on the remainder of the LAMP cycles, with the next LAMP cycle being either 1500 or 2100 UTC.

9. CONCLUSIONS AND FUTURE PLANS

The redevelopment of the LAMP system offers the forecasting community a mechanism for a rapid refresh of guidance by using the most recent data available. LAMP will be updating GFS MOS hourly, running centrally, and providing guidance for over 1500 stations as well as thunderstorm guidance on a 20-km grid out 25 hours. We believe that this guidance, for these reasons, will provide more timely and vital guidance than the NGM MOS-based LAMP guidance, and will be of great interest to the aviation community. Results from 0900 UTC indicate that LAMP is typically superior to both persistence and 0000 UTC GFS MOS in the early periods of 1-9 hours, and sometimes as far out as 15 hours. LAMP provides improved ceiling guidance for lower ceilings throughout the 25-h period, which translates into a good improvement over MOS for forecasting of IFR or worse conditions.

Future work will focus on developing and implementing LAMP equations and thresholds for all hours. In addition, a possible area of exploration in the future is the incorporation of observations referred to as “specials” into the LAMP system. Specials represent observations between the regular hourly reporting times, and might capture changing conditions better than the hourly METAR data alone would. Incorporation of the specials might provide even more accurate short-range forecasts for aviation purposes.

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