# J12.3 THE NEW AND IMPROVED LOCALIZED AVIATION MOS PROGRAM (LAMP) ANALYSIS AND PREDICTION SYSTEM

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## 1. INTRODUCTION

The Local AFOS MOS Program (LAMP) was conceived in the late 70's (Glahn 1980) and developed for the Automated Field Operations and Services (AFOS) system (Glahn and Unger 1986). It was implemented on the Advanced Weather Interactive Processing System (AWIPS) with the name Local AWIPS MOS Program (Kelly and Ghirardelli 1998). This system is currently furnishing guidance for most sensible weather elements for projections out to 20 hours. Because of resource limitations and other constraints, it is implemented on an 80-km grid over only the contiguous United States (CONUS).

Due to NWS requirements for guidance over all 50 states, as well as increased hardware capability and data availability, we are redeveloping the system and have given this analysis, modelling, and prediction system the more appropriate name Localized Aviation MOS Program (LAMP). This system will be implemented centrally on the NWS mainframe computer, and the output will be furnished to users in much the same way as MOS forecasts based on the National Centers for Environmental Prediction (NCEP) Global Forecast System (GFS) are furnished today. LAMP will run every hour and furnish guidance at hourly intervals.

The main thrust of LAMP, in addition to its furnishing updated, timely MOS guidance for all sensible weather elements, will be improved forecasts for aviation. Inputs will include lightning strike, radar, and eventually satellite data on a 10-km grid and perhaps output from a small scale dynamic model [e.g., the Rapid Update Cycle (RUC)], as well as METAR observations and MOS forecasts. Regression analysis will determine the optimum blend of all input data for the various predictands. For the early projections (e.g., 1 and 2 hours), the forecasts will be heavily influenced by persistence and advective fields. At the longest projections, the update forecasts will fair into the MOS. At mid-projections, statistics will furnish an optimum blend of all inputs. The guidance from LAMP will assist forecasters in updating grids in the National Digital Forecast Database (NDFD) (Glahn and Ruth 2003) on an event or hourly basis rather than on a 6-h cycle time afforded by most NCEP model and MOS guidance.

This paper shows some results from the current model implemented on AWIPS and discusses the improvements being made for the new implementation in late 2004.

## 2. CURRENT SYSTEM

LAMP has been furnished to each Weather Forecast Office (WFO) in the CONUS and is run on AWIPS. LAMP is designed to be relatively insensitive to changes in NCEP models. At early projections, the current observation (persistence) plays a major role, either as raw input to the predictive regression equations or from the simple advection models, so changes in MOS and NCEP models have relatively little effect. At the longer projections, say greater than 12 hours, MOS plays the major role, so the predictive LAMP equations will carry the improvements in the MOS forecasts as the NCEP model and MOS changes. At intermediate hours, when the blend of persistence and MOS is important, there will be some influence on LAMP predictions, because the equations will not be optimal. However, experience has shown this to not be a major problem, as expected.

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For instance, the currently implemented LAMP equations were based on MOS developed from the Limited area Fine Mesh (LFM) model (Gerrity 1977) but are implemented with MOS developed from the Nested Grid Model (NGM) (Phillips 1979). Figures 1 and 2 show, respectively, the Heidke Skill scores (NWS 1982) for visibility for a warm (April-September 2002) and cool (October 2002-March 2003) season for a LAMP 0500 UTC start time along with comparative scores for persistence, NGM MOS, and MOS based on the GFS. The figures show (1) LAMP and persistence are essentially of equal skill at the 1-h projection, and persistence deteriorates rather rapidly; (2) LAMP is better than NGM MOS (its current input) for

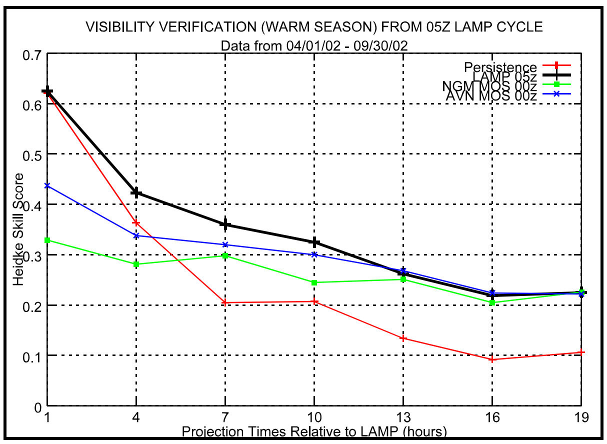


**Figure 1.** Heidke Skill score for current LAMP visibility forecasts for April - September 2002.

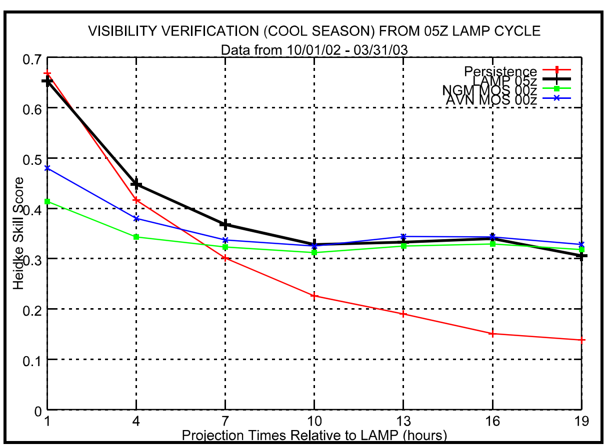


**Figure 2.** Heidke Skill score for current LAMP visibility forecasts for October 2002 - March 2003.

projections less than 13 hours, with little difference between the two after that; and (3) GFS MOS outperforms NGM MOS especially at the early projections. An implication is that LAMP based in both development and implementation on GFS MOS should outperform GFS MOS alone and the current LAMP.

## 3. IMPROVEMENTS IN NEW SYSTEM

It became apparent a few years ago that the current LAMP system could not meet the need for detailed aviation forecast guidance. It was also apparent that no other guidance was available that met that need. Improvements in the new development and implementation that we believe will do that are given here.

### 3.1 *Analyses*

Input to LAMP are analyses of sea level pressure, saturation deficit, and various weather elements like ceiling height, visibility, and wind. The Cressman (1959) analysis technique is used for "continuous" variables and the nearest neighbor technique for categorical and discontinuous variables [see Glahn and Unger (1986) for elaboration]. Current hardware will support a finer grid than the current 80-km LAMP grid. Considerable testing was done with sea level pressure, as well as other continuous (i.e., non categorical) weather variables, to see whether the observations currently and reliably available analyzed on a grid more resolute than 80 km would be better for input to the LAMP system than analyses on the current 80-km grid. The testing showed that detail added on a, say, 10-km grid did not meet the "subjective analyst" test and had to be, in general, smoothed out. However, improvements were made to the analysis technique to keep detail in troughs and lows. This improvement should help with surface wind forecasting, especially in areas of particular importance.

The saturation deficit analysis has been improved with 10-km radar data input as an override feature on the last analysis pass. Radar data at a coarser resolution was used for the previous development, but was not implemented on AWIPS. Wind continues to be on an 80-km grid; available observations will not support more detail, at least without sophisticated data assimilation that we cannot implement in this simplified system. Other variables such as cloud amount continue to be analyzed by the nearest neighbor approach, but now on a 10-km grid rather than an 80-km grid.

While gridpoint values in data sparse areas are in question, boundaries between, say, cloud and no cloud are better defined in more data dense areas.

### 3.2 *Models*

The same advective models are used that are used in the current LAMP, but are driven by GFS winds rather than NGM and LAMP geostrophic winds; tests were made to find the optimum smoothing for the advective winds. To provide better input to the regression analysis, cloud heights and amounts were analyzed and advected in 10 categories or bins (including obscuration)--categories which match the criteria used in TAF (Terminal Aerodrome Forecast) preparation. The winds used for advection are from the GFS model and at levels appropriate to the cloud heights. Tests were made to determine the best winds to use and how much they should be smoothed.

### 3.3 *Input Data*

MOS forecasts are now available four times per day based on the GFS model, rather than twice a day based on the NGM model, and will be used as input to LAMP. Previously, LFM twice daily forecasts were used for development at 6-h increments and current implementation uses NGM forecasts as input. GFS-based MOS not only provides more up-to-date input and consistent development and implementation data, but also the ceiling height forecasts from MOS and LAMP will be for the same categories. MOS forecasts are interpolated from 3-hourly values for input to the regression analysis. Radar data on a 10-km grid are being included. Satellite cloud data are being planned, but a suitable sample of data over the same time period as our other data is not available at the present time.

Lightning strike data are being used in the new development that are not being used in the current LAMP. This is providing valuable information, especially for very short term thunderstorm forecasting. Where possible, hourly data input to the regression analysis and operational forecasts will be quality controlled by the objective analyses. Natural spatial variability of most weather elements does not allow tight thresholds for quality control, but outliers can be "thrown out." This method of quality controlling the input data is not used in the current LAMP or in MOS.

Direct input from the 20-km RUC model being run at NCEP will be tested (Ghirardelli et al. 2004). Figure 3 shows how the various inputs can contribute to LAMP runs at 0700 and 0900 UTC. MOS based on the 0000 UTC GFS run and RUC from the 0600 GFS cycle would be available. The nominal 0900 UTC LAMP run will start at about 0912 UTC when most hourly data are available and will provide output by 1000 UTC and support the 1200 UTC TAF release. It's conceivable the 1000 UTC LAMP could also contribute, in which case the 0600 UTC GFS MOS and 0900 UTC RUC would be available.

### 3.4 *Regression Software*

A new screening regression program was written which will assist in selecting predictors for the equations which are consistent from hour to hour. One of the noted difficulties with the current LAMP cloud layer forecasts is that they "bounce around" somewhat from hour to hour and if used in TAFs without smoothing would occasion hour-to-hour changes not consistent with forecasting accuracy. A regression run can include a weather variable as a predictand for all LAMP projections, or it can include multiple weather elements (e.g., U- and V-wind components and wind speed) as predictands for all projections. Note that all projections are always dealt with in one run. Selection of predictors can be based on either the maximum additional reduction in variance to a single predictand at a single projection or the average over all predictands and projections. In addition, the capability to directly use the "simulated stratification" (Glahn 1986) procedure has been incorporated.

### 3.5 *Larger Geographic Area*

Current LAMP is available for the CONUS. The new LAMP grid covers all 50 states and Puerto Rico. Implementation for other than CONUS locations will proceed in concert with CONUS areas.

### 3.6 *More Stations*

Currently LAMP produces guidance for about 950 stations; this will be increased to about 1500--the same stations available in GFS MOS.

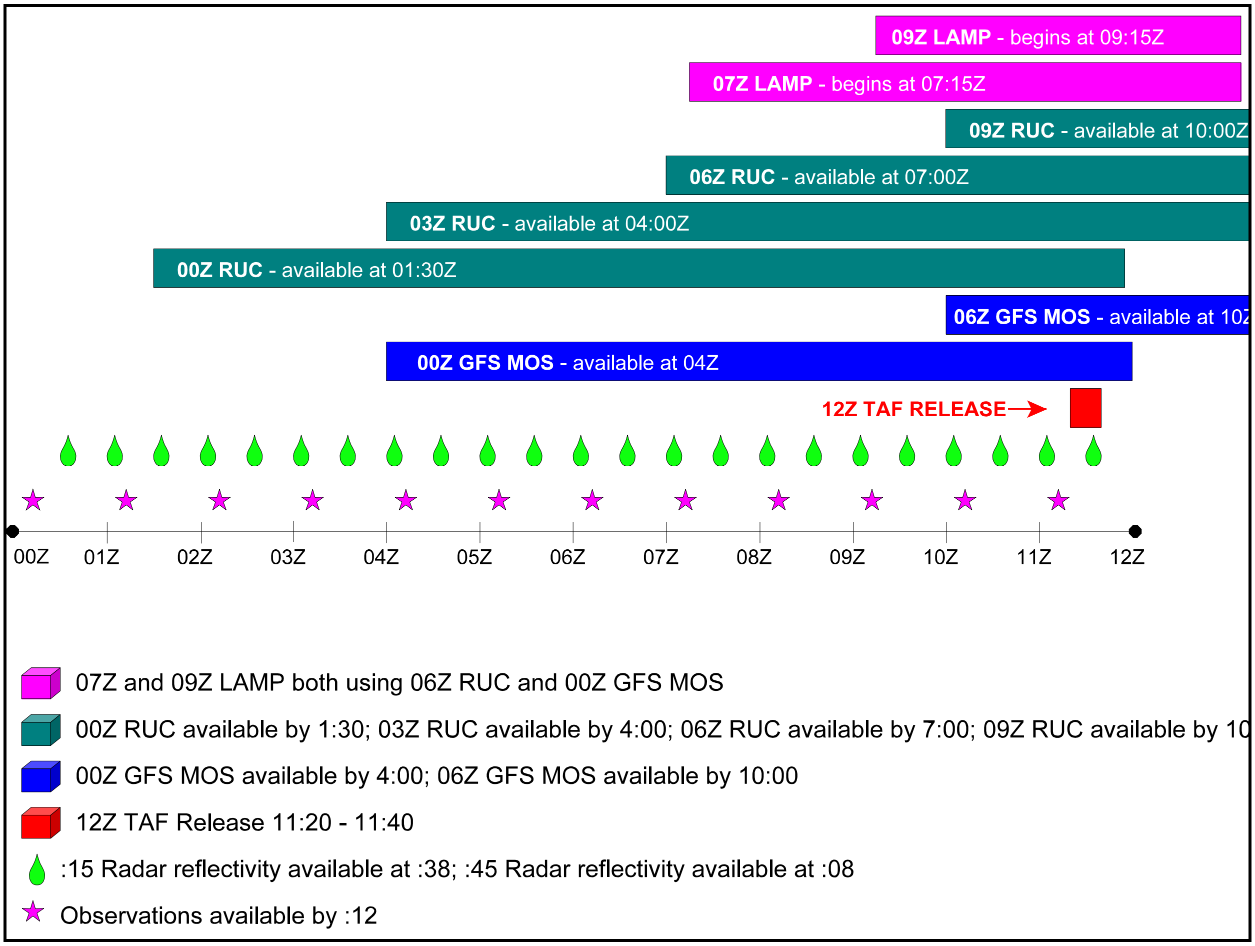


**Figure 3.** Time line of available data sources.

### 3.7 *Gridded Forecasts*

Forecasts will be made available on a 5-km grid consistent with the NDFD. Techniques to do this have to be developed and will be consistent with those being tested for GFS-based MOS. Thunderstorm forecasts will be produced directly on a grid; this is possible because the predictand (lightning data) can be easily defined on a grid.

### 3.8 *Hourly Equations*

Even though LAMP currently runs and produces analyses hourly, equations were developed for only 3-hourly start times, so updated forecasts are produced only every 3 hours. Better organization of the development process and better software will allow development of equations for each hourly start time.

## 4.0 CURRENT STATUS

All analyses and model development are completed and the archival results of the LAMP runs at 0700 and 0900 UTC start times have been completed for a 6 to 7 year sample. Work is still necessary for optimal postprocessing and associated thresholding, which are quite important for final results. Quite likely, the guidance forecasts will be available initially on the web or as downloadable files. Eventually, distribution by AWIPS should be possible.

Figure 4 shows a simplified view of the LAMP development process. It is expected that implementation will begin in 2004 and be completed in phases over a 2-year period as start times and elements are completed.

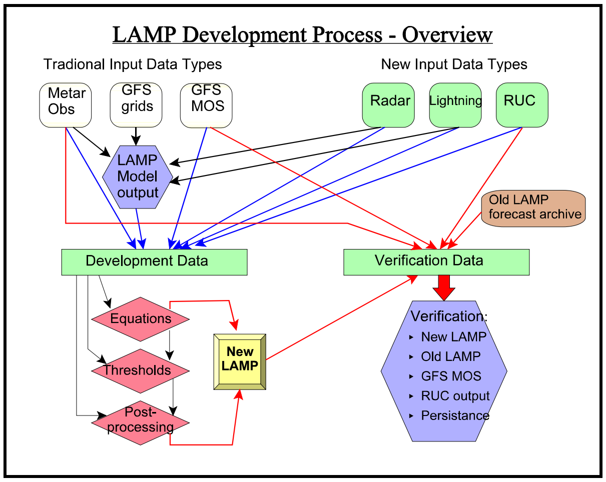


**Figure 4**. An overview of the LAMP development process.

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