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# THE LOCAL AFOS MOS PROGRAM: CURRENT STATUS AND PLANS

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## 1. INTRODUCTION

The Local AFOS MOS Program (LAMP) is a guidance system designed to provide detailed short range statistical weather forecasts and objective analyses of surface conditions. The system will provide hourly forecasts for up to 20 projections at all locations currently receiving MOS guidance, as well as for many additional sites within a forecast office's area of responsibility. LAMP can be initialized at any hour to provide guidance to support any forecast release time.

LAMP consists of a series of programs to decode and analyze hourly data, run simple numerical models, evaluate statistical forecast equations, and display the information. The forecasts are produced by regression equations that combine information from the central MOS guidance, local model output, and the most recent hourly surface observations. LAMP guidance both updates MOS and furnishes forecasts for more projections and locations than are available for the current MOS guidance.

In addition to the forecast guidance, LAMP objectively analyzes the surface observations each hour. The gridfields produced by the analyses, and fields derived from them, can be displayed or used to provide predictors for the statistical guidance. The local analyses are also used to initialize the three locally run numerical models used for LAMP.

The Techniques Development Laboratory (TDL) is developing the LAMP system for implementation at local forecast offices. The system is currently being tested at the Weather Service Forecast Office (WSFO) at Topeka, Kansas. This paper describes LAMP and the prototype system running there. The paper closes with comments about LAMP's integration into the modernized weather service of the future.

## 2. SYSTEM DESCRIPTION

### 2.1 Objective Analyses

The LAMP analysis grid covers most of the conterminous United States and southern Canada, and has a grid spacing of about 83 km at 40°N latitude on a polar stereographic map background. This grid coincides with the course mesh Manually Digitized Radar (MDR) grid with a LAMP gridpoint located at the center of each MDR box. A portion of the grid used for display at Topeka is shown in Fig. 1.

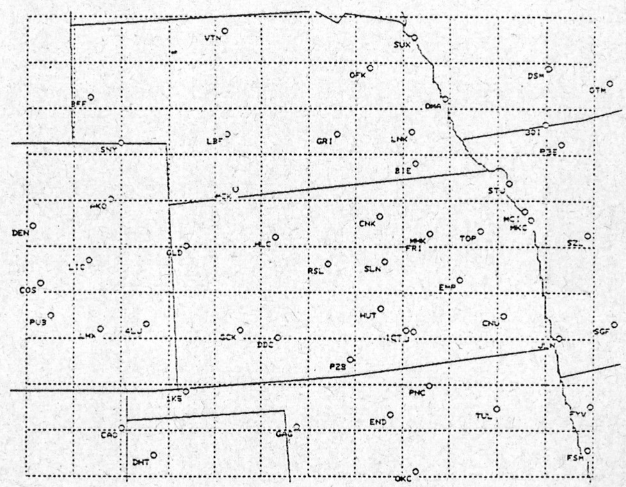

Figure 1. The LAMP grid and station locations over the area used for forecast displays.

Details of the analysis procedures used can be found in Glahn et al. (1984).

LAMP uses a successive correction analysis technique on continuous variables. This procedure is similar to that of Bergthorssen and Doos (1955) and is commonly known as a Cressman analysis (Cressman, 1959). Temperature, dew point, wind (the U and V components and the wind speed), sea level pressure, and a moisture variable known as the saturation deficit are analyzed by this method.

The saturation deficit is an important moisture variable used by the LAMP moisture model and in many of the statistical forecast equations. The parameter indicates the degree of saturation in the 1000- to 500-mb layer. If the amount of moisture in a layer is held constant while the thickness decreases, the air will become more saturated until precipitation begins. The thickness at which precipitation is expected to begin for a given amount of moisture in the atmosphere is known as the saturation thickness. The difference between the saturation thickness and the actual thickness defines the saturation deficit.

An estimate of the saturation thickness is determined by an empirical relationship between the thickness, precipitable water, and precipitation.

Also, the saturation deficit is defined to be zero at locations where precipitation is occurring. The procedure used to estimate the saturation thickness is fully described by Lewis et al. (1985).

The saturation deficit is evaluated at each station and analyzed. The analyzed saturation deficit field is revised on the basis of MDR radar reports of precipitation. The saturation deficit is expressed in meters and ranges from about 500 m to 0.

Another analysis method is used for binary meteorological fields or for elements that may change rapidly over short distances. For these discontinuous fields, the value of the nearest station report is assigned to each gridpoint. Previous hour values are occasionally used in data sparse regions. This analysis technique is used for ceiling, visibility, precipitation type (liquid, freezing, and frozen), and sky cover.

## 2.2 LAMP Numerical Models

The three numerical models used for LAMP (a sea level pressure (SLP), an advection, and a moisture model) were selected because they do not need detailed upper air information for their forecasts. The upper level information required by these models is provided by LFM forecasts of 500-mb heights which are transmitted on AFOS, in gridpoint form, to the local system. The 500-mb heights, available every 6 hours, are interpolated, both in space and time, to obtain an estimate at each hour over the LAMP grid.

All three models use semi-Lagrangian integration to predict changes along the trajectory of an advecting wind. Forecasts output from the models are written to the LAMP database at the end of each of the 1-h timesteps. The models are generally run through the 20-h projection. A brief summary of the three LAMP numerical models can be found in Glahn and Unger (1986).

The SLP model (Unger, 1982) is used to obtain low level advecting winds for the other numerical models, as well as to supply predictors for the statistical guidance. It uses a potential vorticity equation to forecast the 1000-mb heights, initially determined from the LAMP SLP analysis. Geostrophic winds from the LFM 500-mb heights are used by the model to steer the surface systems.

The advection model uses a combination of the 1000 and 500-mb geostrophic winds to advect surface weather elements. Ceiling height, visibility, sky cover, and areas of liquid, freezing, and frozen precipitation are predicted by this model. While advection may not always produce realistic forecasts for these elements, it can provide information about the upstream conditions.

The LAMP moisture model forecasts the saturation deficit. The model conserves the total amount of moisture in the layer between 1000 and 500 mb along the trajectory formed by the same advecting winds used for the advection model. The model compares the terrain elevation and the forecast values of thickness with the initial moisture content (indicated by the saturation deficit) to predict the saturation deficit along the trajectory. A saturation deficit that is forecast to be less than zero at the end of a timestep indicates that the forecast thickness has fallen below the saturation thickness and, therefore, the amount of moisture in that layer is higher than the atmosphere can support. In theory, this excess moisture is removed by the precipitation process.

Any negative saturation deficit forecast by the moisture model is adjusted to zero at the end of each timestep. The amount of this adjustment gives an indication of the forecast precipitation amount. Thus, the LAMP moisture model predicts both the degree of saturation and precipitation. The LAMP moisture model is described in detail by Unger (1985).

## 2.3 Statistical Model

The LAMP statistical model uses screening regression to obtain relationships between the predictors and the predictands. The predictands are obtained from hourly observations of the various weather elements at each location. The predictors come from MOS, the LAMP model forecasts, LAMP analysis fields, and the initial hourly observations.

The interval between MOS projections is usually 3 or 6 hours, and these forecasts are available for about one half of the stations which regularly report hourly observations. A time and space interpolation is used to obtain the MOS forecast predictors for each hour and for every station. A linear time interpolation between the MOS projections supplies hourly MOS forecast estimates. These estimates are then spatially interpolated to each station by a weighted mean of the forecasts at surrounding MOS stations. The weighting was subjectively assigned on the basis of local geography and the distance between the MOS and non-MOS stations.

Predictors from the LAMP model and objective analyses are interpolated biquadratically to the station locations. LAMP model predictors are usually from projections concurrent with the valid time of the forecast.

## 2.4 Equation Derivation

The regression equations are derived from archive data stored at the NOAA computer facility in Washington D.C. The equations, once derived and tested, are implemented on the local system in Topeka. Two seasonal equation sets are derived for each start time—warm season equations, valid for the months of April through September, and cool season equations valid for the remainder of the year. The equations are based on 6 seasons of data, beginning with 1982.

Single station equations are developed for temperature, dew point, and wind. A regional equation approach is used for other elements. Here, data from all stations within an area are grouped to form a single equation used at each station in that region. Usually, equations are derived for two regions—one for stations in the Rocky Mountains and one for the remainder of the stations in the test area. Equations for a few elements (e.g., obstruction to vision) are derived for a single region that includes all stations within the area.

MOS and LAMP guidance elements are defined in exactly the same way, except for the ceiling height forecasts which LAMP defines as a continuous variable—the ceiling height in hundreds of feet. MOS forecasts the probability that the ceiling will occur within specified categories.

LAMP currently has one guidance product with no MOS counterpart, the probability of precipitation at the observation time (PoPO). This forecast element is defined to help determine the time of onset of precipitation. Note that the PoPO gives the probability of the occurrence of precipitation, of any type or intensity, at a specific time, not measurable precipitation over a period.

Best category forecasts for visibility, sky cover, obstruction to vision, and precipitation type are produced from forecast probabilities by a method similar to that used for MOS. The probability that an event will occur within a certain category is compared to a threshold probability selected to produce a favorable bias (about as many forecasts in each category as are observed) on dependent data.

LAMP forecasts are significantly better than MOS through about 6 hours due to the heavy influence of the initial observation. From about 6 to 14 hours the predictors from the recent observation, MOS, and the LAMP models combine to improve the skill of the MOS forecasts. Beyond about 14 hours the skill of the LAMP forecasts is about the same as that of MOS.

## 3. FIELD TEST SYSTEM

The LAMP system has been installed at the NWS forecast office in Topeka, Kansas. The software is run on a Data General Eclipse S230 minicomputer equipped with floating point hardware and is written in Data General FORTRAN 5. Both the floating point hardware and the FORTRAN 5 compiler have provided the system with a gain in computational speed over the standard operational AFOS system. The floating point Eclipse (FPE) used for the implementation of LAMP is configured as a standard Weather Service Office (WSO) spur off of WSFO Topeka. All data products needed to run LAMP are fed to the FPE from the WSFO machine, and all output from the LAMP system is returned to the WSFO computer for use by the field forecasters.

### 3.1 LAMP Analyses

LAMP programs are executed automatically by an applications scheduler. Every hour, current surface observations are decoded and the LAMP analysis programs are run. The analyzed gridfields are subsequently contoured and provided to the forecaster as graphic products. Fig. 2 is an example of an analysis of surface dew point for October 27, 1988. Similar graphics are provided for fields of sea level pressure and temperature. The analyzed winds are displayed as wind vectors plotted at alternate gridpoints over the analysis area.

Although the observed data are analyzed over a much larger area than shown in Fig. 2, the products are displayed over the local area to provide more detail in the forecaster's area of responsibility. LAMP programs, however, are quite flexible and may

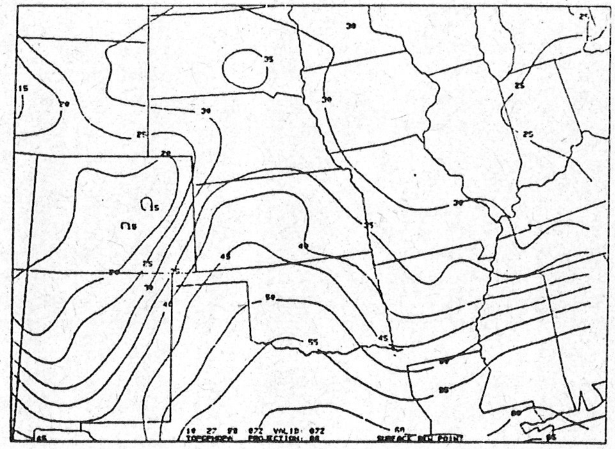

Figure 2. An example of a LAMP dew point analysis for 0700 UTC on October 27, 1988.

easily be altered to allow the display of graphics over the full analyzed area.

In addition to observed fields, the LAMP system computes derived fields based on the surface observations. Fields currently being provided to the forecaster are: surface mixing ratio; mixing ratio convergence; equivalent potential temperature advection; and 2-h changes of surface mixing ratio, mixing ratio convergence, and sea level pressure. Fig. 3 is a sample display of mixing ratio convergence for 0900 UTC April 29, 1989. The graphic displays of derived fields, along with displays of surface observations, provide the forecaster, at each hour, with a detailed picture of the current state of the atmosphere.

### 3.2 LAMP Forecasts

LAMP equations can be derived to produce guidance in support of any official forecast release time. The initial implementation of LAMP in September 1988 supports an early morning forecast release time. The LAMP forecasts are initialized at 0600 UTC during the cool season and 0500 UTC during the warm season. (The one hour time difference was necessary to support a constant local forecast release time.) Fig. 4 shows the relationship

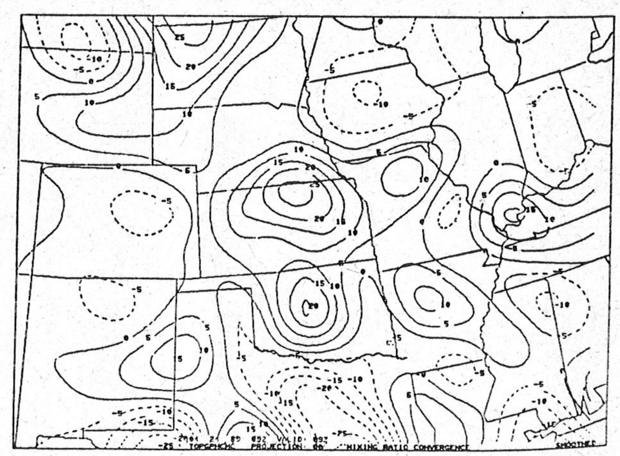

Figure 3. An example of the mixing ratio convergence display for 0900 UTC on April 24, 1989. Dashed contours indicate divergence.

between the 0000 UTC cycle LFM run time, the observations used in MOS, the valid times of MOS and LAMP (0600 UTC) guidance, and the valid times of the early morning official public and aviation forecasts. For this release time, the forecasters have the 0600 UTC local observation available to them. Therefore, the centralized MOS guidance is based on observations made at least 3 hours before, and on a model initialized 6 hours before the observations that can actually be used by the forecaster. LAMP makes use of the 0600 UTC observations to provide an updated forecast valid for a period covering the first 18 hours of the FT valid period and all of the first 12-h period of the public forecast.

The 05/0600 UTC equations implemented in September 1988 are a simplified set of equations using only MOS and observations as predictors. No model predictors were used because two of the LAMP models were not yet ready for implementation. In Summer 1989, it is planned that a full set of equations using model predictors will be installed at Topeka. In addition to the early morning 05/0600 UTC start time, forecasts will be made for an initial time of 2000 UTC to support an afternoon forecast release time.

LAMP guidance is provided to the forecaster in two formats: text and graphic. A bulletin, or table, of LAMP statistical forecast values is available for each station in a format similar to the MOS bulletin provided to the NWS forecasters over the AFOS network. Fig. 5 shows a sample bulletin for WSFO Topeka. Within each bulletin, forecasts are displayed for temperature; dew point; 6-h PoP; PoPO; probability of liquid precipitation type (best category); probability of precipitation type (cool season only); best category of sky cover, obstructions to vision, and visibility; continuous ceiling height; and wind speed and direction. Each of these forecast elements is described in detail in the Appendix. Also included in the bulletin are values of MOS temperature and 6-h PoP for comparison with LAMP values. MOS values can be included in the bulletin for any element; temperature and 6-h PoP were selected because these seem to be the elements of guidance most consistently used by field forecasters.

Contoured graphics of various forecast fields are also provided to the forecasters. Forecasts from the LAMP SLP model are contoured for the valid times 06, 09, 12, 15, and 1800 UTC for the 05/0600 UTC LAMP start time and 21, 00, 03, 06,

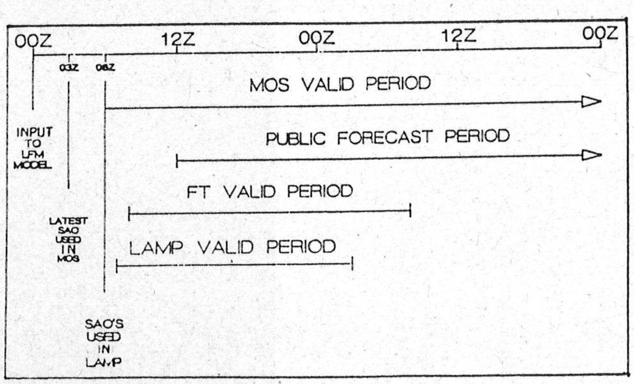


Figure 4. Relationships between inputs to the LFM, MOS, and LAMP for a 0600 UTC start time.

TOP TOPEKA, KS

DATE OF FORECAST: 10/27/88 LAMP MODEL GUIDANCE

LOCATION: TOP TOPEKA, KS INITIAL TIME 0600 Z

| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PROJECTION | | 0 | | | | | | 6 | | | | | | 12 | | | | | | 18 |
| VALID TIME | (Z) | OBS | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 0 |
| TEMP | F | 52 | 51 | 50 | 50 | 50 | 51 | 51 | 50 | 51 | 54 | 56 | 58 | 59 | 59 | 59 | 59 | 58 | 56 | 53 |
| TEMP MOS | F | | 53 | 52 | 52 | 52 | 53 | 53 | 54 | 54 | 56 | 56 | 58 | 59 | 59 | 59 | 59 | 57 | 54 | 52 |
| DEW PT | F | 33 | 33 | 33 | 34 | 35 | 36 | 37 | 37 | 38 | 39 | 40 | 40 | 41 | 41 | 40 | 38 | 39 | 38 | 38 |
| POPO | % | | 00 | 00 | 00 | 00 | 00 | 01 | 02 | 04 | 06 | 07 | 09 | 11 | 10 | 10 | 10 | 10 | 09 | 09 |
| POP-06 | % | | | | | | | 00 | | | | | | 12 | | | | | | 10 |
| POP-06 MOS | % | | | | | | | 02 | | | | | | 16 | | | | | | 12 |
| LIQ PT BEST CAT | | | RW | RW | L | L | L | L | L | L | L | L | L | L | L | L | L | L | L | L |
| SKY COVER | | | CLR | CLR | CLR | CLR | CLR | CLR | CLR | SCT | SCT | BKN | BKN | OVC | OVC | OVC | OVC | OVC | OVC | OVC |
| OBVIS BEST CAT | | | | | | | | | | | | | | | | | | | | |
| VIS BEST CAT | MI | | 6+ | 6+ | 6+ | 6+ | 6+ | 6+ | 6+ | 6+ | 6+ | 6+ | 6+ | 6+ | 6+ | 6+ | 6+ | 6+ | 6+ | 6+ |
| CEILING CONT | FT | 888 | 888 | 888 | 888 | 888 | 888 | 888 | 888 | 888 | 888 | 100 | 100 | 100 | 110 | 120 | 120 | 120 | 120 | 120 |
| WIND DIR | DEG | 20 | 20 | 20 | 20 | 20 | 20 | 21 | 21 | 22 | 24 | 27 | 29 | 30 | 32 | 32 | 33 | 34 | 35 | 35 |
| WIND SPD | KT | 12 | 13 | 12 | 13 | 12 | 12 | 12 | 12 | 12 | 13 | 14 | 14 | 14 | 15 | 15 | 16 | 16 | 17 | 18 |

Figure 5. An example of the LAMP bulletin.

and 0900 UTC for the 2000 UTC start time. These forecasts are provided over the area shown in Fig. 2. LAMP statistical forecasts of temperature and 6-h PoP are analyzed over the local area and contoured graphics are produced for valid times of 12 and 1800 UTC for the 05/0600 UTC initial time and 00 and 0600 UTC for the 2000 UTC start time. A sample contoured analysis of LAMP temperature forecasts is shown in Fig. 6.

### 3.3 Field Use

LAMP, today, is a preliminary version of a local guidance system designed to take advantage of the enhanced technology of the NWS in the next decade. The forecasters at Topeka were asked to become familiar with the system and to provide suggestions and comments which would allow TDL to better design this type of objective guidance for the future. Since the initial implementation, the format and content of the bulletin have been modified, according to suggestions of the Topeka forecasters, to improve the quality and appearance of the guidance.

The suite of analyzed fields was received by the forecasters with much enthusiasm. It was upon their suggestion that the derived fields were added in April 1989. Fig. 7 is a forecast discussion released by Topeka which illustrates how LAMP dew point and sea level pressure analysis fields were used in tracking the south-eastward movement of a cold front, and the northward movement of low level moisture, into the forecaster's area of responsibility. The dew point analysis mentioned in the forecast is shown in Fig. 2.

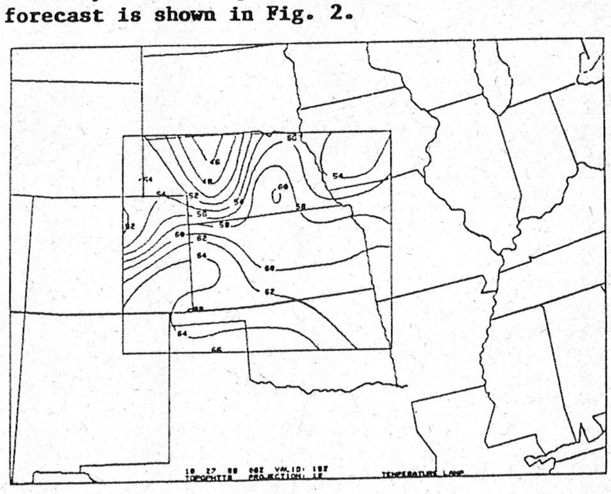

Figure 6. An example of a contoured LAMP 13-h forecast temperature (°F) field valid at 1800 UTC on October 27, 1988.

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STATE FORECAST DISCUSSION
NATIONAL WEATHER SERVICE TOPEKA KS
245 AM CDT THU OCT 27 1988

ALL MODELS ARE REMARKABLY CLOSE ON UPPR AIR FEATURES OVER THE U.S. THIS FCST
PERIOD. IN LOWER LEVELS ALL ARE SIMILAR ON TIMING OF FROPA...BUT NGM IS COLDER
AT 850 (AS IS TYPICAL) THAN LFM. AVN AND NGM SFC PROGS PREFERRED SINCE THEY
BOTH SHOW RIDGING BY 36-48 HRS FROM OK TO NM. THIS FREQUENTLY HAPPENS IN COLD
OUTBREAK SITUATIONS AND LOOKS REASONABLE THIS TIME TOO.

LOW LVL MSTR IS MOVG NWD INTO SRN KS (REF: 07Z LAMP DEWPNT ANLYS) & WIL BE AVBL
WHEN CDFNT ARRIVES LATER TODAY...SO WILL HAVE MENTION OF RW/TRW EAST OF CNK-GCK
LINE TODAY. UPPER SUPPORT WEAK AT BEST SO POPS HELD TO CHC CATEGORY.

ON LOCAL 06Z SFC ANLYS I HAD CDFNT S OF RAP INTO CNTRL WY. NEW 07Z LAMP ANLYS
NOW PLACES FRNT NR BFF...SO IT SEEMS TO BE SCREAMING SEWD. FAST MOVMNT ALSO
SUPPORTED BY 06Z +58 PRES TENDENCY AT WRL. EXPECT FRNT THRU GLD BY 15Z AND
THRU SE KS BY LATE AFTN.

SWIS LOOPS SHOW BACK EDGE OF MID/HI CLDINESS NOW MOVING SEWD THRU NRN

CO AND NEB PANHNDL...AND EXTRAPOLATION WOULD PUT IT PAST NW KS BY ZONES TIME.
HOWEVER...MUCH COLDER AIR BEHIND CDFNT AND LAMP DEWPOINT ANLYS SHOWS MOISTR
AXIS THRU A DDC-HLC LINE...SO WOULD XPCT POST FRNTL SC TO DVLP AS FRNT MOVES
THRU MOISTR FIELD. HENSE...WIL GO WITH PTCLDY EVEN THOUGH MODEL RH FCSTS WOULD
SUPPORT MOSTLY SUNNY IN THE WEST TODAY. SINCE THE MOISTR AXIS IS THRU WRN KS
...BELIEVE THIS IS SUFFICIENT FOR AT LEAST 20% POPS SW INTO NCNTRL THIS MRNG.

STG WNDS XPCTD TODAY WILL SUPPORT LWD IN APPROPRIATE ZONES.

SKIES WILL BE CLEARING TNGT...XCP IN THE SW WHERE RETURN FLOW SHOULD BECOME
UPSLOPE AND COULD (IN COMBINATION WITH WRM ADVTN) SET OFF SOME CLOUD COVER.
WILL STAY WITH MOCLDY CONDS WRN ZONES FRI FOR THESE REASONS...BUT MODEL RH
FCSTS SUGGEST CLOUDS WILL BE STRATUS/OR LOW ALTO TYPES AND NOT CONDUCIVE TO
MUCH PCPN. WILL DROP FRI POPS FROM FCST.

.KS...27/10Z 27/14Z>28/02Z...LWD/NEW...4>17
SCHULTZ
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Figure 7. Use of LAMP in a state forecast discussion.

## 4. FUTURE ENHANCEMENTS

### 4.1 Short-range

At present, development of the basic software required to derive LAMP regression equations and to operationally produce guidance output has been essentially completed. Over the next 2 years, enhancements will focus on additional equation derivation, additional display products, and improved statistical forecasting techniques.

Upon completion of the derivation of cool season equations for the afternoon start time (2200 UTC), the 05/0600 UTC equations will be re-derived to include the full range of MOS, observations, and model predictors. These will replace the interim set of MOS + observation equations implemented before the LAMP models were operational. If time permits, equations to support LAMP guidance for additional forecast release times may be developed. The choice of additional LAMP initialization times will be made according to the recommendations of WSFO Topeka.

Much effort will be made to improve graphic displays in order to help forecasters assess the information available from the LAMP analyses, models, and statistical output. Displays of direct model output will be produced from the moisture and advection models, similar to the sea level pressure maps which we now produce from the SLP model. Graphic displays of additional data fields derived or computed from LAMP analysis and forecast grids will be provided to the forecasters. Some products currently planned to be delivered to the field are a nephanalysis, a surface streamline analysis, and time series graphs of forecast elements.

TDL will refine the statistical guidance system according to forecaster suggestions and operational considerations. New predictors and improvements in equation derivation procedures will be incorporated into the LAMP system. Effort is constantly underway to improve the ability of the equations to resolve sharp changes in conditions (those associated with frontal passages, for example) and to provide guidance for elements such as visibility and sky cover in continuous rather than categorical form.

### 4.2 AWIPS Era

The NWS is currently in the process of modernization with the development of its next generation computer system, the Advanced Weather Interactive Processing System for the 1990's (AWIPS-90). Prior to nationwide implementation of AWIPS, the NWS plans to demonstrate its new operational procedures and techniques during the Modernization and Associated Restructuring Demonstration (MARD), scheduled in the 1992-1993 timeframe. The LAMP system is one of many new techniques that will be demonstrated during the MARD.

Our field experience with LAMP on AFOS in Topeka will help us to develop an operational local statistical guidance system for the AWIPS era. The new computer processing and display capabilities associated with AWIPS will enable new interactive techniques to be developed which will allow the forecaster to make improved use of analysis and statistical guidance. LAMP guidance will, in the AWIPS era, be used along with other information to initialize a database of forecasts from which official forecast products can be automatically formulated after interactive modification by the forecaster (Seguin, 1987).

As AWIPS becomes operational, TDL plans to derive LAMP forecast equations for every forecast office and for regular (e.g., every 4 hours) start times throughout the day. Therefore, over the next decade, our equation development process must be streamlined in order to provide a package of LAMP guidance for the entire country coincident with the implementation of AWIPS-90.

## 5. ACKNOWLEDGMENTS

The authors would like to express their appreciation to all those whose efforts have made LAMP possible. In particular, the dedicated efforts of Harry Glahn and Ward Seguin have enabled the test system to have been placed in Topeka. Thanks to Jack May, MIC at Topeka, and Mike Heathfield, the LAMP focal point at Topeka for their help with maintaining the field system, and to all the staff at WSFO Topeka for their patience in evaluating the new system. We also thank David Hintz and Luther Carroll who assisted with this publication.

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## 7. APPENDIX

The LAMP forecast elements and their interpretation are shown below. Most of them are contained in the bulletin in Fig. 5.

| ELEMENT | INTERPRETATION |
|---|---|
| TEMP | Hourly surface temperature. |
| DEW PT | Hourly surface dew point temperature forecasts. |
| POPO | Probability of precipitation at observation time. Probabilities are expressed to the nearest percent. |
| POP-06 | Probability of precipitation during the 6-h period ending at the given projection. |
| LIQ PT | Type of liquid precipitation - best category. Conditional on the occurrence of precipitation.<br>L - Drizzle<br>R - Rain<br>RW - Rain shower |
| POF | Probability of frozen precipitation. Probabilities are conditional upon the occurrence of precipitation. |
| POZR | Probability of freezing precipitation. Probabilities are conditional upon the occurrence of precipitation. |
| POPT | Probability of precipitation type - best category, conditional on the occurrence of precipitation.<br>FRE - Freezing precipitation<br>FRO - Frozen precipitation<br>LIQ - Liquid precipitation |
| SKY COVER | Opaque sky cover - best category.<br>CLR - Clear<br>SCT - Scattered<br>BKN - Broken<br>OVC - Overcast |
| OBVIS | Obstruction to vision - best category.<br>- None (blank)<br>H - Haze<br>BS - Blowing obstructions<br>F - Fog or ground fog. |
| VIS | Visibility - best category.<br><.5 - < 1/2 mile<br>.5-1 - 1/2 - 7/8 mile<br>1-3 - 1 - 2 3/4 mile<br>3-4 - 3 - 4 miles<br>4-5 - 4 - 5 miles<br>6+ - greater than 6 miles |
| CEILING | Continuous ceiling height in hundreds of feet. 888 indicates unlimited. |
| WIND DIR | Wind direction in tens of degrees. |
| WIND SPEED | Wind speed in knots. |