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EXPERIMENTS IN THE USE OF THE LOCAL AFOS MOS PROGRAM (LAMP) FOR FORECASTING PRECIPITATION TYPE IN THE WASHINGTON, D.C. WSFO FORECAST AREA

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1. INTRODUCTION

The centralized Model Output Statistics (MOS) system (Glahn and Lowry, 1972a) developed by the Techniques Development Laboratory (TDL) provides guidance forecasts twice daily for projections 6 to 48 hours after the National Meteorological Center's (NMC's) nominal run times of 0000 and 1200 GMT. Guidance for most weather elements contained in routine public and aviation terminal forecasts is provided. These forecasts are based on NMC's Limited Area Fine Mesh (LFM) model (Gerrity, 1977; Newell and Deaven, 1981). Because of delays in data receipt, crowded central computer facilities, and the necessity to transmit the guidance forecasts rather early so that receipt can be assured, the shorter range forecasts may be outdated before they are used on station. For instance, the MOS guidance forecasts based on the 0000 GMT LFM run cover the 36-h public and 24-h aviation terminal forecasts. However, the valid periods of these forecasts start 10 to 12 hours after the data input to the LFM and 7 to 9 hours after the latest observation used in MOS. The observations available locally at forecast release time may give more guidance for the next 1 to 12 hours than any centrally produced products presently available.

To make better use of recent local observations in objective guidance forecasts, TDL has undertaken the development of the Local AFOS MOS Program (LAMP). The idea is to develop a MOS system which can be run on a local minicomputer and provide guidance for all weather elements in public and terminal forecasts in the 1-18 h time range. The concept of LAMP is described in detail by Glahn (1980) and Glahn and Unger (1982). Briefly, input to the system will include central MOS forecasts; therefore, LAMP will produce true "update" forecasts--not new forecasts which are not aware of the NMC numerical model results or the central MOS guidance. Input will also include output from simple locally-run advective models as well as hourly weather observations. Use will eventually be made of radar and satellite data. The meteorologist will be able to initiate the system of programs at any hour. Also, intermediate products, such as objective analyses of surface variables and results from advective models, will be available.

It should be possible, within a few years, to run LAMP operationally at local or regional stations. First, we must show that LAMP forecasts do indeed improve upon central MOS forecasts for short range forecasting. In this paper, we describe the development and testing of a LAMP system for forecasting the conditional probability of precipitation type (PoPT) for the Washington, D.C. Weather Service Forecast Office (WBC) area of responsibility. Comparative verifications between the LAMP PoPT forecasts and the central MOS PoPT forecasts are shown. This is a cooperative effort between TDL and WBC.

2. DEVELOPMENT OF EXPERIMENTAL PoPT FORECAST EQUATIONS

A. The Predictand

Observations of precipitation type for each forecast projection were divided into three mutually exclusive categories: snow or ice pellets (SNOW), freezing rain or drizzle (ZR), and rain or mixed types (RAIN). Snow mixed with ice pellets was treated as SNOW; all other mixed precipitation types were defined as RAIN. Only cases in which precipitation occurred at the forecast valid times were included in the developmental sample; therefore, the PoPT forecasts are conditional on the event that precipitation occurs.

B. The Potential Predictors

The potential predictors used in the development of the experimental LAMP PoPT forecast equations are listed in Table 1. The centralized MOS PoPT forecasts were obtained from the system made operational within the National Weather Service in September 1982 (Bocchieri and Maglaras, 1983). These MOS forecasts were based on the 0000 GMT LFM run.

The surface geostrophic U- and V-wind component forecasts and the 1000-500 mb thickness forecasts were obtained from the LAMP sea level pressure model (SLP) (Unger, 1982). The SLP model is adapted from Reed's (1963) model and is essentially the same as that used in the Subsynoptic Advection Model (SAM) (Glahn and Lowry, 1972b). The model is based on a simplified vorticity equation and is cast in a Lagrangian framework. The model is driven by LFM 500-mb height forecasts, from which heights and smoothed geostrophic winds for trajectories are used.

As described later, data from all stations were combined when the LAMP PoPT regression equations were developed. To make combining the data more palatable, the 1000-500 mb thickness forecast from the SLP model was transformed before being used as a predictor. The transformation helps account for the fact that the relationship between 1000-500 mb thickness and the probability of SNOW can vary quite a bit from station to station depending on local factors, especially station elevation. The transformation procedure we used is the same as that used for the predictors in the central MOS PoPT system; see Bocchieri and Maglaras (1983) for more detail.

We also included precipitation type forecasts from another LAMP model, called CLAM for Cloud Advection Model (Grayson and Bermowitz, 1974). CLAM is used to advect cloud amount, ceiling height, visibility, and the three binary precipitation types. Backward trajectories are computed from winds composed of 33% of the 500-mb geostrophic wind and 50% of the 1000-mb geostrophic wind. Initial fields of the three precipitation types are analyzed so that for the frozen category, for instance, each gridpoint can take on a value of one or zero depending, respectively, upon whether frozen precipitation was or was not occurring at the initial time. The value of the frozen precipitation type predictor ranged between zero and one, inclusive, depending on the

Table 1. The potential predictors used in the development of experimental LAMP PoPT forecast equations for the WBC forecast area.

Acronym	Definition
	a. Centralized MOS Predictors
MOS P(ZR)	MOS probability of ZR forecasts
MOS P(SNOW)	MOS probability of SNOW forecasts
	b. Advective Model Predictors
GEO U	Surface geostrophic U-wind component forecasts from the SLP model
GEO V	Surface geostrophic V-wind component forecasts from the SLP model
10-5 TH	1000-500 mb thickness (standardized) forecasts from the SLP and LFM models
LIQ PRECIP	Liquid precipitation forecasts from the CLAM model
FREZ PRECIP	Freezing precipitation forecasts from the CLAM model
FROZ PRECIP	Frozen precipitation forecasts from the CLAM model
	c. Surface Observations
OBS T	Observed surface temperature
OBS Td	Observed surface dew point
OBS W	Observed weather
OBS U	Observed surface U-wind component
OBS V	Observed surface V-wind component

location within the initial analyzed field of the beginning point of the trajectory. The values of the liquid and freezing precipitation type predictors were computed in a similar manner.

Surface observations of temperature, dew point, weather, and U- and V-wind components at stations were also used as potential predictors. The weather predictor was coded to indicate whether no precipitation, RAIN, ZR, or SNOW was occurring.

C. Development Procedures

We developed experimental LAMP PoPT equations with data from 46 stations in and around the WBC forecast area from the four winter seasons (October through March) of 1977-78 through 1980-81; these stations are listed in the Appendix. Data from the 1981-82 winter season were withheld for testing purposes.

Various sets of equations were developed for the 2-, 5-, 8-, and 11-h projections from two initial data times, 0800 GMT and 1300 GMT. It should be noted that the LAMP system is being designed to be run at any hour; we chose these two initial times for testing purposes. LAMP forecasts based on data from 0800 and 1300 GMT, for instance, may be useful as updated, short-range guidance for public and aviation forecast packages released at about 1000 and 1500 GMT. The central MOS P(ZR) and P(SNOW) forecasts used as input to LAMP were based on the 0000 GMT LFM cycle time. Since 0300 GMT surface observations are used as predictors in central MOS, the 2-, 5-, 8-, and 11-h LAMP projections from the 0800 GMT (1300 GMT) initial time represent 7- (12-), 10- (15-), 13- (18-), and 16- (21-) h projections for central MOS.

To develop the LAMP PoPT regression equations, we used forward screening in a statistical technique known as Regression Estimation of Event Probabilities (REEP) (Miller, 1964) to select predictors. A good description of the REEP screening procedure can be found in Glahn and Lowry (1972a). As described in Glahn and Unger (1982), the regression program for LAMP develops equations for one or more predictand variables for all stations and all projections in one run. In our case, we had three predictand variables: the probability of SNOW, ZR, and RAIN. The same predictors are included in each equation, except that the predictor variable is always interpolated to the station's location (if interpolation is indeed necessary) and bears a constant relationship in time to the predictand projection. Observations used as predictors are always specified at the initial time, either 0800 or 1300 GMT for our purposes.

Since the central MOS PoPT forecasts were used as predictors, the MOS forecasts needed to be available for each station and each LAMP forecast projection. Because MOS PoPT is not operationally available for all of the hourly reporting stations used in this study and because the MOS forecast valid times are at 6-h intervals, space and time interpolations of the MOS forecasts were necessary. As shown in the Appendix, space interpolation was done for each non-MOS station by taking a specified average of forecasts available at MOS stations (circled in Fig. 1). Then, we used time interpolation when the MOS PoPT valid time didn't match the LAMP forecast projection.

The various LAMP PoPT equation sets we developed were differentiated by the potential predictors used for each; the six sets of equations and the corresponding potential predictors are shown in Table 2. In the MOS(REGRESS) set, for instance, only central MOS PoPT forecasts were used as predictors. Also, in the MOS+MOD+OBS set, central MOS PoPT forecasts, SLP, and CLAM model forecasts, and initial surface observations were used as potential predictors.

To develop each LAMP equation set, we combined data from all stations--the so-called generalized operator approach. Due to the fact that a number of stations are closed for a portion of the day, the number of stations used varied by initial time and forecast projection. For the 0800 GMT initial time, data from 30 stations were available; for the 1300 GMT initial time, data from 42 stations were used except for the 11-hour projection for which data from 37 stations were available.

The potential predictors were offered to the REEP screening program in both binary and continuous form. The screening procedure was stopped after 12 predictors were included in each set of equations. This number of predictors has been found to be about optimum for MOS regression equations by other investigators (Bocchieri, 1983; Annett et al., 1972; Bocchieri and Glahn, 1972).

Table 2. The potential predictor types (described in Table 1) included in each of six experimental LAMP PoPT equation sets.

Equation Set	Potential Predictors
MOS(REGRESS)	Central MOS forecasts
MOD	SLP and CLAM model forecasts
OBS	Surface observations
MOD+OBS	SLP and CLAM model forecasts and surface observations
MOS+OBS	Central MOS forecasts and surface observations
MOS+MOD+OBS	Central MOS forecasts, SLP and CLAM forecasts, and surface observations

The additional reduction of variance (RV) given by the twelfth predictor in each set was generally between 0.5% and 1.0%.

Table 3 shows the total RV given by each of the six LAMP PoPT equation sets for the RAIN, ZR, and SNOW categories for the developmental sample. Results are shown for the 2- and 8-h projections from the 0800 and 1300 GMT initial times. The number of precipitation cases in this sample was generally between 2500 and 4000 depending on the equation set, initial time, and projection. The relative frequencies of the RAIN, ZR, and SNOW categories were generally 60 to 65%, 2 to 3%, and 30 to 40%, respectively, again depending on the initial time and projection. The results in Table 3 can be summarized as follows:

1. The RV for the ZR category was much lower than for the other categories. This is not surprising in view of the relatively low frequency of occurrence of ZR.

2. There was little difference between MOS+OBS and MOS+MOD+OBS. Either of these sets was, overall, better than all other equation sets.

3. As expected, the OBS set was the worst at the 8-h projection. For the 2-h projection, OBS was better than MOS(REGRESS) and MOD for ZR.

4. There was generally a substantial increase in the RV for the ZR category for equation sets in which initial surface observations were combined with other predictor types as compared to the MOS(REGRESS) set. However, this result should be interpreted cautiously since overfitting of the data may have occurred in the regression process due to the low frequency of occurrence of the ZR category.

Table 4 shows the predictors included in the MOS+OBS PoPT forecast equation for the 2-h projection from the 0800 GMT initial time. The additional RV afforded by each predictor chosen is also shown. The predictors are listed in the order chosen by the REEP screening regression process. It should be noted that, although the additional RV is shown for the 2-h projection, a particular predictor could have been included in the equation because of its contribution to the RV of the predictands for some other projection. This explains why the ninth predictor [MOS P(ZR) $\leq$ 11%] was included in the equation but made very

Table 3. The total RV (percent) given by each of six equation sets (see Table 2) for the 2- and 8-h projections from the 0800 and 1300 GMT LAMP initial times. See text for definition of the predictand. The developmental sample consisted of data from the winter seasons of 1977-78 through 1980-81.

Equation Set	Forecast Projection 2-h RAIN	2-h ZR	2-h SNOW	8-h RAIN	8-h ZR	8-h SNOW
			0800 GMT Initial Time			
MOS(REGRESS)	79.7	24.2	81.9	80.7	17.4	82.2
MOD	79.3	31.3	81.7	74.6	13.2	76.6
OBS	82.6	46.3	80.2	62.1	5.7	58.4
MOD+OBS	83.8	42.9	84.2	74.4	15.0	75.5
MOS+OBS	85.2	52.2	85.9	79.8	19.6	81.3
MOS+MOD+OBS	85.6	46.6	86.7	79.7	20.3	81.4
			1300 GMT Initial Time			
MOS(REGRESS)	82.6	20.4	83.4	78.3	12.7	80.4
MOD	80.5	19.8	83.1	73.5	9.7	76.4
OBS	79.7	23.9	78.1	64.1	10.9	61.3
MOD+OBS	84.2	27.8	85.1	76.3	15.2	77.1
MOS+OBS	84.7	31.5	85.4	79.0	17.8	80.5
MOS+MOD+OBS	85.3	32.4	86.3	79.2	16.4	80.6

Table 4. The predictors included in the MOS+OBS PoPT forecast equation for the 2-h projection from the 0800 GMT initial time. The additional RV (percent) given by each predictor is also shown. The developmental sample consisted of 2484 precipitation cases (1653 RAIN, 67 ZR, and 764 SNOW). The predictors are defined in Table 1 and are listed here in the order picked by the REEP screening process.

Predictor	Binary Threshold	Additional RV RAIN	ZR	SNOW
MOS P(SNOW)	Continuous	76.5	0.1	81.9
MOS P(ZR)	Continuous	2.9	27.1	0.1
OBS T	$\leq$ 32F	2.4	4.6	0.7
OBS W	None, RAIN or ZR	0.4	2.1	1.3
OBS W	None, RAIN	0.9	17.4	0.2
MOS P(ZR)	$\leq$ 6%	0.1	0.2	0.0
OBS T	$\leq$ 34F	1.2	0.1	1.1
MOS P(ZR)	$\leq$ 15%	0.0	0.4	0.0
MOS P(ZR)	$\leq$ 11%	0.0	0.0	0.0
OBS Td	$\leq$ 29F	0.7	0.1	0.5
MOS P(SNOW)	$\leq$ 10%	0.1	0.1	0.1
MOS P(ZR)	$\leq$ 23%	0.0	0.0	0.0

little contribution to the RV for this projection. The first predictor, MOS P(SNOW), accounted for most of the RV for the RAIN and SNOW categories. The second predictor, MOS P(ZR), accounted for about half of the RV for the ZR category. The OBS T and OBS W were also important for the ZR category. The third predictor, for instance, indicates whether or not the OBS T is ≤ 32 F. The fourth and fifth predictors, taken together, isolate those cases when SNOW or ZR is occurring at the initial time.

3. VERIFICATION AND FURTHER EXPERIMENTS

In order to determine if the experimental LAMP PoPT forecasts were better than centrally produced MOS PoPT forecasts, we comparatively verified forecasts from the experimental equation sets and forecasts from the central MOS system (MOS) on the independent data sample (the winter season of 1981-1982). The Brier score (Brier, 1950) was used as a measure of accuracy of the probability forecasts. In the verification, data from all stations were combined. As explained in the previous section, the number of stations varied depending on initial time and forecast projection. However, matched data samples were used for each projection in this verification.

Table 5 shows the Brier scores for the RAIN, ZR, and SNOW categories combined for each LAMP equation set and for MOS for the 2-, 5-, 8-, and 11-h projections from the 0800 and 1300 GMT initial times. The results indicate the following:

1. There was little difference between MOS and MOS(REGRESS). This indicates that the central MOS forecasts are sufficiently tuned for the stations involved so that there was little to be gained by regressing the MOS forecasts.

2. For the 0800 GMT initial time, MOS+MOD+OBS was the best set out to about the 5-h projection; for the 2-h (5-h) projection, the percent improvement over MOS was about 15% (7%). There was little difference between MOS+MOD+OBS and MOS at the 8- and 11-h projections.

3. For the 1300 GMT initial time, MOS+OBS was the best set out to about the 8-h projection, although the improvement was small at 5 hours. The percent improvement over MOS was about 18% at 2 hours, 2% at 5 hours, and 5% at 8 hours.

4. There was, overall, little difference between MOS+OBS and MOS+MOD+OBS. A similar result was obtained for the developmental sample (see Table 3 and discussion in text).

5. The OBS set was the worst for all projections and both initial times except MOD was equally as bad for the 2-h projection from the 0800 GMT initial time. The relatively poor performance of OBS for the very short range (2-h) projection is surprising and will be discussed below.

6. The MOD and MOD+OBS sets were worse than MOS for all projections and both initial times except for the 2-h projection from the 1300 GMT initial time.

The fact that the OBS system was worse than MOS for the 2-h projection is surprising. One would think that if precipitation were occurring at the time, it would be hard to beat a 2-h persistence forecast of the precipitation type. A possible reason for the unexpected result is that both cases when precipitation was and was not occurring at the initial times (0800 or 1300 GMT) were included in the developmental samples. OBS W (observed weather at the initial time) was broken into binary predictors to indicate whether or not precipitation was occurring and the type of precipitation (RAIN, ZR, or SNOW). These binaries were included as potential predictors in developing the experimental equations, but the binary that indicated whether or not precipitation was occurring was not picked in the screening process.

To see if persistence of the precipitation type could be better utilized, we redeveloped the OBS, MOS+OBS, and MOS+MOD+OBS equation sets with stratified samples. One sample consisted of all cases in which precipitation was occurring at the initial time (either 0800 or 1300 GMT) and the other consisted of all cases in which precipitation wasn't occurring at the initial time. As in the previous experiments, data from four winter seasons were used in the development.

Table 5. Brier scores for all predictands combined for PoPT forecasts from the LAMP forecast system (see Table 2) and from the central MOS system. Independent data combined from 30 to 42 stations (depending on projection) from the 1981-82 winter season. The numbers of cases are shown in parentheses. The percents improvement in Brier score over MOS are shown in brackets.

System	Projection 2-h		5-h		8-h		11-h	
0800 GMT Cycle								
	(600)		(619)		(603)		(576)	
MOS	.123		.161		.142		.141	
MOS(REGRESS)	.122		.160		.144		.140	
OBS	.136	[-10.6]	.215	[-33.5]	.248	[-74.6]	.263	[-86.5]
MOD	.136	[-10.6]	.192	[-19.2]	.190	[-33.8]	.193	[-36.9]
MOD+OBS	.134	[- 8.9]	.169	[- 5.0]	.183	[-28.9]	.180	[-27.7]
MOS+OBS	.106	[+13.8]	.156	[+ 3.1]	.147	[- 3.5]	.146	[- 3.5]
MOS+MOD+OBS	.104	[+15.4]	.150	[+ 6.8]	.142	[0.0]	.142	[- 0.7]
1300 GMT Cycle								
	(858)		(775)		(805)		(737)	
MOS	.178		.125		.141		.178	
MOS(REGRESS)	.178		.126		.138		.179	
OBS	.179	[- 0.6]	.181	[-44.8]	.234	[-66.0]	.308	[-73.0]
MOD	.169	[+ 5.1]	.165	[-32.0]	.189	[-34.0]	.252	[-41.6]
MOD+OBS	.149	[+16.3]	.147	[-17.6]	.167	[-18.4]	.236	[-32.6]
MOS+OBS	.145	[+18.5]	.123	[+ 1.6]	.134	[+ 5.0]	.180	[- 1.1]
MOS+MOD+OBS	.149	[+16.3]	.124	[+ 0.8]	.135	[+ 4.2]	.182	[- 2.2]

Forecasts from the equations developed with the stratified samples were then compared to forecasts from MOS on the same independent sample used for Table 5. Table 6 shows the Brier scores for forecasts made from the equation sets developed on the stratified sample.[1] The percents improvement over MOS are also shown. The results indicate the following:

1. The OBS set was better than MOS for the 2-h projection from both initial times. This is in contrast to the results for the unstratified sample equations (Table 5) which showed OBS was worse than MOS for this projection.

2. As compared to the results in Table 5, there was a substantial increase in the percent improvement of MOS+OBS and MOS+MOD+OBS over MOS for the 2-h projection from both initial times. However, this was generally not the case for the other projections.

3. Some erratic behavior in the scores is apparent upon comparing Table 6 with Table 5. For instance, both MOS+OBS and MOS+MOD+OBS were better than MOS for the 5-h projection from 0800 GMT in Table 5; however, in Table 6, MOS+OBS was worse than MOS for this projection, and the improvement of MOS+MOD+OBS dropped from about 7% to about 2%.

Table 6. The same as Table 5 except that the Brier scores shown are for forecasts from LAMP equation sets developed with the stratified sample.

Systems	Projection 2-h	5-h	8-h	11-h
		0800 GMT Cycle		
	(600)	(619)	(603)	(576)
MOS	.123	.161	.142	.141
OBS	.113 [+ 8.1]	.210 [-30.4]	.245 [-72.5]	.270 [-91.5]
MOS+OBS	.096 [+22.0]	.165 [- 2.5]	.152 [- 7.0]	.147 [- 4.2]
MOS+MOD+OBS	.090 [+26.8]	.158 [+ 1.9]	.147 [- 3.5]	.146 [- 3.5]
		1300 GMT Cycle		
	(846)	(762)	(801)	(737)
MOS	.181	.127	.142	.178
OBS	.156 [+13.8]	.179 [-40.9]	.234 [-64.8]	.313 [-75.8]
MOS+OBS	.137 [+24.3]	.119 [+ 6.3]	.145 [- 2.1]	.183 [- 2.8]
MOS+MOD+OBS	.138 [+23.8]	.117 [+ 7.8]	.150 [- 5.6]	.189 [- 6.2]

[1]The slight difference in the numbers of precipitation cases for the 1300 GMT initial time in Tables 5 and 6 is due to the fact that one day was inadvertently omitted from the sample for Table 6.

Also, note that for the 8-h projection from 1300 GMT in Table 5 both MOS+OBS and MOS+MOD+OBS were better than MOS; however, for this projection in Table 6, these sets were worse than MOS. This erratic behavior is attributed to overfitting on the dependent sample due to the smaller number of cases involved when stratification was done.

In spite of the erratic behavior in the scores, the benefit of using the stratified sample is evident in the results for the 2-h projection. The increased benefit for this projection resulted mainly from the forecasts of precipitation type from the equation sets developed with the sample which included only precipitation cases at the initial times. This was seen when the independent sample was divided into two samples, one in which precipitation was occurring at the initial time and the other in which precipitation wasn't occurring, and the Brier scores (not shown) were computed for each sample for each equation set in Table 6. Apparently, the utility of the observed precipitation type when precipitation was occurring at the initial time could not be fully realized when the LAMP equations were developed on the unstratified sample (Table 5). In an operational sense, it's more desirable to implement a set of equations which is applicable whether or not precipitation is occurring at the initial time. Therefore, further research should be done to develop predictors capable of fully utilizing the information in the initial observation for use in an unstratified forecast system.

4. SUMMARY AND CONCLUSIONS

Experimental LAMP PoPT prediction equations for the Washington, D.C. forecast area were developed and tested. We used four winter seasons of data for development and one season for independent testing. Several equation sets were developed with the REEP screening regression program consisting of various combinations of predictors including central MOS PoPT forecasts, initial surface observations, and output from the LAMP SLP and CLAM advective models.

All experiments were done with initial data times of 0800 and 1300 GMT. These two times would support two of the routine public and aviation forecast release times. PoPT forecasts from each experimental equation set were made for 2-, 5-, 8-, and 11-h projections from each initial time. Brier scores were computed to comparatively verify forecasts from the experimental equation sets and forecasts from the central MOS system on the independent sample. From the results, we concluded that the central MOS PoPT forecasts could be improved upon out to about 5 hours, and possibly 8 hours, depending on initial data time, by experimental systems which include as predictors initial surface observations in combination with central MOS forecasts and output from LAMP advective models. However, the advantage of including output from the advective models as predictors was questionable.

Further experiments were performed in which the experimental PoPT equations were developed on a stratified sample. One sample included only cases in which precipitation was occurring at the initial time and the other only cases in which precipitation was not occurring at the initial time. From these experiments, we concluded that substantial increases in improvement of LAMP forecasts over the central MOS forecasts can be obtained for the 2-h projection when the stratified sample is used for development as compared to using an unstratified sample. Apparently, the utility of the observed precipitation type could not be fully realized when the LAMP equations were developed with the unstratified sample.

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APPENDIX

Stations Used in the Study

The forty-six stations in TDL's hourly data archive in and around the WBC WSFO area of responsibility used in this study are shown in Table 7. Fig. 1 shows the locations of MOS and non-MOS stations and the space interpolation scheme used.

Table 7. The 46 stations in and around the WBC forecast area used to develop experimental LAMP PoPT forecast equations.

Station	Call Letters	Station	Call Letters
Atlantic City, N.J.	ACY	Latrobe, Pa.	LBE
Andrews AFB, Md.	ADW	Langley AFB, Va.	LFI
Altoona, Pa.	AOO	Lewisburg, W. Va.	LWB
Baltimore, Md.	BWI	Lynchburg, Va.	LYH
Beckley, W. Va.	BKW	Middletown/Olmstead AFB, Pa.	MDT
Bluefield, W. Va.	BLF	Morgantown, W. Va.	MGW
Charlottesville, Va.	CHO	Millville, N.J.	MIV
Clarksburg, W. Va.	CKB	Martinsburg, W. Va.	MRB
Charleston, W. Va.	CRW	Baltimore/Glenn Martin, Md.	MTN
Harrisburg, Pa.	CXY	Norfolk NAS, Va.	NGU
Fort Belvoir, Va.	DAA	Patuxent River NAS, Md.	NHK
Danville, Va.	DAN	Oceana NAS, Va.	NTU
Washington/National, D.C.	DCA	Quantico MCAS, Va.	NYG
Dover AFB, Del.	DOV	Norfolk, Va.	ORF
Elkins, W. Va.	EKN	Newport News, Va.	PHF
Fort Eustis, Va.	FAF	Philadelphia, Pa.	PHL
Fort Meade, Md.	FME	Raleigh-Durham, N.C.	RDU
Greensboro, N.C.	GSO	Richmond, Va.	RIC
Hagerstown, Md.	HGR	Roanoke, Va.	ROA
Hot Springs, Va.	HSP	Salisbury, Md.	SBY
Washington/Dulles, Va.	IAD	Staunton, Va.	SHD
Wilmington, Del.	ILG	Wallops Island, Va.	WAL
Johnstown, Pa.	JST	Bristol, Tenn.	TRI

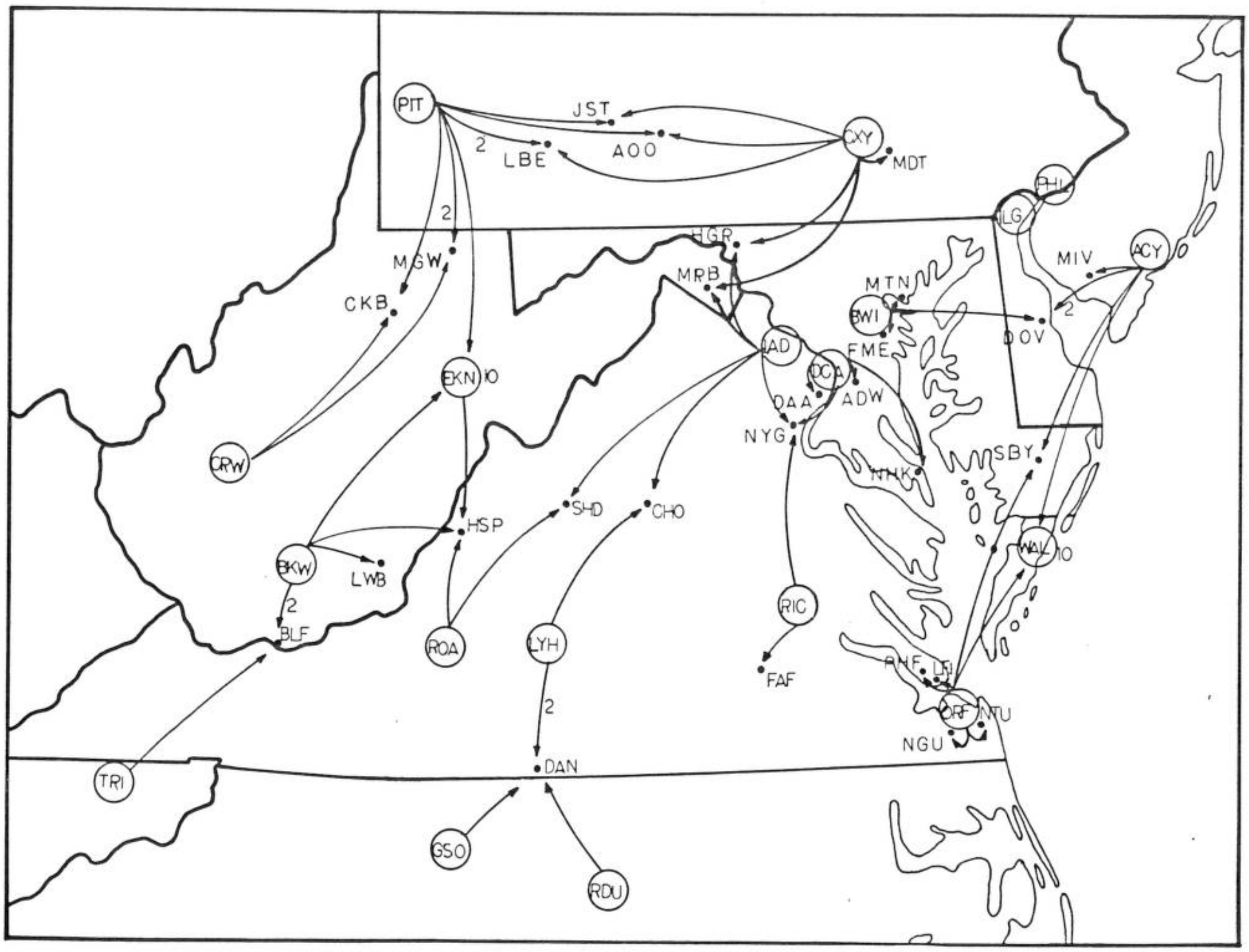

Figure 1. The stations in and around the WBC forecast area used in the development of experimental LAMP PoPT forecast equations. The circled stations are the ones for which centralized MOS forecasts are operationally available. The arrows show which stations were used to obtain MOS forecasts for stations not receiving MOS forecasts operationally. If there are two arrows, an average (weighted if a number appears beside the arrow) MOS forecast was obtained as indicated.