U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE
OFFICE OF SYSTEMS DEVELOPMENT
TECHNIQUES DEVELOPMENT LABORATORY

TDL OFFICE NOTE 88-1

AFOS-ERA VERIFICATION OF GUIDANCE AND LOCAL AVIATION/PUBLIC WEATHER FORECASTS--NO. 8 (APRIL 1987-SEPTEMBER 1987)

Valery J. Dagostaro, Gary M. Carter, and J. Paul Dallavalle

February 1988

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1. INTRODUCTION

This is the eighth in the series of Techniques Development Laboratory (TDL) office notes which compare the performance of TDL's automated guidance with National Weather Service (NWS) local forecasts made at Weather Service Forecast Offices (WSFO's). Verification statistics are presented for the warm season months of April 1987 through September 1987 for probability of precipitation (POP), surface wind, cloud amount, ceiling height, visibility, and maximum/minimum (max/min) temperature. Due to a change in the issuance time of the NWS official terminal forecasts (FT's), the local and guidance forecasts for the aviation weather elements (ceiling height, visibility, and wind speed and direction) are no longer valid at the same time. Consequently, the same observation can not be used to verify both the local and guidance forecasts and comparisons of the two sets are not meaningful. In addition, since the local aviation forecasts and observations were not available for the new FT times for a full season, only statistics for the guidance will be presented for those elements. Verification summaries are provided for both the 0000 and 1200 GMT forecast cycles. The scores are those recommended in the NWS National Verification Plan (National Weather Service, 1982).

All of the forecasts (both local and guidance) and most of the verifying observations were collected locally at the WSFO's, transmitted via the Automation of Field Operations and Services (AFOS) system to the National Meteorological Center, and archived centrally by TDL. The aviation element surface observations, which are valid at the same time as the guidance, were collected from hourly observations archived by TDL. The national AFOS-era verification data processing system is described in detail by Dagostaro (1985). The local collection system is described by Ruth and Alex (1987), while guidelines for the public/aviation forecast verification program are given in National Weather Service (1983).

The local PoP and max/min forecasts used for verification were official public weather forecasts obtained from the Coded City Forecast (FPUS4) bulletin. The local cloud amount and 42-h significant wind forecasts were manually entered by the forecasters at the WSFO's. The local subjective forecasts may or may not be based on the objective guidance. Also, surface observations as late as 2 hours before the first valid forecast time may have been used in preparation of the local forecasts.

The automated guidance was based on forecast equations developed by application of the Model Output Statistics (MOS) technique (Glahn and Lowry, 1972). In particular, these prediction equations were derived by using archived surface observations and forecast fields from the Limited-area Fine Mesh (LFM) Model (Gerrity, 1977; Newell and Deaven, 1981). The surface observations used in these equations were taken at least 9 hours before the first verification valid time.

As noted in the sections which follow for each of the various weather elements, implementation of the new AFOS-era verification system in late 1983 introduced significant changes from past verifications in regard to the characteristics of the local forecasts and the verifying observations. For example, the local and guidance max/min temperature forecasts are verified by using max/min temperatures observed during approximately 12-h periods instead of 24-h (calendar day) periods. Also, the cloud amount observations are given in terms of total sky cover rather than opaque sky cover. Hence, we do not think it is meaningful to compare results for the 1987 warm season with statistics based on the pre-AFOS verification system (e.g., Maglaras et al., 1984).

2. PROBABILITY OF PRECIPITATION

MOS PoP forecasts were produced by the warm season prediction equations described in Technical Procedures Bulletin No. 299 (National Weather Service, 1981a). This guidance was available for the first, second, and third periods, which correspond to 12-24, 24-36, and 36-48 hours, respectively, after 0000 and 1200 GMT. The predictors for the equation development were forecast fields from the LFM model and weather elements observed at the forecast site at 0300 or 1500 GMT. However, in day-to-day operations, surface observations at 0200 or 1400 GMT (or even 0100 or 1300 GMT) were used as input to the prediction equations. The LFM model schedule makes this necessary, and the guidance is available earlier than if the 0300 and 1500 GMT observations were used.

The forecasts were verified by computing Brier scores (Brier, 1950) for 93 of the 94 stations listed in Table 2.1. Note that we used the standard NWS Brier score for PoP which is one-half the original score defined by Brier. Brier scores will vary from one station to the next and from one year to the next because of changes in the relative frequency of precipitation. Therefore, we also computed the percent improvement over climate, that is, the percent improvement of Brier scores obtained from the local or guidance forecasts over analogous Brier scores produced by climatic forecasts. Climatic forecasts are defined as relative frequencies of precipitation by month and by station determined from a 15-yr sample (Jorgensen, 1967). Because local forecasters should be encouraged to depart from the guidance if they have reason to believe it is incorrect, the number of times local forecasters deviated from the guidance by at least 20% and the Brier score when such deviations occurred were tabulated.

Tables 2.2 and 2.7 present the 1987 warm season results for all 93 stations combined, for the 0000 and 1200 GMT cycle forecasts, respectively. Tables 2.3-2.6 and Tables 2.8-2.11 show scores for the NWS Eastern, Southern, Central, and Western Regions, for the 0000 and 1200 GMT cycles, respectively.

3. SURFACE WIND

The objective surface wind forecasts were generated by the warm season, LFM-based equations described in Technical Procedures Bulletin No. 347 (National Weather Service, 1984). Prior to the 1984 warm season, the surface wind prediction equations were rederived to account for the latest available data from the LFM model. The objective surface wind forecast is defined in the same way as the observed wind, namely, the 1-min average wind direction and speed for a specific time. All objective forecasts of wind speed were adjusted by an "inflation" technique (Klein et al., 1959) involving the multiple correlation coefficient and the mean value of wind speed for each particular station and forecast valid time.

Since the local and guidance forecasts are no longer valid for the same time, verification of a matched sample is not possible. Although we computed statistics for the local forecasts issued at the new FT times for a portion of the warm season, those results will not be presented here. In verifying the 12-, 18-, and 24-h guidance from both 0000 and 1200 GMT, we continued to use the same method of verification as in previous seasons. First, for those cases in which the MOS wind speed forecasts were $\geq$10 kt, the mean absolute error (MAE) and the mean algebraic error of the speed forecasts were computed. Cases where the observed wind was calm were then eliminated from this sample and the MAE of direction was computed. Second, for all cases where the MOS forecasts were available, skill score,[1] percent correct, bias by category,[2] and the threat score[3] were computed from contingency tables of wind speed. The definitions of the categories used in the contingency tables for wind speed and direction are given in Table 3.1. The threat score used here was calculated by combining events of the upper two categories (winds $\geq$28 kt). In addition, for all cases in which the wind speed forecasts were at least 10 kt, the skill score for the wind direction forecasts was computed from contingency tables. The 91 (92) stations used in the verification for the 0000 (1200) GMT cycle are listed in Table 2.1.

The results for all 91 (92) stations combined for the 0000 (1200) GMT cycle are presented in Table 3.2 (Table 3.7). Tables 3.3-3.6 and 3.8-3.11 show scores for the NWS Eastern, Southern, Central, and Western Regions, for 0000 and 1200 GMT, respectively.

In addition, 42-h forecasts of winds $\geq$23 knots were collected as part of the AFOS-era verification system. The local forecasts were manually entered by forecasters at the WSFO's. However, for the warm season, the sample of 42-h forecasts was insufficient to provide a meaningful comparative verification.

4. CLOUD AMOUNT

During the 1987 warm season, the objective cloud amount forecasts were produced by the prediction equations described in Technical Procedures Bulletin No. 303 (National Weather Service, 1981b). These regionalized equations used LFM model output and either 0100 or 0200 (1300 or 1400) GMT surface observations to produce probability forecasts of the four categories of cloud amount shown in Table 4.1. We converted the probability estimates to "best category" forecasts by an algorithm that produced good bias characteristics (bias of approximately 1.0 for each category) on the developmental sample. The algorithm used to obtain the best category is described in Technical Procedures Bulletin No. 303.

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[1] The skill score used throughout this report is the Heidke skill score (Panofsky and Brier, 1965).

[2] In the discussion of surface wind, cloud amount, ceiling height, and visibility, bias by category refers to the number of forecasts of a particular category (event) divided by the number of observations of that category. A value of 1.0 denotes unbiased forecasts for a particular category.

[3] Threat score = H/(F+O-H), where H is the number of correct forecasts of a category, and F and O are the number of forecasts and observations of that category, respectively.

We compared the local forecasts with a matched sample of guidance forecasts for the 94 stations listed in Table 2.1 for the 12-, 18-, and 24-h projections from 0000 and 1200 GMT. Four-category (clear, scattered, broken, and overcast), forecast-observed contingency tables were prepared from the local and objective categorical predictions. Using these tables, we computed the percent correct, skill score, and bias by category. Prior to the 1984 warm season, opaque sky cover amounts from surface observations were used in determining the observed categories. However, the hourly surface reports from which the verifying observations are now being taken do not record total opaque sky cover as part of the observation; in fact, thin clouds are included as part of the total sky cover. For example, a report of overcast with eight tenths opaque and two tenths thin, which previously was put into the broken category, now is categorized as overcast. The result of this change is to decrease (increase) the number of observations of the broken (overcast) category compared to previous verifications. This change has greatly affected the overall bias by category statistics for both the guidance and local forecasts.

The results for all stations combined are shown in Tables 4.2 and 4.7 for the 0000 and 1200 GMT cycle forecasts, respectively. Tables 4.3-4.6 and Tables 4.8-4.11 show scores for the NWS Eastern, Southern, Central, and Western Regions, for the 0000 and 1200 GMT cycles, respectively.

5. CEILING AND VISIBILITY

During the 1987 warm season, the ceiling and visibility guidance was produced by the prediction equations described in Technical Procedures Bulletin No. 303 (National Weather Service, 1981b). Operationally, the guidance was based primarily on LFM model output and either 0100 or 0200 (1300 or 1400) GMT surface observations.

Verification scores were computed for the guidance only for 91 (92) of the 94 stations listed in Table 2.1 for the 0000 (1200) GMT cycle. Persistence based on an observation taken at 0900 (2100) GMT for the 0000 (1200) GMT forecast cycle was used as a standard of comparison. The objective forecasts were verified for 12-, 18-, and 24-h projections after 0000 and 1200 GMT.

We constructed forecast-observed contingency tables for the four categories of ceiling and visibility given in Table 5.1. These categories were used for computing several different scores: bias by category, percent correct, skill score, and log score.[4] We have summarized the results in Tables 5.2-5.5. It should be noted that the persistence forecasts for the 12-, 18-, and 24-h projections are actually 3-, 9-, and 15-h forecasts, respectively, from the latest available surface observation, and in this sense, the guidance are usually 10-, 16-, and 22-h forecasts.

6. MAXIMUM/MINIMUM TEMPERATURE

Throughout the 1987 warm season, the max/min temperature guidance was generated by the prediction equations described in Technical Procedures Bulletin

[4]The log score is proportional to the absolute value of $\log_{10} f_i - \log_{10} O_i$, where f_i is the forecast category for each case and O_i is the observed category for each case. The result is averaged over all cases and scaled by multiplying by 50.

No. 356 (National Weather Service, 1985). These equations forecast daytime max and nighttime min temperatures.

During the warm season, daytime is defined as 8 a.m. to 7 p.m. Local Standard Time (LST), while nighttime extends from 7 p.m. to 8 a.m. LST. The guidance equations were developed by stratifying archived LFM model forecasts, station observations, and the first two harmonics of the day of the year into seasons of 3-mo duration (Erickson and Dallavalle, 1986). The spring season is defined as March-May; the summer, as June-August; and the fall, as September-November. During the 0000 GMT cycle, the MOS max/min guidance is valid for periods corresponding to today's max, tonight's min, tomorrow's max, and tomorrow night's min. Similarly, for the 1200 GMT forecast cycle, guidance is available for tonight's min, tomorrow's max, tomorrow night's min, and the day after tomorrow's max. Station observations at 0000 GMT (1200 GMT) are used as possible predictors only in the first period forecast of today's max (tonight's min). The valid periods of the guidance closely approximate those of the local forecaster who makes predictions of today's high, tonight's low, and so forth.

In this publication, we present results for both guidance and local forecasts which were verified by using observations that approximate the daytime high or nighttime low. In the local AFOS-era verification software (Ruth and Alex, 1987), daytime is defined as 7 a.m to 7 p.m. LST and nighttime as 7 p.m. to 8 a.m. LST. The local program scans the synoptic and hourly reports to determine if the reported max/min observation adequately represents the daytime or nighttime period. If this observation is satisfactory, it is kept. If, however, the reported value is not representative of the day or night period, then an algorithm is used to deduce the appropriate value from available synoptic and hourly temperature observations. The local forecaster is also provided the option of replacing the estimated observation with the exact nighttime low or daytime high. It's important to note, then, that the verifying observations correspond reasonably well to the local and guidance forecast periods.

We verified the local and MOS max/min temperature forecasts for both the 0000 and 1200 GMT cycles. The mean algebraic error (forecast minus observed temperature), mean absolute error, percent of absolute errors >10°F, probability of detection[5] of min temperatures ≤32°F, and false alarm ratio[6] for min temperatures ≤32°F were computed for 93 stations in the conterminous United States (Table 2.1). At 0000 (1200) GMT, the local max temperature forecasts are valid for daytime periods ending approximately 24 (36) and 48 (60) hours after 0000 (1200) GMT. Similarly, at 0000 (1200) GMT, the local min temperature forecasts are valid for nighttime periods ending approximately 36 (24) and 60 (48) hours after 0000 (1200) GMT. However, it should be noted that the local forecasters occasionally may not have put much effort into making the 60-h min forecasts from 0000 GMT, especially during severe weather events.

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[5] Here, the probability of detection is defined to be the fraction of time the min temperature was correctly forecast to be ≤32°F when the previous day's min was ≥40°F.

[6] Here, the false alarm ratio is defined to be the fraction of forecasts of ≤32°F that failed to verify when the previous day's min was ≥40°F.

For all stations combined, the results for 0000 and 1200 GMT are shown in Tables 6.1 and 6.6, respectively. Similarly, Tables 6.2-6.5 give the 0000 GMT cycle verification scores for the Eastern, Southern, Central, and Western Regions, respectively. Tables 6.7-6.10 show analogous scores by NWS region for the 1200 GMT cycle.

7. SUMMARY

Highlights of the 1987 warm season verification results, summarized by general type of weather element, are:

- Probability of Precipitation - The PoP verification involved 93 stations and forecast projections of 12-24, 24-36, and 36-48 hours from 0000 and 1200 GMT. The NWS Brier scores for all stations and both forecast cycles combined show that the local forecasts were 4.0% better than the guidance for the first period, 1.9% better for the second period, and 1.7% better for the third period. Depending on the projection and cycle, the local forecasters deviated by 20% or more from the guidance about 11% of the time. In those cases, the NWS Brier scores for all stations and both forecast cycles combined show that the local forecasters were 10.7% better than the guidance for the first period, 5.5% better for the second period, and 6.3% better for the third period. The percent improvement over climate scores for all three periods and both forecast cycles combined indicate that the local forecasts were better than those for the previous warm season, (Dagostaro et al., 1986) but the guidance was slightly worse.

- Surface Wind - The local wind speed and direction forecasts were not available for a full season, so statistics were computed for the guidance forecasts only. The MOS wind speed and direction forecasts were verified for 91 (92) stations for projections of 12, 18, and 24 hours from 0000 (1200) GMT. Since a comparative verification of local and guidance forecasts was not possible, only conclusions of a general nature can be drawn from the results. The mean absolute error and skill score for all stations, projections, and both forecast cycles combined show that the MOS wind direction forecasts were generally worse than for the previous warm season. The skill score, threat score, mean algebraic error, and bias by category for all stations, projections, and both cycles combined show that the wind speed forecasts were worse than those for the previous warm season; however, in terms of percent correct the wind speed forecasts were better than last year's results. The mean absolute error for all stations, projections, and both cycles combined remained about the same as last year's results.

- Cloud Amount - The verification for cloud amount involved 94 stations and forecasts for projections of 12, 18, and 24 hours from 0000 and 1200 GMT. The skill scores and percents correct for all stations combined indicate both the 0000 and 1200 GMT cycle local forecasts were better than the corresponding guidance for the 12-h projection, while the guidance was better than the local forecasts for the 18- and 24-h projections. In terms of bias by category (clear, scattered, broken, and overcast), the results varied by category, cycle, and forecast projection, but usually, the guidance was better than the local

forecasts except for the prediction of scattered. In terms of skill score and percent correct, the results indicate that both types of forecasts were better than those for the previous warm season, while the bias by category remained about the same as last year's results.

- Ceiling and Visibility - The verification involved the comparison of MOS guidance and persistence for 91 (92) stations for projections of 12, 18, and 24 hours from 0000 (1200) GMT. These are actually 3-, 9-, and 15-h forecasts from the latest available surface observations for persistence, and in this sense, they are usually 10-, 16-, and 22-h forecasts for the guidance. For both forecast cycles, the log scores, percents correct, and skill scores show that persistence was more accurate than the guidance forecasts for the 12-h projection for both ceiling and visibility. The guidance was always better than persistence for the 18- and 24-h projections from 0000 GMT, while persistence was usually better for the 1200 GMT cycle. The bias by category scores varied greatly from projection to projection and cycle to cycle indicating no clear trends. A comparative verification of local and guidance forecasts was not possible, so these results were not compared to those for the previous warm season.

- Maximum/Minimum Temperature - Objective and local forecasts were verified for 93 stations for both the 0000 and 1200 GMT cycles. At 0000 (1200) GMT, the local maximum temperature forecasts were valid for daytime periods ending approximately 24 (36) and 48 (60) hours after 0000 or 1200 GMT, while the minimum temperature forecasts were valid for nighttime periods ending approximately 36 (24) and 60 (48) hours after initial model time. The valid periods of the guidance closely approximate those of the local forecasts. As verifying observations, max or min temperatures for daytime or nighttime intervals were used.

  For all stations and projections combined, we found the mean absolute errors of the local max and min temperature forecasts were 0.2°F and 0.1°F, respectively, more accurate than those for the MOS guidance. For all stations combined, the local forecasters were almost always able to improve over the MOS guidance, both in terms of mean absolute error and the percentage of errors >10°F. Compared to the 1986 warm season verification, the local forecasts improved in terms of mean absolute error for all stations and projections combined. In fact, the mean absolute error is the lowest recorded for the warm season since 1966 (Carter and Polger, 1986). Most of the improvement occurred in the min forecasts. In terms of the percentage of errors >10°F, both the local forecasts and the guidance improved over that of the previous warm season.

8. ACKNOWLEDGMENTS

We are grateful to Fred Marshall and Eston Pennington for assistance in archiving the data, and to Allison Denson for typing the text.

REFERENCES

Brier, G. W., 1950: Verification of forecasts expressed in terms of probability. Mon. Wea. Rev., 78, 1-3.

Carter, G. M., and P. D. Polger, 1986: A 20-year summary of national weather service verification results for temperature and precipitation. NOAA Technical Memorandum NWS FCST-31, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 50 pp.

Dagostaro, V. J., 1985: The national AFOS-era verification data processing system. TDL Office Note 85-9, National Weather Service, NOAA, U.S. Department of Commerce, 47 pp.

_____, Carter, G. M., J. P. Dallavalle, and G. W. Hollenbaugh, 1986: AFOS-era verification of guidance and local aviation/public weather forecasts--No. 6 (April 1986-September 1986). TDL Office Note 86-4, National Weather Service, NOAA, U.S. Department of Commerce, 45 pp.

Erickson, M. C., and J. P. Dallavalle, 1986: Objectively forecasting the short-range maximum/minimum temperature - A new look. Preprints Eleventh Conference on Weather Forecasting and Analysis, Kansas City, Amer. Meteor. Soc., 33-38.

Gerrity, J. P., Jr., 1977: The LFM model--1976: A documentation. NOAA Technical Memorandum NWS NMC-60, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 68 pp.

Glahn, H. R., and D. A. Lowry, 1972: The use of Model Output Statistics (MOS) in objective weather forecasting. J. Appl. Meteor., 11, 1203-1211.

Jorgensen, D. L., 1967: Climatological probabilities of precipitation for the conterminous United States. ESSA Tech. Report WB-5, Environmental Science Services Administration, U.S. Department of Commerce, 60 pp.

Klein, W. H., B. M. Lewis, and I. Enger, 1959: Objective prediction of five-day mean temperatures during winter. J. Meteor., 16, 672-682.

Maglaras, G. J., G. M. Carter, J. P. Dallavalle, G. W. Hollenbaugh, and B. E. Schwartz, 1984: Comparative verification of guidance and local aviation/public weather forecasts--No. 16 (April 1983-September 1983). TDL Office Note 84-4, National Weather Service, NOAA, U.S. Department of Commerce, 69 pp.

National Weather Service, 1981a: The use of Model Output Statistics for predicting probability of precipitation (PoP). NWS Technical Procedures Bulletin No. 299, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 12 pp.

_____, 1981b: The use of Model Output Statistics for predicting ceiling, visibility, cloud amount, and obstructions to vision. NWS Technical Procedures Bulletin No. 303, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 11 pp.

_____, 1982: National Verification Plan. National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 81 pp.

_____, 1983: Public/aviation forecast verification. NWS Operations Manual, Chapter C-73, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 18 pp.

_____, 1984: The use of Model Output Statistics for predicting surface wind. NWS Technical Procedures Bulletin No. 347, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 11 pp.

_____, 1985: Automated daytime maximum, nighttime minimum, 3-hourly surface temperature, and 3-hourly surface dew point guidance. NWS Technical Procedures Bulletin No. 356, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 14 pp.

Newell, J. E., and D. G. Deaven, 1981: The LFM-II model--1980. NOAA Technical Memorandum NWS NMC-66, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 20 pp.

Panofsky, H. A., and G. W. Brier, 1965: Some Applications of Statistics to Meteorology. Pennsylvania State University, University Park, 224 pp.

Ruth, D. P., and C. L. Alex, 1987: AFOS-era forecast verification. NOAA Techniques Development Laboratory Computer Program NWS TDL CP 87-2, National Weather Service, NOAA, U.S. Department of Commerce, 50 pp.

Table 2.1. Ninety-four stations used for comparative verification of MOS guidance and local probability of precipitation, surface wind, cloud amount, ceiling height, visibility, and max/min temperature forecasts. Please note that LAX was not included in the PoP and max/min temperature verifications. TCC was not available during the 0000 GMT cycle for surface wind, ceiling height, and visibility. ELP was not available for surface wind, ceiling height, and visibility during the 1200 GMT cycle.

DCA	Washington, D.C.	ORF	Norfolk, Virginia
PWM	Portland, Maine	CON	Concord, New Hampshire
BOS	Boston, Massachusetts	PVD	Providence, Rhode Island
ALB	Albany, New York	BTV	Burlington, Vermont
BUF	Buffalo, New York	SYR	Syracuse, New York
LGA	New York (LaGuardia), New York	EWR	Newark, New Jersey
RDU	Raleigh-Durham, North Carolina	CLT	Charlotte, North Carolina
CLE	Cleveland, Ohio	CMH	Columbus, Ohio
PHL	Philadelphia, Pennsylvania	AVP	Scranton, Pennsylvania
PIT	Pittsburgh, Pennsylvania	ERI	Erie, Pennsylvania
CAE	Columbia, South Carolina	CHS	Charleston, South Carolina
CRW	Charleston, West Virginia	BKW	Beckley, West Virginia
BHM	Birmingham, Alabama	MOB	Mobile, Alabama
LIT	Little Rock, Arkansas	FSM	Fort Smith, Arkansas
MIA	Miami, Florida	TPA	Tampa, Florida
ATL	Atlanta, Georgia	SAV	Savannah, Georgia
MSY	New Orleans, Louisiana	SHV	Shreveport, Louisiana
JAN	Jackson, Mississippi	MEI	Meridian, Mississippi
ABQ	Albuquerque, New Mexico	TCC	Tucumcari, New Mexico
OKC	Oklahoma City, Oklahoma	TUL	Tulsa, Oklahoma
MEM	Memphis, Tennessee	BNA	Nashville, Tennessee
DFW	Dallas-Ft. Worth, Texas	ABI	Abilene, Texas
LBB	Lubbock, Texas	ELP	El Paso, Texas
SAT	San Antonio, Texas	IAH	Houston, Texas
DEN	Denver, Colorado	GJT	Grand Junction, Colorado
ORD	Chicago (O'Hare), Illinois	SPI	Springfield, Illinois
IND	Indianapolis, Indiana	SBN	South Bend, Indiana
DSM	Des Moines, Iowa	ALO	Waterloo, Iowa
TOP	Topeka, Kansas	ICT	Wichita, Kansas
SDF	Louisville, Kentucky	LEX	Lexington, Kentucky
DTW	Detroit, Michigan	GRR	Grand Rapids, Michigan
MSP	Minneapolis, Minnesota	DLH	Duluth, Minnesota
STL	St. Louis, Missouri	MCI	Kansas City, Missouri
OMA	Omaha, Nebraska	LBF	North Platte, Nebraska
BIS	Bismarck, North Dakota	FAR	Fargo, North Dakota
FSD	Sioux Falls, South Dakota	RAP	Rapid City, South Dakota
MKE	Milwaukee, Wisconsin	MSN	Madison, Wisconsin
CYS	Cheyenne, Wyoming	CPR	Casper, Wyoming
PHX	Phoenix, Arizona	TUS	Tucson, Arizona
LAX	Los Angeles, California	SAN	San Diego, California
SFO	San Francisco, California	FAT	Fresno, California
BOI	Boise, Idaho	PIH	Pocatello, Idaho
GTF	Great Falls, Montana	HLN	Helena, Montana
RNO	Reno, Nevada	LAS	Las Vegas, Nevada
PDX	Portland, Oregon	MFR	Medford, Oregon
SLC	Salt Lake City, Utah	CDC	Cedar City, Utah
SEA	Seattle-Tacoma, Washington	GEG	Spokane, Washington

Table 2.2. Comparative verification of MOS guidance and local PoP forecasts for 93 stations, 0000 GMT cycle.

Forecast Projection (h)	Type of Forecast	Brier Score	% Imp. Over Guid.	% Imp. Over Clim.	No. of Cases	Changes GE 20% to Guidance: Brier Score	Changes GE 20% to Guidance: % Imp. Over Guid.	Changes GE 20% to Guidance: No. of Changes
12-24	MOS	0.1038		29.5		0.2163		
(1st period)	LOCAL	0.1002	3.5	31.9	16313	0.1969	9.0	2025
24-36	MOS	0.1096		23.3		0.2079		
(2nd period)	LOCAL	0.1069	2.4	25.2	16063	0.1952	6.1	1607
36-48	MOS	0.1189		19.1		0.2169		
(3rd period)	LOCAL	0.1172	1.4	20.2	16207	0.2057	5.1	1588

Table 2.3. Same as Table 2.2 except for 24 stations in the Eastern Region.

Forecast Projection (h)	Type of Forecast	Brier Score	% Imp. Over Guid.	% Imp. Over Clim.	No. of Cases	Changes GE 20% to Guidance: Brier Score	Changes GE 20% to Guidance: % Imp. Over Guid.	Changes GE 20% to Guidance: No. of Changes
12-24	MOS	0.1151		36.8		0.1948		
(1st period)	LOCAL	0.1129	1.9	38.0	4197	0.1892	2.9	673
24-36	MOS	0.1198		31.2		0.2010		
(2nd period)	LOCAL	0.1180	1.5	32.3	4160	0.1952	2.9	506
36-48	MOS	0.1340		26.4		0.2055		
(3rd period)	LOCAL	0.1354	-1.0	25.6	4171	0.2107	-2.5	498

Table 2.4. Same as Table 2.2 except for 24 stations in the Southern Region.

Forecast Projection (h)	Type of Forecast	Brier Score	% Imp. Over Guid.	% Imp. Over Clim.	No. of Cases	Changes GE 20% to Guidance: Brier Score	Changes GE 20% to Guidance: % Imp. Over Guid.	Changes GE 20% to Guidance: No. of Changes
12-24	MOS	0.1176		21.7		0.2227		
(1st period)	LOCAL	0.1136	3.4	24.4	4269	0.1984	10.9	616
24-36	MOS	0.1109		13.7		0.2009		
(2nd period)	LOCAL	0.1082	2.4	15.8	4102	0.1893	5.8	435
36-48	MOS	0.1292		13.7		0.2232		
(3rd period)	LOCAL	0.1275	1.4	14.9	4245	0.2094	6.2	532

Table 2.5. Same as Table 2.2 except for 28 stations in the Central Region.

Forecast Projection (h)	Type of Forecast	Brier Score	% Imp. Over Guid.	% Imp. Over Clim.	No. of Cases	Changes GE 20% to Guidance: Brier Score	Changes GE 20% to Guidance: % Imp. Over Guid.	Changes GE 20% to Guidance: No. of Changes
12-24	MOS	0.1059		30.5		0.2249		
(1st period)	LOCAL	0.1026	3.1	32.7	4912	0.2043	9.2	589
24-36	MOS	0.1254		23.1		0.2062		
(2nd period)	LOCAL	0.1228	2.1	24.7	4886	0.1984	3.8	514
36-48	MOS	0.1250		17.9		0.2198		
(3rd period)	LOCAL	0.1223	2.1	19.6	4881	0.2073	5.7	426

Table 2.6. Same as Table 2.2 except for 17 stations in the Western Region.

Forecast Projection (h)	Type of Forecast	Brier Score	% Imp. Over Guid.	% Imp. Over Clim.	No. of Cases	Changes GE 20% to Guidance: Brier Score	Changes GE 20% to Guidance: % Imp. Over Guid.	Changes GE 20% to Guidance: No. of Changes
12-24	MOS	0.0638		24.1		0.2533		
(1st period)	LOCAL	0.0585	8.3	30.4	2935	0.1962	22.5	147
24-36	MOS	0.0666		21.2		0.2569		
(2nd period)	LOCAL	0.0625	6.1	26.1	2915	0.2011	21.7	152
36-48	MOS	0.0720		13.8		0.2248		
(3rd period)	LOCAL	0.0677	5.9	18.9	2910	0.1666	25.9	132

Table 2.7. Comparative verification of MOS guidance and local PoP forecasts for 93 stations, 1200 GMT cycle.

Forecast Projection (h)	Type of Forecast	Brier Score	% Imp. Over Guid.	% Imp. Over Clim.	No. of Cases	Changes GE 20% to Guidance: Brier Score	Changes GE 20% to Guidance: % Imp. Over Guid.	Changes GE 20% to Guidance: No. of Changes
12-24	MOS	0.1032		28.0		0.2191		
(1st period)	LOCAL	0.0985	4.6	31.3	15985	0.1919	12.4	2054
24-36	MOS	0.1105		24.5		0.2093		
(2nd period)	LOCAL	0.1090	1.4	25.6	16136	0.1990	4.9	1696
36-48	MOS	0.1154		18.8		0.2162		
(3rd period)	LOCAL	0.1131	2.0	20.4	15891	0.2001	7.4	1518

Table 2.8. Same as Table 2.7 except for 24 stations in the Eastern Region.

Forecast Projection (h)	Type of Forecast	Brier Score	% Imp. Over Guid.	% Imp. Over Clim.	No. of Cases	Changes GE 20% to Guidance: Brier Score	Changes GE 20% to Guidance: % Imp. Over Guid.	Changes GE 20% to Guidance: No. of Changes
12-24 (1st period)	MOS	0.1101		37.0		0.1731		
	LOCAL	0.1089	1.1	37.7	4138	0.1706	1.5	623
24-36 (2nd period)	MOS	0.1228		32.2		0.1865		
	LOCAL	0.1237	-0.7	31.7	4148	0.1951	-4.6	526
36-48 (3rd period)	MOS	0.1308		23.9		0.2202		
	LOCAL	0.1282	2.0	25.4	4115	0.2056	6.6	472

Table 2.9. Same as Table 2.7 except for 24 stations in the Southern Region.

Forecast Projection (h)	Type of Forecast	Brier Score	% Imp. Over Guid.	% Imp. Over Clim.	No. of Cases	Changes GE 20% to Guidance: Brier Score	Changes GE 20% to Guidance: % Imp. Over Guid.	Changes GE 20% to Guidance: No. of Changes
12-24 (1st period)	MOS	0.1060		18.0		0.2241		
	LOCAL	0.1008	4.9	22.1	4100	0.1942	13.3	559
24-36 (2nd period)	MOS	0.1231		17.6		0.2297		
	LOCAL	0.1189	3.4	20.4	4247	0.1974	14.1	571
36-48 (3rd period)	MOS	0.1159		10.7		0.2044		
	LOCAL	0.1136	2.0	12.5	4077	0.1880	8.0	430

Table 2.10. Same as Table 2.7 except for 28 stations in the Central Region.

Forecast Projection (h)	Type of Forecast	Brier Score	% Imp. Over Guid.	% Imp. Over Clim.	No. of Cases	Changes GE 20% to Guidance: Brier Score	Changes GE 20% to Guidance: % Imp. Over Guid.	Changes GE 20% to Guidance: No. of Changes
12-24	MOS	0.1186		27.3		0.2441		
(1st period)	LOCAL	0.1113	6.2	31.8	4853	0.2070	15.2	693
24-36	MOS	0.1133		25.1		0.2039		
(2nd period)	LOCAL	0.1130	0.3	25.3	4848	0.2079	-2.0	467
36-48	MOS	0.1282		20.3		0.2264		
(3rd period)	LOCAL	0.1259	1.8	21.8	4822	0.2135	5.7	471

Table 2.11. Same as Table 2.7 except for 17 stations in the Western Region.

Forecast Projection (h)	Type of Forecast	Brier Score	% Imp. Over Guid.	% Imp. Over Clim.	No. of Cases	Changes GE 20% to Guidance: Brier Score	Changes GE 20% to Guidance: % Imp. Over Guid.	Changes GE 20% to Guidance: No. of Changes
12-24	MOS	0.0635		25.5		0.2664		
(1st period)	LOCAL	0.0589	7.3	31.0	2894	0.2008	24.6	179
24-36	MOS	0.0694		17.4		0.2310		
(2nd period)	LOCAL	0.0665	4.2	20.9	2893	0.1909	17.3	132
36-48	MOS	0.0712		16.2		0.2048		
(3rd period)	LOCAL	0.0692	2.8	18.5	2877	0.1746	14.7	145

Table 3.1. Definition of the categories used for MOS guidance, local forecasts, and surface observations of wind direction and speed.

Category	Direction (degrees)	Speed (kt)
1	340-20	$\leq$ 12
2	30-60	13-17
3	70-110	18-22
4	120-150	23-27
5	160-200	28-32
6	210-240	$\geq$ 33
7	250-290	---
8	300-330	---

Table 3.2. Verification of MOS surface wind guidance for 91 stations, 0000 GMT cycle.

		Direction			Speed											
								Contingency Table								
											Bias by Category					
Fcst Proj (h)	Type of Fcst.	Mean Abs. Error (deg)	Skill Score	No. of Cases	Mean Abs. Error (kt)	Mean Alg. Error (kt)	No. of Cases	Skill Score	Percent Fcst. Correct	Threat Score (>27 kt)	1 No. Obs	2 No. Obs	3 No. Obs	4 No. Obs	5 No. Obs	6 No. Obs
12	MOS	24	0.518	1856	3.4	1.8	1877	0.329	94.1	0.00	1.01 14526	0.85 632	0.73 113	0.41 22	0.00 7	* 0
18	MOS	27	0.440	4677	2.9	0.4	4688	0.344	82.8	0.00	1.08 12503	0.66 2282	0.59 410	0.65 57	0.10 10	0.00 1
24	MOS	31	0.423	3855	3.3	0.8	3878	0.308	84.3	0.06	1.07 12845	0.66 1827	0.60 415	0.35 77	0.17 12	0.00 5

* This category was neither forecast nor observed.

Table 3.3. Same as Table 3.2 except for 24 stations in the Eastern Region.

		Direction			Speed											
								Contingency Table								
											Bias by Category					
Fcst Proj (h)	Type of Fcst.	Mean Abs. Error (deg)	Skill Score	No. of Cases	Mean Abs. Error (kt)	Mean Alg. Error (kt)	No. of Cases	Skill Score	Percent Fcst. Correct	Threat Score (>27 kt)	1 No. Obs	2 No. Obs	3 No. Obs	4 No. Obs	5 No. Obs	6 No. Obs
12	MOS	24	0.493	489	3.1	1.1	492	0.322	93.2	0.00	1.02 3740	0.72 206	0.54 35	1.00 2	0.00 2	* 0
18	MOS	29	0.369	1304	2.7	0.4	1306	0.306	82.1	0.00	1.09 3233	0.59 647	0.58 77	0.73 11	0.00 1	* 0
24	MOS	32	0.375	544	3.1	1.1	548	0.214	91.3	0.00	1.04 3639	0.50 272	0.53 30	0.20 5	* 0	* 0

* This category was neither forecast nor observed.

Table 3.4. Same as Table 3.2 except for 21 stations in the Southern Region.

Fcst Proj (h)	Type of Fcst.	Direction: Mean Abs. Error (deg)	Direction: Skill Score	Direction: No. of Cases	Speed: Mean Abs. Error (kt)	Speed: Mean Alg. Error (kt)	Speed: No. of Cases	Contingency Table: Skill Score	Contingency Table: Percent Fcst. Correct	Contingency Table: Threat Score (>27 kt)	Bias by Category: 1 No. Obs	2 No. Obs	3 No. Obs	4 No. Obs	5 No. Obs	6 No. Obs
12	MOS	24	0.491	318	3.6	2.1	322	0.311	96.4	0.00	1.00 3636	1.11 76	0.76 17	0.40 5	0.00 2	* 0
18	MOS	28	0.440	1009	2.9	1.1	1012	0.363	86.7	0.00	1.03 3252	0.83 399	0.75 69	0.30 10	0.00 1	* 0
24	MOS	28	0.432	848	3.0	1.4	853	0.314	88.1	0.00	1.03 3311	0.82 327	0.59 63	0.00 6	0.00 1	* 0

* This category was neither forecast nor observed.

Table 3.5. Same as Table 3.2 except for 28 stations in the Central Region.

Fcst Proj (h)	Type of Fcst.	Direction: Mean Abs. Error (deg)	Direction: Skill Score	Direction: No. of Cases	Speed: Mean Abs. Error (kt)	Speed: Mean Alg. Error (kt)	Speed: No. of Cases	Contingency Table: Skill Score	Contingency Table: Percent Fcst. Correct	Contingency Table: Threat Score (>27 kt)	Bias by Category: 1 No. Obs	Bias by Category: 2 No. Obs	Bias by Category: 3 No. Obs	Bias by Category: 4 No. Obs	Bias by Category: 5 No. Obs	Bias by Category: 6 No. Obs
12	MOS	21	0.558	665	3.1	1.5	667	0.322	92.8	0.00	1.02 4451	0.69 262	1.03 35	0.44 9	0.00 3	* 0
18	MOS	22	0.498	1763	2.9	-0.3	1768	0.328	77.1	0.00	1.15 3523	0.61 979	0.49 204	0.38 26	0.00 7	0.00 1
24	MOS	29	0.424	1300	3.1	0.0	1306	0.280	81.8	0.10	1.12 3811	0.52 715	0.34 154	0.09 22	0.14 7	0.00 3

* This category was neither forecast nor observed.

Table 3.6. Same as Table 3.2 except for 18 stations in the Western Region.

		Direction			Speed											
								Contingency Table								
											Bias by Category					
Fcst Proj (h)	Type of Fcst.	Mean Abs. Error (deg)	Skill Score	No. of Cases	Mean Abs. Error (kt)	Mean Alg. Error (kt)	No. of Cases	Skill Score	Percent Fcst. Correct	Threat Score (>27 kt)	1 No. Obs	2 No. Obs	3 No. Obs	4 No. Obs	5 No. Obs	6 No. Obs
12	MOS	29	0.436	384	4.0	2.7	396	0.360	94.3	0.00	0.99 2699	1.41 88	0.58 26	0.17 6	* 0	* 0
18	MOS	35	0.327	601	3.5	1.4	602	0.396	88.4	0.00	1.02 2495	0.80 257	0.73 60	1.60 10	1.00 1	* 0
24	MOS	33	0.334	1163	3.7	0.9	1171	0.321	73.8	0.00	1.06 2084	0.84 513	0.85 168	0.55 44	0.25 4	0.00 2

* This category was neither forecast nor observed.

Table 3.7. Verification of MOS surface wind guidance for 92 stations, 1200 GMT cycle.

		Direction			Speed											
								Contingency Table								
											Bias by Category					
Fcst Proj (h)	Type of Fcst.	Mean Abs. Error (deg)	Skill Score	No. of Cases	Mean Abs. Error (kt)	Mean Alg. Error (kt)	No. of Cases	Skill Score	Percent Fcst. Correct	Threat Score (>27 kt)	1 No. Obs	2 No. Obs	3 No. Obs	4 No. Obs	5 No. Obs	6 No. Obs
12	MOS	28	0.462	4076	3.0	0.8	4094	0.342	84.6	0.11	1.06 12745	0.72 1827	0.62 417	0.38 76	0.15 13	0.00 5
18	MOS	26	0.475	1742	3.6	1.8	1773	0.277	93.3	0.00	1.02 13958	0.68 730	0.52 122	0.00 18	0.00 4	* 0
24	MOS	25	0.488	1498	3.7	1.7	1521	0.263	94.2	0.00	1.02 14365	0.65 627	0.39 107	0.35 23	0.00 7	* 0

* This category was neither forecast nor observed.

Table 3.8. Same as Table 3.7 except for 24 stations in the Eastern Region.

		Direction			Speed											
								Contingency Table								
											Bias by Category					
Fcst Proj (h)	Type of Fcst.	Mean Abs. Error (deg)	Skill Score	No. of Cases	Mean Abs. Error (kt)	Mean Alg. Error (kt)	No. of Cases	Skill Score	Percent Fcst. Correct	Threat Score (>27 kt)	1 No. Obs	2 No. Obs	3 No. Obs	4 No. Obs	5 No. Obs	6 No. Obs
12	MOS	30	0.400	643	3.0	1.3	646	0.285	91.5	0.00	1.03 3599	0.61 272	0.61 31	0.00 3	* 0	* 0
18	MOS	24	0.481	268	3.3	1.2	272	0.245	95.5	0.00	1.02 3731	0.45 148	0.46 13	0.00 3	* 0	* 0
24	MOS	26	0.459	400	3.3	1.0	404	0.287	93.5	0.00	1.03 3682	0.54 204	0.41 34	2.00 2	0.00 2	* 0

* This category was neither forecast nor observed.

Table 3.9. Same as Table 3.7 except for 22 stations in the Southern Region.

Fcst Proj (h)	Type of Fcst.	Direction			Speed											
								Contingency Table								
											Bias by Category					
		Mean Abs. Error (deg)	Skill Score	No. of Cases	Mean Abs. Error (kt)	Mean Alg. Error (kt)	No. of Cases	Skill Score	Percent Fcst. Correct	Threat Score (>27 kt)	1 No. Obs	2 No. Obs	3 No. Obs	4 No. Obs	5 No. Obs	6 No. Obs
12	MOS	27	0.451	846	2.9	1.3	850	0.317	88.1	0.00	1.03 3300	0.84 321	0.60 63	0.14 7	0.00 1	* 0
18	MOS	23	0.403	401	3.8	2.5	409	0.327	94.6	0.00	0.99 3364	1.35 103	0.64 28	0.00 3	* 0	* 0
24	MOS	27	0.379	316	4.0	2.6	323	0.266	96.0	0.00	1.00 3605	1.33 78	0.36 14	0.00 5	0.00 2	* 0

* This category was neither forecast nor observed.

Table 3.10. Same as Table 3.7 except for 28 stations in the Central region.

		Direction			Speed											
								Contingency Table								
											Bias by Category					
Fcst Proj (h)	Type of Fcst.	Mean Abs. Error (deg)	Skill Score	No. of Cases	Mean Abs. Error (kt)	Mean Alg. Error (kt)	No. of Cases	Skill Score	Percent Fcst. Correct	Threat Score (>27 kt)	1 No. Obs	2 No. Obs	3 No. Obs	4 No. Obs	5 No. Obs	6 No. Obs
12	MOS	27	0.468	1415	2.9	0.2	1421	0.319	81.5	0.09	1.10 3781	0.63 722	0.48 155	0.26 23	0.13 8	0.00 3
18	MOS	28	0.455	626	3.3	1.3	633	0.287	91.7	0.00	1.04 4297	0.53 319	0.44 50	0.00 8	0.00 2	* 0
24	MOS	21	0.534	488	3.3	1.2	489	0.232	93.0	0.00	1.04 4412	0.48 257	0.50 32	0.40 10	0.00 3	* 0

* This category was neither forecast nor observed.

Table 3.11. Same as Table 3.7 except for 18 stations in the Western region.

Fcst Proj (h)	Type of Fcst.	Direction			Speed											
								Contingency Table								
											Bias by Category					
		Mean Abs. Error (deg)	Skill Score	No. of Cases	Mean Abs. Error (kt)	Mean Alg. Error (kt)	No. of Cases	Skill Score	Percent Fcst. Correct	Threat Score (>27 kt)	1 No. Obs	2 No. Obs	3 No. Obs	4 No. Obs	5 No. Obs	6 No. Obs
12	MOS	28	0.385	1172	3.3	0.7	1177	0.361	75.6	0.17	1.07 2065	0.83 512	0.76 168	0.51 43	0.25 4	0.00 2
18	MOS	27	0.462	447	3.9	2.1	459	0.236	91.1	0.00	1.02 2566	0.79 160	0.58 31	0.00 4	0.00 2	* 0
24	MOS	28	0.479	294	4.3	2.5	305	0.284	95.0	0.00	1.02 2666	0.82 88	0.26 27	0.00 6	* 0	* 0

* This category was neither forecast nor observed.

Table 4.1. Definitions of the cloud amount categories used for the local forecasts and observations. The MOS guidance was based on these same categories for opaque amounts only.

Category	Cloud Amount
1	CLR, -SCT -BKN, -OVC, -X
2	SCT
3	BKN
4	OVC, X

Table 4.2. Comparative verification of MOS guidance and local forecasts of four categories of cloud amount (clear, scattered, broken, and overcast) for 94 stations, 0000 GMT cycle.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	Percent Correct	Skill Score
12	MOS	0.70	1.67	1.36	0.80	52.0	0.350
	LOCAL	0.77	1.33	1.56	0.84	61.0	0.468
	No. Obs.	6700	3221	2017	4307		
18	MOS	0.71	1.37	1.20	0.73	53.4	0.369
	LOCAL	0.61	1.30	1.64	0.61	49.7	0.325
	No. Obs.	4930	4864	2890	3573		
24	MOS	0.78	1.39	1.21	0.70	49.5	0.318
	LOCAL	0.65	1.28	1.78	0.59	45.1	0.270
	No. Obs.	5222	4508	2714	3799		

Table 4.3. Same as Table 4.2 except for 24 stations in the Eastern Region.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	Percent Correct	Skill Score
12	MOS	0.59	1.56	1.67	0.88	51.1	0.338
	LOCAL	0.66	1.45	1.86	0.82	55.3	0.398
	No. Obs.	1348	749	490	1583		
18	MOS	0.41	1.34	1.34	0.80	51.4	0.331
	LOCAL	0.48	1.22	1.66	0.69	48.1	0.296
	No. Obs.	742	1289	800	1344		
24	MOS	0.56	1.57	1.34	0.85	48.0	0.305
	LOCAL	0.49	1.43	1.93	0.75	43.6	0.258
	No. Obs.	1224	948	611	1385		

Table 4.4. Same as Table 4.2 except for 24 stations in the Southern Region.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	Percent Correct	Skill Score
12	MOS	0.61	1.81	1.23	0.69	48.2	0.302
	LOCAL	0.68	1.43	1.46	0.80	57.0	0.419
	No. Obs.	1757	999	662	867		
18	MOS	0.67	1.30	1.12	0.62	52.9	0.334
	LOCAL	0.50	1.25	1.46	0.45	46.8	0.248
	No. Obs.	1026	1573	1025	662		
24	MOS	0.72	1.35	1.13	0.61	46.7	0.262
	LOCAL	0.60	1.22	1.70	0.39	42.2	0.207
	No. Obs.	1131	1460	887	810		

Table 4.5. Same as Table 4.2 except for 28 stations in the Central Region.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	Percent Correct	Skill Score
12	MOS	0.66	1.77	1.36	0.80	51.4	0.344
	LOCAL	0.82	1.30	1.44	0.86	62.7	0.485
	No. Obs.	2019	957	581	1264		
18	MOS	0.70	1.46	1.17	0.76	52.8	0.361
	LOCAL	0.55	1.44	1.76	0.61	48.9	0.320
	No. Obs.	1622	1352	758	1084		
24	MOS	0.79	1.42	1.19	0.67	50.7	0.332
	LOCAL	0.61	1.29	1.90	0.58	44.1	0.259
	No. Obs.	1592	1337	771	1114		

Table 4.6. Same as Table 4.2 except for 18 stations in the Western Region.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	Percent Correct	Skill Score
12	MOS	0.95	1.35	1.18	0.74	59.8	0.382
	LOCAL	0.93	1.03	1.51	0.92	72.2	0.576
	No. Obs.	1576	516	284	593		
18	MOS	0.90	1.44	1.16	0.62	58.0	0.365
	LOCAL	0.82	1.32	1.86	0.59	57.1	0.371
	No. Obs.	1540	650	307	483		
24	MOS	1.02	1.18	1.22	0.48	53.8	0.335
	LOCAL	0.91	1.19	1.50	0.49	52.9	0.335
	No. Obs.	1275	763	445	490		

Table 4.7. Comparative verification of MOS guidance and local forecasts of four categories of cloud amount (clear, scattered, broken, and overcast) for 94 stations, 1200 GMT cycle.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	Percent Correct	Skill Score
12	MOS	0.88	1.32	1.20	0.64	51.3	0.341
	LOCAL	0.81	1.13	1.48	0.76	56.4	0.416
	No. Obs.	5175	4497	2685	3749		
18	MOS	0.87	1.59	1.09	0.83	55.8	0.351
	LOCAL	0.66	1.77	2.10	0.71	49.9	0.309
	No. Obs.	8005	2570	1614	3740		
24	MOS	0.82	1.57	1.14	0.79	52.0	0.339
	LOCAL	0.74	1.51	1.70	0.70	48.0	0.297
	No. Obs.	6636	3173	2009	4270		

Table 4.8. Same as Table 4.7 except for 24 stations in the Eastern Region.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	Percent Correct	Skill Score
12	MOS	0.66	1.48	1.45	0.77	50.0	0.334
	LOCAL	0.66	1.25	1.71	0.82	54.8	0.399
	No. Obs.	1209	934	603	1341		
18	MOS	0.78	1.68	1.34	0.92	53.8	0.348
	LOCAL	0.61	1.89	2.31	0.77	50.4	0.332
	No. Obs.	1725	540	395	1422		
24	MOS	0.64	1.57	1.41	0.91	50.4	0.323
	LOCAL	0.65	1.47	2.02	0.76	46.9	0.290
	No. Obs.	1331	718	488	1542		

Table 4.9. Same as Table 4.7 except for 24 stations in the Southern Region.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	Percent Correct	Skill Score
12	MOS	0.98	1.22	1.03	0.59	49.5	0.302
	LOCAL	0.77	1.14	1.39	0.64	56.5	0.405
	No. Obs.	1126	1455	879	798		
18	MOS	0.84	1.73	0.86	0.78	54.1	0.315
	LOCAL	0.57	1.84	2.03	0.64	44.8	0.241
	No. Obs.	2174	780	503	635		
24	MOS	0.73	1.75	0.98	0.69	48.4	0.295
	LOCAL	0.64	1.62	1.62	0.53	43.2	0.237
	No. Obs.	1736	992	660	866		

Table 4.10. Same as Table 4.7 except for 28 stations in the Central Region.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	Percent Correct	Skill Score
12	MOS	0.91	1.29	1.17	0.67	52.1	0.349
	LOCAL	0.78	1.11	1.49	0.85	55.1	0.398
	No. Obs.	1559	1331	750	1099		
18	MOS	0.91	1.62	1.10	0.78	56.6	0.349
	LOCAL	0.66	1.95	2.16	0.71	49.2	0.295
	No. Obs.	2458	702	441	1139		
24	MOS	0.81	1.66	1.19	0.72	51.2	0.327
	LOCAL	0.76	1.57	1.62	0.67	47.6	0.287
	No. Obs.	1997	935	568	1242		

Table 4.11. Same as Table 4.7 except for 18 stations in the Western Region.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	Percent Correct	Skill Score
12	MOS	0.97	1.35	1.22	0.35	54.4	0.348
	LOCAL	1.03	1.03	1.33	0.60	60.7	0.439
	No. Obs.	1281	777	453	511		
18	MOS	0.98	1.24	1.11	0.77	59.4	0.358
	LOCAL	0.86	1.32	1.86	0.67	57.1	0.353
	No. Obs.	1648	548	275	544		
24	MOS	1.07	1.08	0.96	0.78	60.6	0.378
	LOCAL	0.88	1.26	1.50	0.84	56.8	0.357
	No. Obs.	1572	528	293	620		

Table 5.1. Definitions of the categories used for verification of persistence and guidance forecasts of ceiling height and visibility.

Category	Ceiling (ft)	Visibility (mi)
1	≤400	<1
2	500-900	1-2 3/4
3	1000-2900	3-6
4	≥3000	>6

Table 5.2. Comparative verification of MOS and persistence ceiling height forecasts for 91 stations, 0000 GMT cycle.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	Log Score	Percent Correct	Skill Score
12	MOS	1.07	0.81	0.91	1.01	2.197	83.4	0.370
	PERSISTENCE	0.86	0.72	0.89	1.03	1.390	88.9	0.560
	No. Obs.	500	651	1113	12592			
18	MOS	0.78	0.72	0.98	1.01	1.069	86.8	0.403
	PERSISTENCE	5.02	1.59	0.65	1.00	1.760	84.6	0.332
	No. Obs.	85	290	1509	12819			
24	MOS	0.90	0.54	1.03	1.01	0.798	92.1	0.349
	PERSISTENCE	3.75	2.26	1.50	0.93	1.820	85.7	0.221
	No. Obs.	114	207	652	13545			

Table 5.3. Same as Table 5.2 except for 92 stations, 1200 GMT cycle.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	Log Score	Percent Correct	Skill Score
12	MOS	1.22	0.65	1.05	1.00	0.814	92.1	0.362
	PERSISTENCE	0.73	0.98	1.47	0.98	0.550	93.3	0.528
	No. Obs.	109	209	644	13553			
18	MOS	1.37	0.75	1.06	1.00	1.495	88.5	0.368
	PERSISTENCE	0.31	0.58	1.20	1.01	1.158	89.0	0.345
	No. Obs.	264	344	782	13146			
24	MOS	1.78	0.80	0.95	0.98	2.853	81.3	0.343
	PERSISTENCE	0.16	0.31	0.87	1.08	2.079	83.2	0.230
	No. Obs.	498	658	1106	12561			

Table 5.4. Same as Table 5.2 except for visibility, 0000 GMT cycle.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	Log Score	Percent Correct	Skill Score
12	MOS	1.19	1.16	1.02	0.98	2.697	73.1	0.383
	PERSISTENCE	0.61	0.46	0.77	1.11	1.749	80.8	0.483
	No. Obs.	371	928	2663	11002			
18	MOS	0.75	0.74	1.30	0.97	1.163	84.5	0.359
	PERSISTENCE	7.06	1.61	1.31	0.94	1.726	81.4	0.304
	No. Obs.	32	266	1558	13057			
24	MOS	0.64	0.78	1.40	0.97	1.106	85.6	0.365
	PERSISTENCE	4.87	1.60	1.51	0.92	1.790	81.0	0.267
	No. Obs.	47	267	1347	13243			

Table 5.5. Same as Table 5.2 except for visibility for 92 stations, 1200 GMT cycle.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	Log Score	Percent Correct	Skill Score
12	MOS	2.15	1.08	1.12	0.98	1.140	86.7	0.377
	PERSISTENCE	0.79	0.95	1.02	1.00	0.646	92.0	0.600
	No. Obs.	47	260	1337	13222			
18	MOS	2.64	1.35	1.04	0.97	1.670	83.2	0.355
	PERSISTENCE	0.33	0.76	0.87	1.03	1.145	86.8	0.406
	No. Obs.	108	317	1561	12640			
24	MOS	2.39	1.37	1.07	0.90	3.413	70.5	0.371
	PERSISTENCE	0.10	0.27	0.52	1.21	2.523	75.2	0.243
	No. Obs.	373	926	2630	10991			

Table 6.1. Verification of MOS guidance and local max/min temperature forecasts for 93 stations, 0000 GMT cycle.

Forecast Projection	Forecast Type	Number of Cases	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Percent of Absolute Errors >10°F	Probability of Detection (32°F)	False Alarm Ratio (32°F)
Today's	MOS		-0.1	2.8	1.8	--	--
Max	LOCAL	16118	0.0	2.6	1.4	--	--
Tonight's	MOS		0.1	2.7	0.6	0.27	0.35
Min	LOCAL	16042	0.1	2.6	0.6	0.27	0.39
Tomorrow's	MOS		0.0	3.5	3.9	--	--
Max	LOCAL	16071	0.0	3.4	3.4	--	--
Tomorrow	MOS		0.1	3.3	1.9	0.11	0.71
Night's Min	LOCAL	16010	-0.1	3.2	2.0	0.14	0.62

Table 6.2. Same as Table 6.1 except for 24 stations in the Eastern Region.

Forecast Projection	Forecast Type	Number of Cases	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Percent of Absolute Errors >10°F	Probability of Detection (32°F)	False Alarm Ratio (32°F)
Today's	MOS		0.0	3.1	2.3	--	--
Max	LOCAL	4198	0.0	2.9	1.9	--	--
Tonight's	MOS		0.1	2.7	0.5	0.29	0.50
Min	LOCAL	4156	0.0	2.7	0.6	0.21	0.50
Tomorrow's	MOS		0.0	3.6	4.6	--	--
Max	LOCAL	4192	-0.2	3.6	3.9	--	--
Tomorrow	MOS		-0.4	3.3	1.5	0.29	0.69
Night's Min	LOCAL	4153	-0.5	3.3	1.6	0.21	0.73

Table 6.3. Same as Table 6.1 except for 24 stations in the Southern Region.

Forecast Projection	Forecast Type	Number of Cases	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Percent of Absolute Errors >10°F	Probability of Detection (32°F)	False Alarm Ratio (32°F)
Today's	MOS		-0.1	2.3	0.8	--	--
Max	LOCAL	4106	0.1	2.1	0.6	--	--
Tonight's	MOS		0.6	2.4	0.6	0.50	0.50
Min	LOCAL	4127	0.3	2.3	0.5	0.50	0.50
Tomorrow's	MOS		0.2	2.9	2.2	--	--
Max	LOCAL	4099	0.2	2.8	1.9	--	--
Tomorrow	MOS		0.7	2.6	1.2	*	**
Night's Min	LOCAL	4121	0.4	2.6	1.3	*	**

* No events of ≤32°F were observed.
** No forecasts of ≤32°F were made.

Table 6.4. Same as Table 6.1 except for 28 stations in the Central Region.

Forecast Projection	Forecast Type	Number of Cases	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Percent of Absolute Errors >10°F	Probability of Detection (32°F)	False Alarm Ratio (32°F)
Today's Max	MOS		-0.3	3.1	2.3	--	--
	LOCAL	4899	0.0	2.9	1.7	--	--
Tonight's Min	MOS		-0.1	3.0	0.7	0.24	0.00
	LOCAL	4875	0.1	2.9	0.7	0.33	0.13
Tomorrow's Max	MOS		-0.2	3.9	5.0	--	--
	LOCAL	4880	-0.2	3.7	4.4	--	--
Tomorrow Night's Min	MOS		0.1	3.8	3.0	0.00	1.00
	LOCAL	4871	-0.1	3.6	3.0	0.05	0.75

Table 6.5. Same as Table 6.1 except for 17 stations in the Western Region.

Forecast Projection	Forecast Type	Number of Cases	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Percent of Absolute Errors >10°F	Probability of Detection (32°F)	False Alarm Ratio (32°F)
Today's Max	MOS		-0.1	2.7	1.5	--	--
	LOCAL	2915	0.1	2.5	1.3	--	--
Tonight's Min	MOS		-0.3	3.0	0.8	0.24	0.29
	LOCAL	2884	-0.2	2.7	0.7	0.19	0.50
Tomorrow's Max	MOS		0.1	3.7	3.3	--	--
	LOCAL	2900	0.0	3.3	3.4	--	--
Tomorrow Night's Min	MOS		0.0	3.4	1.6	0.10	0.60
	LOCAL	2865	-0.2	3.1	1.8	0.20	0.33

Table 6.6. Verification of MOS guidance and local max/min temperature forecasts for 93 stations, 1200 GMT cycle.

Forecast Projection	Forecast Type	Number of Cases	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Percent of Absolute Errors >10°F	Probability of Detection (32°F)	False Alarm Ratio (32°F)
Tonight's Min	MOS		-0.2	2.6	0.5	0.33	0.34
	LOCAL	15970	-0.3	2.4	0.4	0.39	0.22
Tomorrow's Max	MOS		-0.1	3.4	3.1	--	--
	LOCAL	16001	-0.2	3.1	2.4	--	--
Tomorrow Night's Min	MOS		-0.2	3.0	1.1	0.14	0.64
	LOCAL	15867	-0.3	2.9	1.1	0.17	0.50
Day After Tomorrow's Max	MOS		-0.3	4.0	5.6	--	--
	LOCAL	15884	-0.3	3.8	5.4	--	--

Table 6.7. Same as Table 6.6 except for 24 stations in the Eastern Region.

Forecast Projection	Forecast Type	Number of Cases	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Percent of Absolute Errors >10°F	Probability of Detection (32°F)	False Alarm Ratio (32°F)
Tonight's Min	MOS		-0.1	2.5	0.2	0.19	0.25
	LOCAL	4134	-0.3	2.5	0.4	0.25	0.00
Tomorrow's Max	MOS		0.0	3.5	3.8	--	--
	LOCAL	4169	-0.2	3.3	3.0	--	--
Tomorrow Night's Min	MOS		-0.5	3.0	1.0	0.13	0.83
	LOCAL	4112	-0.5	2.9	1.0	0.19	0.63
Day After Tomorrow's Max	MOS		-0.3	4.2	6.4	--	--
	LOCAL	4142	-0.4	4.1	6.1	--	--

Table 6.8. Same as Table 6.6 except for 24 stations in the Southern Region.

Forecast Projection	Forecast Type	Number of Cases	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Percent of Absolute Errors >10°F	Probability of Detection (32°F)	False Alarm Ratio (32°F)
Tonight's Min	MOS		0.2	2.2	0.3	0.60	0.67
	LOCAL	4125	-0.1	2.1	0.3	0.40	0.67
Tomorrow's Max	MOS		-0.1	2.8	1.5	--	--
	LOCAL	4100	-0.1	2.5	1.2	--	--
Tomorrow Night's Min	MOS		0.4	2.5	0.4	*	1.00
	LOCAL	4100	0.1	2.4	0.6	*	1.00
Day After Tomorrow's Max	MOS		-0.1	3.2	2.3	--	--
	LOCAL	4074	-0.1	3.1	2.6	--	--

* No events of ≤32°F were observed.

Table 6.9. Same as Table 6.6 except for 28 stations in the Central Region.

Forecast Projection	Forecast Type	Number of Cases	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Percent of Absolute Errors >10°F	Probability of Detection (32°F)	False Alarm Ratio (32°F)
Tonight's Min	MOS		-0.4	2.8	0.7	0.30	0.13
	LOCAL	4843	-0.3	2.7	0.5	0.43	0.09
Tomorrow's Max	MOS		-0.3	3.7	4.2	--	--
	LOCAL	4848	-0.4	3.4	3.1	--	--
Tomorrow Night's Min	MOS		-0.2	3.3	1.6	0.19	0.38
	LOCAL	4813	-0.2	3.2	1.7	0.19	0.38
Day After Tomorrow's Max	MOS		-0.4	4.4	7.9	--	--
	LOCAL	4813	-0.4	4.2	7.1	--	--

Table 6.10. Same as Table 6.6 except for 17 stations in the Western Region.

Forecast Projection	Forecast Type	Number of Cases	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Percent of Absolute Errors >10°F	Probability of Detection (32°F)	False Alarm Ratio (32°F)
Tonight's Min	MOS		-0.8	2.7	0.7	0.40	0.27
	LOCAL	2868	-0.5	2.5	0.6	0.45	0.18
Tomorrow's Max	MOS		-0.1	3.4	2.6	--	--
	LOCAL	2884	-0.1	3.0	2.3	--	--
Tomorrow Night's Min	MOS		-0.6	3.2	1.4	0.10	0.33
	LOCAL	2842	-0.5	2.9	1.0	0.15	0.25
Day After Tomorrow's Max	MOS		-0.1	4.2	5.2	--	--
	LOCAL	2855	-0.2	3.9	5.3	--	--