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COMPARATIVE VERIFICATION OF GUIDANCE AND LOCAL AVIATION/PUBLIC WEATHER FORECASTS--NO. 16 (APRIL 1983-SEPTEMBER 1983)

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1. INTRODUCTION

This is the sixteenth in the series of Techniques Development Laboratory (TDL) office notes which compare the performance of TDL's automated guidance forecasts with National Weather Service (NWS) local forecasts made at Weather Service Forecast Offices (WSFO's). The local forecasts, which are produced subjectively, may or may not be based on the automated guidance. In this report, we present verification statistics for the warm season months of April through September 1983 for probability of precipitation (PoP), surface wind, opaque sky cover (cloud amount), ceiling height, visibility, and maximum/minimum (max/min) temperature. The PoP, ceiling height, visibility, and max/min temperature verification results are provided for both forecast cycles, 0000 and 1200 GMT.

The objective guidance is based on equations developed through application of the Model Output Statistics (MOS) technique (Glahn and Lowry, 1972). Over the years we have derived many sets of prediction equations by using archived surface observations and forecast fields from the Limited-area Fine Mesh (LFM) model (Gerrity, 1977; Newell and Deaven, 1981; National Weather Service, 1981a), the Trajectory model (Reap, 1972), and/or the 6-layer coarse mesh Primitive Equation (PE) model (Shuman and Hovermale, 1968). Unless indicated otherwise, we usually refer to MOS forecasts based on the LFM model as "early" guidance; "final" guidance indicates the objective forecasts were based on PE and Trajectory model data. Also, the observation times of surface weather elements used as predictors in the early and final guidance generally differed. The final guidance is no longer disseminated operationally due to the superiority of the early guidance, but comparative results for previous years are included on the figures presented in this report.

The local public weather PoP forecasts used for this verification were official forecasts obtained from the Coded City Forecast (FPUS4) bulletin. In contrast, the local aviation forecasts from the WSFO's were collected by the Services Evaluation Branch of the Office of Meteorology for the purpose of the NWS combined aviation/public weather verification system (National Weather Service, 1973). These forecasts were recorded for verification according to the direction that they be "... not inconsistent with ..." the official weather prognosis. Surface observations as late as 2 hours before the first valid forecast time may have been used in the preparation of the local forecasts.

In the past, local max/min forecasts from the FPUS4 bulletin were compared with the MOS temperature guidance. However, the verification procedure was controversial because the local forecast was valid for a 12- or 18-h period, while the corresponding guidance applied to a particular calendar day. Hence, in conformance with a recommendation from the 1982 NWS Line Forecasters Technical Advisory Committee, this report contains temperature verification results for the guidance only. We will continue this policy in future reports until the new verification system outlined in the NWS National Verification Plan (National Weather Service, 1982a) is fully implemented. Also, due to preimplementation testing of the new verification system, the number of verification stations for surface wind, cloud amount, ceiling height, and visibility was reduced substantially from the number used for previous studies.

We obtained all required observed verification data from the National Climatic Data Center in Asheville, North Carolina. These observations were carefully error-checked prior to computation of any of the verification scores. Also, the scores referenced in each section as those for the previous warm season can be found in Carter et al. (1983).

2. PROBABILITY OF PRECIPITATION

Objective PoP forecasts were produced by the set of warm season prediction equations described in Technical Procedures Bulletin No. 299 (National Weather Service, 1981b). Only the early guidance has been available since the 1980 warm season. The guidance was verified for the first, second, and third periods, which correspond to forecast projections of 12-24 hours, 24-36 hours, and 36-48 hours, respectively, after 0000 or 1200 GMT. The majority of the predictor variables were forecast fields from the LFM model; surface variables observed at the forecast site at 0300 or 1500 GMT were included as predictors for the first period.

The PoP forecasts were verified by computing Brier scores (Brier, 1950) for the 87 stations shown in Table 2.1. Please note that we used the standard NWS Brier score 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; in particular, the scores usually are better for periods of below normal 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 as determined from a 15-yr sample (Jorgensen, 1967).

Tables 2.2 and 2.7 present the 1983 results for all 87 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. The overall Brier scores in Table 2.2 and 2.7 indicate the first-period local forecasts were superior to guidance forecasts by 4.4% and 3.3% for the 0000 and 1200 GMT cycles, respectively. First-period local forecasts were also superior for each region and cycle. For the second and third period forecasts, overall, the local forecasts are better than the guidance for the second period from 1200 GMT, and for the third period from 0000 GMT. Regional scores for 0000 GMT show the guidance to be better than the local forecasts only in the Eastern and Central Regions for the second period. For 1200 GMT, the guidance is better than the locals only in the Southern and Central Regions for the third period.

Fig. 2.1 shows the trend since 1971 in skill (expressed in terms of percent improvement over climate) of the first- and third-period 0000 GMT cycle PoP forecasts. Due to the loss of local forecast data, we did not include the local verification results for the 1982 warm season. Fig. 2.1 indicates that both the local and guidance 0000 GMT first- and third-period forecast scores for the 1983 warm season were the highest ever since the verification program began with the 1971 warm season; this was especially true for the first period.

3. SURFACE WIND

The objective surface wind forecasts were generated by the warm season, LFM-based equations described in Technical Procedures Bulletin No. 316 (National Weather Service, 1982b). Only the early guidance has been available since the 1978 warm season. In addition to LFM model forecasts, predictors in the equations include the sine and cosine of the day of the year and of twice the day of the year. A significant change occurred in the operational early guidance wind prediction system during the 1981 warm season. In particular, new sets of equations, developed without screening as predictors any surface pressure or boundary layer fields from the LFM model, were implemented on May 28, 1981. The impact of removal of the surface pressure and boundary layer fields as predictors in objective surface wind forecasting is described by Janowiak (1981).

We verified the 18-, 30-, and 42-h forecasts from 0000 GMT; these were the only projections for which local forecasts were available. 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. Since the local forecasts were recorded as calm if the wind speed was expected to be less than 8 knots, the wind forecasts were verified in two ways. First, for all those cases in which both the local and objective wind speed forecasts were at least 8 knots, the mean absolute error (MAE) of speed was 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 both local and automated forecasts were available, skill score[1], percent correct, and bias by category[2] were computed from contingency tables of wind speed. The seven categories in the tables were: < 8, 8-12, 13-17, 18-22, 23-27, 28-32, and > 32 knots. Table 3.1 lists the 71 stations used in this verification. Note that all the 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.

The results for all 71 stations combined are shown in Tables 3.2 and 3.3. The MAE's for the direction reveal an advantage for the guidance that is 4° for all three projections. Overall, the skill scores and percent correct for

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

[2]In the discussion of surface wind, opaque sky cover, 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.

wind speed were better for the guidance; however the MAE's were better for the local forecasts. The bias by category values in Table 3.2 and the contingency tables in Table 3.3 indicate the guidance overestimated winds stronger than 22 knots (i.e, categories 5, 6, and 7) for all the three forecast projections, whereas the local forecasts underestimated winds in these categories. This is the third warm season where the guidance overforecast the stronger winds; we think this is partly due to implementation of new equations. Some of the overforecasting also may have been caused by LFM model errors in predicting the movement and intensity of synoptic scale weather systems. Although the guidance was not developed to overforecast strong winds, this characteristic may be desirable for some applications.

Tables 3.4-3.7 show scores for the NWS Eastern, Southern, Central, and Western Regions, respectively. The regional comparisions generally have the same characteristics as for the entire group of stations. Note the advantage of the local speed MAE's for most regions and projections except for the Eastern Region.

Table 3.8 shows the distribution of the wind direction absolute errors by categories--0-30°, 40-60°, 70-90°, 100-120°, 130-150°, and 160-180°--for all 71 stations combined. The guidance had about 4.5% fewer errors of 40° or more than did the local forecasts for all three projections.

Distributions of direction errors for the individual regions are given in Tables 3.9-3.12. In general, these results are much like those in Table 3.8 except, once again, the advantage of the guidance over local forecasts differs somewhat from region to region.

A comparison of the overall MAE's and skill scores during the past 10 warm seasons for the 18- and 42-h guidance and local forecasts is presented in Figs. 3.1-3.3. Except for 1983 in which the number of stations verified declined, the verification data throughout this period were relatively homogeneous; the number of stations varied only slightly from season to season, while the basic set of verification stations remained the same. The MAE and the skill score in Figs. 3.2 and 3.3 reveal the superiority of the early guidance over both the final guidance and the local forecasts.

The MAE's for direction are given in Fig. 3.1. The curves indicate that the guidance and local forecasts for both projections improved during the period from 1975 to 1978. In contrast, the MAE's for speed in Fig. 3.2 denote a general decrease in accuracy for the final guidance forecasts after the introduction of inflation in July of 1975. We realized that inflation would have this effect; however, previous wind speed verifications indicated that the bias by category values of inflated forecasts were somewhat closer to 1.0 compared to the values of uninflated forecasts (Carter and Hollenbaugh, 1976). Despite use of the inflation technique, the MAE's for the 18-h early guidance are generally as good as the 1974 (pre-inflation) values. For the 18-h projection, the local forecast scores are now equal to those for the guidance, while the 42-h local forecast MAE's are better.

Figure 3.3 is a comparison of guidance and local skill scores computed on five (instead of seven) categories of wind speed; the fifth category includes all speeds greater than 22 knots. Of note is the magnitude of the advantage of the guidance over the locals for both projections.

4. OPAQUE SKY COVER

During the 1983 warm season, the opaque sky cover guidance was produced by the warm season prediction equations described in Technical Procedures Bulletin No. 303 (National Weather Service, 1981c). These equations used LFM model output and 0300 (1500) GMT surface observations to produce operational forecasts for 10 projections at 6-h intervals from 6 to 60 hours after 0000 and 1200 GMT. Only early guidance was available for verification since the final guidance was terminated after the 1979 warm season. Regionalized equations produced probability forecasts of the four categories of opaque sky cover, more commonly known as cloud amount, shown in Table 4.1. We converted the probability estimates to "best category" forecasts in a manner which produced good bias characteristics, that is, a bias value of approximately 1.0 for each category. The threshold technique described in Technical Procedures Bulletin No. 303 was used to obtain the best category forecast.

We compared the local forecasts with a matched sample of guidance forecasts for the 71 stations listed in Table 3.1 for 18-, 30-, and 42-h forecast projections from 0000 GMT. The local forecasts and the surface observations used for verification were converted from opaque sky cover amounts to the categories given in Table 4.1. 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.

The results for all stations combined are shown in Table 4.2. For all projections, the guidance forecasts were superior to the local forecasts in terms of percent correct and skill score. Examination of the bias by category scores shows that the guidance forecasts were better (i.e., closer to 1.0) than the local forecasts for each projection and category except for the 18-h forecasts of clear and the 42-h forecasts of broken. The local forecasts generally exhibited a tendency to underforecast the clear and overcast categories, and overforecast the scattered and broken categories. To a lesser extent, the guidance forecasts showed a tendency to underforecast the clear and broken categories, and overforecast the scattered category.

The verification scores for the stations in the NWS Eastern, Southern, Central, and Western Regions are given in Tables 4.3-4.6, respectively. The percent correct and skill scores for the guidance forecasts for all three projections were superior to those for the locals. The one exception was the 18-h projection for the Western Region local forecasts which were better than the guidance. Also, the bias by category values for the guidance forecasts generally were closer to 1.0 than those for the local forecasts.

Percents correct and skill scores for the past nine warm seasons are shown in Figs. 4.1 and 4.2, respectively, for the 18- and 42-h projections. These figures indicate the 1983 guidance and local forecasts increased in accuracy compared to the results for the previous year. Of note are the scores for the 42-h guidance forecasts which were the highest ever.

Figures 4.3-4.6 show bias values for categories 1 through 4, respectively, for the 18-h forecasts.[3] The local forecast biases for all four categories with some minor fluctuations, have remained relatively constant over the years. The graphs also show that the locals have a tendency to underforecast the clear and overcast categories, and overforecast the scattered and (to a lesser extent) the broken categories. The biases for the guidance forecasts have, in general, been superior to the local forecasts over the years. We also note that the deterioration of the bias values for the 18-h guidance forecasts of category 1 (clear), which began with the 1982 warm season, continued during the 1983 warm season.

5. CEILING AND VISIBILITY

During the 1983 warm season, the ceiling and visibility guidance was produced by the warm season prediction equations described in Technical Procedures Bulletin No. 303 (National Weather Service, 1981c). Operationally, the guidance was based primarily on LFM output and 0300 (1500) GMT surface observations. Forecasts were produced for 6-h intervals from 6 to 60 hours after 0000 and 1200 GMT.

Verification scores were computed for both local and guidance forecasts for the 71 stations listed in Table 3.1. In each case, persistence, based on an observation taken at 0900 GMT for the 0000 GMT cycle and at 2100 GMT (or 2200 GMT) for the 1200 GMT cycle, provided a standard of comparison. Guidance forecasts were verified for both cycles for the 12-, 18-, 24-, 36-, and 48-h projections. The local forecasts were verified for 12-, 15-, and 21-h projections from 0000 and 1200 GMT. On a day-to-day basis, the guidance and the persistence observations usually were available in time for preparation of the local forecasts.

We constructed forecast-observed contingency tables for the six categories given in Table 5.1 for all the forecasts involved in the comparative verification. These categories were used for computing several different scores: bias by category, percent correct, and skill score. We then collapsed the tables to two categories (categories 1 and 2 combined versus categories 3 through 6 combined) and calculated the bias and the threat score[4] for categories 1 and 2 combined. Skill score and percent correct also were calculated for the two-category contingency tables. We have summarized the results in Tables 5.2-5.9. Skill scores and bias values for categories 1 and 2 combined for the past eight warm seasons also are shown in Figs. 5.1-5.8 for selected projections from 0000 GMT.

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[3] In many of our past verification reports (e.g., Maglaras et al., 1981), the bias by category graphs were plotted on a linear scale. Here the bias graphs are plotted on a semi-log scale. The reason for the change is because we think that biases of X and 1/X are equally bad. For example, forecasting an event four times as often as it occurred should appear as bad as forecasting that event only one-fourth as many times as it occurred.

[4] 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.

Tables 5.2-5.5 present verification results for the six-category ceiling and visibility forecasts. The scores in Table 5.3 for the 12-h projection from 0000 GMT indicate the skill of the local visibility forecasts exceeded the skill of persistence. For both forecast cycles and weather elements, the 12-h guidance forecasts had lower (worse) skill scores than those for the locals and persistence. With the exception of visibility forecasts for the 15-h projection from 1200 GMT (Table 5.5), the local forecasts of ceiling and visibility had higher skill scores than persistence for the 15- and 21-h projections from both 0000 and 1200 GMT. With the exception of the visibility forecasts for the 18-h projection from 1200 GMT (Table 5.5), the guidance usually outperformed persistence by a wide margin in terms of skill score for the 18-, 24-, 36-, and 48-h projections from both 0000 and 1200 GMT. Also, for projections of more than 12 hours, the guidance bias by category characteristics were better (i.e., closer to 1.0) than those for persistence. For the 12-h projection (actually a 3-h projection for both the local and persistence forecasts, and a 9-h projection for the guidance), the bias values for the guidance generally were better than those for the local forecasts. Of note in Tables 5.2-5.5 is the rarity (generally less than 20 cases in a sample of more than 12,000) of category 1 ceiling and visibility events during afternoon and evening hours.

Tables 5.6-5.9 show comparative verification results for the two-category ceiling and visibility forecasts. The relative frequency of ceiling less than 500 feet and visibility less than 1 mile ranged from .003 to .027. This fact, plus lower skill scores for the two-category tables as compared to the six-category tables, indicates these events are difficult to forecast. For the 12-h projection from 0000 GMT, the persistence forecasts of ceiling and visibility had the highest skill scores. For the 12-h projection from 1200 GMT, the persistence forecasts had the highest skill scores for ceiling, but the local forecasts had the highest skill scores for visibility. In contrast, the guidance skill scores were much lower than those for persistence and the locals. For the 15-h projection, the persistence skill scores were higher than those for the local ceiling forecasts from both 0000 and 1200 GMT; however, for visibility, the local skill scores were higher than those of persistence for both cycles. For the 21-h projection, the skill score for the local forecasts was higher than that of persistence, except for the 0000 GMT forecasts of visibility. The skill of the guidance forecasts for the 18-, 24-, 36-, and 48-h projections varied a great deal from projection to projection, but usually it was much higher than the score for persistence.

Figs. 5.1-5.8 are trend graphs for skill score and bias for selected projections for the 0000 GMT cycle, two-category ceiling and visibility forecasts. The scores in Figs. 5.1-5.4 show that the skill of the local, guidance, and persistence ceiling and visibility forecasts for the 12-h projection decreased over the 1982 warm season scores. The results for the 15- and 18-h projections varied, depending on the type of forecast. The results in Figs. 5.5-5.8 (see footnote 3 for details about the format) indicate the guidance bias characteristics improved substantially after the threshold technique for category selection was introduced in 1977. The bias values for the 12-h projection have remained relatively unchanged since 1977 for the local and persistence forecasts; however, for the first time, guidance forecasts considerably overforecast categories 1 and 2 of ceiling and visibility during the 1983 warm season. The graphs also reveal a consistent low bias for the local forecasts for the 15-h projection (i.e., a tendency to underforecast the operationally significant weather conditions which these categories represent). Also, for the first time, the 18-h guidance forecasts slightly overforecast categories 1 and 2 of ceiling and visibility.

6. MAXIMUM/MINIMUM TEMPERATURE

The objective max/min temperature guidance for the 1983 warm season was generated by the LFM-based regression equations described in Technical Procedures Bulletin No. 285 (National Weather Service, 1980). The predictand data for these equations consisted of local calendar day max or min temperatures valid approximately 24, 36, 48, and 60 hours after the model initial data times of 0000 and 1200 GMT. The guidance was based on equations 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 (Dallavalle et al., 1980). We defined spring as March-May, summer as June-August, and fall as September-November. Station observations taken 3 hours after initial model time were also used as predictors in much of the guidance for the first two periods.

Since the automated max/min forecasts are valid for the local calendar day, the first period objective forecast of the max based on 0000 GMT model data is provided for the calendar day starting at the subsequent midnight. The max/min guidance for the other periods corresponds to specific calendar days in an analogous manner.

In prior verification reports (e.g., Maglaras et al., 1981), we compared the skill of the local max/min temperature forecasts with that of the objective guidance. However, the valid period of the local forecasts corresponds to a daytime max and a nighttime min, rather than a particular calendar day. This procedure of using a calendar day verifying observation generated a considerable amount of controversy. Because appropriate daytime max and nighttime min observations are not available for verification, the 1982 NWS Line Forecasters Technical Advisory Committee recommended that comparisons between local and objective max/min forecasts no longer be published. In compliance with this request, only the automated forecasts were verified. Eventually, with implementation of the new AFOS verification system, the required observations will be available and comparisons between the guidance and locals will be possible.

For the 1983 warm season, we verified both the 0000 and 1200 GMT cycle objective forecasts. The mean algebraic error (forecast minus observed temperature), mean absolute error, and the number of absolute errors $\geq 10^{\circ}$F were computed for 87 stations (Table 2.1). For the 0000 GMT cycle, forecast projections of approximately 24 (max), 36 (min), 48 (max), and 60 (min) hours were verified; for the 1200 GMT cycle, forecasts of approximately 24 (min), 36 (max), 48 (min), and 60 (max) hours were verified.

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 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.

The 0000 GMT cycle guidance tended to be too warm (positive algebraic error) for all stations combined for the 24-, 36-, and 48-h projections. In contrast, the bias in the 1200 GMT cycle guidance for all stations combined was small and varied in type from one projection to another. However, note that the guidance showed a pronounced warm bias for all projections and both cycles in the Southern Region. In the Western Region, the guidance was too warm on the average for all max temperature forecasts and too cold for all min temperature forecasts.

The verifications for all stations combined indicate that for the same projection the max temperature was more difficult to predict than the min. As an example, the mean absolute error for the 36-h projection of the max was 3.3°F; for the min, the error was 2.9°F. For the four projections combined, the MAE's of the max guidance averaged 0.4°F more than the corresponding errors for the min. This trend in the relative difficulty of forecasting the max or min was not as evident in the Southern Region, but it was particularly pronounced in the Central and Western Regions for all projections. Overall, the greatest number of temperature forecasts with errors $\geq$10°F occurred for the 48- and 60-h max guidance. We think this difficulty in predicting the max temperature during the warm season is due to localized convective activity (e.g., Schwartz, 1984) that is beyond the resolution of the LFM model.

Max temperature forecast MAE's for the 0000 GMT cycle during the last 13 warm seasons are shown in Fig. 6.1. The final guidance, based on output from the coarse mesh Primitive Equation model (Shuman and Hovermale, 1968) or the Spectral model (Sela, 1980), was ended in December 1980 because of poor performance compared to the LFM-based early guidance. The error curves in Fig. 6.1 are somewhat irregular because of natural variability and also because of the difficulty in predicting max temperatures during the warm season. Nevertheless, over the 13-yr period, the objective forecasts have improved substantially with the smallest errors being recorded in 1982 and 1983. From 1971 to 1983, the MAE for the 24- and 48-h max decreased by 0.7°F and 0.6°F, respectively. Although the comparisons between the local and objective forecasts were unavailable in 1982 and 1983, we believe the local forecasters continued to improve upon the automated guidance. From Fig. 6.2, note, too, that the skill of the objective forecasts increased in 1974 when MOS equations were introduced (Klein and Hammons, 1975) and again in 1976 when 3-mo equations were first used (Hammons, et al., 1976). Improvements in the 24-h early guidance coincided with the introduction of LFM-based equations during the 1978 warm season (Carter et al., 1979). The 48-h MOS forecasts were enhanced with the application of new, 3-mo equations in the 1980 warm season (Dallavalle et al., 1980).

An analogous time series is shown in Fig. 6.2 for the min temperature forecasts from 0000 GMT. Again, local forecast verifications were unavailable for the 1982 and 1983 warm seasons. In addition, verifications for the 60-h projection are shown only for the last eight warm seasons. Although natural variability results in irregular error curves for both the 36- and 60-h projections, the 36-h objective forecasts have shown improvement since the verifications began. Similar to the max temperature guidance, the greatest improvements in accuracy for the 36-h min forecasts were in 1974 and 1976. For the 60-h guidance, the warm season MAE's increased from 1982 to 1983. We noticed, too, that the number of large errors in the 60-h guidance increased from the 1982 to the 1983 warm season. Since the 60-h forecast equations tend to rely strongly on climatic terms, we suspect that anomalous conditions during the 1983 warm season may have contributed to the deterioration in the MOS guidance.

7. SUMMARY

Highlights of the 1983 warm season verification results, summarized by general type of weather element, are:

- Probability of Precipitation - The comparative verifications involved 87 stations and forecast projections of 12-24, 24-36, and 36-48 hours from both 0000 and 1200 GMT. For all stations combined, the NWS Brier scores show the first-period local forecasts were better than the guidance for both forecast cycles. For the second period, the local forecasts were better than the guidance for the 1200 GMT cycle. The scores for the third-period, 0000 GMT cycle local forecasts also were superior to the guidance. In terms of percent improvement over climate, the results indicate that the local and guidance forecasts for the 1983 warm season were the most accurate since the verification program began in 1971.

- Surface Wind - The wind verification study was conducted for 71 stations and forecast projections of 18, 30, and 42 hours from 0000 GMT. The overall results for most scores indicate the wind direction and speed guidance was generally more accurate than the corresponding local forecasts. However, the local MAE's for speed were as good as, or better than those for the guidance. The accuracy of both guidance and local forecasts changed very little from that of the previous warm season.

- Opaque Sky Cover - Verification results for all 71 stations combined indicate the 0000 GMT cycle guidance was better than the local forecasts in terms of percent correct, skill score, and bias by category for all projections. The percent correct, skill score, and bias by category generally improved when compared with the scores for the 1982 warm season.

- Ceiling and Visibility - The verifications involved the comparison of local forecasts, MOS guidance, and persistence for 71 stations and for projections ranging from 12 to 48 hours for both 0000 and 1200 GMT. However, direct comparison of local, MOS, and persistence forecasts was possible only for the 12-h projection. This projection is actually a 3-h forecast from the latest available surface observation for the locals and persistence, and in this sense it is a 9-h forecast for the guidance. Most of the 12-h projection verification scores for both ceiling and visibility show that the local and persistence forecasts were superior to the guidance. However, for the longer range projections, the local and guidance forecasts generally were much better than persistence. The scores for forecasts of the lowest two categories of ceiling and visibility varied depending on the cycle and projection, but overall the 1983 results were slightly worse than those for 1982.

- Maximum/Minimum Temperature - The objective max/min temperature forecasts were verified for 87 stations for both the 0000 and 1200 GMT cycles. At 0000 (1200) GMT, the max temperature guidance was valid for calendar day periods approximately 24 (36) and 48 (60) hours in advance, while the min temperature forecasts were valid for calendar day periods approximately 36 (24) and 60 (48) hours after the initial model time. Overall, in terms of the mean absolute error, we found that the 1983 warm season guidance for the first three periods was generally as accurate as any other year in our period of record. However, the 60-h temperature guidance showed some deterioration from the 1982 warm season, perhaps because of anomalous synoptic conditions. The combined mean algebraic errors generally were small, although a pronounced warm bias was observed in the Southern Region for all projections and for both the max and the min. As is usual during the warm season, the min temperature forecasts were more accurate than the max forecasts for the same projection. We think this difference is caused by frequent convective activity during the afternoon, the time of day during which the max temperature usually occurs.

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REFERENCES

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

Carter, G. M., and G. W. Hollenbaugh, 1976: Comparative verification of local and guidance surface wind forecasts--No. 4. TDL Office Note 76-7, National Weather Service, NOAA, U.S. Department of Commerce, 18 pp.

_____, J. P. Dallavalle, A. L. Forst, and W. H. Klein, 1979: Improved automated surface temperature guidance. Mon. Wea. Rev., 107, 1263-1274.

_____, J. P. Dallavalle, G. W. Hollenbaugh, G. J. Maglaras, and B. E. Schwartz, 1983: Comparative verification of guidance and local aviation/public weather forecasts--No. 14 (April 1982-September 1982). TDL Office Note 83-7, National Weather Service, NOAA, U.S. Department of Commerce, 70 pp.

Dallavalle, J. P., J. S. Jensenius, Jr., and W. H. Klein, 1980: Improved surface temperature guidance from the limited-area fine mesh model. Preprints Eighth Conference on Weather Forecasting and Analysis, Denver, Amer. Meteor. Soc., 1-8.

Gerrity, J. F., 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.

Hammons, G. A., J. P. Dallavalle, and W. H. Klein, 1976: Automated temperature guidance based on three-month seasons. Mon. Wea. Rev., 104, 1557-1564.

Janowiak, J. E., 1981: The usefulness of LFM boundary layer forecasts as predictors in objective surface wind forecasting. TDL Office Note 81-6, National Weather Service, NOAA, U.S. Department of Commerce, 10 pp.

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.

_____, and G. A. Hammons, 1975: Maximum/minimum temperature forecasts based on Model Output Statistics. Mon. Wea. Rev., 103, 796-806.

Maglaras, G. J., J. P. Dallavalle, K. F. Hebenstreit, G. W. Hollenbaugh, B. E. Schwartz, and D. J. Vercelli, 1981: Comparative verification of guidance and local aviation/public weather forecasts--No. 10 (April 1980-September 1980). TDL Office Note 81-7, National Weather Service, NOAA, U.S. Department of Commerce, 61 pp.

National Weather Service, 1973: Combined aviation/public weather forecast verification. NWS Operational Manual, Chapter C-73, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 15 pp.

_____, 1980: Automated maximum/minimum temperature, 3-hourly surface temperature, and 3-hourly surface dew point guidance. NWS Technical Procedures Bulletin No. 285, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 16 pp.

_____, 1981a: More efficient LFM by applying fourth order operators. NWS Technical Procedures Bulletin No. 300, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 9 pp.

_____, 1981b: 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.

_____, 1981c: 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.

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

_____, 1982b: The use of Model Output Statistics for predicting surface wind. NWS Technical Procedures Bulletin No. 316, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 13 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, Pa., 224 pp.

Reap, R. M., 1972: An operational three-dimensional trajectory model. J. Appl. Meteor., 11, 1193-1202.

Schwartz, B. E., 1984: Typical warm season MOS guidance errors. Preprints Tenth Conference on Weather Forecasting and Analysis, Clearwater Beach, Amer. Meteor. Soc., (in press).

Sela, J. G., 1980: Spectral modeling at the National Meteorological Center. Mon. Wea. Rev., 108, 1279-1292.

Shuman, F. G., and J. B. Hovermale, 1968: An operational six-layer primitive equation model. J. Appl. Meteor., 7, 525-547.

Table 2.1. Eighty-seven stations used for comparative verification of automated and local PoP and max/min temperature forecasts.

BDL	Hartford, Connecticut
DCA	Washington, D.C.
PWM	Portland, Maine
BWI	Baltimore, Maryland
BOS	Boston, Massachusetts
ALB	Albany, New York
BUF	Buffalo, New York
JFK	New York (Kennedy), New York
SYR	Syracuse, New York
AVL	Asheville, North Carolina
CLT	Charlotte, North Carolina
RDU	Raleigh-Durham, North Carolina
CLE	Cleveland, Ohio
CMH	Columbus, Ohio
CVG	Cincinnati, Ohio
DAY	Dayton, Ohio
PHL	Philadelphia, Pennsylvania
PIT	Pittsburgh, Pennsylvania
PVD	Providence, Rhode Island
CAE	Columbia, South Carolina
CHS	Charleston, South Carolina
BTV	Burlington, Vermont
ORF	Norfolk, Virginia
RIC	Richmond, Virginia
CRW	Charleston, West Virginia
BHM	Birmingham, Alabama
LIT	Little Rock, Arkansas
JAX	Jacksonville, Florida
MIA	Miami, Florida
ORL	Orlando, Florida
TPA	Tampa, Florida
ATL	Atlanta, Georgia
MSY	New Orleans, Louisiana
SHV	Shreveport, Louisiana
JAN	Jackson, Mississippi
ABQ	Alburquerque, New Mexico
OKC	Oklahoma City, Oklahoma
TUL	Tulsa, Oklahoma
BNA	Nashville, Tennessee
MEM	Memphis, Tennessee
AMA	Amarillo, Texas
AUS	Austin, Texas
BRO	Brownsville, Texas
DFW	Dallas-Fort Worth, Texas
ELP	El Paso, Texas
IAH	Houston, Texas
LBB	Lubbock, Texas
MAF	Midland, Texas
SAT	San Antonio, Texas
DEN	Denver, Colorado
ORD	Chicago (O'Hare), Illinois
EVV	Evansville, Indiana
IND	Indianapolis, Indiana
DSM	Des Moines, Iowa
ICT	Wichita, Kansas
TOP	Topeka, Kansas
SDF	Louisville, Kentucky
DTW	Detroit, Michigan
SSM	Sault Ste. Marie, Michigan
DLH	Duluth, Minnesota
MSP	Minneapolis, Minnesota
MCI	Kansas City, Missouri
STL	St. Louis, Missouri
LBF	North Platte, Nebraska
OMA	Omaha, Nebraska
BIS	Bismarck, North Dakota
FAR	Fargo, North Dakota
FSD	Sioux Falls, South Dakota
RAP	Rapid City, South Dakota
MKE	Milwaukee, Wisconsin
CPR	Casper, Wyoming
CYS	Cheyenne, Wyoming
FLG	Flagstaff, Arizona
PHX	Phoenix, Arizona
TUS	Tucson, Arizona
SAN	San Diego, California
SFO	San Francisco, California
BOI	Boise, Idaho
BIL	Billings, Montana
GTF	Great Falls, Montana
HLN	Helena, Montana
LAS	Las Vegas, Nevada
RNO	Reno, Nevada
PDX	Portland, Oregon
SLC	Salt Lake City, Utah
GEG	Spokane, Washington
SEA	Seattle-Tacoma, Washington

Table 2.2 Comparative verification of early guidance and local PoP forecasts for 87 stations, 0000 GMT cycle.

Projection (h)	Type of Forecast	Brier Score	Improvement Over Guidance (%)	Improvement Over Climate (%)	Number of Cases
12-24	Early	.1072		32.2	
(1st period)	Local	.1025	4.4	35.2	9182
24-36	Early	.1219		23.5	
(2nd period)	Local	.1224	-0.4	23.2	9181
36-48	Early	.1251		19.6	
(3rd period)	Local	.1235	1.3	20.7	9182

Table 2.3. Same as Table 2.2 except for 25 stations in the Eastern Region.

Projection (h)	Type of Forecast	Brier Score	Improvement Over Guidance (%)	Improvement Over Climate (%)	Number of Cases
12-24 (1st period)	Early Local	.1240 .1168	 5.8	41.2 44.6	1311
24-36 (2nd period)	Early Local	.1330 .1334	 -0.3	31.4 31.2	1309
36-48 (3rd period)	Early Local	.1475 .1465	 0.7	25.9 26.4	1311

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

Projection (h)	Type of Forecast	Brier Score	Improvement Over Guidance (%)	Improvement Over Climate (%)	Number of Cases
12-24 (1st period)	Early Local	.1076 .1028	 4.4	25.6 28.9	2873
24-36 (2nd period)	Early Local	.1160 .1157	 0.3	18.0 18.2	2872
36-48 (3rd period)	Early Local	.1316 .1284	 2.5	14.3 16.4	2872

Table 2.5. Same as Table 2.2 except for 23 stations in the Central Region.

Projection (h)	Type of Forecast	Brier Score	Improvement Over Guidance (%)	Improvement Over Climate (%)	Number of Cases
12-24	Early	.1106		33.7	
(1st period)	Local	.1062	4.0	36.4	2932
24-36	Early	.1380		25.3	
(2nd period)	Local	.1419	-2.8	23.2	2934
36-48	Early	.1248		22.3	
(3rd period)	Local	.1244	0.3	22.6	2933

Table 2.6. Same as Table 2.2 except for 15 stations in the Western Region.

Projection (h)	Type of Forecast	Brier Score	Improvement Over Guidance (%)	Improvement Over Climate (%)	Number of Cases
12-24	Early	.0912		30.4	
(1st period)	Local	.0876	4.0	33.1	2066
24-36	Early	.1004		20.8	
(2nd period)	Local	.0969	3.5	23.5	2066
36-48	Early	.1020		17.5	
(3rd period)	Local	.1007	1.3	18.6	2066

Table 2.7. Comparative verification of early guidance and local PoP forecasts for 87 stations, 1200 GMT cycle.

Projection (h)	Type of Forecast	Brier Score	Improvement Over Guidance (%)	Improvement Over Climate (%)	Number of Cases
12-24	Early	.1093		30.6	
(1st period)	Local	.1057	3.3	32.9	8824
24-36	Early	.1143		25.3	
(2nd period)	Local	.1120	2.0	26.8	8824
36-48	Early	.1258		18.2	
(3rd period)	Local	.1265	-0.5	17.8	8822

Table 2.8. Same as Table 2.7 except for 25 stations in the Eastern Region.

Projection (h)	Type of Forecast	Brier Score	Improvement Over Guidance (%)	Improvement Over Climate (%)	Number of Cases
12-24 (1st period)	Early Local	.1040 .0982	5.6	42.1 45.4	1289
24-36 (2nd period)	Early Local	.1246 .1247	-0.0	37.5 37.5	1290
36-48 (3rd period)	Early Local	.1381 .1350	2.3	22.2 24.0	1288

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

Projection (h)	Type of Forecast	Brier Score	Improvement Over Guidance (%)	Improvement Over Climate (%)	Number of Cases
12-24 (1st period)	Early Local	.1087 .1054	3.1	24.3 26.6	2631
24-36 (2nd period)	Early Local	.1196 .1163	2.7	19.1 21.3	2631
36-48 (3rd period)	Early Local	.1197 .1208	-0.9	14.1 13.3	2630

Table 2.10. Same as Table 2.7 except for 23 stations in the Central Region.

Projection (h)	Type of Forecast	Brier Score	Improvement Over Guidance (%)	Improvement Over Climate (%)	Number of Cases
12-24	Early	.1273		31.1	
(1st period)	Local	.1238	2.7	33.0	2729
24-36	Early	.1159		26.7	
(2nd period)	Local	.1155	0.3	26.9	2728
36-48	Early	.1427		19.5	
(3rd period)	Local	.1465	-2.7	17.3	2729

Table 2.11. Same as Table 2.7 except for 15 stations in the Western Region.

Projection (h)	Type of Forecast	Brier Score	Improvement Over Guidance (%)	Improvement Over Climate (%)	Number of Cases
12-24	Early	.0905		28.8	
(1st period)	Local	.0877	3.0	31.0	2175
24-36	Early	.0996		20.6	
(2nd period)	Local	.0949	4.7	24.3	2175
36-48	Early	.1047		18.0	
(3rd period)	Local	.1031	1.6	19.3	2175

Table 3.1. Seventy-one stations used for comparative verification of guidance and local surface wind, opaque sky cover, ceiling height, and visibility forecasts.

DCA	Washington, D. C.	DEN	Denver, Colorado
PWM	Portland, Maine	GJT	Grand Junction, Colorado
CON	Concord, New Hampshire	ORD	Chicago (O'Hare), Illinois
EWR	Newark, New Jersey	SPI	Springfield, Illinois
ALB	Albany, New York	IND	Indianapolis, Indiana
BUF	Buffalo, New York	SBN	South Bend, Indiana
JFK	New York (Kennedy), New York	ALO	Waterloo, Iowa
SYR	Syracuse, New York	DSM	Des Moines, Iowa
ERI	Erie, Pennsylvania	LEX	Lexington, Kentucky
CXY	Harrisburg, Pennsylvania	SDF	Louisville, Kentucky
PHL	Philadelphia, Pennsylvania	INL	International Falls, Minnesota
PIT	Pittsburgh, Pennsylvania	MSP	Minneapolis, Minnesota
CHS	Charleston, South Carolina	MCI	Kansas City, Missouri
CAE	Columbia, South Carolina	STL	St. Louis, Missouri
GSP	Greenville, South Carolina	BFF	Scottsbluff, Nebraska
ORF	Norfolk, Virginia	OMA	Omaha, Nebraska
CRW	Charleston, West Virginia	BIS	Bismarck, North Dakota
HTS	Huntington, West Virginia	FAR	Fargo, North Dakota
BHM	Birmingham, Alabama	FSD	Sioux Falls, South Dakota
MOB	Mobile, Alabama	RAP	Rapid City, South Dakota
JAX	Jacksonville, Florida	CYS	Cheyenne, Wyoming
MIA	Miami, Florida	SHR	Sheridan, Wyoming
ATL	Atlanta, Georgia	PHX	Phoenix, Arizona
SAV	Savannah, Georgia	FAT	Fresno, California
MSY	New Orleans, Louisiana	LAX	Los Angeles, California
SHV	Shreveport, Louisiana	SAN	San Diego, California
JAN	Jackson, Mississippi	SFO	San Francisco, California
MEI	Meridian, Mississippi	GTF	Great Falls, Montana
ABQ	Albuquerque, New Mexico	MSO	Missoula, Montana
TCC	Tucumcari, New Mexico	LAS	Las Vegas, Nevada
OKC	Oklahoma City, Oklahoma	RNO	Reno, Nevada
TUL	Tulsa, Oklahoma	PDT	Pendleton, Oregon
ABI	Abilene, Texas	PDX	Portland, Oregon
DFW	Dallas-Ft. Worth, Texas	GEG	Spokane, Washington
IAH	Houston, Texas	SEA	Seattle-Tacoma, Washington
SAT	San Antonio, Texas		

Table 3.2. Comparative verification of early guidance and local surface wind forecasts for 71 stations, 0000 GMT cycle.

		Direction		Speed														
								Contingency Table										
										Bias by Category								
Fcst. Proj. (h)	Type of Fcst.	Mean Abs. Error (Deg)	No. of Cases	Mean Abs. Error (Kts)	Mean Fcst. (Kts)	Mean Obs. (Kts)	No. of Cases	Skill Score	Percent Fcst. Correct	1 (No. Obs)	2 (No. Obs)	3 (No. Obs)	4 (No. Obs)	5 (No. Obs)	6 (No. Obs)	7 (No. Obs)	No. of Cases
18	Early	30	6194	3.1	12.3	11.2	6224	.293	53.8	1.05	0.94	0.98	1.18	1.44	1.36	1.00	12279
	Local	34		3.1	12.4			.268	52.5	0.85 (4847)	1.13 (5063)	1.07 (1860)	0.94 (407)	0.64 (78)	0.36 (22)	1.00 (2)	
30	Early	33	2919	3.9	11.8	9.6	2973	.310	66.3	0.97	0.99	1.27	1.20	1.22	0.71	**	12086
	Local	37		3.8	11.6			.281	64.9	0.96 (8166)	1.11 (3010)	1.04 (720)	0.76 (156)	0.52 (27)	0.43 (7)	* (0)	
42	Early	39	5964	3.6	12.5	10.9	6009	.228	49.4	1.00	0.95	1.02	1.40	1.81	1.22	3.50	12292
	Local	43		3.5	12.1			.193	48.2	0.92 (4870)	1.12 (5087)	0.96 (1841)	0.77 (400)	0.49 (74)	0.33 (18)	0.00 (2)	

*This category was forecast once but was never observed.
**This category was forecast five times but was never observed.

Table 3.3. Contingency tables for early guidance and local surface wind forecasts for 71 stations, 0000 GMT cycle.

18-h Forecasts

		1	2	3	4	5	6	7	T
		Guidance							
	1	3234	1440	155	15	3	0	0	4847
	2	1713	2506	750	85	9	0	0	5063
	3	117	740	734	234	31	4	0	1860
OBS	4	9	56	167	113	47	15	0	407
	5	3	3	21	28	16	5	2	78
	6	1	0	3	7	5	6	0	22
	7	1	0	0	0	1	0	0	2
	T	5078	4745	1830	482	112	30	2	12279
		Local							
		1	2	3	4	5	6	7	T
	1	2651	1978	196	13	0	0	0	4847
	2	1341	2883	771	61	7	0	0	5063
	3	138	748	788	167	17	2	0	1860
OBS	4	10	74	200	108	15	0	0	407
	5	1	11	28	25	8	4	1	78
	6	0	1	6	10	3	2	0	22
	7	1	0	0	0	0	0	1	2
	T	4142	5704	1989	384	50	8	2	12279

30-h Forecasts

		1	2	3	4	5	6	7	T
		Guidance							
	1	6504	1416	226	19	1	0	0	8166
	2	1302	1241	394	67	5	0	1	3010
	3	120	283	232	69	10	4	2	720
OBS	4	17	44	53	27	13	1	1	156
	5	4	6	10	4	3	0	0	27
	6	1	1	2	1	1	0	1	7
	7	0	0	0	0	0	0	0	0
	T	7948	2991	917	187	33	5	5	12086
		Local							
		1	2	3	4	5	6	7	T
	1	6311	1660	171	24	0	0	0	8166
	2	1357	1308	307	37	1	0	0	3010
	3	153	320	203	38	4	1	1	720
OBS	4	21	53	60	16	5	1	0	156
	5	4	10	7	2	3	1	0	27
	6	1	2	1	2	1	0	0	7
	7	0	0	0	0	0	0	0	0
	T	7847	3353	749	119	14	3	1	12086

42-h Forecasts

		1	2	3	4	5	6	7	T
		Guidance							
	1	2958	1577	290	37	8	0	0	4870
	2	1685	2390	825	163	20	4	0	5087
	3	197	752	602	238	47	4	1	1841
OBS	4	13	93	141	100	39	10	4	400
	5	5	11	19	19	16	3	1	74
	6	1	4	3	4	4	1	1	18
	7	1	1	0	0	0	0	0	2
	T	4860	4828	1880	561	134	22	7	12292
		Local							
		1	2	3	4	5	6	7	T
	1	2614	1935	292	25	3	1	0	4870
	2	1607	2680	713	79	5	3	0	5087
	3	230	900	574	120	15	2	0	1841
OBS	4	31	146	157	58	8	0	0	400
	5	7	24	17	22	4	0	0	74
	6	0	4	8	5	1	0	0	18
	7	1	1	0	0	0	0	0	2
	T	4490	5690	1761	309	36	6	0	12292

Table 3.4. Same as Table 3.2 except for 18 stations in the Eastern Region.

		Direction		Speed						Contingency Table							
										Bias by Category							
Fcst. Proj. (h)	Type of Fcst.	Mean Abs. Error (Deg)	No. of Cases	Mean Abs. Error (Kts)	Mean Fcst. (Kts)	Mean Obs. (Kts)	No. of Cases	Skill Score	Percent Fcst. Correct	1 (No. Obs)	2 (No. Obs)	3 (No. Obs)	4 (No. Obs)	5 (No. Obs)	6 (No. Obs)	7 (No. Obs)	No. of Cases
18	Early	30	1570	2.7	11.6	10.8	1575	.266	53.6	1.03	0.99	0.98	0.99	0.54	****	*	2895
	Local	34		3.0	12.0			.248	52.7	0.89 (1054)	1.07 (1339)	1.13 (418)	0.62 (71)	0.46 (13)	* (0)	* (0)	
30	Early	33	603	3.9	11.4	8.7	626	.358	70.4	0.95	1.11	1.36	2.11	***	*	*	2885
	Local	36		4.2	11.9			.304	70.2	0.88 (2219)	1.30 (544)	1.87 (104)	1.28 (18)	* (0)	* (0)	** (0)	
42	Early	39	1561	3.4	12.2	10.4	1573	.202	48.7	0.91	0.97	1.17	1.61	2.15	****	***	2905
	Local	43		3.4	11.9			.171	48.0	0.94 (1062)	1.04 (1353)	1.08 (406)	0.79 (71)	0.38 (13)	*** (0)	* (0)	

*This category was neither forecast nor observed.
**This category was forecast once but was never observed.
***This category was forecast three times but was never observed.
****This category was forecast four times but was never observed.

Table 3.5. Same as Table 3.2 except for 18 stations in the Southern Region.

		Direction		Speed													
								Contingency Table									
										Bias by Category							
Fcst. Proj. (h)	Type of Fcst.	Mean Abs. Error (Deg)	No. of Cases	Mean Abs. Error (Kts)	Mean Fcst. (Kts)	Mean Obs. (Kts)	No. of Cases	Skill Score	Percent Fcst. Correct	1 (No. Obs)	2 (No. Obs)	3 (No. Obs)	4 (No. Obs)	5 (No. Obs)	6 (No. Obs)	7 (No. Obs)	No. of Cases
18	Early	29	1690	3.1	12.4	11.1	1699	.311	54.8	1.09	0.85	1.05	1.47	1.90	1.25	**	3245
	Local	32		3.1	12.4			.242	51.1	0.70 (1257)	1.22 (1392)	1.12 (473)	1.22 (95)	0.85 (20)	0.38 (8)	* (0)	
30	Early	29	696	3.9	12.3	10.2	701	.348	69.8	1.00	0.89	1.35	0.98	1.14	***	*****	3066
	Local	31		3.6	11.8			.340	68.4	0.95 (2132)	1.16 (702)	1.11 (176)	0.61 (49)	1.00 (7)	**** (0)	* (0)	
42	Early	38	1673	3.6	12.4	10.7	1684	.217	48.8	1.02	0.91	1.06	1.63	1.56	1.25	***	3250
	Local	41		3.4	12.0			.163	46.7	0.75 (1262)	1.23 (1397)	1.08 (476)	0.82 (93)	0.11 (18)	0.25 (4)	* (0)	

*This category was neither forecast nor observed.
**This category was forecast once but was never observed.
***This category was forecast twice but was never observed.
****This category was forecast three times but was never observed.
*****This category was forecast four times but was never observed.

Table 3.6. Same as Table 3.2 except for 22 stations in the Central Region.

		Direction		Speed						Contingency Table								
										Bias by Category								
Fcst. Proj. (h)	Type of Fcst.	Mean Abs. Error (Deg)	No. of Cases	Mean Abs. Error (Kts)	Mean Fcst. (Kts)	Mean Obs. (Kts)	No. of Cases	Skill Score	Percent Fcst. Correct	1 (No. Obs)	2 (No. Obs)	3 (No. Obs)	4 (No. Obs)	5 (No. Obs)	6 (No. Obs)	7 (No. Obs)	No. of Cases
18	Early	29	2230	3.1	12.9	12.0	2242	.276	50.2	1.11	0.92	0.90	1.18	1.62	1.15	0.50	3879
	Local	32		3.1	12.8			.270	50.7	0.91 (1229)	1.10 (1609)	0.99 (793)	0.94 (196)	0.54 (37)	0.38 (13)	1.00 (2)	
30	Early	34	1072	3.8	11.9	9.8	1090	.278	62.0	0.99	0.94	1.24	1.20	1.73	0.50	**	3874
	Local	37		3.7	11.5			.257	61.1	0.97 (2442)	1.12 (1078)	0.91 (278)	0.78 (59)	0.36 (11)	0.00 (6)	* (0)	
42	Early	37	2121	3.8	13.1	11.7	2137	.229	47.0	1.11	0.92	0.85	1.32	2.12	1.00	1.00	3878
	Local	41		3.6	12.4			.191	46.0	1.01 (1237)	1.12 (1614)	0.83 (787)	0.78 (191)	0.76 (34)	0.08 (13)	0.00 (2)	

*This category was neither forecast nor observed.
**This category was forecast once but was never observed.

Table 3.7. Same as Table 3.2 except for 13 stations in the Western Region.

		Direction		Speed													
										Contingency Table							
										Bias by Category							
Fcst. Proj. (h)	Type of Fcst.	Mean Abs. Error (Deg)	No. of Cases	Mean Abs. Error (Kts)	Mean Fcst. (Kts)	Mean Obs. (Kts)	No. of Cases	Skill Score	Percent Fcst. Correct	1 (No. Obs)	2 (No. Obs)	3 (No. Obs)	4 (No. Obs)	5 (No. Obs)	6 (No. Obs)	7 (No. Obs)	No. of Cases
18	Early	41	704	3.5	11.8	10.2	708	.274	58.9	0.96	1.04	1.18	0.89	0.88	1.00	*	2260
	Local	43		3.6	11.9			.251	57.3	0.92 (1307)	1.13 (723)	1.13 (176)	0.89 (45)	0.88 (8)	0.00 (1)	* (0)	
30	Early	37	548	3.8	11.6	9.7	556	.239	58.3	0.94	1.09	1.20	1.00	0.33	0.00	*	2261
	Local	43		3.7	11.2			.208	59.8	1.10 (1373)	0.91 (686)	0.65 (162)	0.67 (30)	0.33 (9)	0.00 (1)	* (0)	
42	Early	47	609	3.9	11.8	9.9	615	.213	55.2	0.94	1.03	1.34	0.93	0.67	0.00	*	2259
	Local	54		4.0	11.5			.176	54.7	1.00 (1309)	1.06 (723)	0.89 (172)	0.62 (45)	0.33 (9)	1.00 (1)	* (0)	

*This category was neither forecast nor observed.

Table 3.8. Distribution of absolute errors associated with early guidance and local forecasts of surface wind direction for 71 stations, 0000 GMT cycle.

Forecast Projection (h)	Type of Forecast	Percentage Frequency of Absolute Errors by Category					
		0-30°	40-60°	70-90°	100-120°	130-150°	160-180°
18	Early	71.2	17.7	5.5	2.8	1.6	1.2
	Local	66.7	18.8	7.3	3.5	2.1	1.5
30	Early	69.3	16.4	6.6	3.1	2.9	1.7
	Local	64.7	18.6	7.0	4.3	2.8	2.6
42	Early	60.5	21.1	8.6	4.5	3.1	2.1
	Local	55.8	22.7	10.0	5.4	3.6	2.5

Table 3.9. Same as Table 3.8 except for 18 stations in the Eastern Region.

Forecast Projection (h)	Type of Forecast	Percentage Frequency of Absolute Errors by Category					
		0-30°	40-60°	70-90°	100-120°	130-150°	160-180°
18	Early	71.3	17.9	5.7	2.9	1.5	0.8
	Local	65.4	20.3	7.5	3.8	1.9	1.1
30	Early	67.8	19.4	6.5	2.8	2.5	1.0
	Local	62.7	21.9	8.1	3.6	1.7	2.0
42	Early	59.4	23.1	8.6	4.2	2.9	1.7
	Local	53.9	25.0	10.7	5.2	3.2	2.0

Table 3.10. Same as Table 3.8 except for 18 stations in the Southern Region.

Forecast Projection (h)	Type of Forecast	Percentage Frequency of Absolute Errors by Category					
		0-30°	40-60°	70-90°	100-120°	130-150°	160-180°
18	Early	73.0	17.7	5.2	2.2	1.1	0.9
	Local	68.5	19.1	7.0	2.7	1.8	0.9
30	Early	75.1	12.9	5.5	1.9	1.7	2.9
	Local	71.7	15.4	5.5	2.9	2.0	2.6
42	Early	60.2	22.3	9.1	4.0	2.5	1.9
	Local	58.2	21.6	9.3	5.3	3.0	2.7

Table 3.11. Same as Table 3.8 except for 22 stations in the Central Region.

Forecast Projection (h)	Type of Forecast	Percentage Frequency of Absolute Errors By Category					
		0-30°	40-60°	70-90°	100-120°	130-150°	160-180°
18	Early	72.7	17.6	4.5	2.5	1.6	1.0
	Local	68.1	18.7	6.9	2.7	2.1	1.4
30	Early	68.6	16.4	6.5	3.8	3.2	1.5
	Local	64.2	18.6	7.4	4.7	2.9	2.3
42	Early	62.9	20.4	7.2	3.8	3.4	2.3
	Local	57.8	22.3	9.7	4.4	3.6	2.2

Table 3.12. Same as Table 3.8 except for 13 stations in the Western Region.

Forecast Projection (h)	Type of Forecast	Percentage Frequency of Absolute Errors By Category					
		0-30°	40-60°	70-90°	100-120°	130-150°	160-180°
18	Early	61.6	17.2	8.9	5.1	3.4	3.7
	Local	60.9	15.3	9.1	7.4	3.0	4.3
30	Early	64.8	17.7	8.4	3.5	4.2	1.5
	Local	59.3	19.2	6.8	6.0	5.1	3.6
42	Early	56.0	15.4	12.3	8.9	4.1	3.3
	Local	47.0	21.0	11.3	9.9	6.6	4.3

Table 4.1. Definitions of the cloud amount categories used for the local forecasts of opaque sky cover. The same definitions were used for the guidance forecasts except category 1 included only 0 tenths of opaque sky cover, while category 2 included 1-5 tenths.

Category	Cloud Amount (Opaque Sky Cover in tenths)
1	0-1
2	2-5
3	6-9
4	10

Table 4.2. Comparative verification of early guidance and local forecasts of four categories of opaque sky cover (clear, scattered, broken, and overcast) for 71 stations, 0000 GMT cycle.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	Percent Correct	Skill Score	Number of Cases
	Early	0.61	1.40	0.97	1.04	51.0	.336	
18	Local	0.61	1.49	1.13	0.70	49.2	.308	12267
	No. Obs.	3828	3685	2591	2163			
	Early	0.95	1.26	0.81	1.00	55.6	.343	
30	Local	0.65	2.04	1.50	0.63	46.3	.263	11827
	No. Obs.	5792	2097	1478	2460			
	Early	0.83	1.32	0.77	1.03	48.6	.300	
42	Local	0.54	1.69	1.09	0.52	42.1	.207	12267
	No. Obs.	3824	3692	2592	2159			

Table 4.3. Same as Table 4.2 except for 18 stations in the Eastern Region.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	Percent Correct	Skill Score	Number of Cases
18	Early	0.39	1.32	1.13	1.07	49.5	.311	2906
	Local	0.53	1.36	1.33	0.65	46.6	.269	
	No. Obs.	708	961	624	613			
30	Early	0.89	1.32	0.89	1.03	54.6	.358	2906
	Local	0.69	2.04	1.51	0.61	46.5	.281	
	No. Obs.	1248	480	381	797			
42	Early	0.55	1.37	0.92	1.03	46.0	.261	2906
	Local	0.48	1.55	1.19	0.55	41.7	.195	
	No. Obs.	702	951	631	622			

Table 4.4. Same as Table 4.2 except for 18 stations in the Southern Region.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	Percent Correct	Skill Score	Number of Cases
18	Early	0.58	1.45	0.87	0.90	53.4	.346	3243
	Local	0.63	1.49	0.96	0.55	50.5	.300	
	No. Obs.	852	1129	800	462			
30	Early	0.99	1.32	0.63	0.91	57.4	.336	3067
	Local	0.68	2.11	1.29	0.52	46.3	.234	
	No. Obs.	1620	593	364	490			
42	Early	0.82	1.49	0.63	0.77	51.5	.315	3243
	Local	0.52	1.72	0.88	0.33	44.5	.202	
	No. Obs.	859	1129	798	457			

Table 4.5. Same as Table 4.2 except for 22 stations in the Central Region.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	Percent Correct	Skill Score	Number of Cases
	Early	0.53	1.48	0.99	1.10	49.7	.325	
18	Local	0.51	1.63	1.13	0.75	47.0	.284	3870
	No. Obs.	1264	1111	778	717			
	Early	0.90	1.34	0.89	0.99	54.2	.331	
30	Local	0.57	2.14	1.66	0.68	45.2	.262	3696
	No. Obs.	1796	659	436	805			
	Early	0.79	1.31	0.79	1.10	46.5	.273	
42	Local	0.45	1.78	1.16	0.59	38.9	.171	3870
	No. Obs.	1263	1122	775	710			

Table 4.6. Same as Table 4.2 except for 13 stations in the Western Region.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	Percent Correct	Skill Score	Number of Cases
	Early	0.90	1.28	0.87	1.04	51.5	.314	
18	Local	0.78	1.42	1.15	0.88	54.6	.369	2248
	No. Obs.	1004	484	389	371			
	Early	1.05	0.96	0.80	1.05	56.6	.323	
30	Local	0.72	1.77	1.49	0.70	47.9	.260	2158
	No. Obs.	1128	365	297	368			
	Early	1.07	0.87	0.78	1.20	51.6	.300	
42	Local	0.72	1.68	1.25	0.59	44.9	.239	2248
	No. Obs.	1000	490	388	370			

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

Category	Ceiling (ft)	Visibility (mi)
1	<200	<1/2
2	200-400	1/2-7/8
3	500-900	1-2 3/4
4	1000-2900	3-4
5	3000-7500	5-6
6	>7500	>6

Table 5.2. Comparative verification of early guidance, persistence, and local ceiling forecasts for 71 stations, 0000 GMT cycle.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	5	6	Percent Correct	Skill Score
12	Early	1.54	1.59	0.96	1.02	1.01	0.98	71.7	.364
	Local	0.49	0.91	0.73	1.15	1.07	1.00	79.5	.527
	Persistence	0.94	0.83	0.78	0.89	1.01	1.03	80.6	.538
	No. Obs.	78	248	532	998	1284	8866		
15	Local	0.25	0.46	0.46	0.97	1.30	1.01	75.8	.438
	Persistence	4.63	1.43	0.84	0.62	1.17	1.03	74.4	.393
	No. Obs.	16	147	498	1440	1112	8867		
18	Early	0.33	1.52	1.22	0.93	1.01	1.00	71.9	.365
	Persistence	8.22	2.85	1.74	0.68	0.79	1.05	70.7	.310
	No. Obs.	9	73	238	1314	1648	8735		
21	Local	0.10	0.25	0.48	0.97	1.05	1.01	73.1	.339
	Persistence	7.40	4.12	2.27	1.06	0.66	1.02	69.0	.244
	No. Obs.	10	51	184	847	1982	9004		
24	Early	0.79	1.64	1.21	1.02	0.94	1.00	77.8	.361
	Persistence	5.29	3.27	2.20	1.49	0.81	0.96	70.4	.214
	No. Obs.	14	64	189	600	1590	9566		
36	Early	0.91	2.87	0.95	0.99	0.79	0.98	68.9	.301
	Persistence	0.95	0.86	0.79	0.88	1.01	1.03	65.7	.182
	No. Obs.	78	244	527	1014	1283	8870		
48	Early	0.73	1.76	1.12	1.01	0.87	1.01	76.6	.311
	Persistence	4.93	3.17	2.17	1.48	0.82	0.95	65.9	.094
	No. Obs.	15	66	191	601	1579	9571		

Table 5.3. Same as Table 5.2 except for visibility, 0000 GMT cycle.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	5	6	Percent Correct	Skill Score
12	Early	1.29	1.54	1.49	1.05	1.10	0.93	65.9	.286
	Local	0.40	0.83	0.54	1.18	1.51	0.96	73.2	.414
	Persistence	0.69	0.57	0.46	0.69	1.05	1.09	76.3	.405
	No. Obs.	154	116	749	1024	1152	8777		
15	Local	0.24	0.38	0.32	0.91	1.26	1.01	76.3	.312
	Persistence	6.41	1.38	0.82	1.02	0.96	1.00	75.5	.303
	No. Obs.	17	48	428	698	1272	9585		
18	Early	0.50	1.26	1.07	1.00	1.11	0.99	81.7	.294
	Persistence	10.80	2.13	1.46	1.52	1.31	0.93	77.0	.242
	No. Obs.	10	31	240	461	930	10318		
21	Local	0.11	0.04	0.27	0.63	1.47	1.00	82.8	.250
	Persistence	12.11	2.87	1.66	1.65	1.48	0.91	76.9	.217
	No. Obs.	9	23	215	432	824	10541		
24	Early	0.43	0.88	1.06	0.80	1.10	1.00	83.4	.285
	Persistence	7.71	2.54	1.49	1.49	1.56	0.91	76.6	.208
	No. Obs.	14	26	235	473	781	10467		
36	Early	1.19	1.37	1.05	1.04	1.10	0.97	66.9	.277
	Persistence	0.71	0.59	0.46	0.68	1.05	1.09	67.9	.198
	No. Obs.	152	111	762	1032	1158	8775		
48	Early	1.06	1.44	1.22	1.01	1.35	0.97	80.8	.250
	Persistence	6.75	2.44	1.47	1.48	1.58	0.91	74.4	.136
	No. Obs.	16	27	239	476	772	10466		

Table 5.4. Same as Table 5.2 except for ceiling, 1200 GMT cycle.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	5	6	Percent Correct	Skill Score
12	Early	0.40	1.48	1.12	1.07	0.95	1.00	78.6	.383
	Local	0.20	0.58	0.70	1.36	1.15	0.96	80.8	.476
	Persistence	0.81	0.87	0.91	1.29	1.19	0.95	80.6	.478
	No. Obs.	15	62	186	611	1614	9716		
15	Local	0.39	0.44	0.63	1.47	0.96	0.99	80.0	.422
	Persistence	0.67	0.55	0.71	1.32	1.30	0.95	75.5	.336
	No. Obs.	18	99	238	602	1481	9822		
18	Early	1.58	1.55	1.19	0.97	0.91	1.00	77.1	.366
	Persistence	0.33	0.45	0.60	1.04	1.41	0.96	72.3	.270
	No. Obs.	33	119	284	752	1329	9431		
21	Local	0.24	0.55	0.66	1.44	0.89	1.00	74.9	.371
	Persistence	0.15	0.30	0.40	0.90	1.42	1.00	68.6	.215
	No. Obs.	72	181	420	872	1325	9125		
24	Early	1.52	1.60	1.02	0.97	0.79	1.01	71.9	.339
	Persistence	0.14	0.22	0.32	0.79	1.49	1.02	66.4	.188
	No. Obs.	79	243	520	990	1271	8935		
36	Early	0.80	1.43	1.31	1.08	0.76	1.03	77.6	.325
	Persistence	0.80	0.84	0.88	1.32	1.19	0.95	68.5	.147
	No. Obs.	15	63	189	589	1589	9639		
48	Early	2.13	1.27	0.90	0.96	0.77	1.03	69.9	.278
	Persistence	0.14	0.21	0.32	0.79	1.49	1.02	61.7	.073
	No. Obs.	78	248	517	979	1254	8894		

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

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	5	6	Percent Correct	Skill Score
12	Early	1.27	1.33	1.04	0.90	1.03	1.00	85.1	.344
	Local	0.27	0.79	0.39	0.97	1.70	0.97	86.2	.454
	Persistence	0.67	1.08	0.86	0.86	1.43	0.98	88.0	.508
	No. Obs.	15	24	231	473	772	10646		
15	Local	0.50	0.95	0.70	1.38	1.68	0.94	83.3	.350
	Persistence	0.83	1.19	1.16	0.96	1.39	0.97	85.4	.383
	No. Obs.	12	21	171	426	798	10793		
18	Early	2.08	1.74	1.03	0.92	0.95	1.00	83.5	.309
	Persistence	0.27	0.74	0.97	0.78	1.44	0.98	83.1	.327
	No. Obs.	37	35	206	520	769	10347		
21	Local	0.29	1.00	1.15	1.75	1.50	0.90	73.1	.280
	Persistence	0.09	0.45	0.64	0.60	1.15	1.04	78.9	.267
	No. Obs.	108	55	311	680	970	9824		
24	Early	1.19	1.47	1.18	1.15	1.02	0.96	67.8	.304
	Persistence	0.06	0.23	0.26	0.40	0.96	1.17	71.2	.200
	No. Obs.	154	111	755	1029	1149	8805		
36	Early	0.69	1.74	1.01	0.87	1.10	1.00	82.5	.242
	Persistence	0.63	0.93	0.85	0.89	1.42	0.98	80.9	.215
	No. Obs.	16	27	232	463	767	10547		
48	Early	1.30	1.18	1.04	1.09	1.14	0.96	65.9	.263
	Persistence	0.06	0.21	0.26	0.40	0.96	1.17	68.9	.139
	No. Obs.	156	117	765	1027	1133	8738		

Table 5.6. Comparative verification for early guidance, persistence, and local ceiling forecasts for 71 stations, 0000 GMT cycle. Scores are computed from two-category (categories 1 and 2 combined versus categories 3-6 combined) contingency tables.

Projection (h)	Type of Forecast	Rel. Freq. Cats. 1&2 combined	Bias Cats. 1&2 combined	Percent Correct	Skill Score	Threat Score
12	Early	0.027	1.58	94.7	.214	.137
	Local		0.81	97.1	.392	.255
	Persistence		0.86	97.3	.452	.304
15	Local	0.013	0.44	98.5	.199	.114
	Persistence		1.74	97.2	.219	.132
18	Early	0.007	1.39	98.7	.198	.114
	Persistence		3.44	94.7	.134	.077
21	Local	0.005	0.23	99.4	.105	.056
	Persistence		4.66	97.4	.091	.052
24	Early	0.006	1.49	98.7	.200	.115
	Persistence		3.63	97.3	.096	.056
36	Early	0.026	2.39	92.0	.084	.063
	Persistence		0.88	95.5	.079	.054
48	Early	0.007	1.56	98.5	.127	.072
	Persistence		3.49	97.1	.028	.020

Table 5.7. Same as Table 5.6 except for visibility, 0000 GMT cycle.

Projection (h)	Type of Forecast	Rel. Freq. Cats. 1&2 combined	Bias Cats. 1&2 combined	Percent Correct	Skill Score	Threat Score
12	Early	0.023	1.40	96.0	.233	.145
	Local		0.58	98.0	.417	.271
	Persistence		0.64	98.0	.442	.292
15	Local	0.005	0.34	99.4	.136	.074
	Persistence		2.69	98.2	.101	.057
18	Early	0.003	1.07	99.3	.044	.024
	Persistence		4.24	98.3	.041	.024
21	Local	0.003	0.06	99.7	.000	-.000
	Persistence		5.47	98.3	.015	.010
24	Early	0.003	0.73	99.4	.026	.015
	Persistence		4.35	98.2	.004	.005
36	Early	0.022	1.27	95.9	.164	.102
	Persistence		0.66	96.8	.103	.063
48	Early	0.004	1.30	99.2	.057	.031
	Persistence		4.05	98.2	-.006	.000

Table 5.8. Same as Table 5.6 except for ceiling, 1200 GMT cycle.

Projection (h)	Type of Forecast	Rel. Freq. Cats. 1&2 combined	Bias Cats. 1&2 combined	Percent Correct	Skill Score	Threat Score
12	Early	0.006	1.27	98.8	.166	.094
	Local		0.52	99.4	.359	.221
	Persistence		0.86	99.3	.430	.277
15	Local	0.010	0.44	98.9	.222	.128
	Persistence		0.56	98.9	.257	.151
18	Early	0.013	1.55	97.5	.215	.128
	Persistence		0.43	98.5	.150	.085
21	Local	0.021	0.46	97.4	.151	.088
	Persistence		0.26	97.5	.067	.039
24	Early	0.027	1.58	94.6	.193	.123
	Persistence		0.20	97.0	.054	.032
36	Early	0.006	1.30	98.8	.161	.091
	Persistence		0.83	98.9	.093	.051
48	Early	0.027	1.48	94.3	.125	.083
	Persistence		0.20	96.9	.027	.018

Table 5.9. Same as Table 5.6 except for visibility, 1200 GMT cycle.

Projection (h)	Type of Forecast	Rel. Freq. Cats. 1&2 combined	Bias Cats. 1&2 combined	Percent Correct	Skill Score	Threat Score
12	Early	0.003	1.31	99.3	.108	.059
	Local		0.59	99.6	.289	.170
	Persistence		0.92	99.5	.184	.103
15	Local	0.003	0.79	99.6	.202	.113
	Persistence		1.06	99.5	.086	.046
18	Early	0.006	1.92	98.4	.098	.055
	Persistence		0.50	99.1	.033	.019
21	Local	0.014	0.52	98.3	.193	.112
	Persistence		0.21	98.4	.026	.015
24	Early	0.022	0.93	95.9	.172	.107
	Persistence		0.14	97.6	.021	.013
36	Early	0.004	1.35	99.2	.056	.031
	Persistence		0.81	99.4	.023	.013
48	Early	0.023	1.25	95.9	.174	.108
	Persistence		0.13	97.4	.001	.003

Table 6.1. Verification of the guidance max/min temperature forecasts for 87 stations, 0000 GMT cycle.

Forecast Projection (h)	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Number (%) of Absolute Errors $\geq$ 10°	Number of Cases
24 (Max)	0.5	2.8	329 (2.1)	15832
36 (Min)	0.3	2.9	293 (1.9)	15826
48 (Max)	0.1	3.5	764 (4.8)	15832
60 (Min)	-0.1	3.5	643 (4.1)	15826

Table 6.2. Same as Table 6.1 except for 25 stations in the Eastern Region.

Forecast Projection (h)	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Number (%) of Absolute Errors ≥ 10°	Number of Cases
24 (Max)	0.2	2.8	62 (1.4)	4550
36 (Min)	0.3	2.9	66 (1.5)	4550
48 (Max)	-0.2	3.4	177 (3.9)	4550
60 (Min)	-0.2	3.6	186 (4.1)	4550

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

Forecast Projection (h)	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Number (%) of Absolute Errors ≥ 10°	Number of Cases
24 (Max)	0.8	2.5	81 (1.9)	4368
36 (Min)	0.8	2.8	99 (2.3)	4368
48 (Max)	0.4	3.0	162 (3.7)	4368
60 (Min)	0.6	3.2	169 (3.9)	4368

Table 6.4. Same as Table 6.1 except for 23 stations in the Central Region.

Forecast Projection (h)	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Number (%) of Absolute Errors ≥ 10°	Number of Cases
24 (Max)	0.5	3.1	122 (2.9)	4186
36 (Min)	0.2	3.2	99 (2.4)	4180
48 (Max)	-0.0	4.0	284 (6.8)	4186
60 (Min)	-0.3	3.8	216 (5.2)	4180

Table 6.5. Same as Table 6.1 except for 15 stations in the Western Region.

Forecast Projection (h)	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Number (%) of Absolute Errors ≥ 10°	Number of Cases
24 (Max)	0.6	2.9	64 (2.3)	2728
36 (Min)	-0.4	2.7	29 (1.1)	2728
48 (Max)	0.3	3.7	141 (5.2)	2728
60 (Min)	-0.9	3.1	72 (2.6)	2728

Table 6.6. Verification of the guidance max/min temperature forecasts for 87 stations, 1200 GMT cycle.

Forecast Projection (h)	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Number (%) of Absolute Errors ≥ 10°	Number of Cases
24 (Min)	-0.1	2.6	204 (1.3)	15814
36 (Max)	0.1	3.3	593 (3.7)	15819
48 (Min)	-0.1	3.2	431 (2.7)	15800
60 (Max)	0.1	4.0	1121 (7.1)	15732

Table 6.7. Same as Table 6.6 except for 25 stations in the Eastern Region.

Forecast Projection (h)	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Number (%) of Absolute Errors ≥ 10°	Number of Cases
24 (Min)	-0.1	2.6	45 (1.0)	4545
36 (Max)	-0.2	3.3	144 (3.2)	4545
48 (Min)	-0.3	3.3	110 (2.4)	4540
60 (Max)	-0.3	3.9	295 (6.5)	4520

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

Forecast Projection (h)	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Number (%) of Absolute Errors ≥ 10°	Number of Cases
24 (Min)	0.3	2.5	70 (1.6)	4365
36 (Max)	0.2	2.8	120 (2.7)	4365
48 (Min)	0.7	3.0	127 (2.9)	4362
60 (Max)	0.3	3.4	202 (4.7)	4341

Table 6.9. Same as Table 6.6 except for 23 stations in the Central Region.

Forecast Projection (h)	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Number (%) of Absolute Errors ≥ 10°	Number of Cases
24 (Min)	-0.1	2.9	69 (1.7)	4177
36 (Max)	0.2	3.7	224 (5.4)	4182
48 (Min)	-0.1	3.4	152 (3.6)	4172
60 (Max)	0.1	4.5	390 (9.4)	4159

Table 6.10. Same as Table 6.6 except for 15 stations in the Western Region.

Forecast Projection (h)	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Number (%) of Absolute Errors ≥ 10°	Number of Cases
24 (Min)	-0.8	2.6	20 (0.7)	2727
36 (Max)	0.1	3.4	105 (3.8)	2727
48 (Min)	-0.8	2.9	42 (1.5)	2726
60 (Max)	0.5	4.2	234 (8.6)	2712

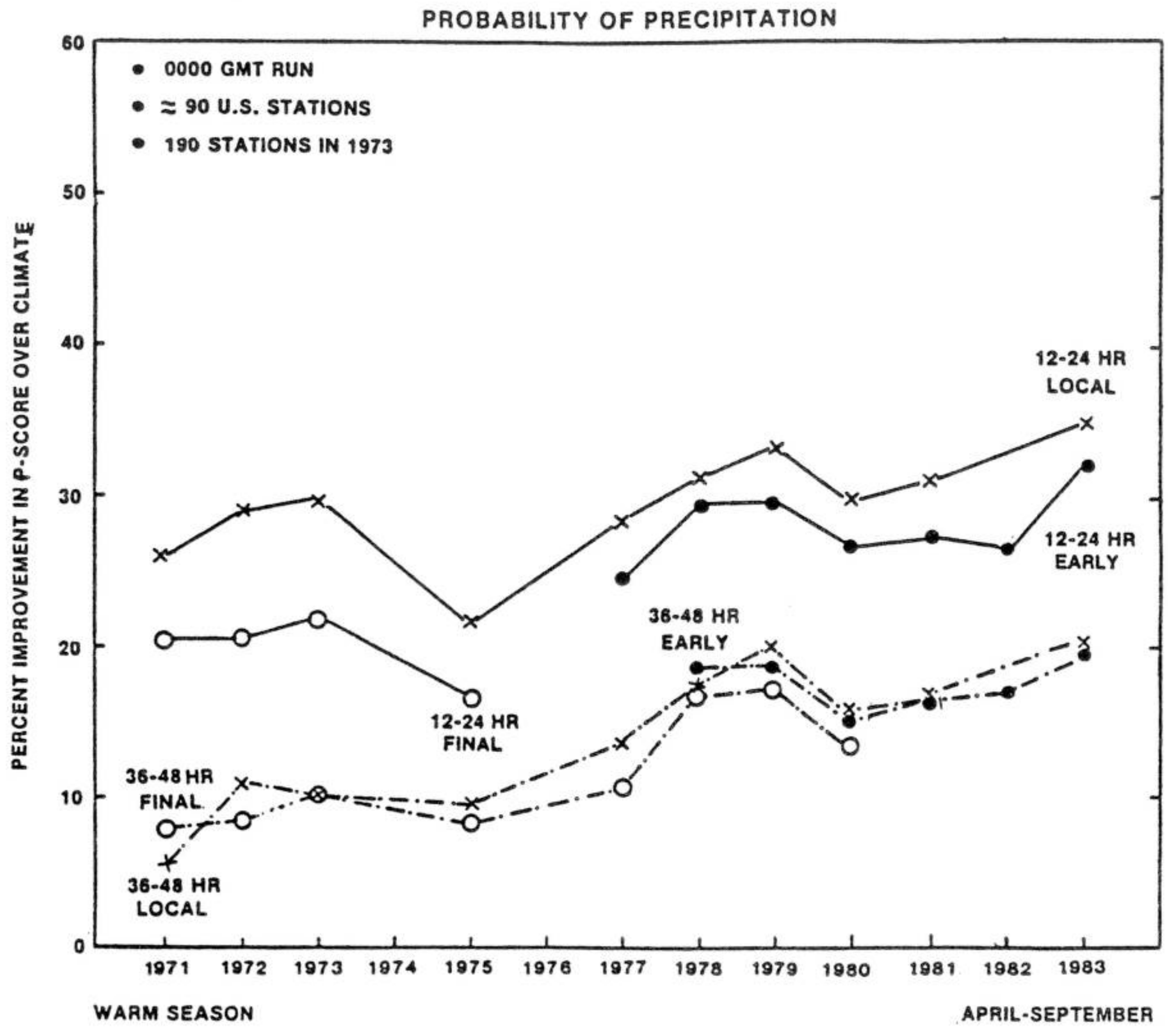

Figure 2.1. Percent improvement over climate in the Brier score of the local and the early and final guidance PoP forecasts. Results for 1974, 1976, and 1982 (local only) are unavailable because of missing data.

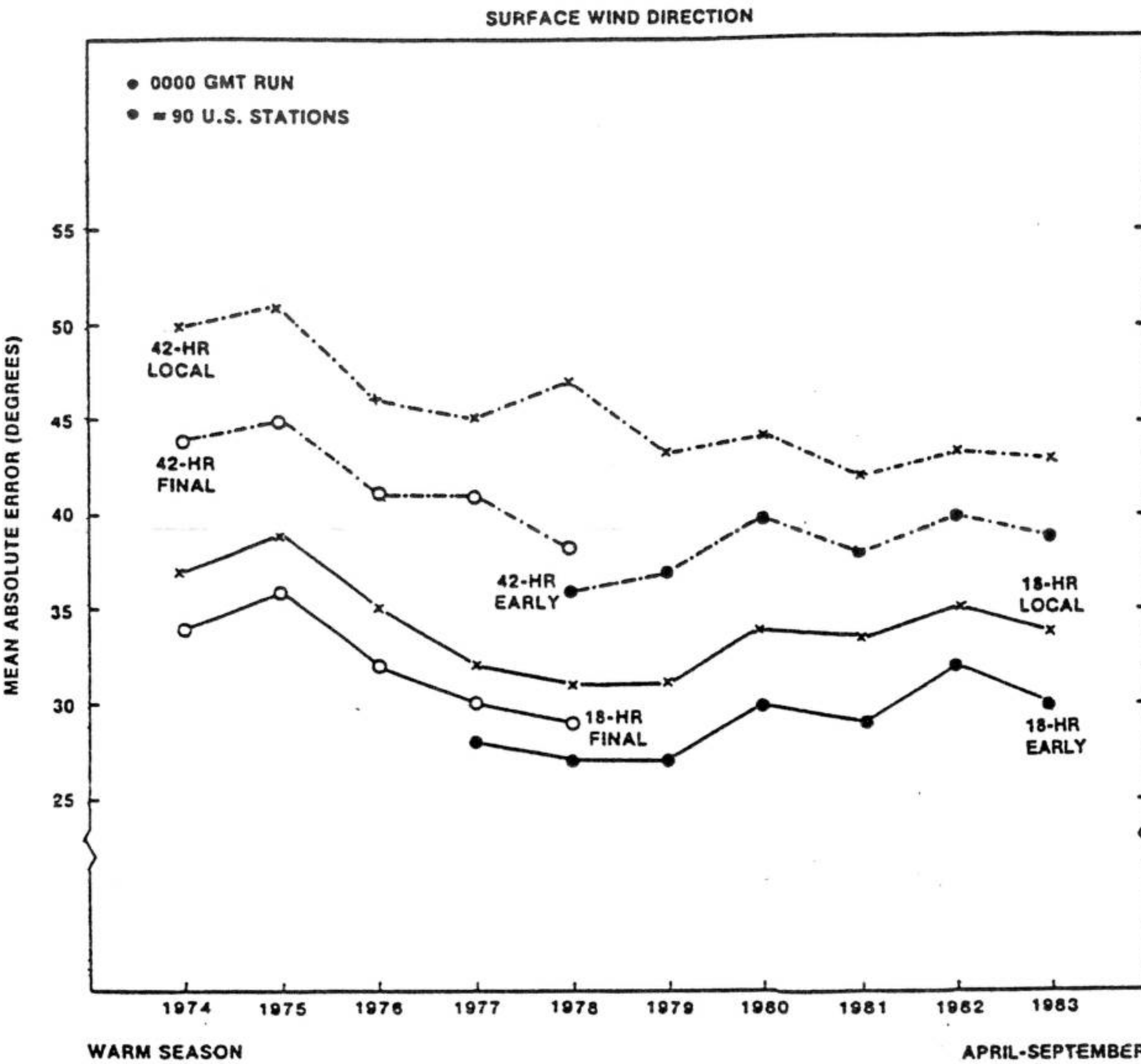

Figure 3.1. Mean absolute error for the local and the early and final guidance surface wind direction forecasts. Only 71 stations were available for 1983.

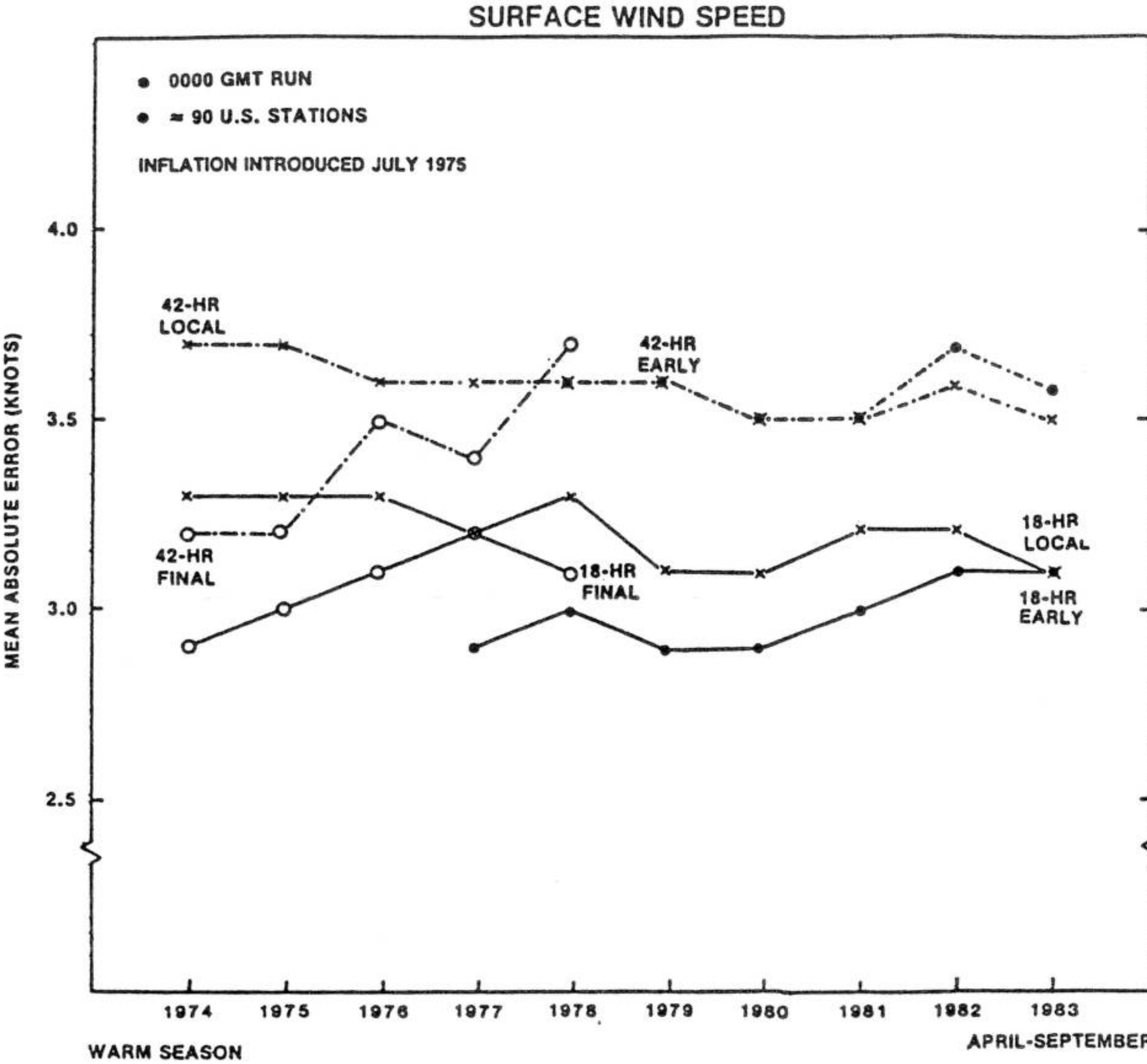

Figure 3.2. Same as Fig. 3.1 except for surface wind speed.

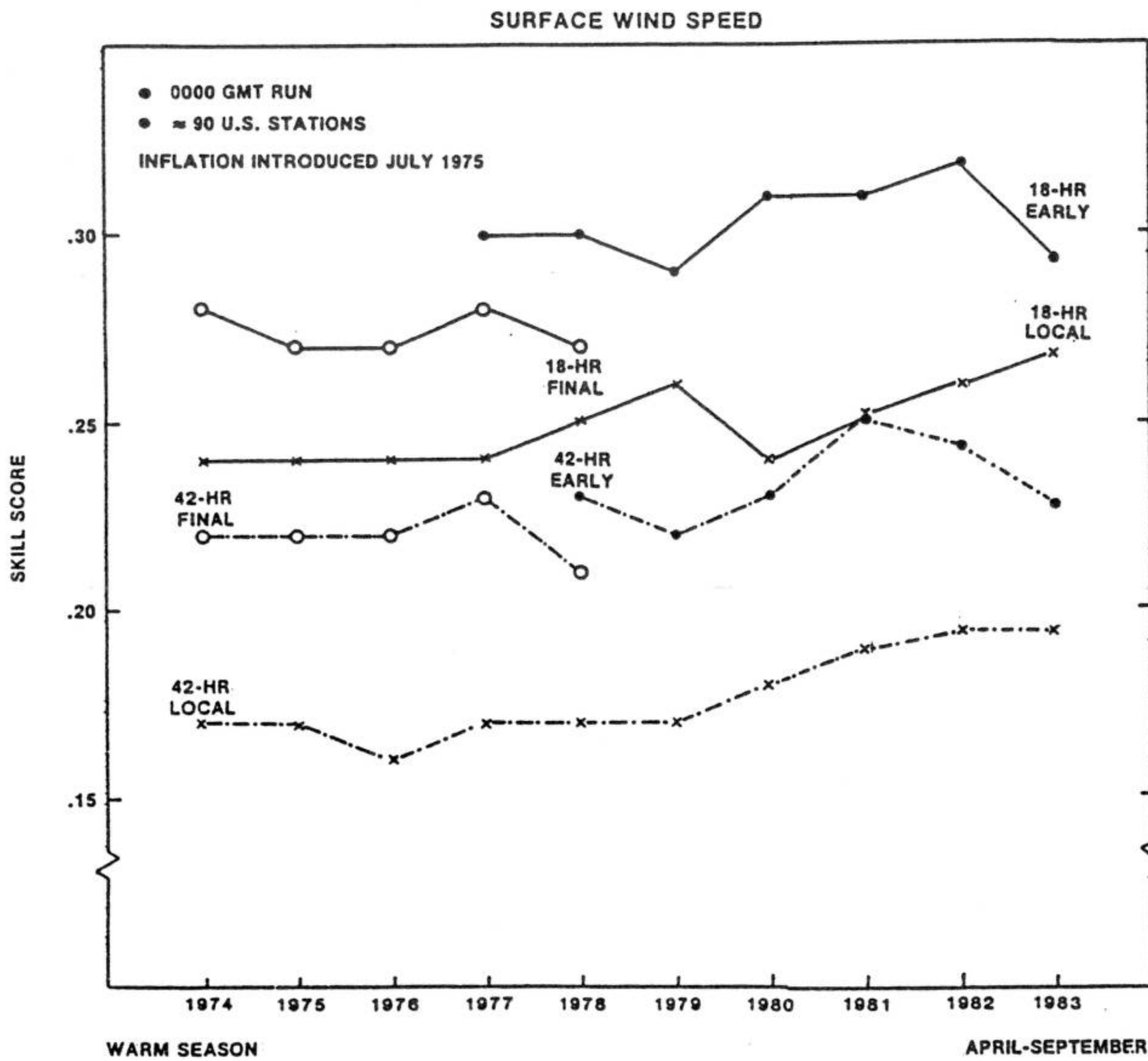

Figure 3.3. Skill score computed from five-category contingency tables for the local and the early and final guidance surface wind speed forecasts.

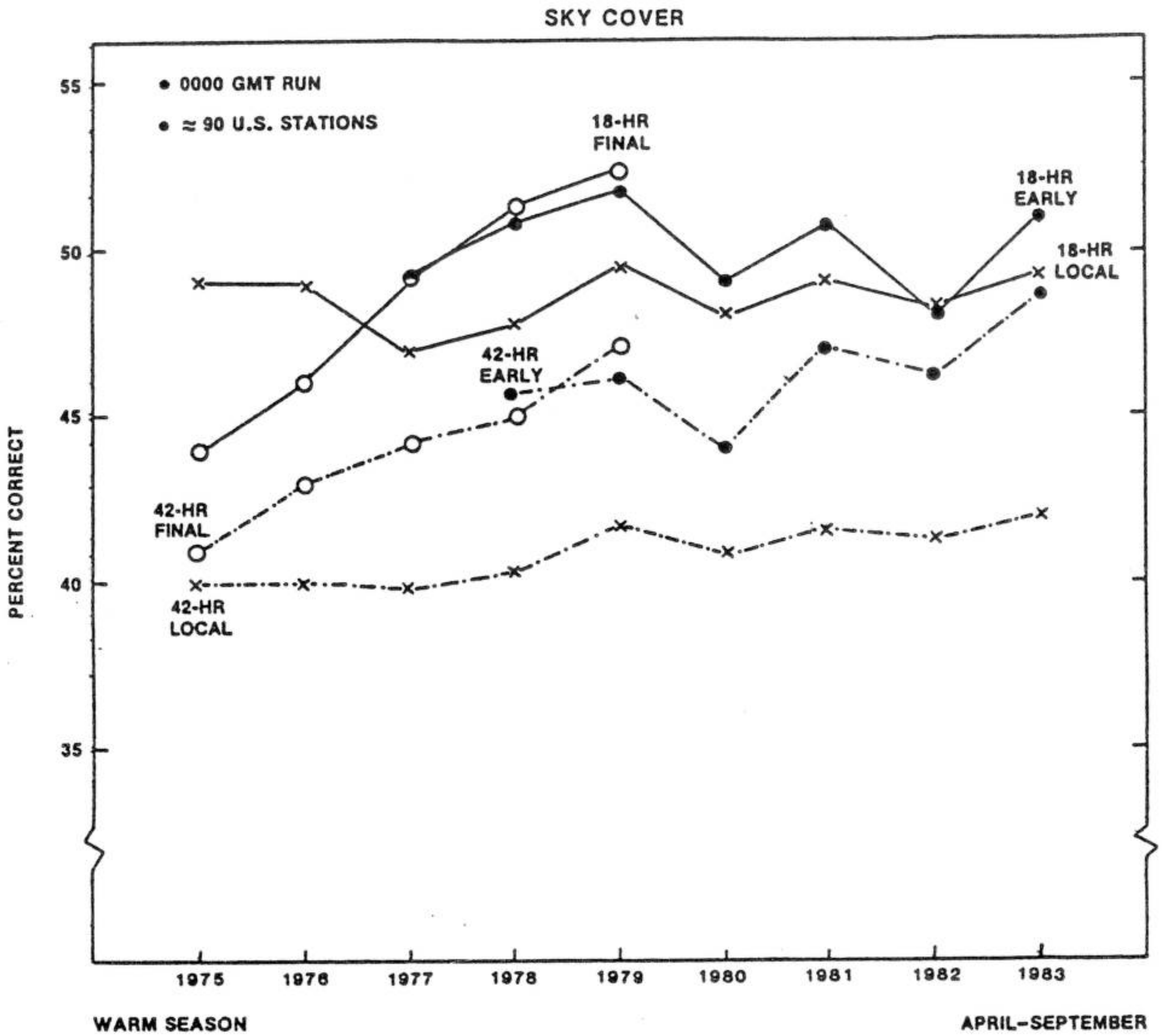

Figure 4.1. Percent correct for the local and the early and final guidance opaque sky cover forecasts. Only 71 stations were available for 1983.

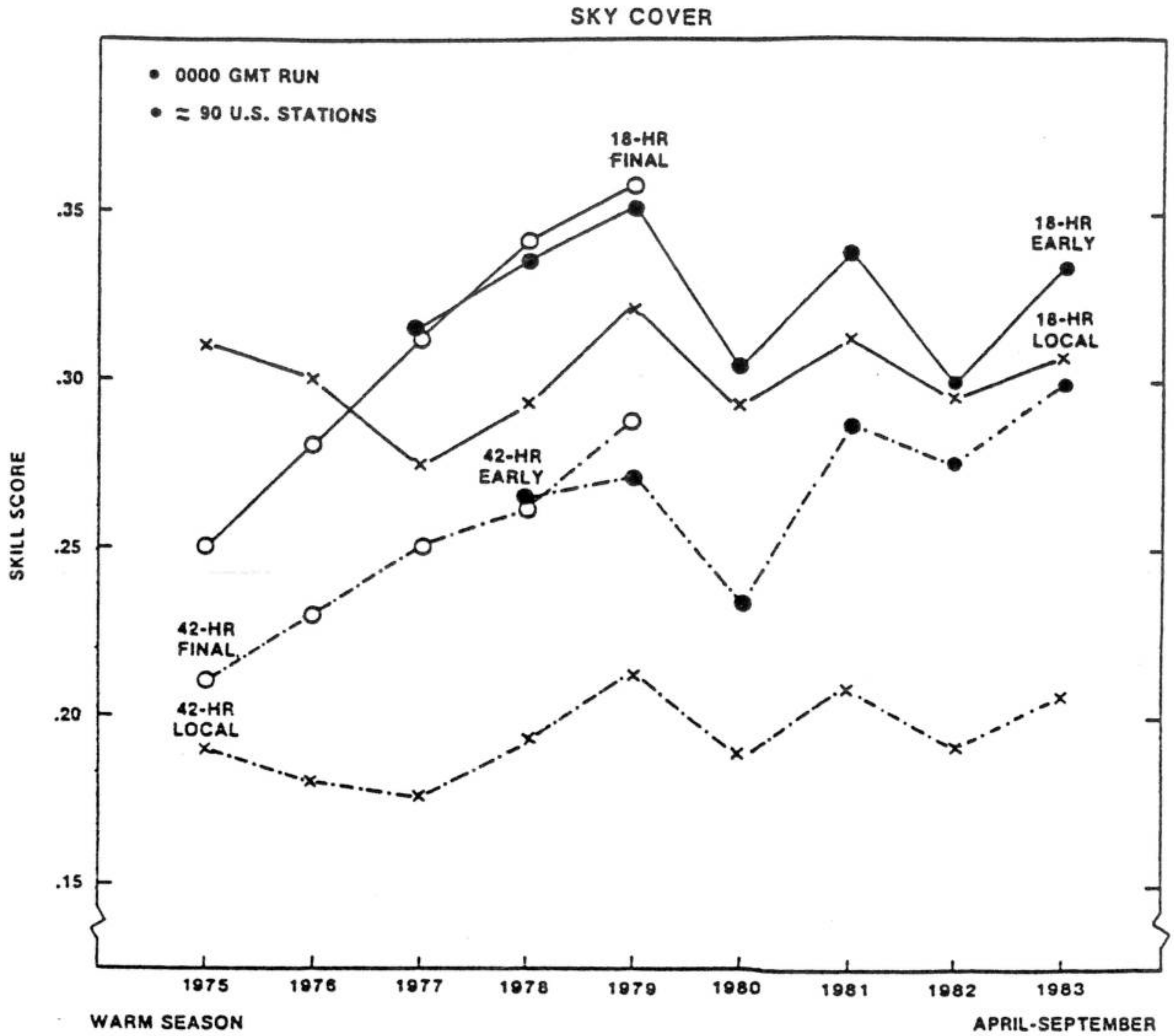

Figure 4.2. Same as Fig. 4.1 except for skill score.

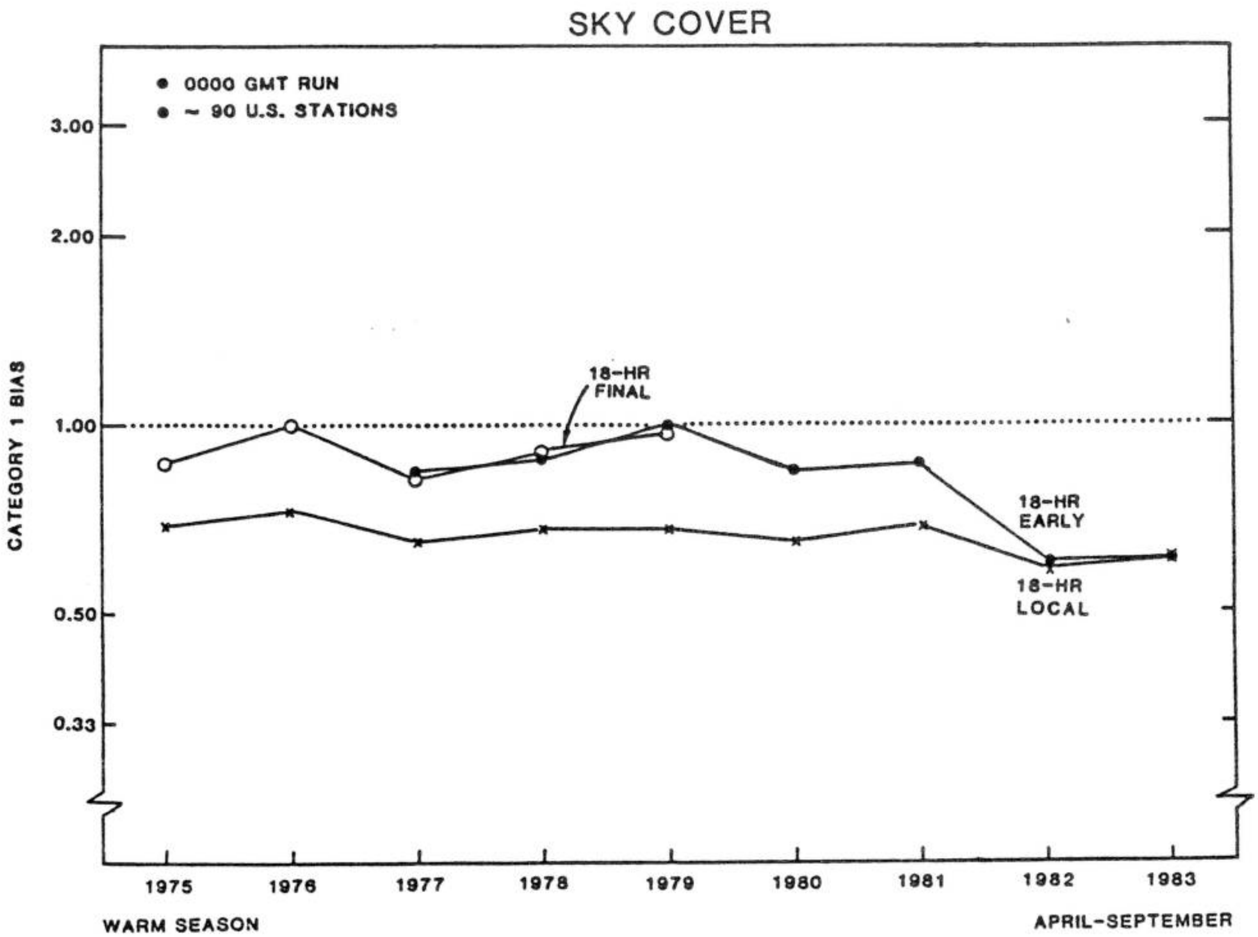

Figure 4.3. Category 1 bias for the local and the early and final guidance opaque sky cover forecasts. Only 71 stations were available for 1983.

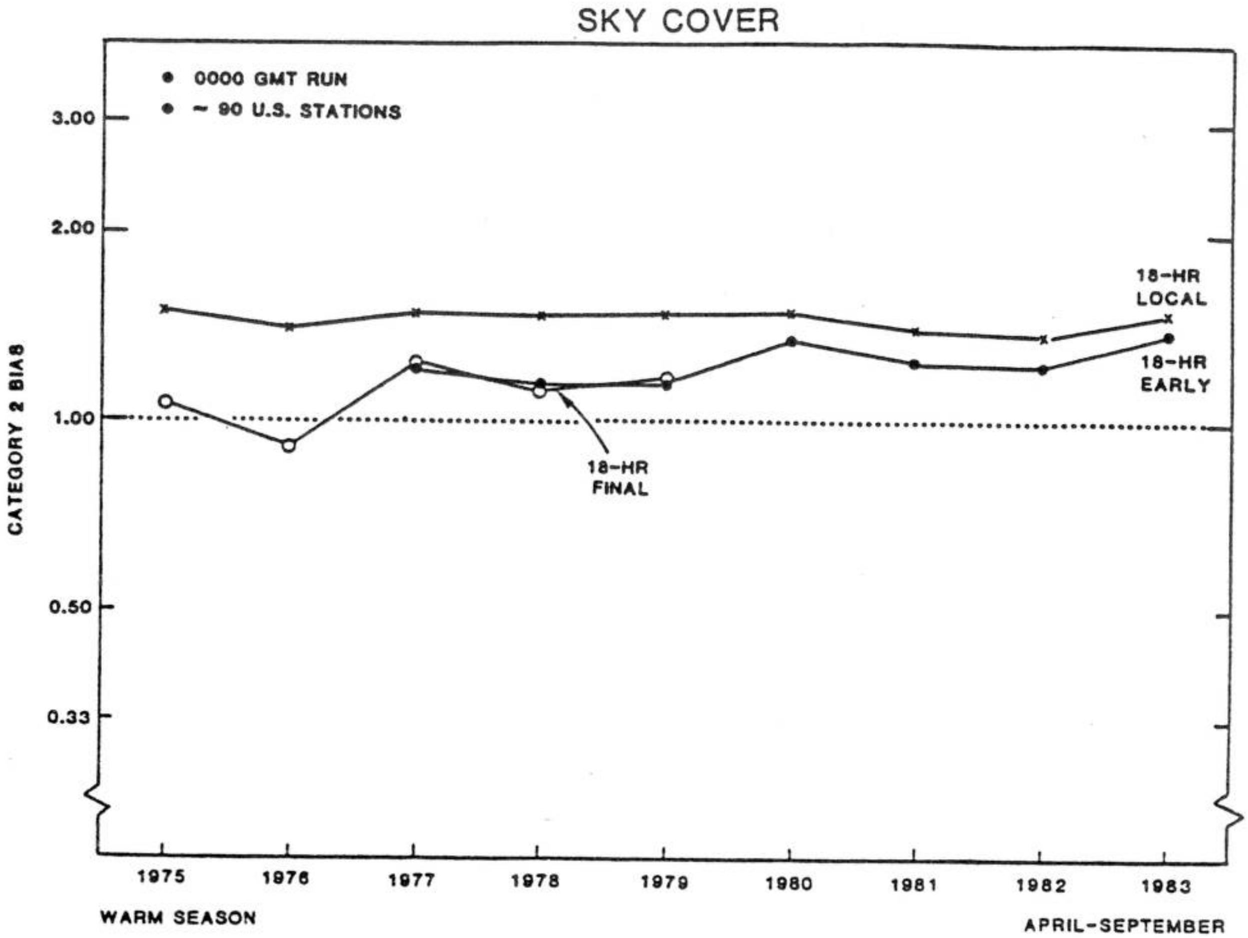

Figure 4.4. Same as Fig. 4.3 except for category 2 bias.

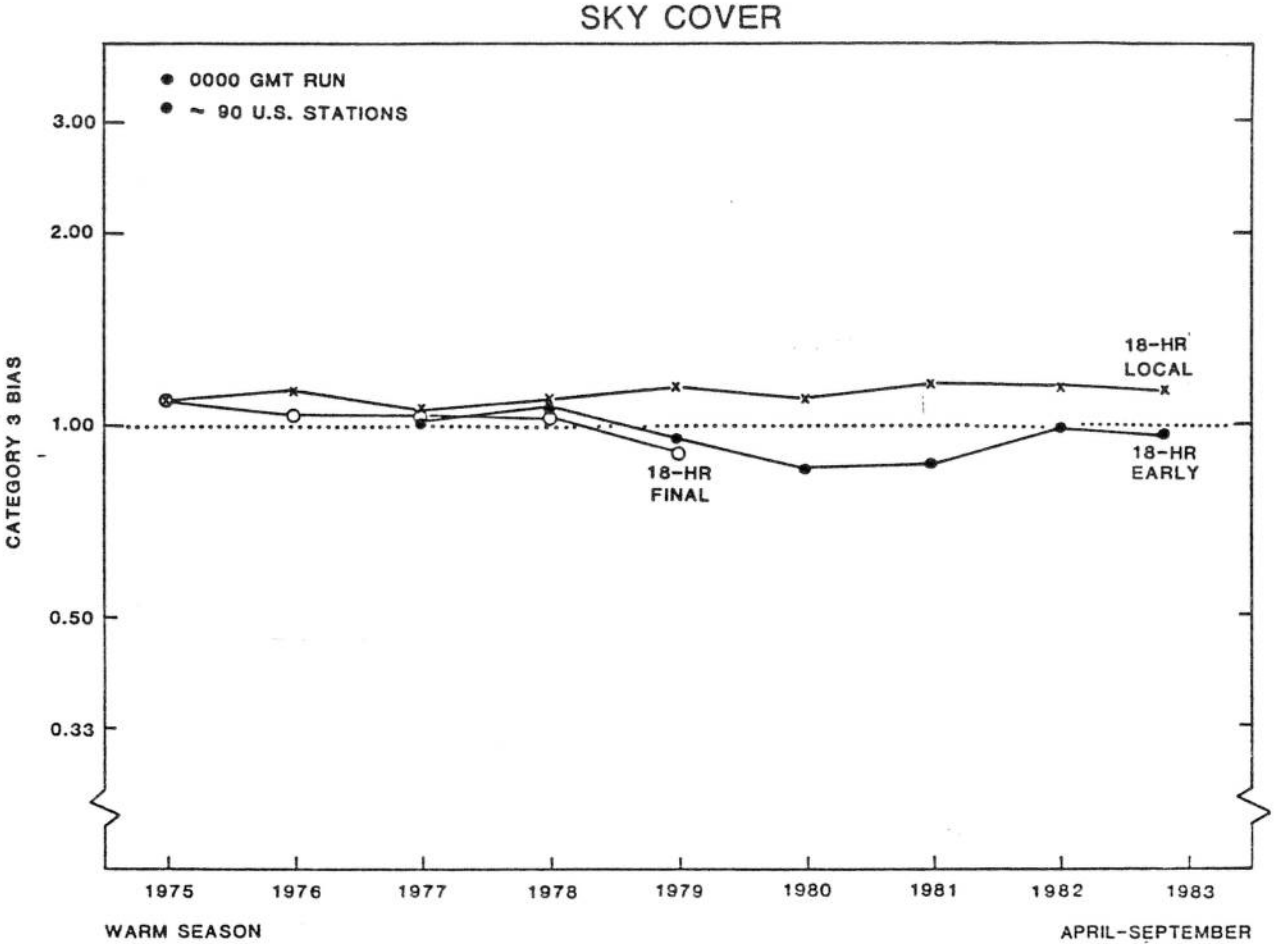

Figure 4.5. Same as Fig. 4.3 except for category 3 bias.

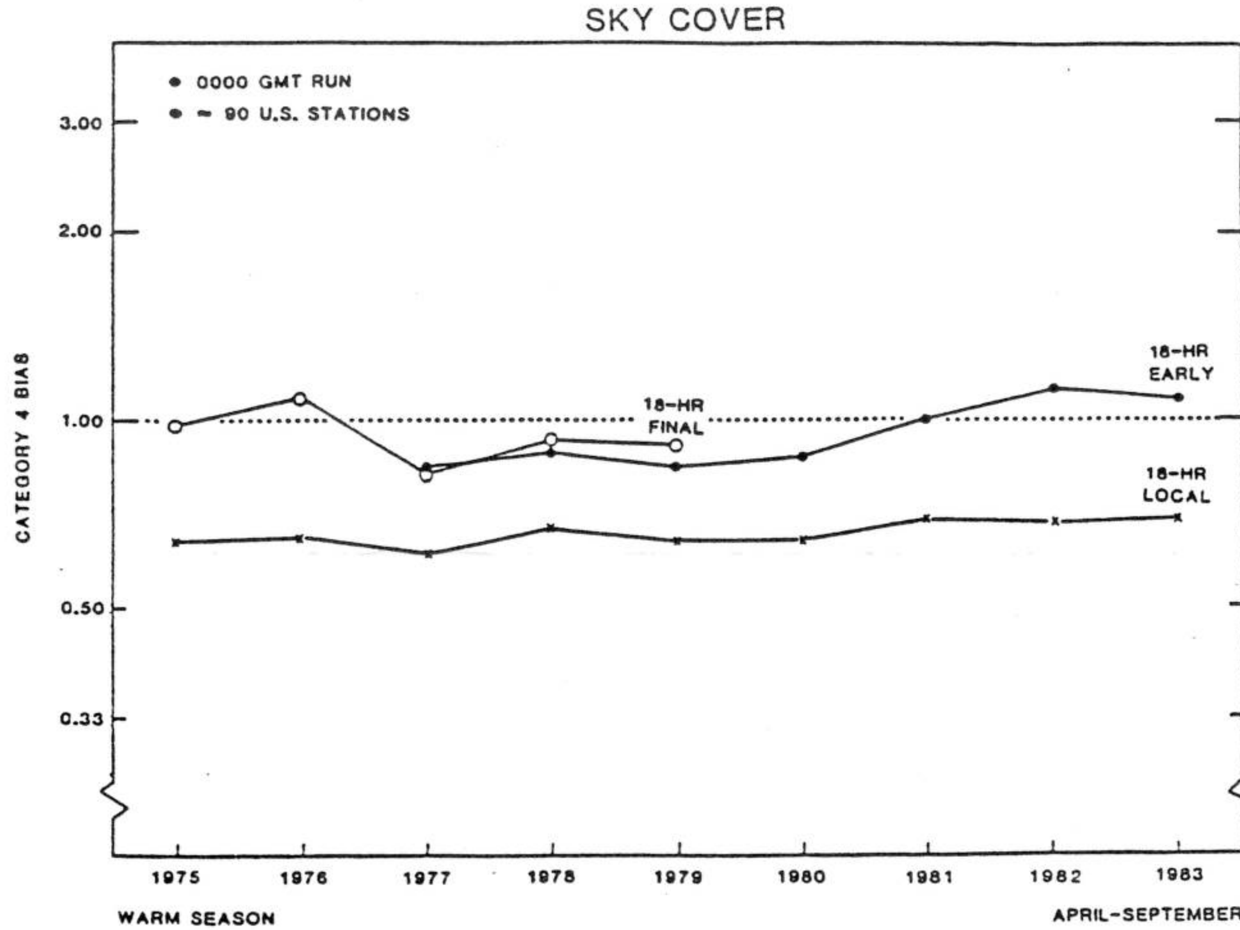

Figure 4.6. Same as Fig. 4.3 except for category 4 bias.

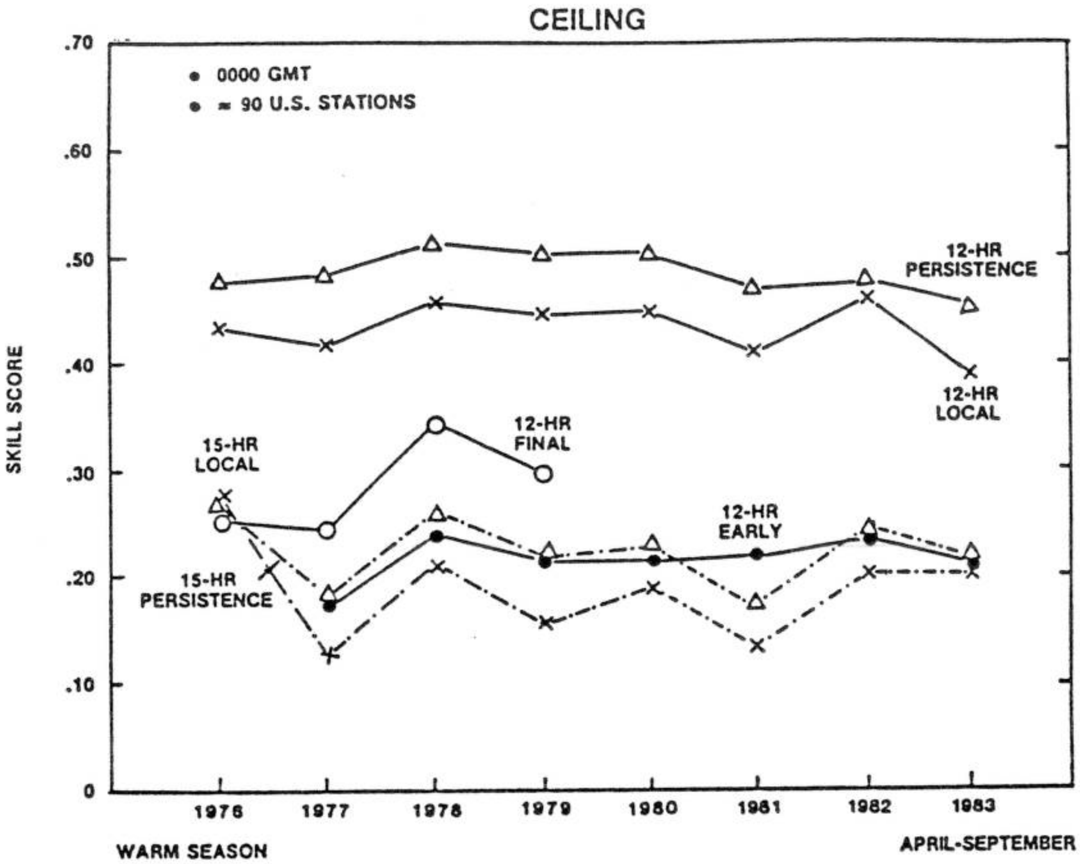

Figure 5.1. Skill score computed from two-category contingency tables for persistence, local, and guidance (early and final) ceiling height forecasts. Only 71 stations were available for 1983.

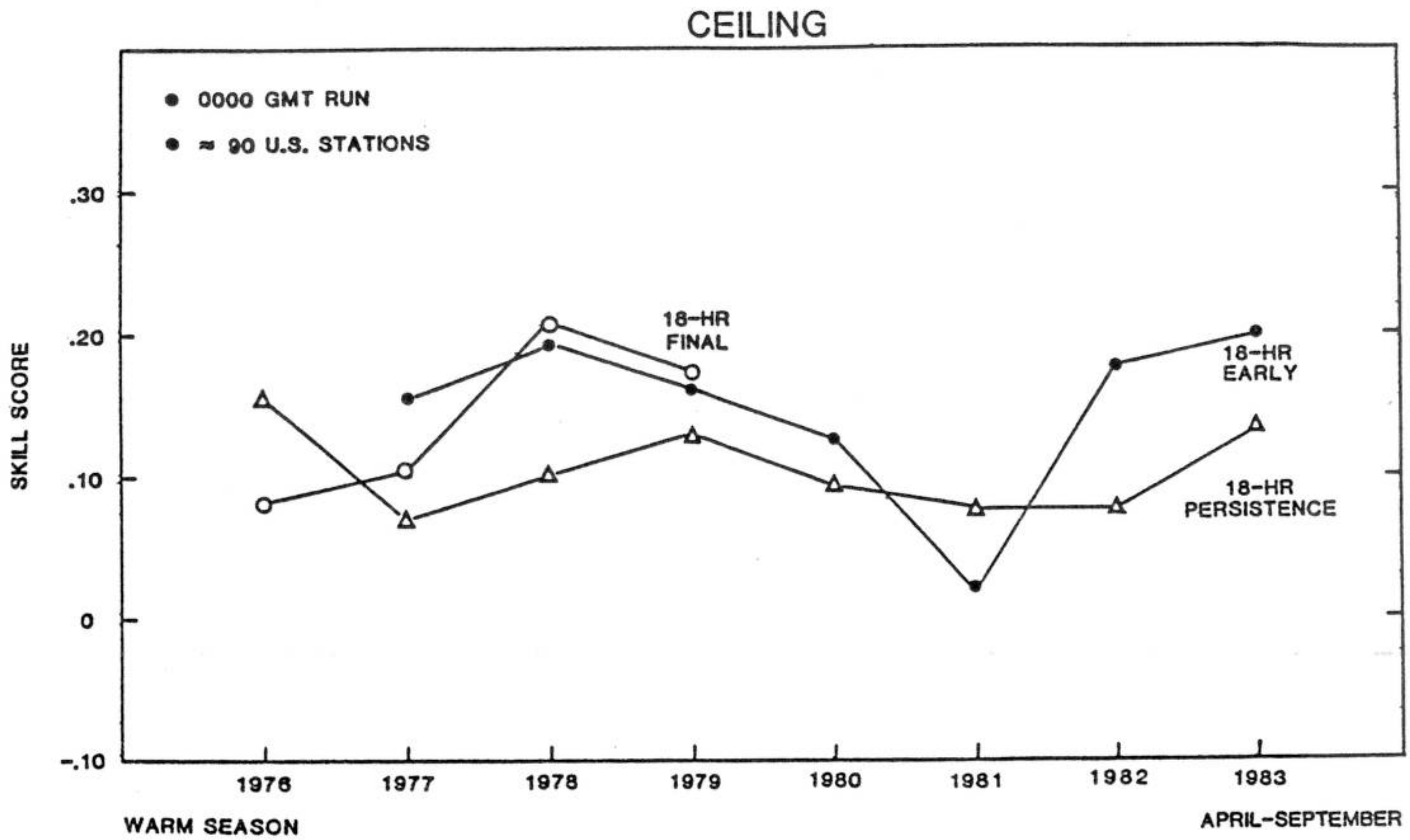

Figure 5.2. Same as Fig. 5.1 except for forecast projection.

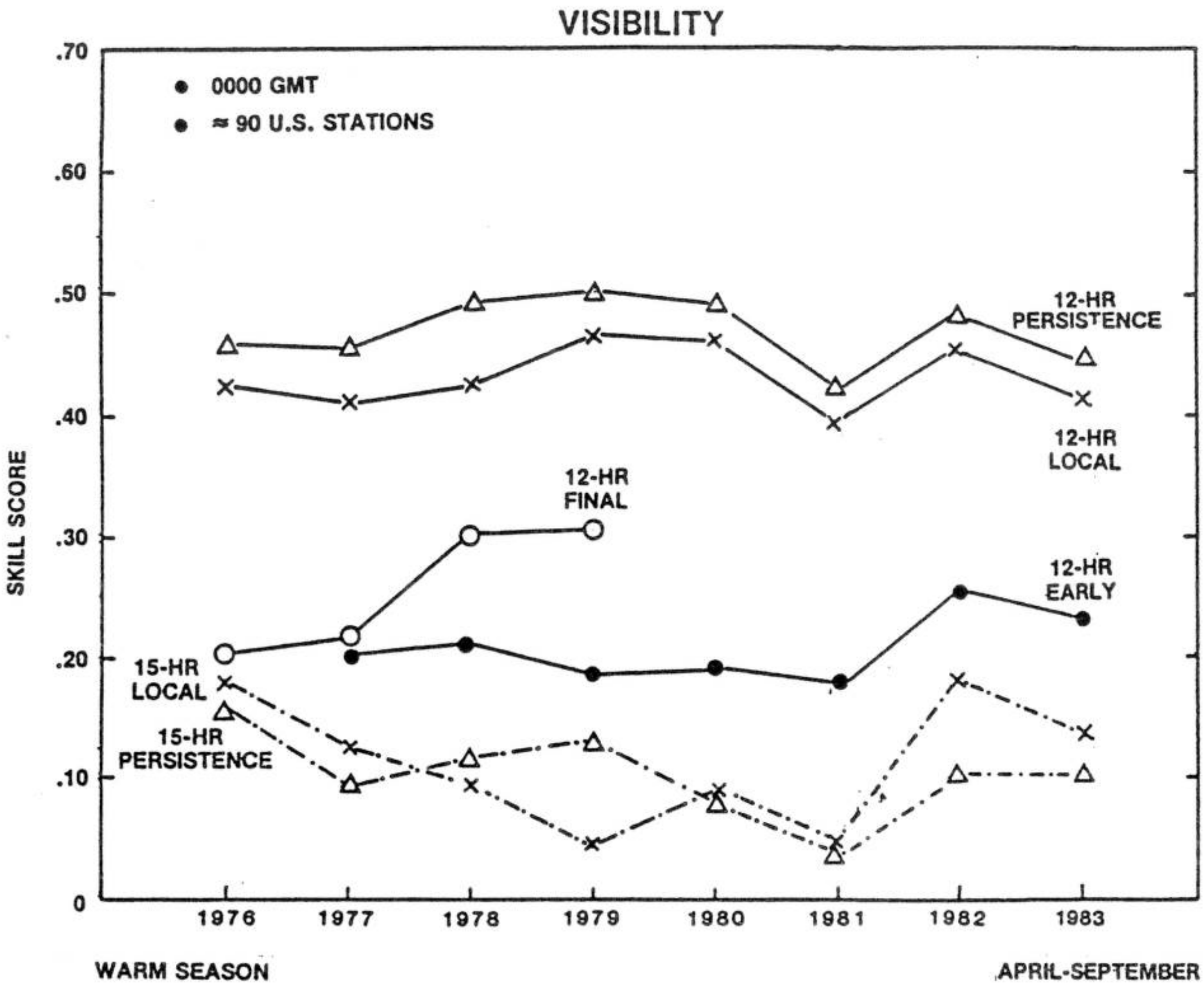

Figure 5.3. Same as Fig. 5.1 except for visibility.

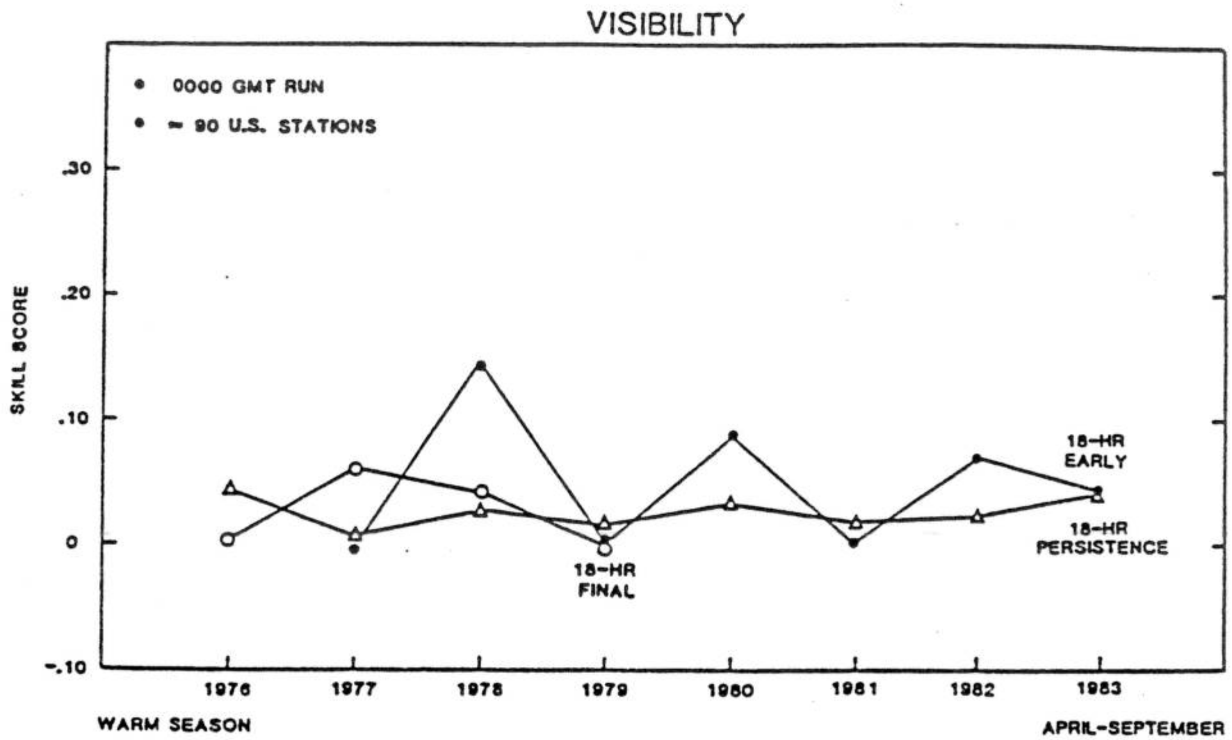

Figure 5.4. Same as Fig. 5.1 except for visibility and forecast projection.

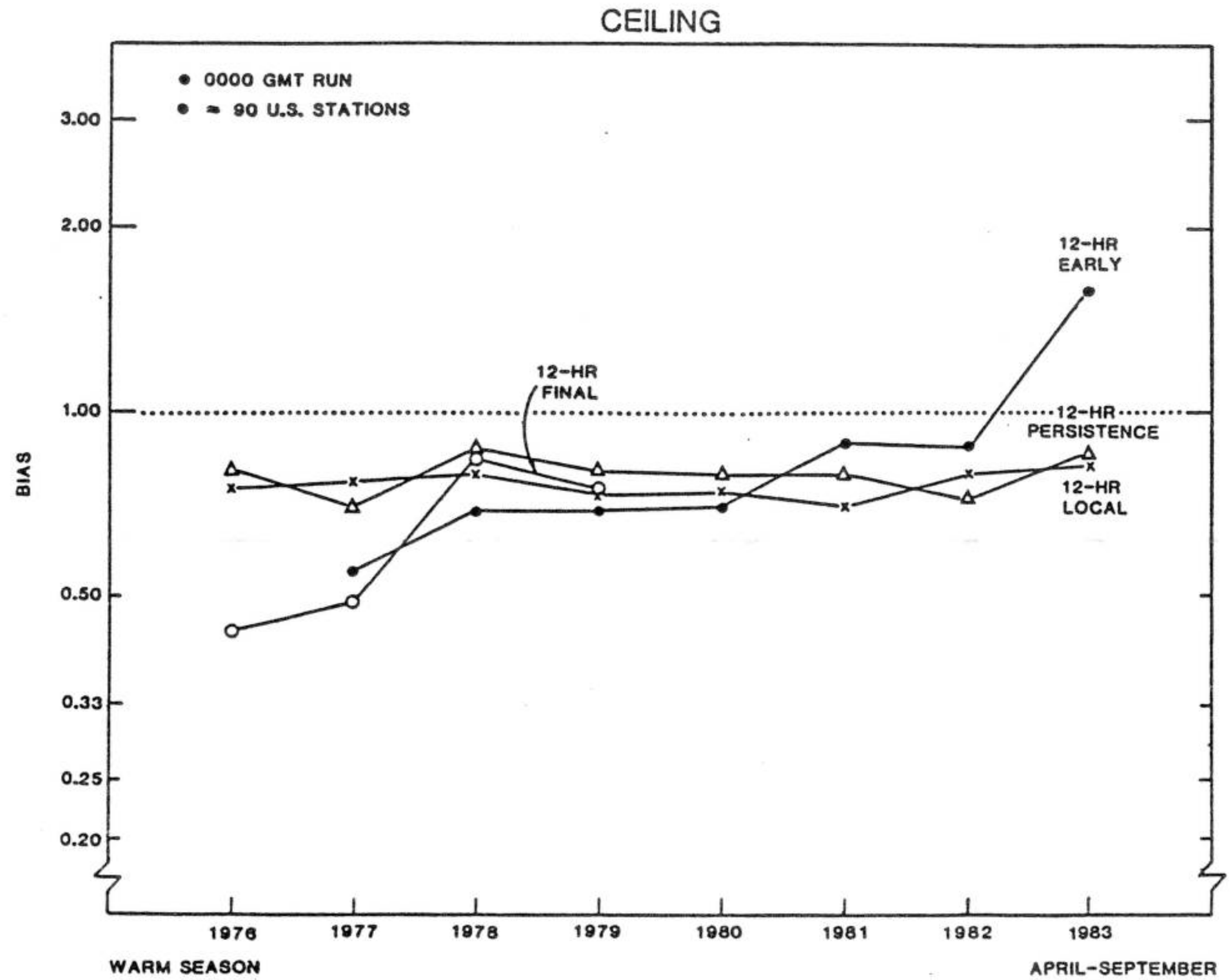

Figure 5.5. Bias for categories 1 and 2 combined for persistence, local, and guidance (early and final) ceiling height forecasts. Only 71 stations were available for 1983.

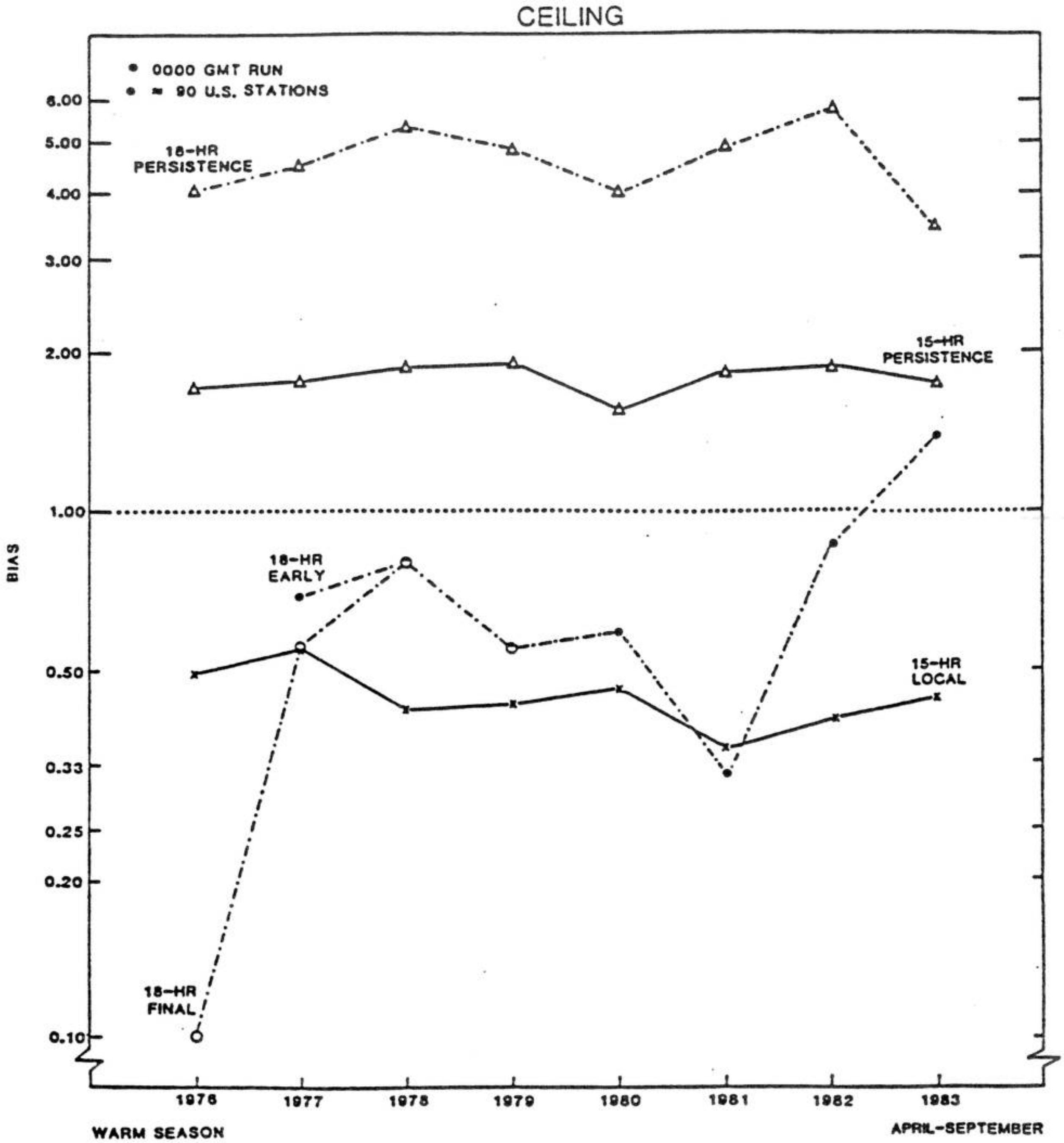

Figure 5.6. Same as Fig. 5.5 except for forecast projection.

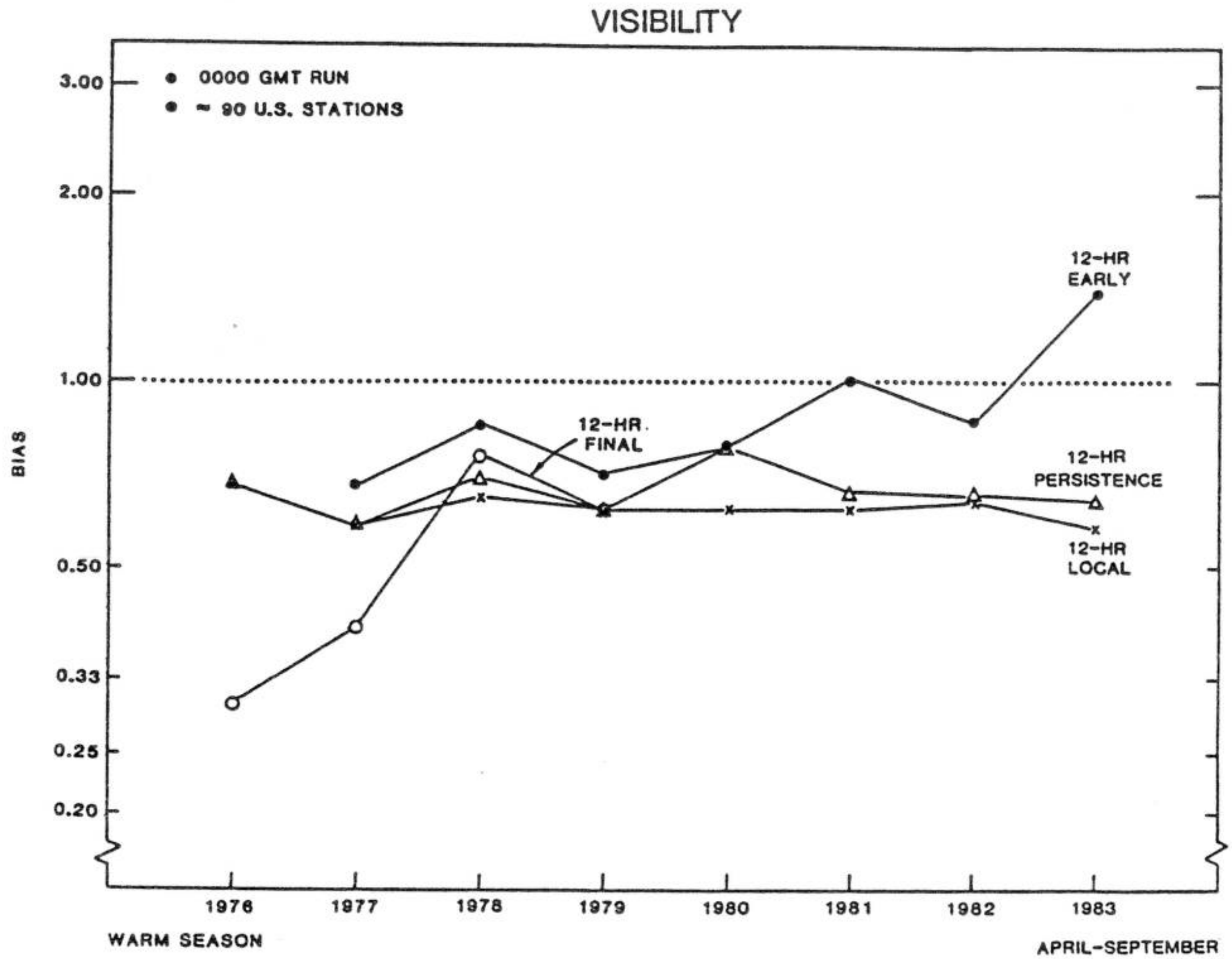

Figure 5.7. Same as Fig. 5.5 except for visibility.

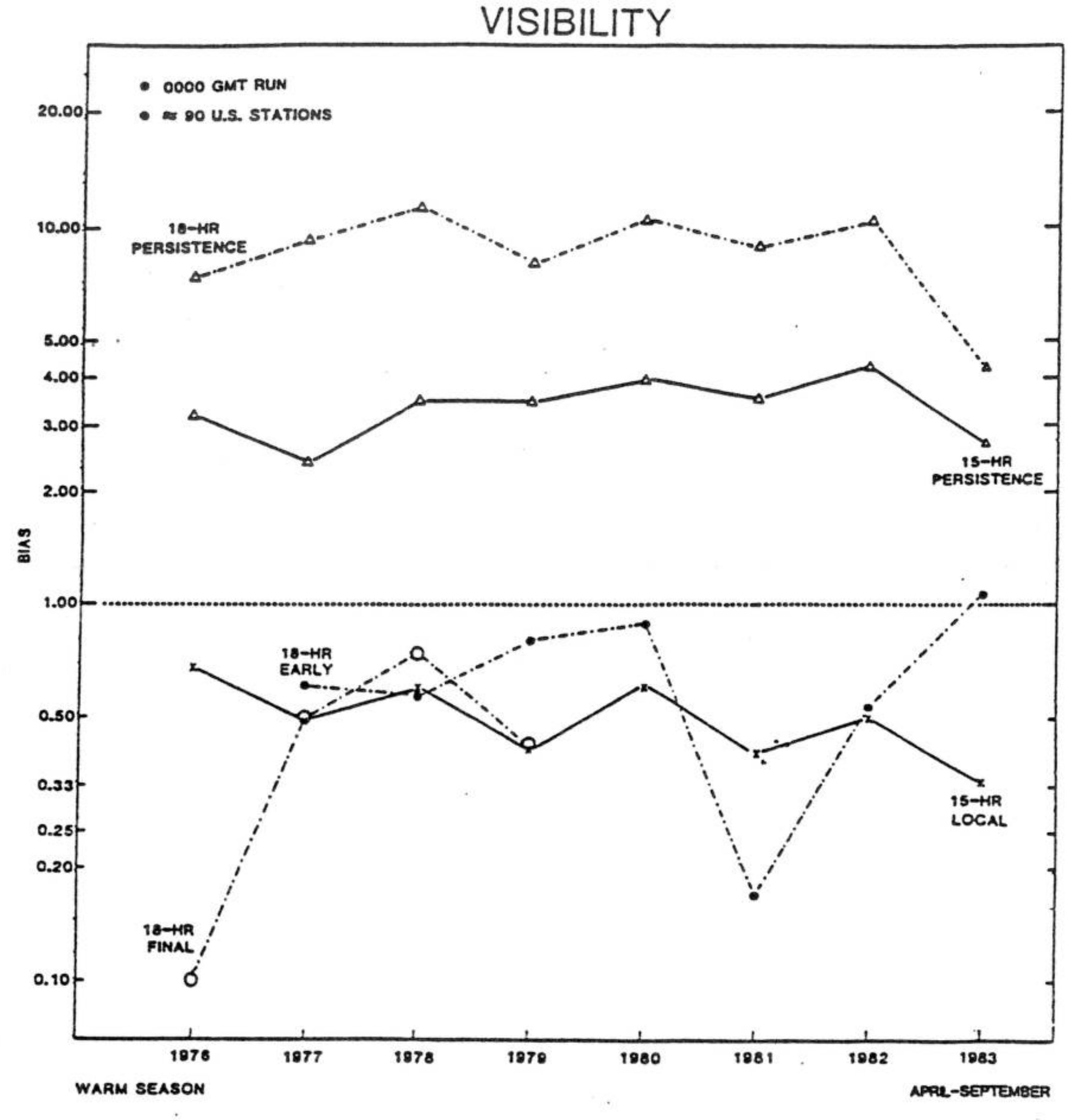

Figure 5.8. Same as Fig. 5.5 except for visibility and forecast projection.

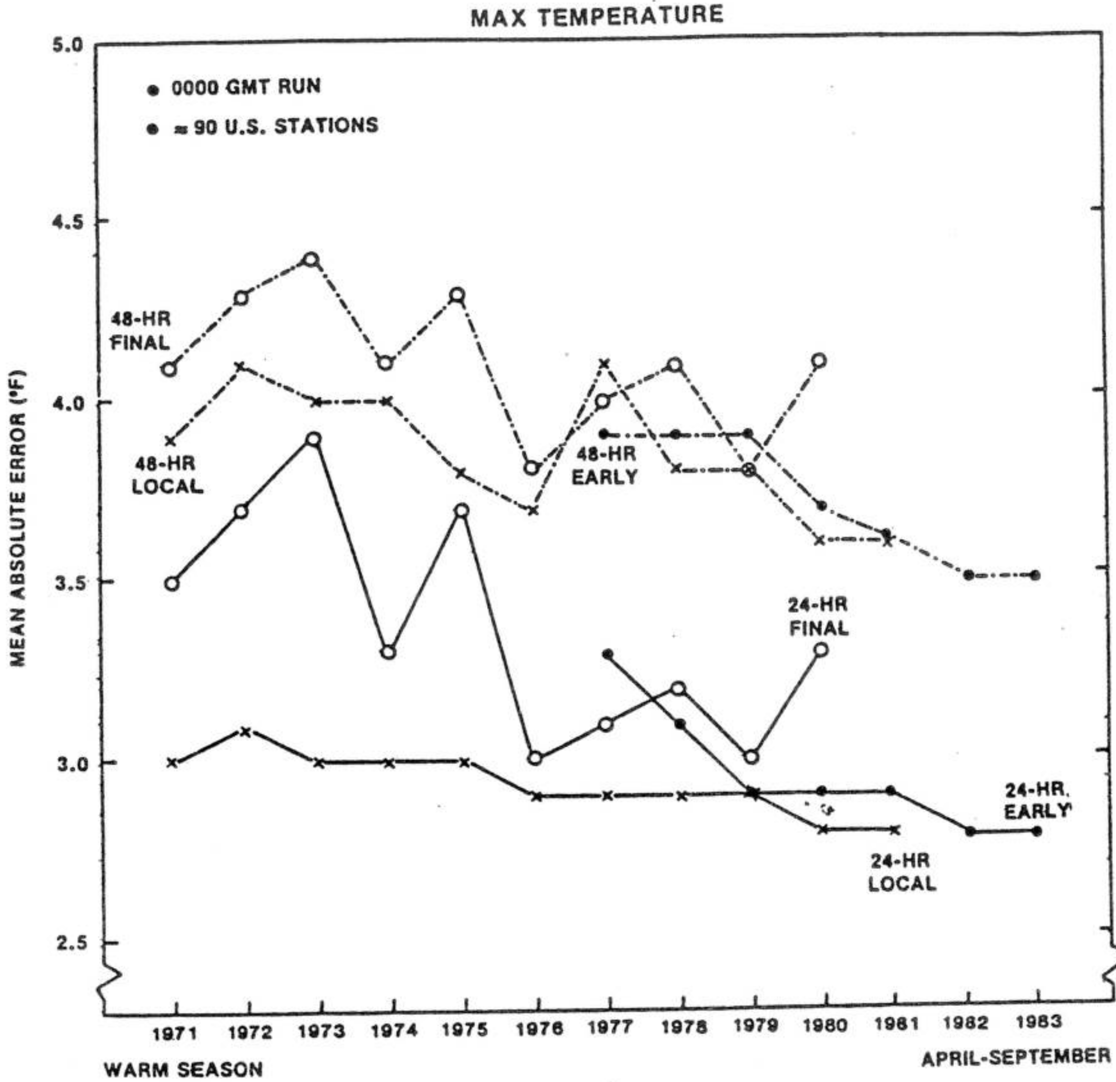

Figure 6.1. Mean absolute error for the local and the early and final guidance max temperature forecasts.

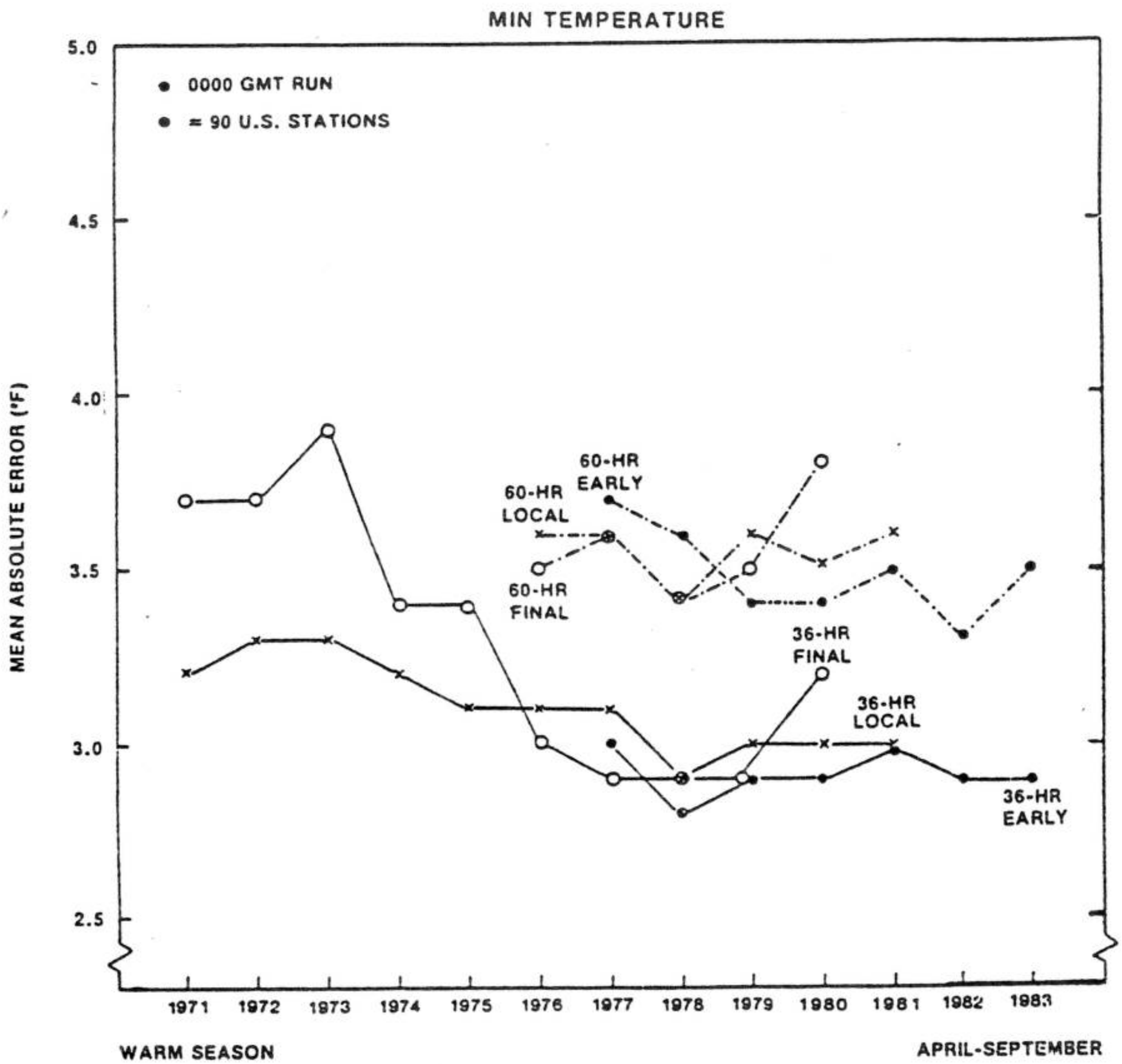

Figure 6.2. Same as Fig. 6.1 except for the min temperature.