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COMPARATIVE VERIFICATION OF GUIDANCE AND LOCAL AVIATION/PUBLIC WEATHER FORECASTS--No. 12
(April 1981-September 1981)

Gary M. Carter, Joseph R. Bocchieri, J. Paul Dallavalle,
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1. INTRODUCTION

This is the twelfth 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 1981 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 GMT and 1200 GMT.

The objective guidance is based on equations developed through application of the Model Output Statistics (MOS) technique (Glahn and Lowry, 1972). We derived these prediction equations by using archived surface observations and forecast fields from the Limited-area Fine Mesh (LFM) model (Gerrity, 1977), 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 produced from PE data. Also, the observation times of surface weather elements used as predictors in the early and final guidance generally differ. The final guidance is no longer disseminated operationally due to the superiority of the early guidance, but comparative results for earlier years are included on the figures presented in this report. In operations, forecast fields from the LFM-II model (Newell and Deaven, 1981) are employed in the MOS guidance equations when LFM data are required.

The local forecasts from the WSFO's were collected by the Technical Procedures Branch of the Office of Meteorology and Oceanography for the purposes of the NWS combined aviation/public weather verification system (National Weather Service, 1973). The aviation forecasts were recorded for verification according to the direction that they be "... not inconsistent with ..." the official weather prognosis. The public weather max/min and PoP forecasts used for verification were official forecasts taken from the Coded City Forecast (FPUS4) bulletin. Surface observations as late as 2 hours before the first valid forecast time may have been used in the preparation of the local forecasts. We obtained all observed verification data from the National Climatic Center in Asheville, North Carolina.

2. PROBABILITY OF PRECIPITATION

Objective PoP forecasts were produced by the new set of warm season prediction equations described in Technical Procedures Bulletin No. 299

(National Weather Service, 1981a). Early guidance was available for the first, second, and third periods, which correspond to 12-24 hours, 24-36 hours, and 36-48 hours, respectively, after 0000 GMT or 1200 GMT. Final PoP guidance was terminated in December 1980 and will not be discussed for this warm season. The majority of the predictor variables were forecast fields from the LFM-II model; surface variables observed at the forecast site at 0300 GMT or 1500 GMT were included as predictors for the first period.

The PoP forecasts were verified by computing Brier scores (Brier, 1950) for the 89 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 determined from a 15-year sample (Jorgensen, 1967).

Tables 2.2 and 2.7 present the 1981 warm season results for all 89 stations for the 0000 GMT and 1200 GMT cycle forecasts, respectively. This is the first warm season for which we have verified 1200 GMT cycle PoP forecasts. 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 GMT and 1200 GMT cycles, respectively. In comparison to the 1980 warm season (Maglaras et al., 1981), the Brier scores for the 0000 GMT cycle early guidance and local forecasts deteriorated for each region and for all stations combined. Most likely, this is related to the exceptionally dry summer during 1980 that occurred throughout most of the United States. (In terms of improvement over climate, the 1981 scores are better than the 1980 scores, as noted later in this report.)

Comparison of the Brier scores and percent improvement over climate in Table 2.2 indicates, overall, the 0000 GMT cycle local forecasts were superior to the guidance for the first and second periods and were about the same as the guidance for the third period. This result generally applies on the regional level (Tables 2.3-2.6), except for the third period, where the local forecasts were worse than the guidance for the Eastern, Southern, and Central Regions and better than the guidance in the Western Region.

As shown in Table 2.7, overall, the 1200 GMT cycle local forecasts were better (worse) than the early guidance for the first and second periods (third period). This result also was true for the regional breakdown except the local forecasts were worse than the guidance for both the second and third periods for the Eastern and Central Regions. For the Western Region, the local forecasts were better than the guidance for all three periods.

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 forecasts. Both the early guidance and the local forecasts for the first and third periods increased in skill from the 1980 to the 1981 warm season. Also, the 1981 guidance and local forecast scores were much better than those for any warm season between 1971 and 1975 although, for the first period, the local forecasts were only slightly better than the local forecasts in 1972 and

1973. Please note that the results for the 1974 and 1976 seasons are unavailable because of missing data, and results for 1973 are based on a much larger sample of 190 stations.

3. SURFACE WIND

The objective surface wind forecasts were generated by the LFM-based equations valid for the warm season described in Technical Procedures Bulletin No. 288 (National Weather Service, 1980b). Only the early, LFM-based guidance has been available since the 1978 warm season. In addition to LFM model forecasts, predictors in the equations included the sine and cosine of the day of the year and of twice the day of the year; also, surface weather observations were used as predictors for the 6- and 12-h projections. During the 1981 warm season, a significant change occurred in the operational early guidance wind prediction system. New equations were developed without screening as predictors any surface pressure or boundary layer fields from the LFM model. These new equations were implemented on May 28, 1981. Thereafter, the guidance forecasts were produced by these new sets of equations. 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. The objective surface wind forecast is defined in the same way as the observed wind, namely, the 1-minute 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. Secondly, 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 95 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 95 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 forecast projections. Overall, the speed MAE's, skill scores, and percent correct also were better for the guidance. 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) at both the 18- and 42-h projections. The local forecasts for all three

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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.

projections, as well as the guidance at the 30-h projection, underestimated these winds. This is the first warm season where the guidance has not underforecast the stronger winds; we think this is due to the implementation of the new equations. Overall, the results were quite similar to those for the 1980 warm season except for a slight deterioration of the bias by category values for the 42-h projection.

Tables 3.4-3.7 show scores for the NWS Eastern, Southern, Central, and Western Regions, respectively. The regional comparisons generally have the same characteristics as for the entire group of stations, except the advantage of the guidance over the local forecasts varies from region to region. However, for the Southern Region (Table 3.5), the MAE's for the local 30- and 42-h wind speed forecasts are slightly better than those for the guidance.

Table 3.8 shows the distribution of wind direction absolute errors by categories--0-30°, 40-60°, 70-90°, 100-120°, 130-150°, and 160-180°--for all 95 stations combined. Note that the guidance had about 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 from region to region.

A comparison of the overall MAE's and skill scores during the past eight warm seasons for the 18- and 42-h guidance and local forecasts is presented in Figs. 3.1-3.3. The verification data throughout this period were relatively homogeneous; the number of stations varied only slightly from season to season and the basic set of verification stations were the same. In general, the MAE's and skill scores in these figures denote the consistent superiority of the early guidance over the final guidance.

The MAE's for direction are given in Fig. 3.1. For the most part, the guidance and local forecasts for both projections generally improved over the span of these eight seasons. 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. Note the consistent superiority of the early guidance forecasts over the local forecasts for the 18-h projection.

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 particular note is the continued superiority of the guidance over the locals for both projections. Also, the 42-h guidance skill score has continued to improve to the level that it is now equal to that of the 18-h local forecasts.

4. OPAQUE SKY COVER

During the 1981 warm season, the opaque sky cover forecasts for April and May were produced by the warm season prediction equations described in Technical Procedures Bulletin No. 234 (National Weather Service, 1978). Forecasts for June through September were produced by the new set of warm season prediction equations described in Technical Procedures Bulletin No. 303 (National Weather Service, 1981b). These equations used LFM-II model output and 0300 (1500) GMT surface observations to produce forecasts for eight projections (10 for the new equations) at 6-h intervals from 6 to 48 hours (6 to 60 hours) after 0000 GMT 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 a single "best category" forecast in a manner which produced good bias characteristics, that is, a bias value of approximately 1.0 for each category. The old equations used an inflation technique to obtain the best category, while the new equations used the threshold technique. See Technical Procedures Bulletin No. 303 for more details.

We compared the local forecasts with a matched sample of early guidance forecasts for the 95 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, forecast-observed contingency tables were prepared from the categorical local and the best-category objective 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 the 30- and 42-h projections, the guidance forecasts were superior to the local forecasts in terms of percent correct and skill score. Although the guidance was also better than the locals at 18 hours, the differences were not as great. Examination of the bias by category scores shows that, except for one case, the guidance forecasts were better (i.e., closer to 1.0) than the local forecasts for each projection and category. The exception was the 42-h forecasts of the broken category. The local forecasts exhibited a tendency to underforecast the clear and overcast categories and overforecast the scattered and broken categories.

The verification scores for 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 were, for the most part, superior to those of the local forecasts. However, in the Western Region, the 18-h local forecasts were better than the guidance in regard to skill score. In the regional breakdown, the bias by category values for the guidance forecasts generally were better than those for the local forecasts.

Percent correct and skill scores for the past seven warm seasons are shown in Figs. 4.1 and 4.2, respectively, for the 18- and 42-h projections. These figures show that both the 1981 guidance and the local forecasts improved substantially over last year which was a poor year for the cloud amount forecasts; however, in most cases the percent correct and skill score did not surpass the high levels reached during the 1979 warm season. These figures also show the guidance scores remained superior to the locals, as they have since the early guidance was introduced.

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 figures also indicate the locals have a tendency to underforecast the clear and overcast categories, and overforecast the scattered and (to a much lesser extent) the broken categories. The biases for the guidance forecasts have, for all but the broken category, been consistently superior to the local forecasts. For the broken category, both the guidance and local forecasts have had good bias characteristics.

5. CEILING AND VISIBILITY

During most of the 1981 warm season, the ceiling and visibility guidance was produced by the new set of warm season prediction equations described in Technical Procedures Bulletin No. 303 (National Weather Service, 1981b). As with opaque sky cover, forecasts during April and May were produced by the old equations described in Technical Procedures Bulletin No. 234 (National Weather Service, 1978). Only the early guidance was available since the final guidance was discontinued after the 1979 warm season. Operationally, the guidance was based primarily on LFM-II output and 0300 (1500) GMT surface observations. Forecasts were produced for 6-h intervals from 6 to 60 hours after 0000 (1200) GMT.

Verification scores were computed for both local and guidance forecasts for the 95 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 (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 and local forecasts for the 12-, 15-, and 21-h projections. The objective forecasts and the persistence observation usually were available daily to the local forecaster.

We constructed six-category forecast-observed contingency tables for the 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

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[3]In past verification reports, bias graphs were plotted on a linear scale. Beginning with this report, 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 occurs should appear as bad as forecasting that event only one-fourth as many times as it occurs. Therefore, bias values have been plotted on a semi-log scale so biases of X and 1/X will be equally distant from the optimal value of 1.0.

categories 3 through 6 combined) and calculated bias and threat score[4] for categories 1 and 2 combined as well as skill score and percent correct. We have summarized the results in Tables 5.2-5.9. The skill score and bias for categories 1 and 2 combined for the past six warm seasons are also shown in Figs. 5.1-5.8 for selected projections from 0000 GMT.

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 the 12-h projection from 1200 GMT, the scores in Table 5.4 show the skill of the local ceiling forecasts was slightly better than that of persistence. For both forecast cycles and weather elements, the 12-h guidance forecasts had lower skill scores than those for the locals and persistence. With the exception of the 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 for both forecast cycles. At the 18-, 24-, 36-, and 48-h projections, the guidance usually outperformed persistence by a wide margin in skill; in fact, only the persistence forecasts of visibility for the 18-h projection from 1200 GMT (Table 5.5) were more skillful than the guidance. Also, for projections of more than 12 hours the guidance bias by category characteristics were generally better (i.e., closer to 1.0) than those for the persistence forecasts. For the 12-h projection (actually a 3-h projection for both the local and persistence forecasts), the bias by category values for the guidance (actually a 9-h forecast from the latest surface observation) were slightly better than those of persistence and the local forecasts. The persistence of weather conditions, especially during the warm season, should be reflected in the bias characteristics of persistence forecasts at 24-h intervals. Tables 5.2-5.5 show this to be true; that is, the persistence forecast bias values for the 12- and 36-h projections, and for the 24- and 48-h projections, are nearly the same. Also of note is the rarity (generally less than 20 cases in a sample of more than 10,000) 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 0.002 to 0.034. 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 local forecasts had the highest skill scores. 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 much higher than that of persistence in all cases. The

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[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.

skill of the guidance forecasts for 18-, 24-, 36-, and 48-h projections varied a great deal from projection to projection.

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 (see footnote 3 for more details about the new format of Figs. 5.5-5.8). The results indicate the guidance bias characteristics improved substantially after the threshold technique for category selection was introduced in 1977. Further improvement is noted for the 12-h projection guidance this year as a result of the new forecast equations; however, the bias for the 18-h projection worsened. 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, the guidance skill scores for the 12-h projection have remained about the same during the past four warm seasons, but the scores for local and persistence forecasts dropped during 1981. For the 18-h projection, the skill of the guidance has been more variable.

6. MAXIMUM/MINIMUM TEMPERATURE

The objective max/min temperature guidance for April through September 1981 was generated by LFM-based regression equations. The predictand was the local calendar day max or min valid approximately 24, 36, 48, and 60 hours after the model input data times of 0000 GMT and 1200 GMT. The guidance was based on equations developed by stratifying archived LFM and LFM-II model output, station observations, and the first two harmonics of the day of the year into seasons of 3-month duration (Dallavalle et al., 1980; National Weather Service, 1980a). We used spring (March-May), summer (June-August), and fall (September-November) equations to produce the guidance for the 1981 warm season. Station observations taken 3 hours after the initial model time were also used as predictors in much of the guidance for the first two periods.

As mentioned before, the automated max/min forecasts are valid for the local calendar day; for example, the first period objective forecast of the max based on 0000 GMT model data is valid for the calendar day starting at the subsequent midnight. In contrast, the valid period of the local max/min forecast does not correspond to a calendar day since the local forecaster usually predicts a max or min for a 12-h period of approximately 1200 to 0000 GMT or 0000 to 1200 GMT, respectively. This latter time, however, is extended to around 1800 GMT for forecasters in the Western Region and for others in the western parts of the Central and Southern Regions.

In routine comparative verifications between the MOS max/min temperature guidance and the forecasts produced by local NWS offices, we've been using calendar day reports as the verifying observations. This procedure has generated controversy because, as we mentioned before, the local forecasters predict max/min temperatures for 12- or 18-h periods while the MOS guidance is valid for calendar day periods. To investigate how the type of verifying observation influences the results, we recomputed the verification scores for the 0000 GMT cycle 24- and 48-h max and the 36- and 60-h min forecasts made during October 1980-March 1981. This time, on a matched sample for 85 stations, we used calendar day observations for one set of verification statistics and 12-h synoptic max/min reports for a second set of verifications. For the 36-h min and 48-h max projections, the number of absolute errors ≥10°F and the mean absolute errors (MAE's) for the local forecasts improved slightly when the 12-h verifying observations were used. The greatest improvement occurred in the NWS Eastern Region; little or no change took place in the Southern, Central, and Western Regions. In contrast, the MAE's for the 36-h MOS guidance increased by 0.4°F when 12-h verifying observations were used. For the 24-h max and 60-h min projections, the errors of the local forecasts remained virtually the same, irrespective of the verifying observation; the accuracy of the MOS guidance again deteriorated when verified against 12-h observations. In all cases, it was apparent that the guidance scores were impacted far more by the type of verifying observation (12-h or calendar day) than those for the locals. Details of this study have been distributed as an addendum to TDL Office Note 81-10 (Schwartz et al., 1981) which contains the original comparative verification results for October 1980-March 1981.

For the warm season of 1981, we verified both the 0000 GMT and 1200 GMT cycle local and objective forecasts by using calendar day max and min temperatures from the National Climatic Center. Mean algebraic error (forecast minus observed temperature), mean absolute error, and the number of absolute errors ≥10°F were computed for 88 stations (Table 2.1) in the conterminous United States. Four forecast projections of approximately 24 (max), 36 (min), 48 (max), and 60 (min) hours after 0000 GMT were verified; for the 1200 GMT cycle, forecasts of approximtely 24 (min), 36 (max), 48 (min), and 60 (max) hours were verified. This is the first warm season for which we have verified the 1200 GMT cycle guidance.

The results for all stations combined for 0000 GMT are shown in Table 6.1. In terms of MAE, the local forecasts were 0.1°F more accurate than the guidance for the 24-h max; this difference was reversed for the 60-h min. For the 36-h min and 48-h max, the MAE's of the local forecasts and the objective guidance were about the same. For all projections, the guidance had fewer large errors than did the local forecasters. From past experience, however, we think this difference is related to the different forecast periods used in the subjective and objective forecasts.

Tables 6.2-6.5 give the 0000 GMT verification scores for the Eastern, Southern, Central, and Western Regions, respectively. In terms of MAE, the local forecasters in the Southern and Western Regions improved slightly upon the guidance for both the 24- and 48-h max forecasts.

Table 6.6 shows verification results for all stations combined for the 1200 GMT cycle. As before, the guidance had fewer large errors for all projections than the corresponding local forecasts. The regional verification scores shown in Tables 6.7-6.10 generally follow the trends for all stations combined although forecasters in the Southern and Western Regions improved over the guidance for several projections. Note, too, from Tables 6.1-6.10 that the MAE's for similar projections (24-h max/min, 36-h max/min, and so forth) are generally larger for the max forecast than for the min.

Max temperature forecast MAE's (0000 GMT cycle only) for the last 11 warm seasons are shown in Fig. 6.1. The final guidance, which was based on output from the coarse-mesh Primitive Equation (Shuman and Hovermale, 1968) or

Spectral (Sela, 1980) models was ended in December 1980 because of poor performance compared to the LFM-based early guidance. The error curves in Fig. 6.1 are irregular because of natural variability in the max and because of the difficulty of predicting max temperatures during the warm season. The curves indicate there has been improvement in the quality of the local and guidance forecasts during the 11-year period with the smallest errors being recorded in 1980 and 1981. The accuracy of the objective forecasts increased in 1974 when MOS equations were introduced (Klein and Hammons, 1975) and again in 1976 when 3-month equations were first used (Hammons et al., 1976). The 24-h early guidance was enhanced in 1978 with the introduction of LFM-based equations (Carter et al., 1979). In 1980, the 48-h MOS forecasts improved with the application of the new, 3-month equations. The errors in the guidance during 1980 and 1981 were the smallest observed during this period of record.

An analogous time series is shown in Fig. 6.2 for the min forecasts. Verifications for the 60-h projection are available for only the last six seasons. For the 36-h projection, there has been an overall improvement in both the objective and local forecasts since 1971. Similar to the max temperature guidance, the greatest improvements in accuracy for the 36-h min forecasts were in 1974 and 1976. The 36- and 60-h guidance and the 60-h local forecasts deteriorated by 0.1^{o}F MAE from 1980 to 1981. As data become available, similar curves will be plotted for the 1200 GMT cycle results.

7. SUMMARY

Highlights of the 1981 warm season verification results, summarized by general type of weather element, are:

o Probability of Precipitation - The comparative verification involved 89 stations and forecast projections of 12-24, 24-36, and 36-48 hours from both 0000 GMT and 1200 GMT. The Brier scores for all stations combined show the local forecasts for the first and second periods were better than the corresponding LFM-based guidance. For the third period, the scores for the 0000 GMT cycle local forecasts were about the same as those for the guidance, while for the 1200 GMT cycle they were less accurate than the guidance. As compared with results for the 1980 warm season, the skill (in terms of improvement over climate) improved slightly for both the guidance and local forecasts.

o Surface Wind - The comparative verifications were conducted for 95 stations and projections of 18, 30, and 42 hours from 0000 GMT. The overall results indicate the LFM-based surface wind guidance was consistently more accurate than the corresponding local forecasts. In general, the results for the 1981 warm season were quite similar to those for 1980 except the guidance is no longer underforecasting wind speeds greater than 22 knots.

o Opaque Sky Cover - The 0000 GMT cycle verification results for all 95 stations combined indicate the LFM-based guidance was slightly better than the local forecasts in terms of percent correct, skill score, and bias by category (clear, scattered, broken, and overcast) for the 18-h projection, and was much better for the 30- and 42-h projections except for the 42-h forecast broken category bias values. The percent correct, skill score, and bias by category for guidance and local forecasts for all three projections improved or remained about the same when compared with scores for the 1980 warm season; in May 1981, new sets of MOS prediction equations for this weather element had been implemented. The long-term trends for percent correct and skill score reveal noticeable increases in accuracy for the guidance forecasts.

o Ceiling and Visibility - The verification involved comparison of local forecasts, LFM-based guidance, and persistence for 95 stations and for projections ranging from 12 to 48 hours from both 0000 GMT 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 the local and persistence forecasts were superior to the guidance. For the longer-range projections, the local and guidance forecasts were much better than persistence. In comparison to the scores for the 1980 warm season, the guidance forecasts performed about as well, while persistence and the locals declined. Of further note were the poor skill scores and biases associated with the 0000 GMT cycle 18-h guidance forecasts for the lowest two categories of ceiling and visibility. For the skill scores this continues a downward trend, despite the implementation of new forecast equations during May 1981.

o Maximum/Minimum Temperature - Local and objective max/min temperature forecasts were verified for 88 stations. The objective guidance is valid for calendar day periods, while the valid period for the local max/min forecasts does not correspond to a calendar day. All forecasts in this study, however, were verified against calendar day max/min reports. We verified forecasts for four periods of approximately 24, 36, 48, and 60 hours from both 0000 GMT and 1200 GMT. For the 0000 GMT cycle guidance, the max forecasts were equal in accuracy to those for the 1980 warm season. The accuracy of the min forecasts deteriorated by 0.1°F mean absolute error from 1980 to 1981. In comparing the local and objective max forecasts for 1981, we note that the local forecasts were better by about 0.1°F mean absolute error than the guidance for the 24-h and 36-h projections from 0000 GMT and 1200 GMT, respectively. For the other projections and for the min, the guidance and local forecasts were about the same in terms of mean absolute error.

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Table 2.1. Eighty-nine stations used for comparative verification of guidance and local PoP and max/min temperature forecasts. Note, because of data problems the max/min forecasts for Los Angeles, California (LAX) were not verified.

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

Table 2.2 Comparative verification of early guidance and local PoP forecasts for 89 stations, 0000 GMT cycle.

Projection (h)	Type of Forecast	Brier Score	Improvement Over Guidance (%)	Improvement Over Climate (%)	Number of Cases
12-24	Early	.1094		27.7	
(1st period)	Local	.1054	3.8	30.6	12872
24-36	Early	.1239		21.0	
(2nd period)	Local	.1225	1.2	22.0	12788
36-48	Early	.1281		16.2	
(3rd period)	Local	.1285	0.0	16.2	12790

Table 2.3. Same as Table 2.2 except for 26 stations in the Eastern Region.

Projection (h)	Type of Forecast	Brier Score	Improvement Over Guidance (%)	Improvement Over Climate (%)	Number of Cases
12-24	Early	.1163		33.5	
(1st period)	Local	.1139	2.0	34.8	3700
24-36	Early	.1307		27.0	
(2nd period)	Local	.1280	2.0	28.5	3675
36-48	Early	.1396		22.9	
(3rd period)	Local	.1419	-1.6	21.6	3674

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	Early	.1177		19.8	
(1st period)	Local	.1120	4.8	23.7	3562
24-36	Early	.1170		18.1	
(2nd period)	Local	.1171	-0.1	18.1	3539
36-48	Early	.1263		12.2	
(3rd period)	Local	.1272	-0.7	11.6	3540

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 (1st period)	Early	.1112		33.0	
	Local	.1078	3.1	35.0	3537
24-36 (2nd period)	Early	.1415		22.3	
	Local	.1412	0.2	22.5	3515
36-48 (3rd period)	Early	.1392		16.2	
	Local	.1403	-1.0	15.5	3517

Table 2.6. Same as Table 2.2 except for 16 stations in the Western Region.

Projection (h)	Type of Forecast	Brier Score	Improvement Over Guidance (%)	Improvement Over Climate (%)	Number of Cases
12-24 (1st period)	Early	.0798		22.1	
	Local	.0745	6.6	27.2	2073
24-36 (2nd period)	Early	.0936		13.2	
	Local	.0902	3.6	16.3	2059
36-48 (3rd period)	Early	.0917		11.0	
	Local	.0868	5.3	15.7	2059

Table 2.7. Comparative verification of early guidance and local PoP forecasts for 89 stations, 1200 GMT cycle.

Projection (h)	Type of Forecast	Brier Score	Improvement Over Guidance (%)	Improvement Over Climate (%)	Number of Cases
12-24	Early	.1144		26.4	
(1st period)	Local	.1104	3.6	29.0	13246
24-36	Early	.1187		21.7	
(2nd period)	Local	.1180	0.8	22.5	13248
36-48	Early	.1294		16.6	
(3rd period)	Local	.1324	-2.1	15.0	13245

Table 2.8. Same as Table 2.7 except for 26 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	.1159		34.0	
	Local	.1122	3.2	36.1	3846
24-36 (2nd period)	Early	.1302		26.5	
	Local	.1310	-0.6	26.1	3847
36-48 (3rd period)	Early	.1356		22.2	
	Local	.1386	-2.2	20.5	3845

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	.1120		20.6	
	Local	.1102	1.7	21.9	3702
24-36 (2nd period)	Early	.1194		17.3	
	Local	.1165	2.4	19.3	3702
36-48 (3rd period)	Early	.1209		13.6	
	Local	.1226	-1.4	12.4	3703

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 (1st period)	Early Local	.1344 .1283	4.5	26.7 30.0	3584
24-36 (2nd period)	Early Local	.1249 .1268	-1.5	25.5 24.3	3585
36-48 (3rd period)	Early Local	.1516 .1581	-4.3	17.5 13.9	3583

Table 2.11. Same as Table 2.7 except for 16 stations in the Western Region.

Projection (h)	Type of Forecast	Brier Score	Improvement Over Guidance (%)	Improvement Over Climate (%)	Number of Cases
12-24 (1st period)	Early Local	.0818 .0770	5.9	22.3 26.9	2114
24-36 (2nd period)	Early Local	.0857 .0819	4.5	14.3 18.1	2114
36-48 (3rd period)	Early Local	.0953 .0945	0.9	10.3 11.1	2114

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

DCA	Washington, D.C.
PWM	Portland, Maine
BOS	Boston, Massachusetts
CON	Concord, New Hampshire
EWR	Newark, New Jersey
ALB	Albany, New York
BUF	Buffalo, New York
JFK	New York (Kennedy), New York
SYR	Syracuse, New York
CLT	Charlotte, North Carolina
RDU	Raleigh-Durham, North Carolina
CLE	Cleveland, Ohio
CMH	Columbus, Ohio
ABE	Allentown, Pennsylvania
ERI	Erie, Pennsylvania
PHL	Philadelphia, Pennsylvania
PIT	Pittsburgh, Pennsylvania
PVD	Providence, Rhode Island
CHS	Charleston, South Carolina
CAE	Columbia, South Carolina
GSP	Greenville, South Carolina
BTV	Burlington, Vermont
ORF	Norfolk, Virginia
CRW	Charleston, West Virginia
HTS	Huntington, West Virginia
BHM	Birmingham, Alabama
MOB	Mobile, Alabama
FSM	Fort Smith, Arkansas
LIT	Little Rock, Arkansas
JAX	Jacksonville, Florida
MIA	Miami, 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
TYS	Knoxville, Tennessee
ABI	Abilene, Texas
DFW	Dallas-Ft. Worth, Texas
ELP	El Paso, Texas
IAH	Houston, Texas
LBB	Lubbock, Texas
SAT	San Antonio, Texas
DEN	Denver, Colorado
GJT	Grand Junction, Colorado
ORD	Chicago (O`Hare), Illinois
SPI	Springfield, Illinois
IND	Indianapolis, Indiana
SBN	South Bend, Indiana
BRL	Burlington, Iowa
DSM	Des Moines, Iowa
DDC	Dodge City, Kansas
TOP	Topeka, Kansas
LEX	Lexington, Kentucky
SDF	Louisville, Kentucky
APN	Alpena, Michigan
DTW	Detroit, Michigan
INL	International Falls, Minnestota
MSP	Minneapolis, Minnesota
MCI	Kansas City, Missouri
STL	St. Louis, Missouri
LBF	North Platte, Nebraska
BFF	Scottsbluff, 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
MSN	Madison, Wisconsin
CYS	Cheyenne, Wyoming
SHR	Sheridan, Wyoming
PHX	Phoenix, Arizona
FAT	Fresno, California
LAX	Los Angeles, California
SAN	San Diego, California
SFO	San Francisco, California
BOI	Boise, Idaho
PIH	Pocatello, Idaho
GTF	Great Falls, Montana
MSO	Missoula, Montana
LAS	Las Vegas, Nevada
RNO	Reno, Nevada
PDT	Pendleton, Oregon
PDX	Portland, Oregon
CDC	Cedar City, Utah
SLC	Salt Lake City, Utah
GEG	Spokane, Washington
SEA	Seattle-Tacoma, Washington

Table 3.2. Comparative verification of early guidance and local surface wind forecasts for 95 stations, 0000 GMT cycle.

Fcst. Proj. (h)	Type of Fcst.	Direction		Speed													
								Contingency Table									
										Bias by Category							
		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	8270	3.0	12.2	11.4	8305	.312	54.7	1.05	0.98	0.89	1.19	1.20	1.17	0.00	16124
	Local	33		3.2	12.5			.252	50.7	0.80 (6304)	1.19 (6428)	1.02 (2680)	1.00 (593)	0.62 (103)	1.17 (12)	0.25 (4)	
30	Early	30	3924	3.6	11.3	9.5	4013	.326	67.5	0.99	1.01	1.21	0.64	0.58	0.11	0.00	16083
	Local	34		3.8	11.5			.268	62.9	0.90 (10869)	1.26 (4026)	1.18 (920)	0.59 (234)	0.29 (24)	0.44 (9)	0.00 (1)	
42	Early	38	8159	3.5	12.4	11.0	8207	.252	50.6	1.03	0.97	0.91	1.36	1.56	1.67	1.25	16105
	Local	42		3.5	12.2			.191	47.4	0.81 (6308)	1.24 (6440)	0.95 (2669)	0.73 (573)	0.47 (99)	0.67 (12)	0.00 (4)	

Table 3.3. Contingency tables for early guidance and local surface wind speed forecasts for 95 stations, 0000 GMT cycle.

18-h Forecasts

Guidance

		1	2	3	4	5	6	7	T
	1	4261	1800	216	26	1	0	0	6304
	2	2146	3281	872	117	11	1	0	6428
	3	218	1105	1038	279	38	2	0	2680
OBS	4	9	83	222	225	49	5	0	593
	5	0	3	24	50	20	6	0	103
	6	0	1	2	6	3	0	0	12
	7	0	2	0	0	2	0	0	4
	T	6634	6275	2374	703	124	14	0	16124

Local

		1	2	3	4	5	6	7	T
	1	3222	2730	326	25	1	0	0	6304
	2	1582	3686	1044	110	6	0	0	6428
	3	213	1142	1072	230	19	4	0	2680
OBS	4	17	106	258	185	20	6	1	593
	5	1	7	40	40	13	2	0	103
	6	0	1	1	5	3	2	0	12
	7	0	2	0	0	2	0	0	4
	T	5035	7674	2741	595	64	14	11	16124

30-h Forecasts

Guidance

		1	2	3	4	5	6	7	T
	1	8791	1814	247	17	0	0	0	10869
	2	1761	1749	476	35	4	1	0	4026
	3	153	430	283	51	3	0	0	920
OBS	4	32	59	99	39	5	0	0	234
	5	3	11	6	3	1	0	0	24
	6	0	3	2	3	1	0	0	9
	7	0	0	0	1	0	0	0	1
	T	10740	4066	1113	149	14	1	0	16083

Local

		1	2	3	4	5	6	7	T
	1	7920	2629	298	19	3	0	0	10869
	2	1635	1914	427	50	0	0	0	4026
	3	165	449	262	40	3	1	0	920
OBS	4	41	79	86	24	1	3	0	234
	5	3	9	9	3	0	0	0	24
	6	0	4	3	2	0	0	0	9
	7	0	0	1	0	0	0	0	1
	T	9764	5084	1086	138	7	4	0	16083

42-h Forecasts

Guidance

		1	2	3	4	5	6	7	T
	1	3940	1962	343	56	6	1	0	6308
	2	2151	3095	957	210	24	3	0	6440
	3	357	1045	910	307	43	4	3	2669
OBS	4	24	114	199	175	53	7	1	573
	5	3	11	26	30	24	5	0	99
	6	0	4	2	3	3	0	0	12
	7	0	2	0	0	1	0	1	4
	T	6475	6233	2437	781	154	20	5	16105

Local

		1	2	3	4	5	6	7	T
	1	3035	2858	391	21	3	0	0	6308
	2	1732	3611	985	99	13	0	0	6440
	3	324	1294	871	164	12	4	0	2669
OBS	4	38	187	230	104	10	4	0	573
	5	3	18	43	28	7	0	0	99
	6	1	3	5	2	1	0	0	12
	7	0	2	0	1	1	0	0	4
	T	5133	7973	2525	419	47	8	0	16105

Table 3.4. Same as Table 3.2 except for 25 stations in the Eastern Region.

Fcst. Proj. (h)	Type of Fcst.	Direction		Speed														
								Contingency Table										
										Bias by Category								
		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	2437	2.8	12.0	11.4	2443	.309	54.3	1.09	0.99	0.82	1.32	1.13	0.33	*	4195
	Local	33		3.1	12.6			.210	48.2	0.80 (1346)	1.14 (1852)	1.00 (823)	1.14 (148)	0.57 (23)	1.67 (3)	* (0)	
30	Early	29	931	3.3	10.8	9.2	953	.349	72.5	1.01	0.99	0.98	0.75	1.33	*	*	4185
	Local	33		4.1	12.1			.283	64.7	0.83 (3030)	1.37 (922)	1.69 (198)	1.66 (32)	0.33 (3)	** (0)	* (0)	
42	Early	36	2500	3.2	12.2	11.0	2514	.247	50.0	1.02	0.99	0.87	1.53	1.89	2.00	*	4199
	Local	41		3.3	12.4			.169	46.0	0.76 (1352)	1.18 (1866)	0.97 (818)	1.04 (142)	1.11 (18)	2.00 (3)	* (0)	

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

Table 3.5. Same as Table 3.2 except for 24 stations in the Southern Region.

Fcst. Proj. (h)	Type of Fcst.	Direction		Speed													
								Contingency Table									
										Bias by Category							
		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	28	2032	2.7	11.6	10.9	2041	.329	57.6	1.13	0.91	0.84	1.30	1.00	1.00	0.00	4217
	Local	31		2.8	11.9			.241	52.2	0.72 (1744)	1.32 (1749)	0.92 (612)	0.88 (96)	0.36 (14)	1.00 (1)	1.00 (1)	
30	Early	30	889	3.4	11.4	9.7	908	.390	73.0	0.99	1.03	1.15	0.71	0.83	0.00	*	4202
	Local	30		3.3	10.9			.342	70.1	0.94 (3004)	1.28 (922)	0.80 (214)	0.25 (55)	0.50 (6)	0.00 (1)	* (0)	
42	Early	36	2081	3.2	11.8	10.5	2096	.268	53.4	1.04	0.96	0.87	1.45	2.14	5.00	2.00	4218
	Local	39		3.1	11.6			.166	47.9	0.69 (1747)	1.38 (1749)	0.89 (609)	0.54 (97)	0.29 (14)	1.00 (1)	0.00 (1)	

*This category was neither forecast nor observed.

Table 3.6. Same as Table 3.2 except for 29 stations in the Central Region.

Fcst. Proj. (h)	Type of Fcst.	Direction: Mean Abs. Error (Deg)	Direction: No. of Cases	Speed: Mean Abs. Error (Kts)	Speed: Mean Fcst. (Kts)	Speed: Mean Obs. (Kts)	Speed: No. of Cases	Contingency Table: Skill Score	Contingency Table: Percent Fcst. Correct	Bias by Category: 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	2835	3.2	12.8	11.7	2843	.274	50.1	0.99	0.99	0.96	1.22	1.32	1.83	0.00	4757
	Local	33		3.3	12.9			.238	48.1	0.74 (1599)	1.17 (1920)	1.13 (918)	1.02 (254)	0.65 (57)	1.17 (6)	0.00 (3)	
30	Early	32	1340	3.8	11.5	9.8	1373	.287	56.3	0.83	1.39	1.30	0.43	0.15	0.00	0.00	4744
	Local	36		4.0	11.6			.212	63.0	0.83 (3036)	1.39 (1267)	1.30 (319)	0.43 (103)	0.15 (13)	0.00 (5)	0.00 (1)	
42	Early	40	2740	3.7	12.9	11.4	2748	.202	45.0	1.05	0.94	0.94	1.32	1.31	1.33	1.00	4739
	Local	44		3.7	12.4			.170	44.6	0.76 (1586)	1.26 (1921)	1.00 (921)	0.71 (244)	0.34 (58)	0.17 (6)	0.00 (3)	

Table 3.7. Same as Table 3.2 except for 17 stations in the Western Region.

Fcst. Proj. (h)	Type of Fcst.	Direction		Speed													
								Contingency Table									
										Bias by Category							
		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	34	966	3.5	12.0	11.0	978	.303	58.8	1.00	1.06	0.92	0.77	1.00	0.50	*	2955
	Local	37		3.7	12.4			.273	56.5	0.95 (1615)	1.11 (907)	0.97 (327)	0.88 (95)	1.00 (9)	0.50 (2)	* (0)	
30	Early	31	764	3.6	11.5	9.4	779	.258	60.0	0.96	1.01	1.45	0.52	0.50	0.00	*	2952
	Local	35		3.8	11.2			.242	60.9	1.05 (1799)	0.96 (915)	0.88 (189)	0.61 (44)	0.50 (2)	0.33 (3)	* (0)	
42	Early	39	838	4.0	12.5	10.8	849	.262	56.3	0.99	0.99	1.01	1.11	1.56	0.50	*	2949
	Local	45		4.1	12.0			.188	53.1	1.04 (1623)	1.05 (904)	0.85 (321)	0.51 (90)	0.33 (9)	0.00 (2)	* (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 95 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	73.5	15.9	5.0	2.7	1.8	1.1
	Local	68.6	18.1	6.0	3.3	2.3	1.7
30	Early	72.5	15.4	5.4	3.0	2.1	1.6
	Local	67.6	17.6	6.8	3.7	2.5	1.8
42	Early	63.3	19.1	7.8	4.4	3.1	2.3
	Local	58.0	21.3	8.8	5.3	3.9	2.7

Table 3.9. Same as Table 3.8 except for 25 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 Local	72.8 67.0	17.8 20.0	4.6 6.9	2.8 3.0	1.0 1.9	1.0 1.2
30	Early Local	74.0 67.0	16.3 19.8	5.0 6.0	2.9 4.5	1.4 2.0	0.4 0.7
42	Early Local	64.1 57.6	20.7 22.9	7.0 9.1	3.7 5.4	2.5 3.0	2.0 2.0

Table 3.10. Same as Table 3.8 except for 24 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 Local	75.7 70.2	15.5 18.9	4.2 5.0	2.3 2.5	1.6 1.9	0.7 1.5
30	Early Local	74.4 72.6	13.2 14.8	5.0 5.4	2.9 3.0	2.8 2.6	1.7 1.6
42	Early Local	64.0 60.4	20.1 21.6	7.3 8.7	3.9 3.7	3.1 3.0	1.6 2.6

Table 3.11. Same as Table 3.8 except for 29 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	73.2	16.4	5.3	2.1	1.7	1.3
	Local	69.3	17.4	5.9	3.5	2.1	1.8
30	Early	69.5	17.5	6.5	2.8	2.1	1.6
	Local	64.3	18.8	8.2	4.2	2.3	2.2
42	Early	61.4	18.6	8.6	5.4	3.2	2.8
	Local	56.5	20.8	8.8	6.1	4.9	2.9

Table 3.12. Same as Table 3.8 except for 17 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	71.2	10.9	6.6	4.7	4.6	2.0
	Local	67.5	13.9	6.1	4.7	5.0	2.8
30	Early	73.6	13.5	4.4	3.4	2.4	2.7
	Local	68.3	16.2	6.7	2.9	3.1	2.8
42	Early	65.3	13.5	8.6	5.0	4.8	2.8
	Local	58.2	17.5	8.2	6.7	5.4	4.0

Table 4.1. Definitions of categories used for the guidance and local forecasts of cloud amount.

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 cloud amount (clear, scattered, broken, and overcast) for 95 stations, 0000 GMT cycle.

Projection (h)	Type of Forecast	Bias by Category				Percent Correct	Skill Score	Number of Cases
		1	2	3	4			
18	Early	0.86	1.25	0.87	1.00	50.9	.338	16143
	Local	0.69	1.41	1.16	0.63	49.3	.314	
	No. Obs.	4528	4653	3896	3066			
30	Early	1.03	1.26	0.67	0.94	52.9	.314	15782
	Local	0.65	2.01	1.57	0.55	43.9	.245	
	No. Obs.	7109	2850	2160	3663			
42	Early	1.09	1.14	0.77	0.94	47.2	.286	16142
	Local	0.63	1.65	1.07	0.47	41.7	.206	
	No. Obs.	4514	4675	3894	3059			

Table 4.3. Same as Table 4.2 except for 25 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	0.64	1.20	0.88	1.20	48.9	.311	4207
	Local	0.61	1.36	1.26	0.62	45.9	.267	
	No. Obs.	846	1193	1129	1039			
30	Early	0.96	1.18	0.79	1.06	53.0	.338	4197
	Local	0.63	2.17	1.60	0.60	42.6	.248	
	No. Obs.	1559	642	621	1375			
42	Early	0.79	1.14	0.84	1.18	46.2	.276	4207
	Local	0.60	1.47	1.20	0.56	39.9	.183	
	No. Obs.	841	1199	1129	1038			

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	Number of Cases
18	Early	0.84	1.30	0.77	0.99	50.9	.319	4211
	Local	0.69	1.43	1.00	0.50	51.0	.307	
	No. Obs.	991	1437	1171	612			
30	Early	0.99	1.38	0.61	0.87	51.1	.265	4204
	Local	0.67	1.95	1.39	0.49	44.2	.220	
	No. Obs.	2077	863	566	698			
42	Early	1.09	1.21	0.75	0.84	45.7	.248	4211
	Local	0.60	1.67	0.85	0.34	43.5	.189	
	No. Obs.	988	1446	1166	611			

Table 4.5. Same as Table 4.2 except for 29 stations in the Central Region.

Projection (h)	Type of Forecast	Bias by Category				Percent Correct	Skill Score	Number of Cases
		1	2	3	4			
18	Early Local No. Obs.	0.80 0.60 1262	1.27 1.46 1383	1.03 1.24 1097	0.85 0.62 1030	48.2 46.3	.303 .276	4772
30	Early Local No. Obs.	1.05 0.57 1983	1.24 2.14 829	0.72 1.81 607	0.89 0.49 1168	51.4 41.9	.300 .235	4587
42	Early Local No. Obs.	1.17 0.56 1251	1.13 1.73 1392	0.81 1.13 1099	0.82 0.41 1030	45.0 38.6	.259 .165	4772

Table 4.6. Same as Table 4.2 except for 17 stations in the Western Region.

Projection (h)	Type of Forecast	Bias by Category				Percent Correct	Skill Score	Number of Cases
		1	2	3	4			
18	Early Local No. Obs.	1.04 0.82 1429	1.18 1.36 640	0.72 1.13 499	0.90 0.91 385	57.9 56.8	.367 .380	2953
30	Early Local No. Obs.	1.13 0.76 1490	1.19 1.68 516	0.48 1.41 366	0.76 0.68 422	57.5 48.6	.306 .253	2794
42	Early Local No. Obs.	1.21 0.74 1434	1.00 1.72 638	0.57 1.15 500	0.79 0.57 380	54.2 47.1	.284 .247	2952

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 1/2
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 95 stations, 0000 GMT cycle.

Projection (h)	Type of Forecast	Bias by Category						Percent Correct	Skill Score
		1	2	3	4	5	6		
12	Early	0.74	0.94	0.88	0.87	1.10	1.01	70.6	.355
	Local	0.59	0.74	0.78	1.22	1.17	0.97	76.6	.506
	Persistence	1.00	0.73	0.79	0.92	1.04	1.03	78.8	.529
	No. Obs.	125	412	728	1469	1796	11432		
15	Local	0.43	0.34	0.42	0.98	1.43	1.00	71.9	.400
	Persistence	5.90	1.40	0.76	0.66	1.17	1.04	71.8	.380
	No. Obs.	21	213	755	2068	1591	11303		
18	Early	0.00	0.33	0.57	0.85	1.08	1.03	71.4	.365
	Persistence	62.50	3.49	1.83	0.69	0.81	1.04	67.6	.284
	No. Obs.	2	86	316	1967	2318	11327		
21	Local	1.67	0.17	0.28	0.98	1.17	0.98	69.6	.293
	Persistence	41.33	4.29	2.39	1.14	0.69	1.00	66.4	.22[illegible]
	No. Obs.	3	69	241	1191	2725	11719		
24	Early	0.08	0.38	0.63	0.84	1.11	1.01	76.4	.334
	Persistence	9.62	3.09	2.54	1.52	0.86	0.93	67.6	.190
	No. Obs.	13	97	227	896	2178	12607		
36	Early	0.94	0.77	1.04	0.87	0.96	1.03	67.9	.285
	Persistence	1.00	0.72	0.79	0.92	1.05	1.03	62.2	.160
	No. Obs.	125	418	728	1476	1794	11473		
48	Early	0.17	0.54	1.17	0.83	0.86	1.04	74.7	.256
	Persistence	10.42	3.16	2.53	1.51	0.86	0.94	63.0	.077
	No. Obs.	12	95	228	900	2193	12590		

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	0.80	1.29	1.01	0.74	0.95	1.04	70.0	.335
	Local	0.46	0.84	0.46	1.41	1.40	0.97	71.6	.409
	Persistence	0.69	0.63	0.43	0.77	0.96	1.10	74.8	.397
	No. Obs.	220	160	1209	1322	1624	11327		
15	Local	0.34	0.43	0.20	0.92	1.32	1.01	76.1	.320
	Persistence	5.24	2.40	0.81	1.02	0.96	1.00	75.1	.311
	No. Obs.	29	42	645	997	1616	12528		
18	Early	0.00	0.22	0.61	1.02	0.91	1.02	81.8	.290
	Persistence	25.50	4.43	1.77	1.50	1.12	0.93	76.2	.254
	No. Obs.	6	23	298	681	1400	13532		
21	Local	0.09	0.21	0.16	0.59	1.24	1.01	83.1	.246
	Persistence	13.82	4.21	2.03	1.88	1.27	0.91	76.4	.220
	No. Obs.	11	24	257	541	1222	13787		
24	Early	1.59	0.50	0.55	1.10	0.95	1.01	83.9	.294
	Persistence	9.00	3.40	1.71	1.83	1.35	0.91	75.7	.200
	No. Obs.	17	30	308	560	1162	13865		
36	Early	0.91	0.93	0.86	0.91	1.00	1.03	67.9	.296
	Persistence	0.71	0.61	0.43	0.77	0.96	1.11	66.1	.192
	No. Obs.	217	168	1219	1338	1638	11358		
48	Early	0.47	0.32	0.69	1.06	1.06	1.00	82.2	.248
	Persistence	9.00	3.64	1.68	1.81	1.34	0.91	73.5	.132
	No. Obs.	17	28	313	565	1168	13851		

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	0.77	0.85	0.93	1.03	1.06	0.99	76.4	.352
	Local	0.62	0.43	0.78	1.43	1.26	0.93	78.6	.458
	Persistence	0.38	0.74	1.00	1.32	1.21	0.94	78.8	.456
	No. Obs.	13	96	224	886	2182	12528		
15	Local	0.52	0.35	0.62	1.55	1.01	0.98	76.5	.378
	Persistence	0.19	0.57	0.74	1.34	1.24	0.95	72.8	.305
	No. Obs.	27	124	298	876	2125	12512		
18	Early	0.91	0.97	1.04	0.97	1.01	1.00	74.9	.348
	Persistence	0.09	0.35	0.60	1.10	1.34	0.96	69.8	.250
	No. Obs.	56	203	372	1058	1956	12216		
21	Local	0.35	0.34	0.73	1.47	0.92	1.00	72.0	.353
	Persistence	0.05	0.24	0.41	0.90	1.40	1.00	66.8	.219
	No. Obs.	107	300	546	1305	1871	11672		
24	Early	1.25	1.16	1.02	0.99	1.04	0.99	68.0	.319
	Persistence	0.04	0.17	0.31	0.79	1.48	1.04	63.3	.172
	No. Obs.	126	418	727	1467	1773	11351		
36	Early	0.00	0.30	0.81	0.90	0.92	1.03	75.3	.279
	Persistence	0.45	0.77	1.00	1.32	1.21	0.94	65.6	.116
	No. Obs.	11	94	226	895	2194	12633		
48	Early	1.04	1.16	0.81	0.88	0.99	1.02	66.3	.257
	Persistence	0.04	0.17	0.31	0.80	1.48	1.04	58.3	.059
	No. Obs.	131	416	725	1471	1771	11361		

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	0.39	0.74	0.93	1.10	0.96	1.00	84.3	.322
	Local	0.44	0.67	0.33	1.17	1.57	0.96	85.3	.434
	Persistence	0.50	0.89	0.90	0.96	1.29	0.98	87.7	.501
	No. Obs.	18	27	292	550	1145	13836		
15	Local	0.47	0.61	0.60	1.34	1.80	0.93	82.6	.349
	Persistence	0.60	0.82	1.11	0.90	1.41	0.97	85.1	.379
	No. Obs.	15	28	236	585	1046	13971		
18	Early	1.65	1.57	0.92	0.87	0.93	1.01	82.1	.306
	Persistence	0.23	0.49	0.83	0.68	1.31	1.00	81.8	.310
	No. Obs.	48	49	315	784	1135	13458		
21	Local	0.24	0.78	0.86	1.71	1.39	0.92	73.4	.297
	Persistence	0.07	0.28	0.55	0.54	1.13	1.05	77.7	.252
	No. Obs.	142	83	477	976	1300	12730		
24	Early	1.24	1.41	1.04	1.06	0.99	0.98	67.3	.317
	Persistence	0.05	0.14	0.22	0.40	0.92	1.20	68.7	.172
	No. Obs.	219	166	1212	1326	1618	11224		
36	Early	0.19	0.19	0.64	1.11	1.04	1.00	82.3	.233
	Persistence	0.69	0.89	0.86	0.98	1.28	0.98	79.8	.183
	No. Obs.	16	27	307	541	1160	13914		
48	Early	1.15	0.96	1.06	1.04	0.99	0.99	66.4	.294
	Persistence	0.05	0.14	0.22	0.40	0.92	1.20	65.9	.100
	No. Obs.	226	169	1209	1339	1614	11235		

Table 5.6. Comparative verification for early guidance, persistence, and local ceiling forecasts for 95 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	0.034	0.89	95.2	.220	.139
	Local		0.70	96.7	.406	.268
	Persistence		0.79	96.8	.461	.313
15	Local	0.015	0.35	98.3	.133	.075
	Persistence		1.81	96.6	.161	.097
18	Early	0.006	0.32	99.3	.015	.009
	Persistence		4.83	97.1	.077	.045
21	Local	0.005	0.24	99.5	.066	.035
	Persistence		5.83	97.1	.050	.029
24	Early	0.007	0.35	99.2	.091	.050
	Persistence		3.86	96.9	.049	.031
36	Early	0.034	0.80	94.8	.125	.082
	Persistence		0.78	94.7	.103	.070
48	Early	0.007	0.50	99.1	.109	.060
	Persistence		3.97	96.8	.031	.021

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 Local Persistence	0.024	1.01 0.62 0.66	96.1 97.7 97.7	.179 .391 .425	.110 .252 .279
15	Local Persistence	0.004	0.39 3.56	99.4 98.1	.058 .049	.031 .029
18	Early Persistence	0.002	0.17 8.79	99.8 98.3	.000 .018	.000 .011
21	Local Persistence	0.002	0.17 7.23	99.8 98.2	.048 .017	.025 .011
24	Early Persistence	0.003	0.89 5.43	99.5 98.2	.020 .035	.011 .020
36	Early Persistence	0.024	0.92 0.66	96.1 96.4	.145 .086	.090 .054
48	Early Persistence	0.003	0.38 5.67	99.6 98.2	-.002 .022	.000 .014

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	0.007	0.84	98.9	.154	.086
	Local		0.45	99.4	.403	.254
	Persistence		0.69	99.3	.397	.250
15	Local	0.010	0.38	99.0	.254	.148
	Persistence		0.50	99.0	.260	.152
18	Early	0.016	0.96	97.4	.160	.095
	Persistence		0.30	98.2	.130	.073
21	Local	0.026	0.34	97.1	.154	.090
	Persistence		0.19	97.2	.063	.036
24	Early	0.034	1.18	94.0	.165	.109
	Persistence		0.14	96.3	.047	.028
36	Early	0.006	0.27	99.2	.012	.008
	Persistence		0.73	98.9	.050	.028
48	Early	0.034	1.13	93.7	.117	.081
	Persistence		0.14	96.2	.021	.015

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 Local Persistence	0.003	0.60 0.58 0.73	99.6 99.7 99.6	.081 .252 .203	.043 .145 .114
15	Local Persistence	0.003	0.56 0.74	99.7 99.6	.237 .185	.136 .103
18	Early Persistence	0.006	1.61 0.36	98.6 99.2	.136 .088	.077 .048
21	Local Persistence	0.014	0.44 0.15	98.2 98.4	.134 .035	.076 .020
24	Early Persistence	0.024	1.31 0.09	95.5 97.4	.172 .025	.108 .014
36	Early Persistence	0.003	0.81 0.19	99.7 99.5	-.001 .023	.000 .013
48	Early Persistence	0.025	1.07 0.09	95.7 97.3	.142 .010	.089 .007

Table 6.1. Comparative verification of early guidance and local max/min temperature forecasts for 88 stations, 0000 GMT cycle.

Forecast Projection (h)	Type of Forecast	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Number (%) of Absolute Errors ≥ 10°	Number of Cases
24 (Max)	Early	0.6	2.9	342 (2.5)	13492
	Local	0.4	2.8	349 (2.6)	
36 (Min)	Early	0.1	3.0	252 (1.9)	13399
	Local	0.5	3.0	371 (2.8)	
48 (Max)	Early	0.5	3.6	738 (5.5)	13404
	Local	0.4	3.6	751 (5.6)	
60 (Min)	Early	-0.4	3.5	563 (4.2)	13393
	Local	-0.1	3.6	675 (5.0)	

Table 6.2. Same as Table 6.1 except for 26 stations in the Eastern Region.

Forecast Projection (h)	Type of Forecast	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Number (%) of Absolute Errors ≥ 10°	Number of Cases
24 (Max)	Early Local	0.4 0.3	2.9 2.9	88 (2.2) 101 (2.5)	3987
36 (Min)	Early Local	0.2 0.9	3.1 3.3	81 (2.0) 151 (3.8)	3961
48 (Max)	Early Local	0.3 0.3	3.4 3.6	166 (4.2) 201 (5.1)	3963
60 (Min)	Early Local	-0.3 0.1	3.6 3.7	151 (3.8) 217 (5.5)	3963

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

Forecast Projection (h)	Type of Forecast	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Number(%) of Absolute Errors ≥ 10°	Number of Cases
24 (Max)	Early Local	0.4 0.4	2.5 2.3	61 (1.7) 57 (1.6)	3636
36 (Min)	Early Local	0.2 0.4	2.6 2.5	27 (0.7) 42 (1.2)	3611
48 (Max)	Early Local	0.0 0.3	3.1 3.0	138 (3.8) 126 (3.5)	3609
60 (Min)	Early Local	-0.2 0.2	2.9 3.0	88 (2.4) 104 (2.9)	3607

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

Forecast Projection (h)	Type of Forecast	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Number (%) of Absolute Errors ≥ 10°	Number of Cases
24 (Max)	Early Local	0.8 0.8	3.1 3.1	113 (3.2) 107 (3.0)	3573
36 (Min)	Early Local	-0.0 0.6	3.3 3.4	104 (2.9) 120 (3.4)	3549
48 (Max)	Early Local	0.6 0.7	3.9 4.0	256 (7.2) 274 (7.7)	3553
60 (Min)	Early Final	-0.5 -0.2	4.1 4.2	236 (6.7) 266 (7.5)	3548

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

Forecast Projection (h)	Type of Forecast	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Number (%) of Absolute Errors ≥ 10°	Number of Cases
24 (Max)	Early Local	1.1 0.2	3.0 2.9	80 (3.5) 84 (3.7)	2296
36 (Min)	Early Local	-0.2 -0.2	2.9 2.9	40 (1.8) 58 (2.5)	2278
48 (Max)	Early Local	1.4 0.3	4.0 3.7	178 (7.8) 150 (6.6)	2279
60 (Min)	Early Local	-0.7 -0.6	3.4 3.4	88 (3.9) 88 (3.9)	2275

Table 6.6. Comparative verification of early guidance and local max/min temperature forecasts for 88 stations, 1200 GMT cycle.

Forecast Projection (h)	Type of Forecast	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Number (%) of Absolute Errors ≥ 10°	Number of Cases
24 (Min)	Early	-0.2	2.8	181 (1.3)	
	Local	0.2	2.9	343 (2.5)	13764
36 (Max)	Early	0.3	3.3	543 (3.9)	
	Local	0.1	3.2	561 (4.1)	13766
48 (Min)	Early	-0.2	3.3	399 (2.9)	
	Local	0.1	3.3	502 (3.6)	13760
60 (Max)	Early	0.3	3.9	997 (7.2)	
	Local	0.3	3.9	1051 (7.6)	13762

Table 6.7. Same as Table 6.6 except for 26 stations in the Eastern Region.

Forecast Projection (h)	Type of Forecast	Mean Algebraic Error (^{o}F)	Mean Absolute Error (^{o}F)	Number (%) of Absolute Errors $\geq$ 10^{o}	Number of Cases
24 (Min)	Early	-0.1	2.9	58 (1.4)	4074
	Local	0.4	3.1	143 (3.5)	
36 (Max)	Early	0.2	3.3	152 (3.7)	4072
	Local	-0.1	3.4	165 (4.1)	
48 (Min)	Early	-0.2	3.4	123 (3.0)	4071
	Local	0.4	3.5	183 (4.5)	
60 (Max)	Early	0.1	3.7	235 (5.8)	4071
	Local	0.2	3.9	290 (7.1)	

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

Forecast Projection (h)	Type of Forecast	Mean Algebraic Error (^{o}F)	Mean Absolute Error (^{o}F)	Number(%) of Absolute Errors $\geq$ 10^{o}	Number of Cases
24 (Min)	Early	-0.0	2.4	25 (0.7)	3746
	Local	0.2	2.4	47 (1.3)	
36 (Max)	Early	-0.2	2.8	87 (2.3)	3747
	Local	-0.0	2.6	94 (2.5)	
48 (Min)	Early	-0.1	2.8	51 (1.4)	3746
	Local	0.2	2.7	62 (1.7)	
60 (Max)	Early	-0.3	3.3	185 (4.9)	3746
	Local	0.2	3.2	186 (5.0)	

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

Forecast Projection (h)	Type of Forecast	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Number (%) of Absolute Errors ≥ 10°	Number of Cases
24 (Min)	Early Local	-0.1 0.3	3.1 3.2	69 (1.9) 115 (3.2)	3600
36 (Max)	Early Local	0.4 0.4	3.6 3.5	192 (5.3) 190 (5.3)	3599
48 (Min)	Early Local	-0.2 0.1	3.7 3.8	156 (4.3) 177 (4.9)	3598
60 (Max)	Early Local	0.4 0.6	4.4 4.5	354 (9.8) 364 (10.1)	3601

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

Forecast Projection (h)	Type of Forecast	Mean Algebraic Error (°F)	Mean Absolute Error (°F)	Number (%) of Absolute Errors ≥ 10°	Number of Cases
24 (Min)	Early Local	-0.6 -0.3	2.8 2.7	29 (1.2) 38 (1.6)	2344
36 (Max)	Early Local	1.0 0.1	3.5 3.3	112 (4.8) 112 (4.8)	2348
48 (Min)	Early Local	-0.4 -0.5	3.2 3.2	69 (2.9) 80 (3.4)	2345
60 (Max)	Early Local	1.7 0.3	4.3 4.2	223 (9.5) 211 (9.0)	2344

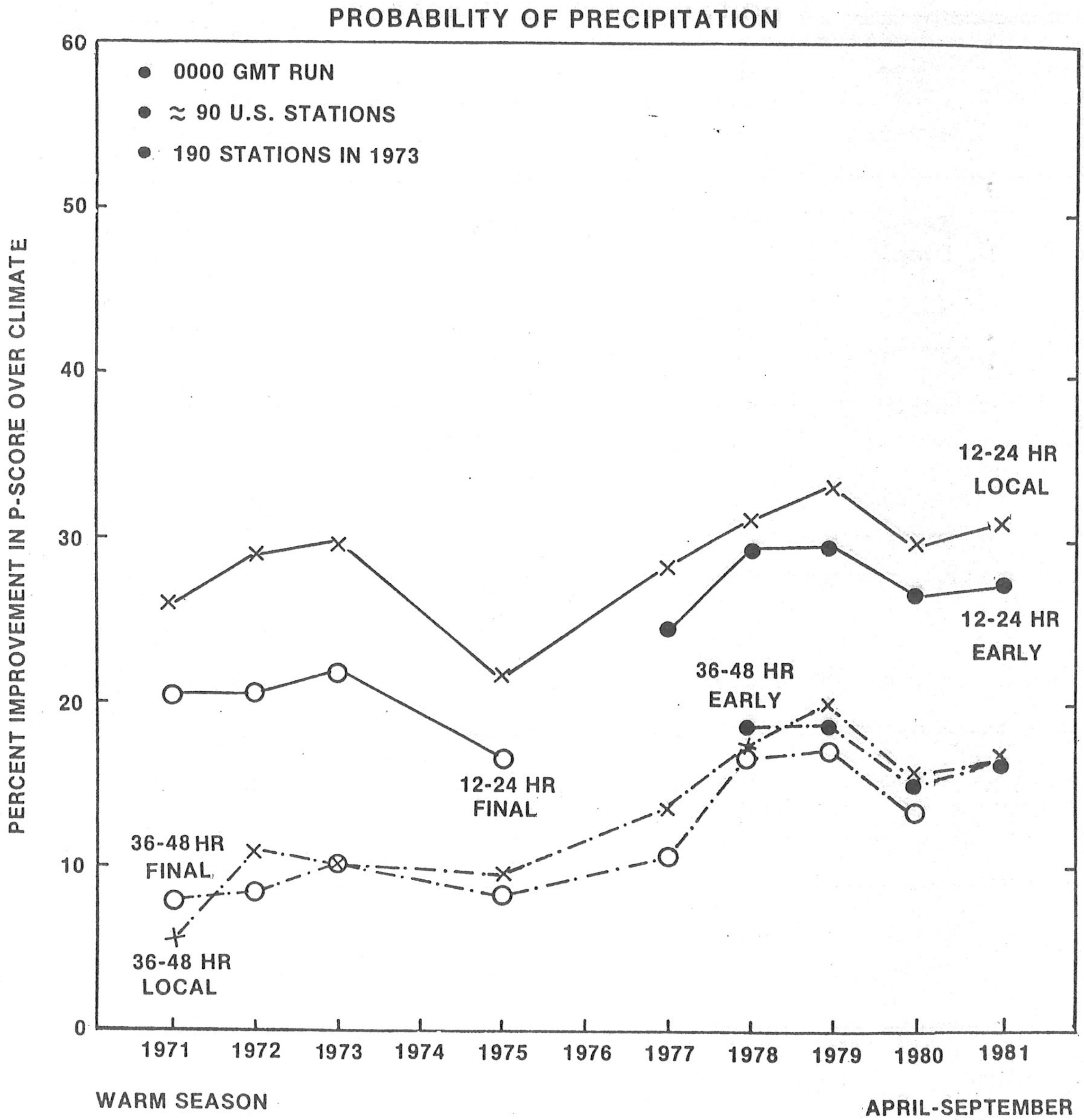

Figure 2.1. Percent improvement over climate in the Brier score of the local and the early and final guidance PoP forecasts. Results for 1974 and 1976 are unavailable because of missing data.

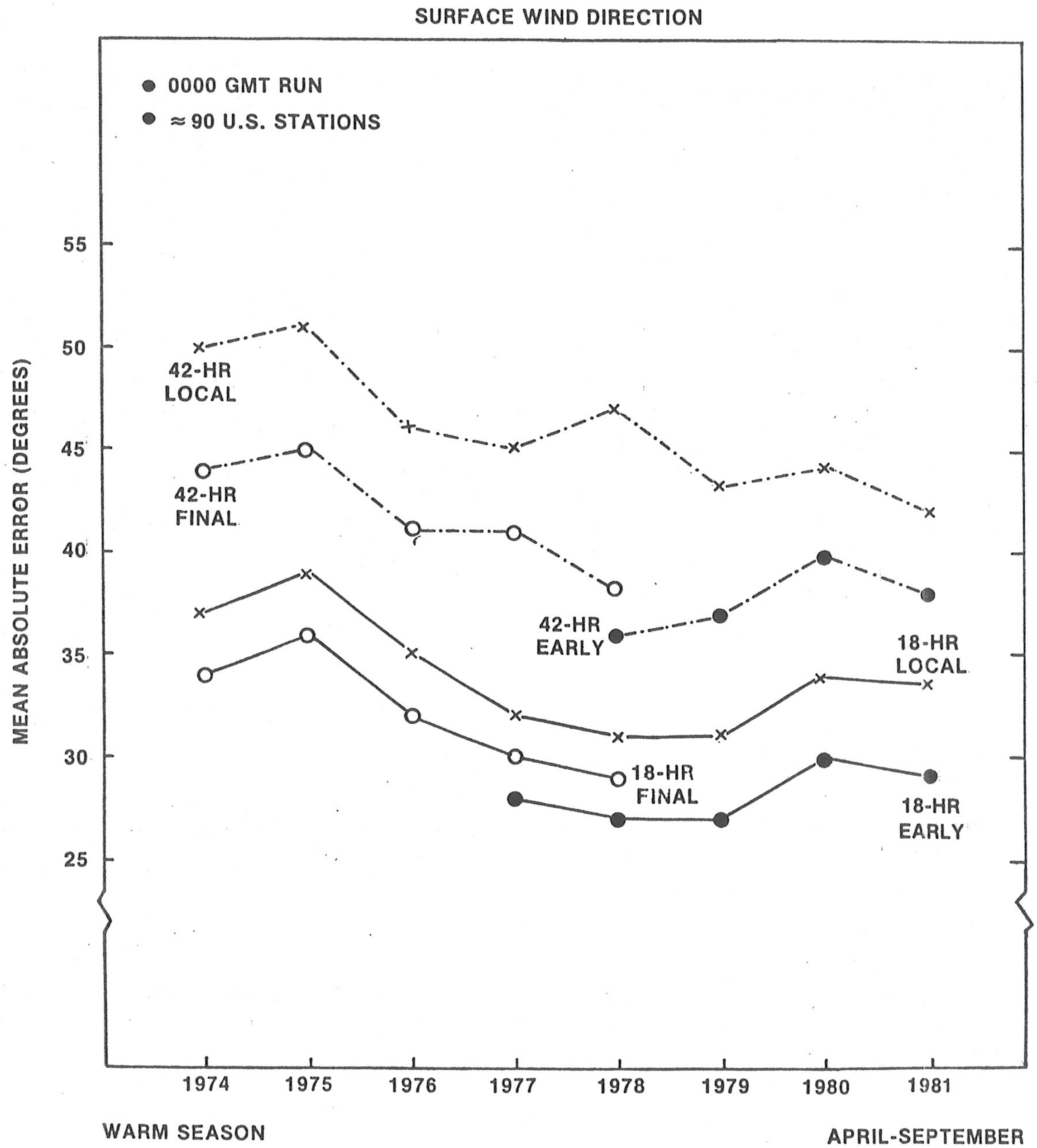

Figure 3.1. Mean absolute error for the local and the early and final guidance surface wind direction forecasts.

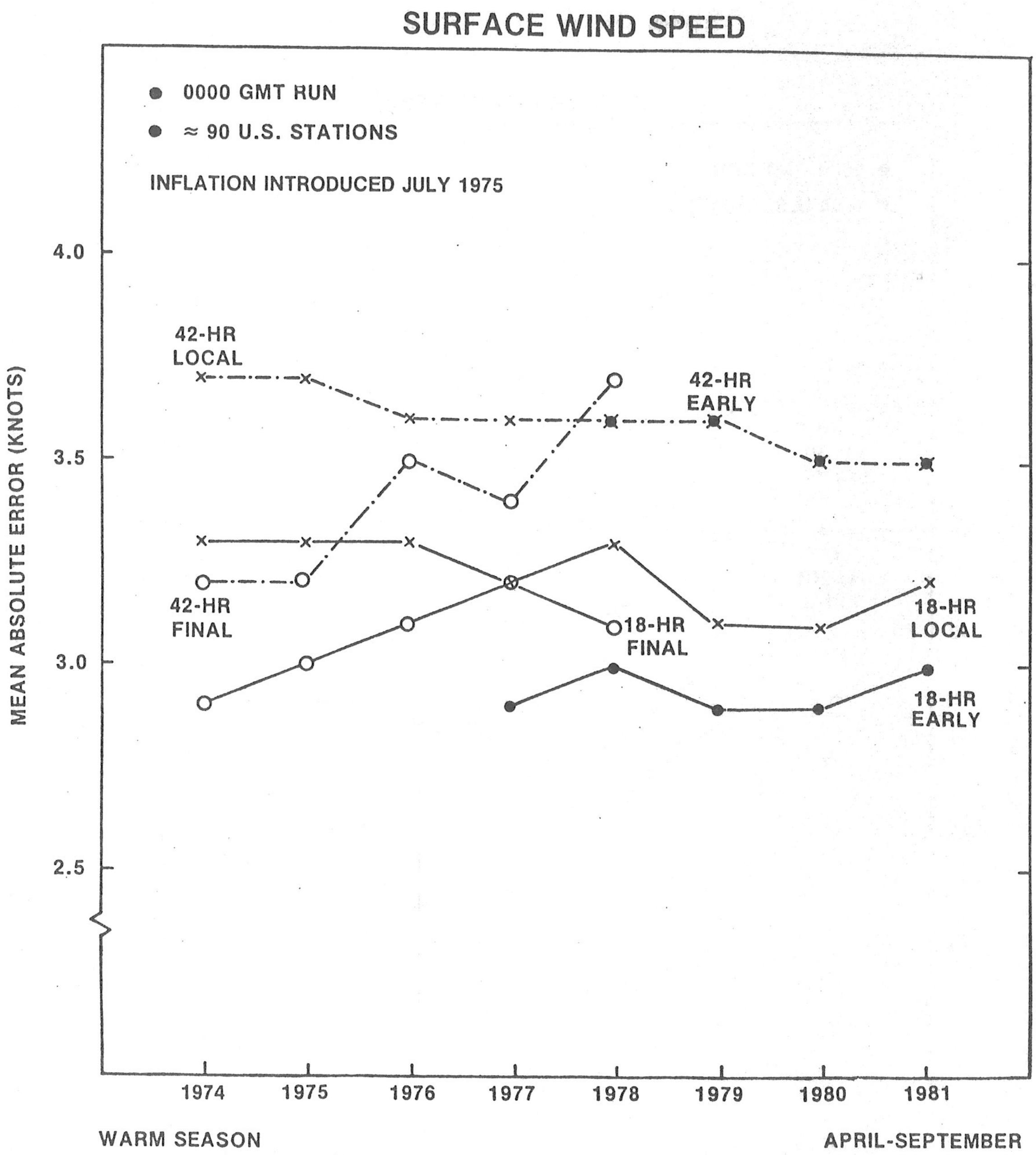

Figure 3.2. Same as Fig. 3.1 except for surface wind speed.

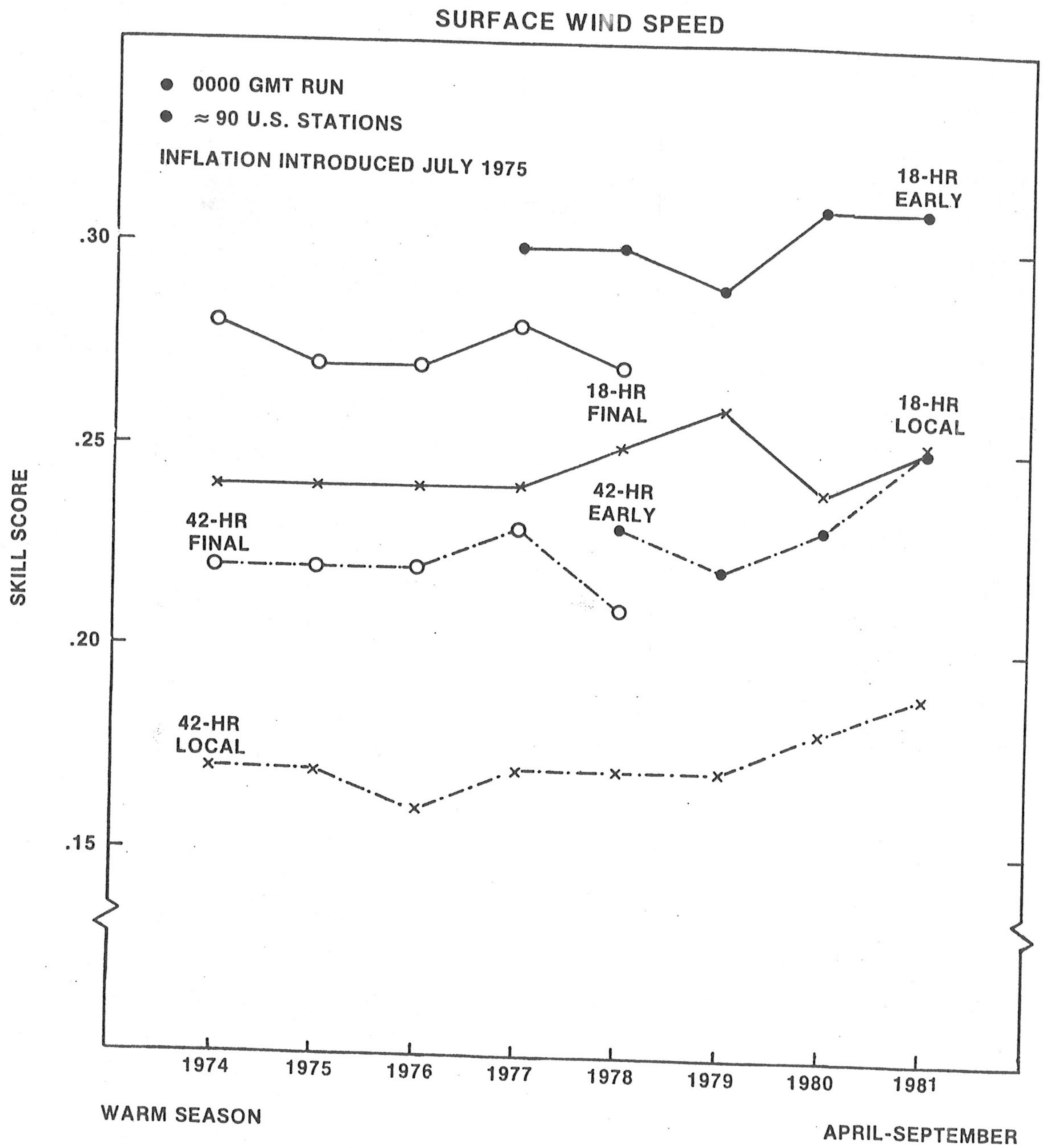

Figure 3.3. Skill score computed from five-category contingency tables for the local and the early and final guidance surface wind speed forecasts.

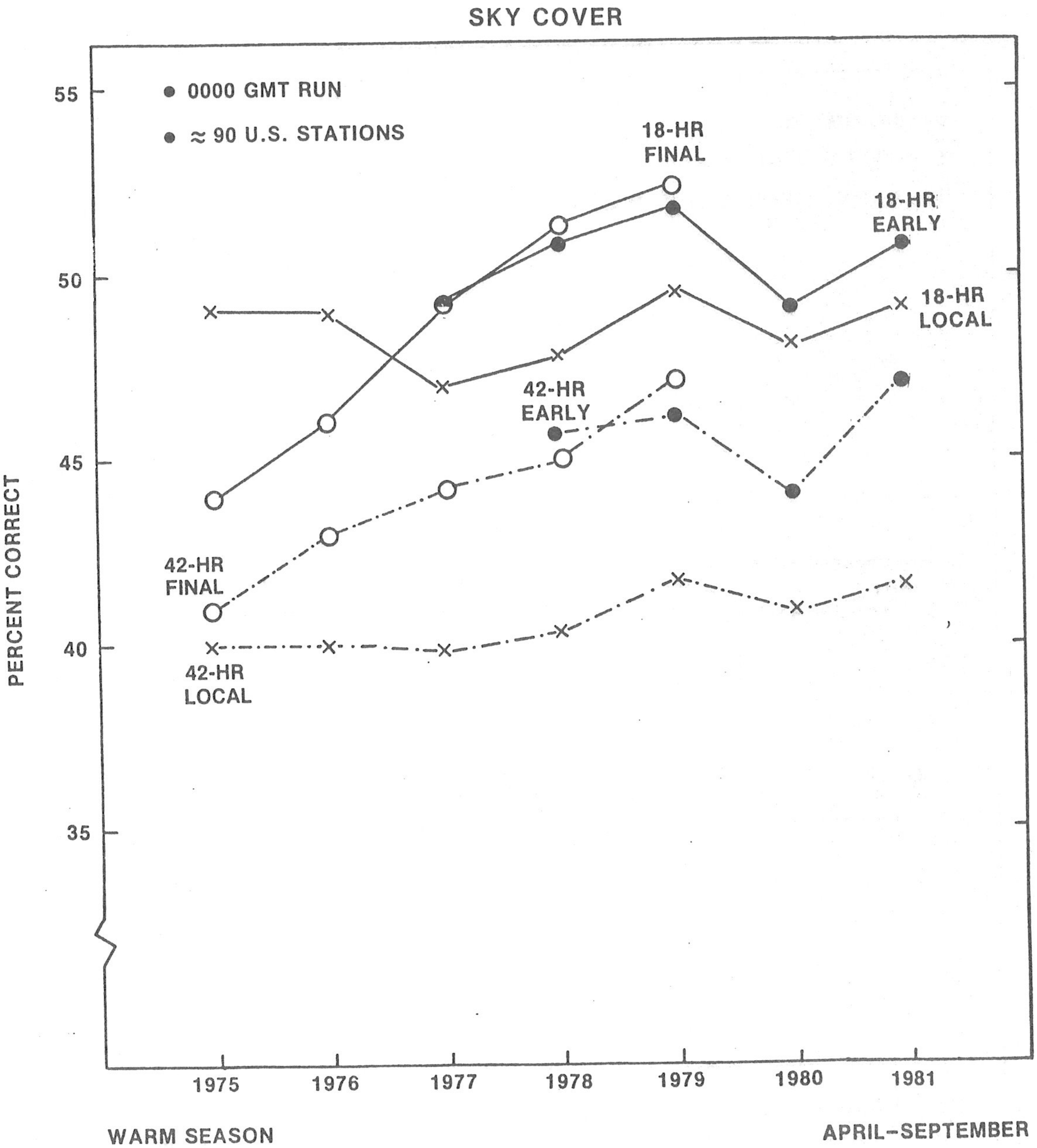

Figure 4.1. Percent correct for the local and the early and final guidance opaque sky cover forecasts.

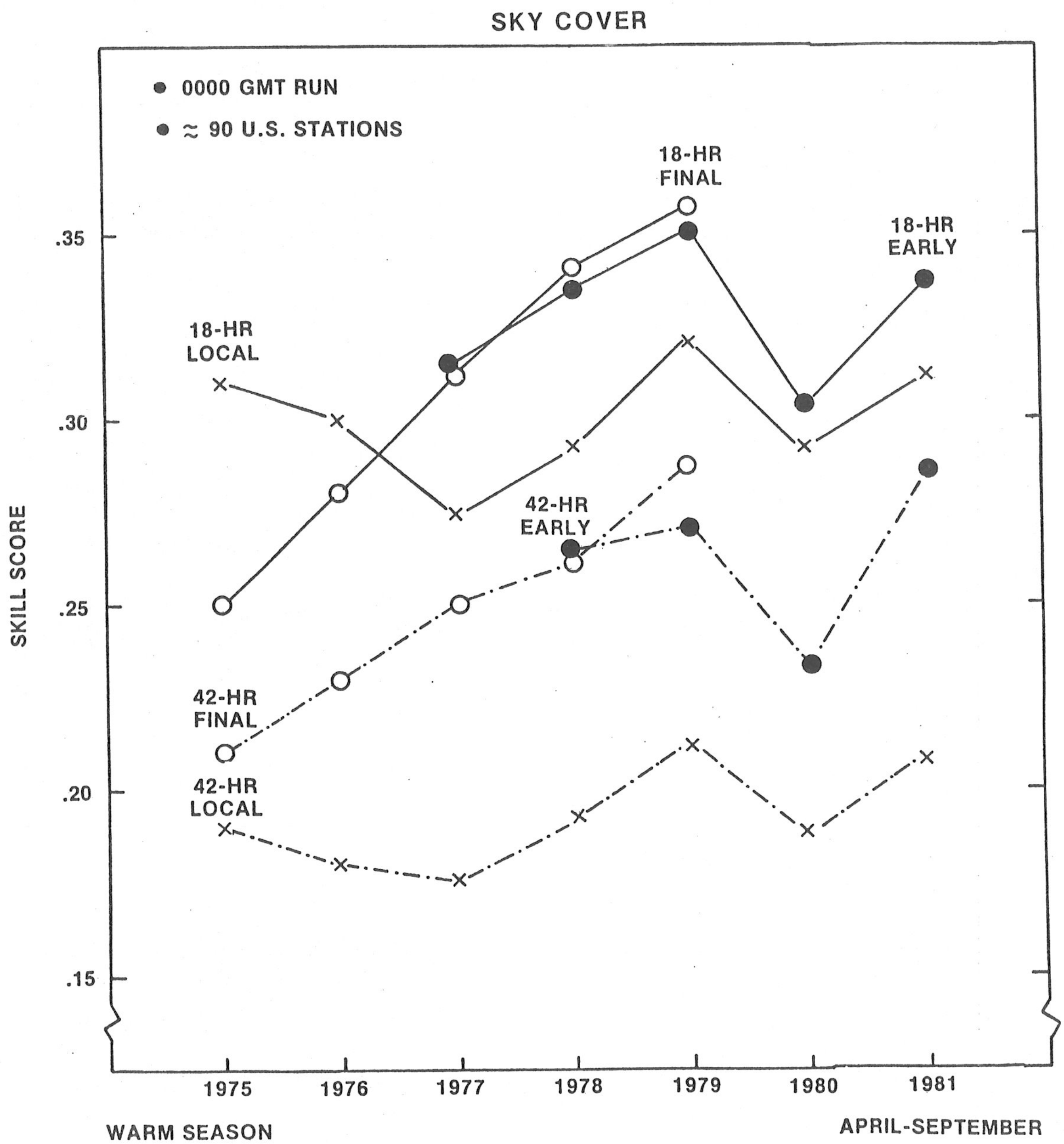

Figure 4.2. Skill score for the local and the early and final guidance opaque sky cover forecasts.

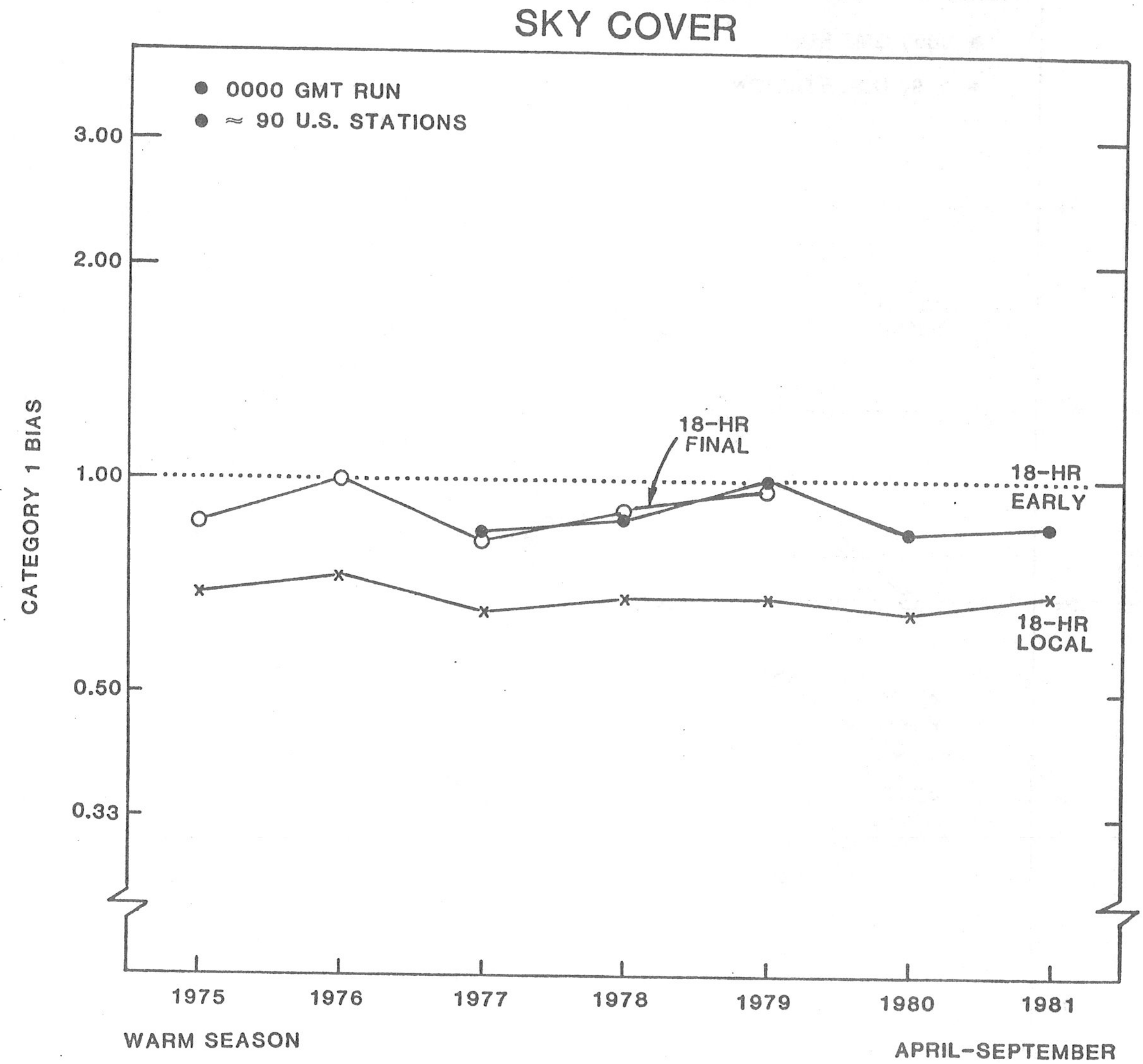

Figure 4.3. Category 1 bias for the local and the early and final guidance opaque sky cover forecasts.

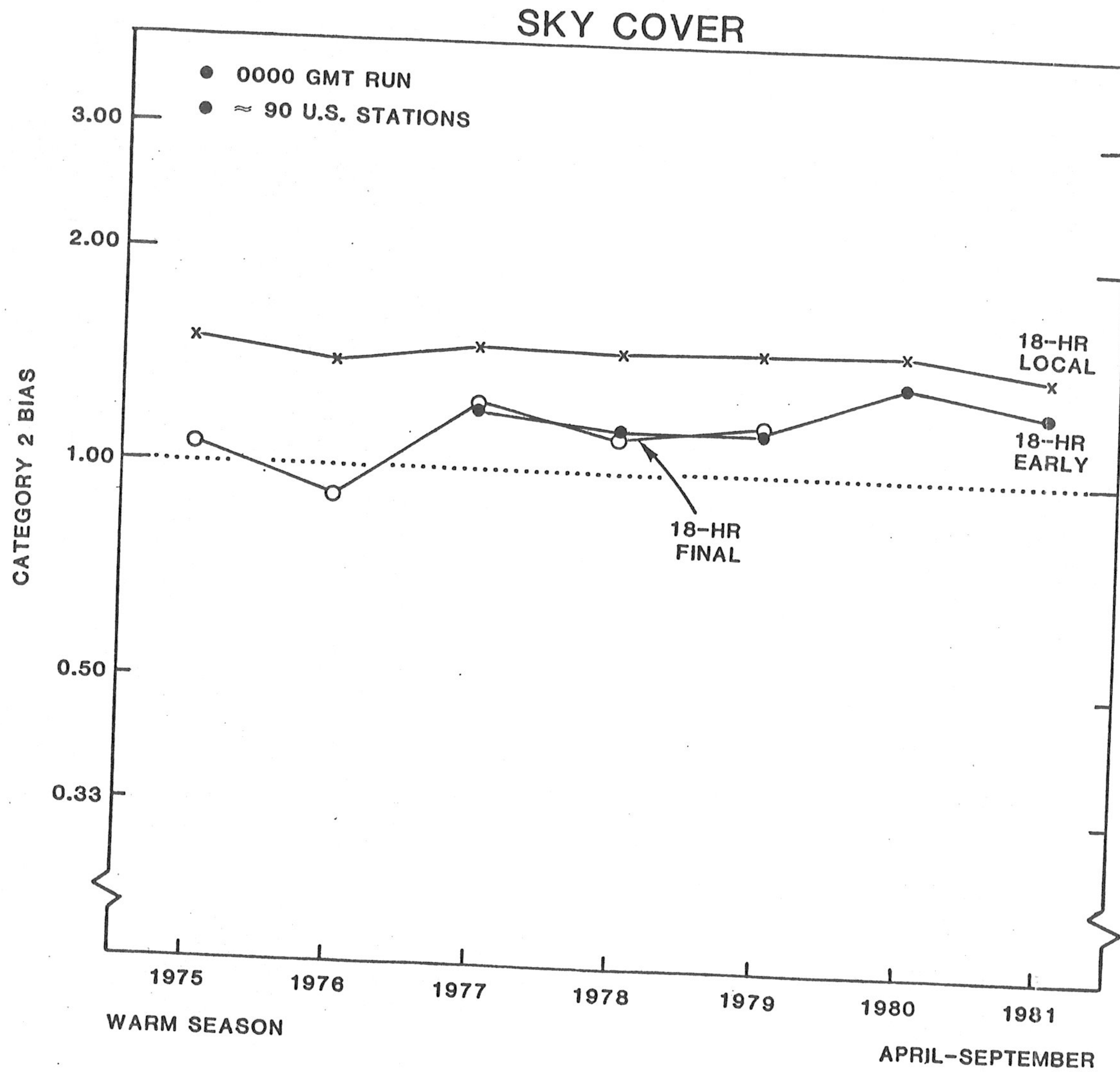

Figure 4.4. Same as Fig. 4.3 except for category 2 bias.

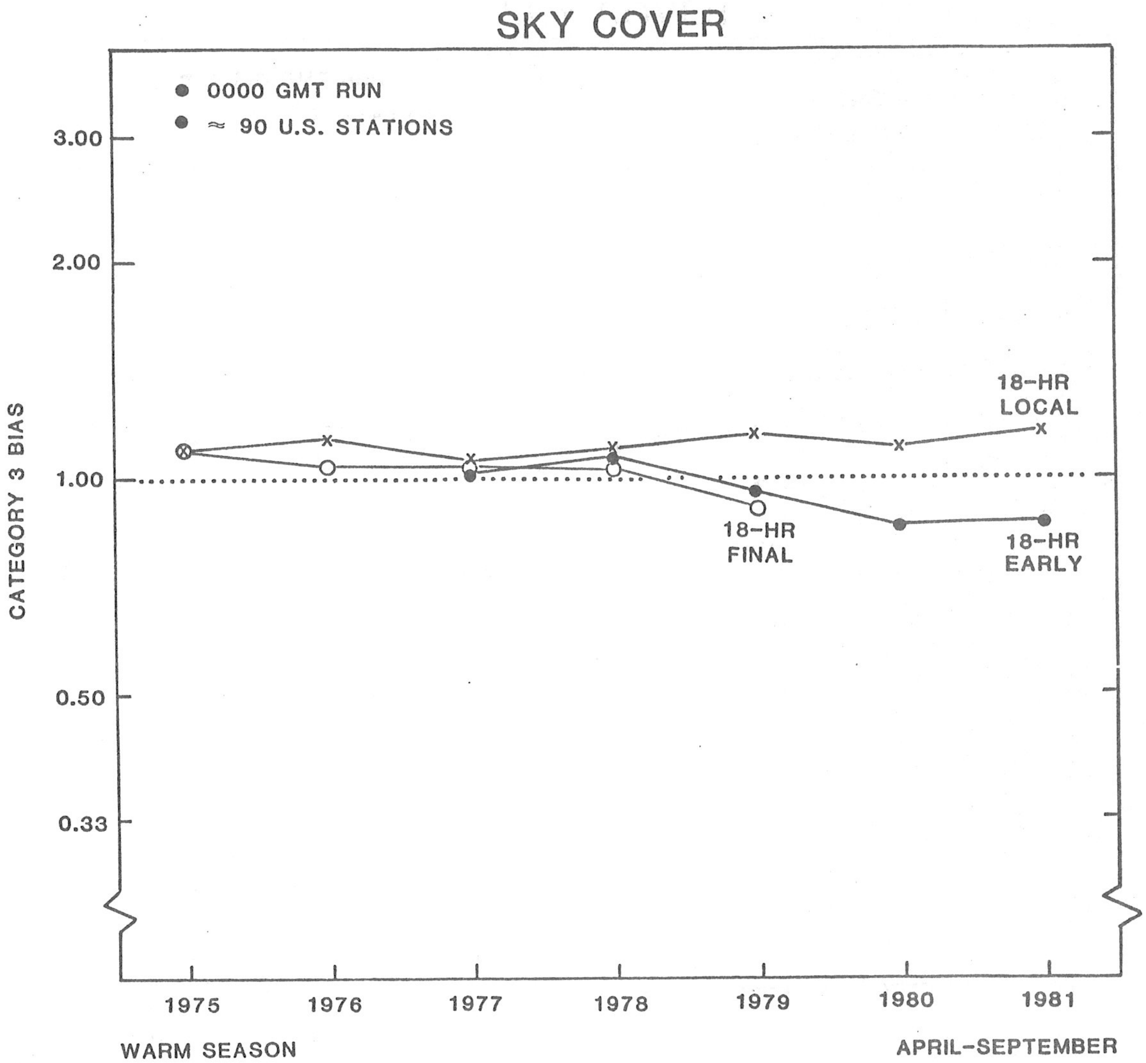

Figure 4.5. Same as Fig. 4.3 except for category 3 bias.

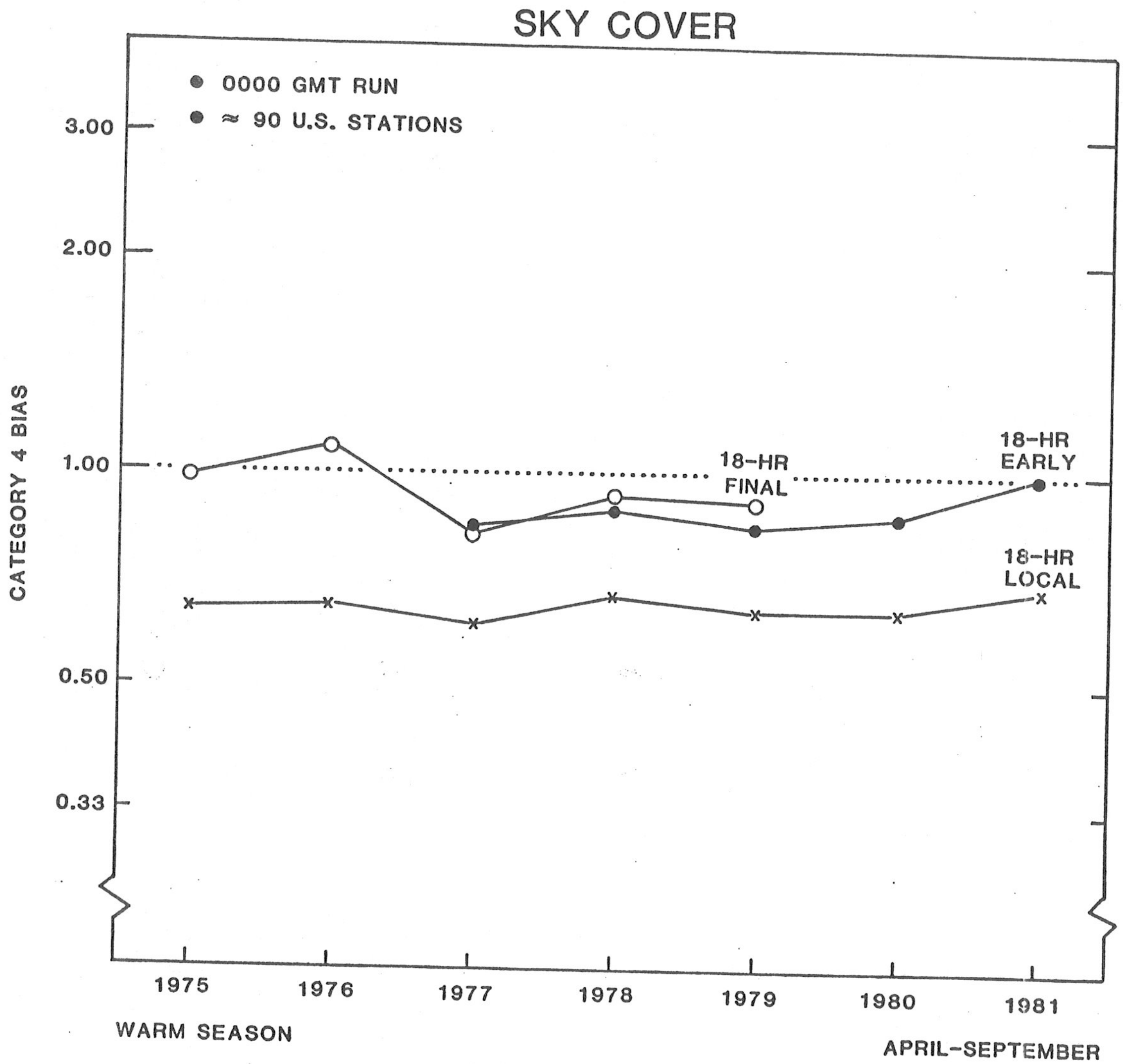

Figure 4.6. Same as Fig. 4.3 except for category 4 bias.

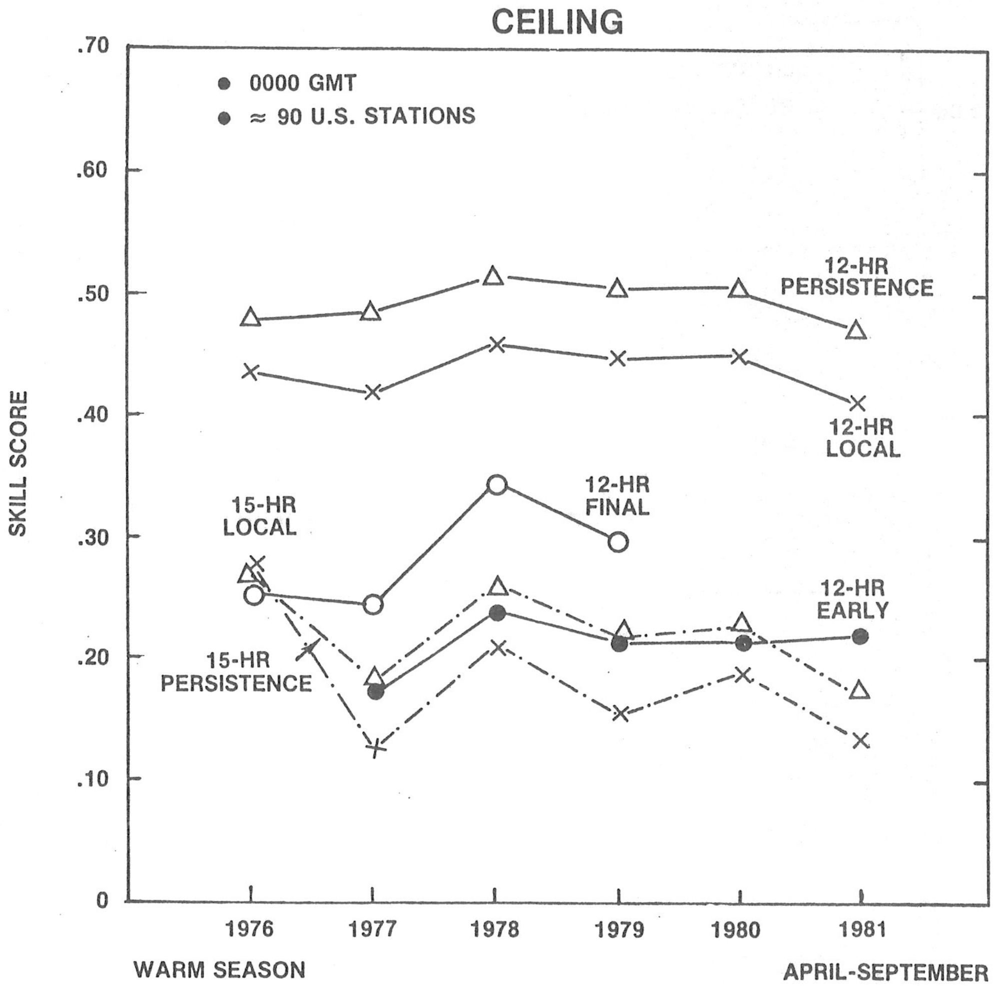

Figure 5.1. Skill score computed from two-category contingency tables for persistence, local, and guidance (early and final) ceiling height forecasts.

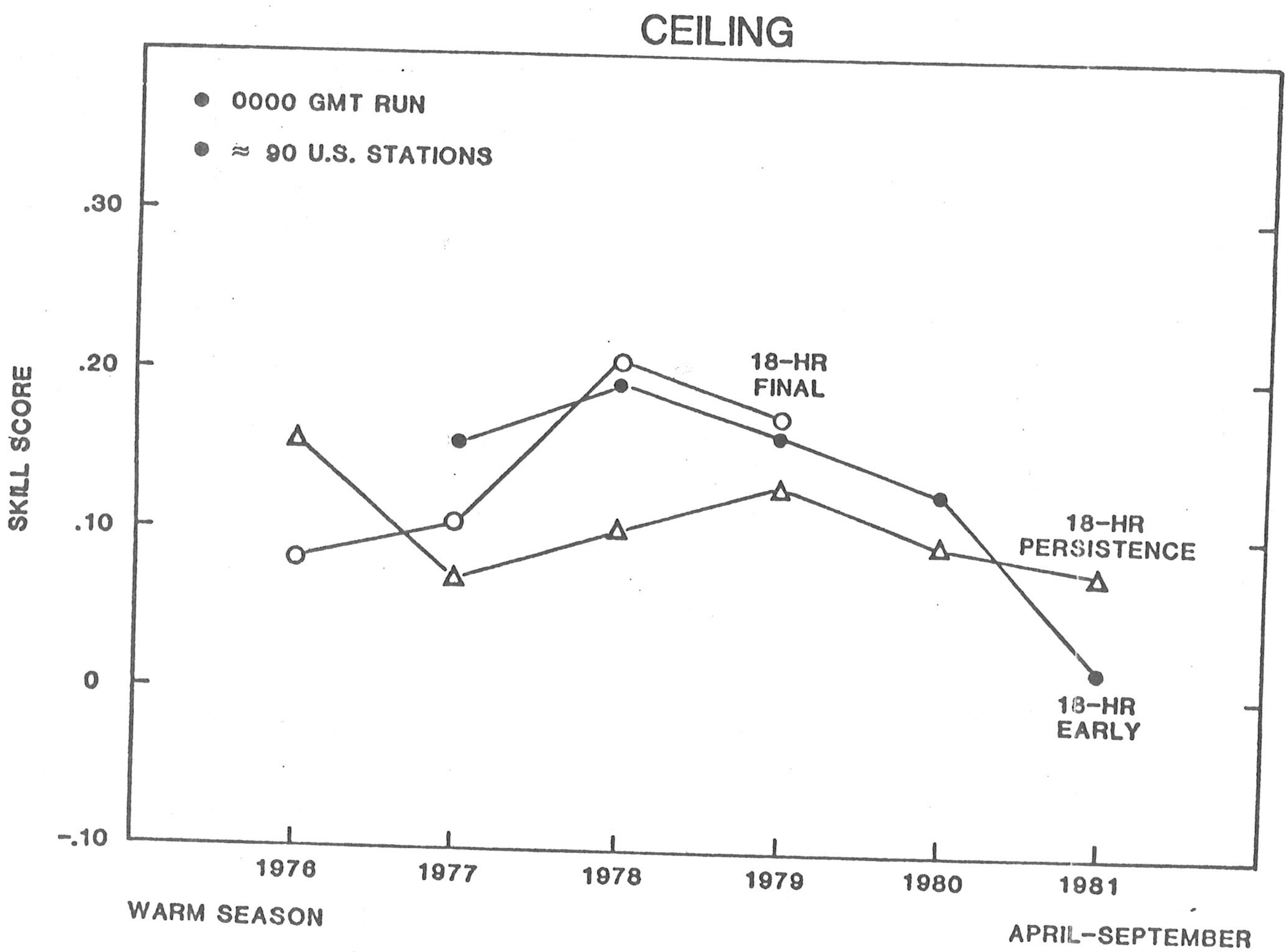

Figure 5.2. Same as Fig. 5.1 except for forecast projection.

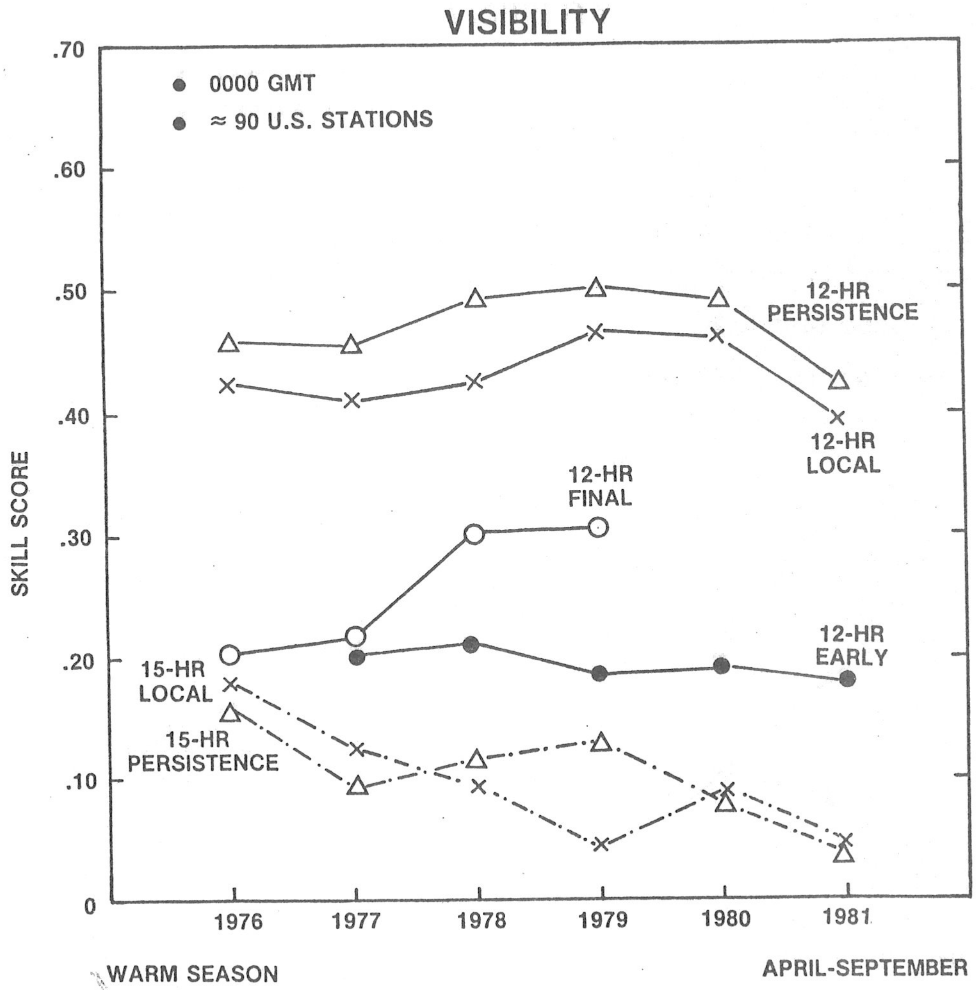

Figure 5.3. Same as Fig. 5.1 except for visibility.

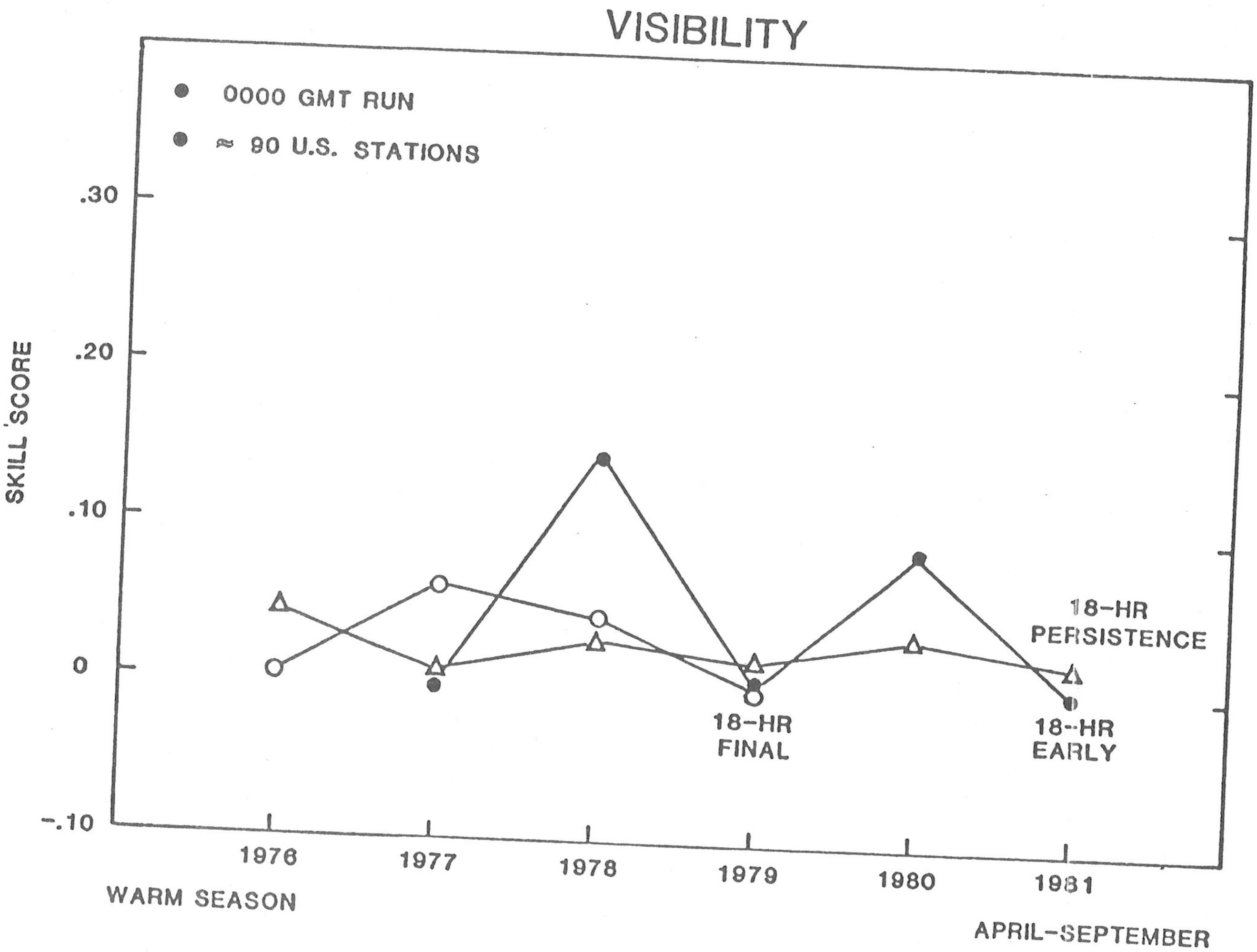

Figure 5.4. Same as Fig. 5.1 except for visibility and forecast projection.

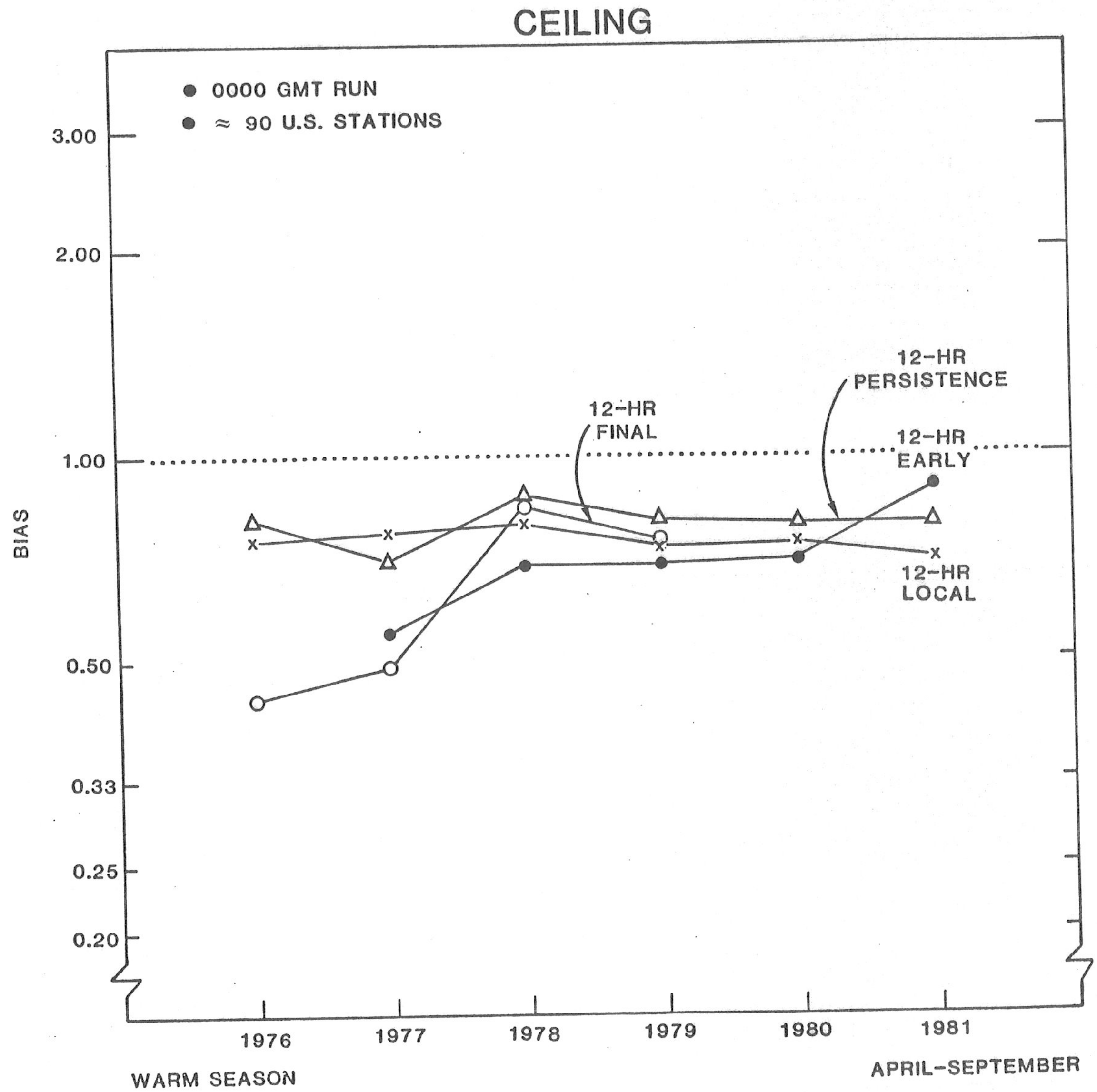

Figure 5.5. Bias for categories 1 and 2 combined for persistence, local, guidance (early and final) ceiling height forecasts.

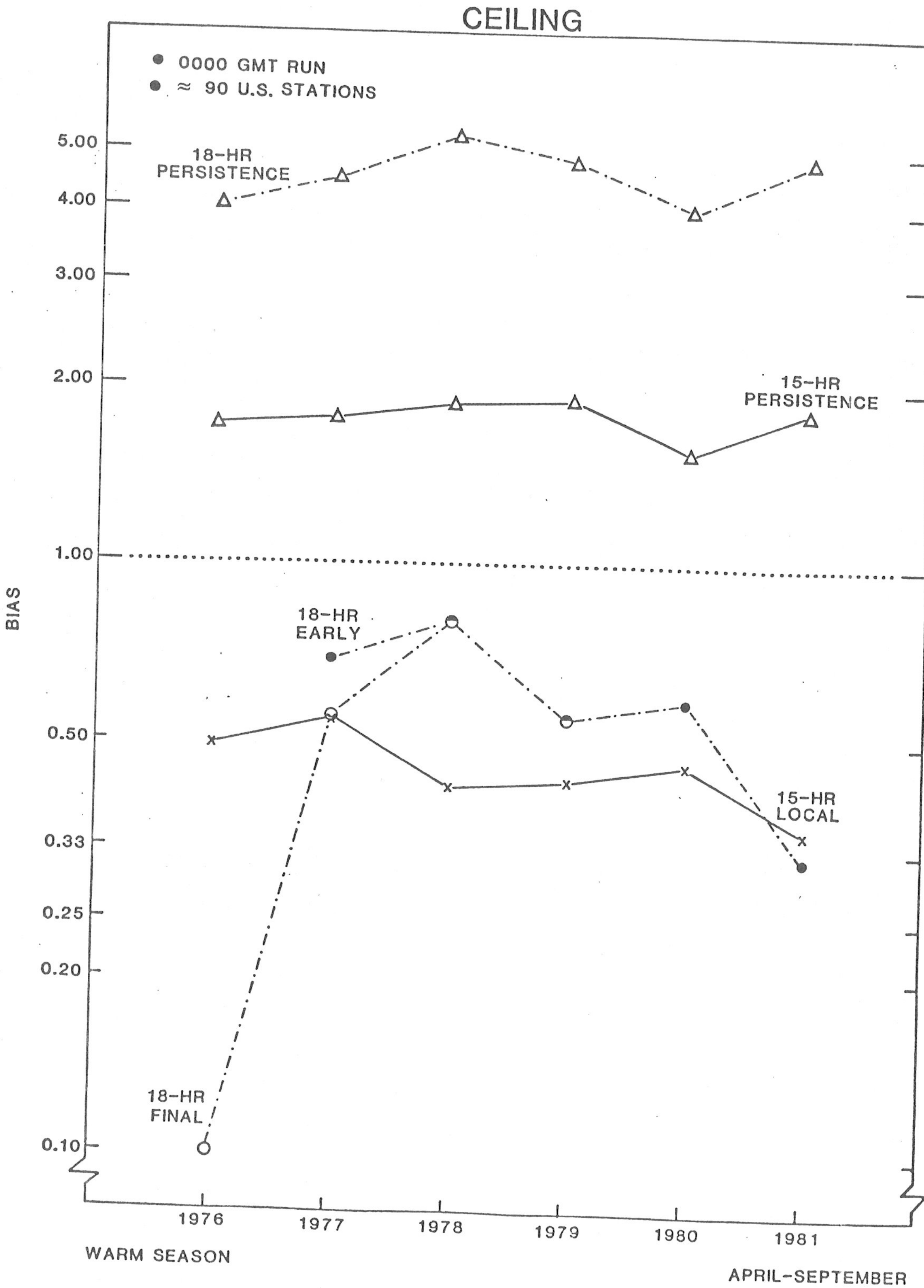

Figure 5.6. Same as Fig. 5.5 except for forecast projection.

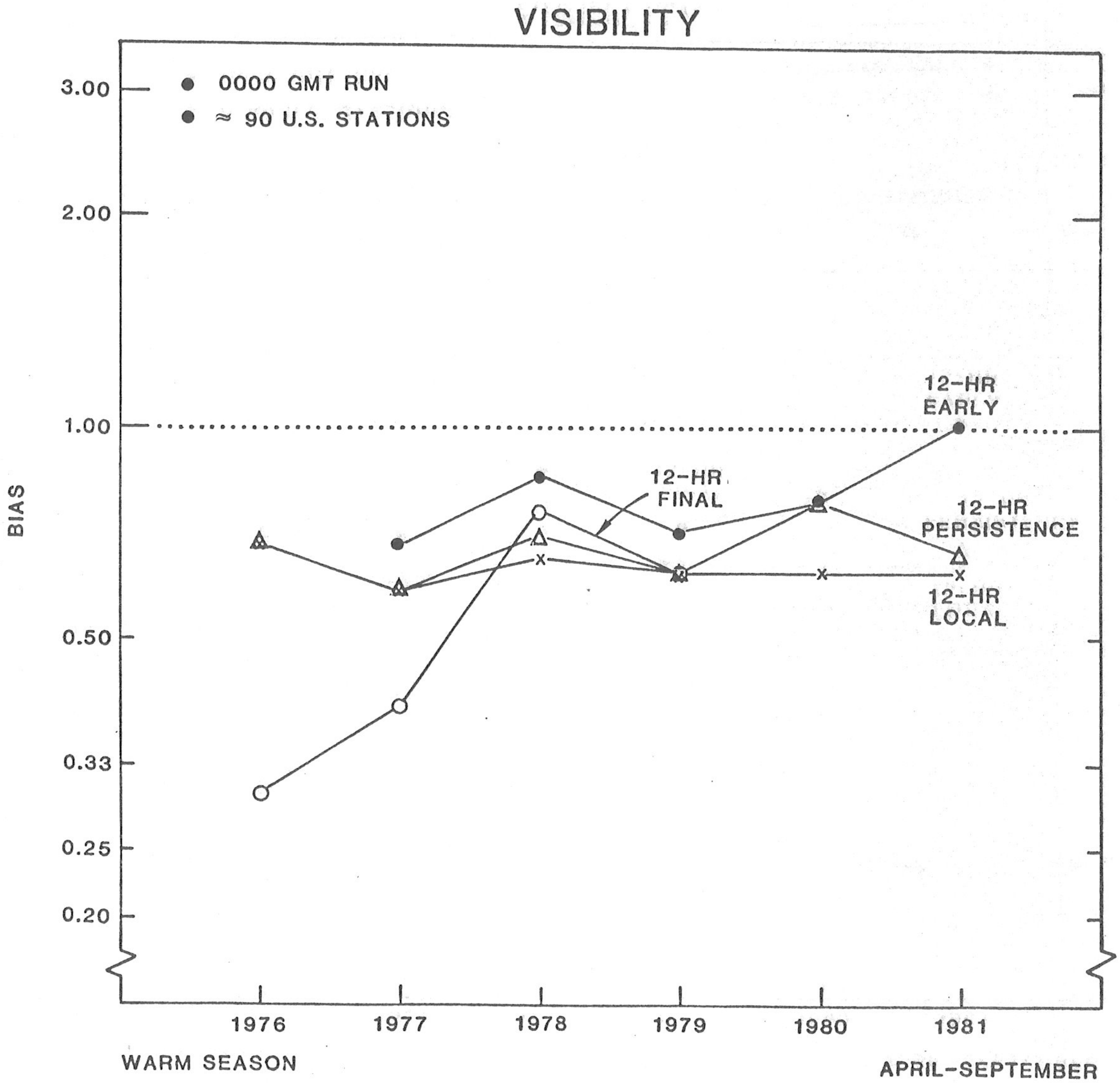

Figure 5.7. Same as Fig. 5.5 except for visibility.

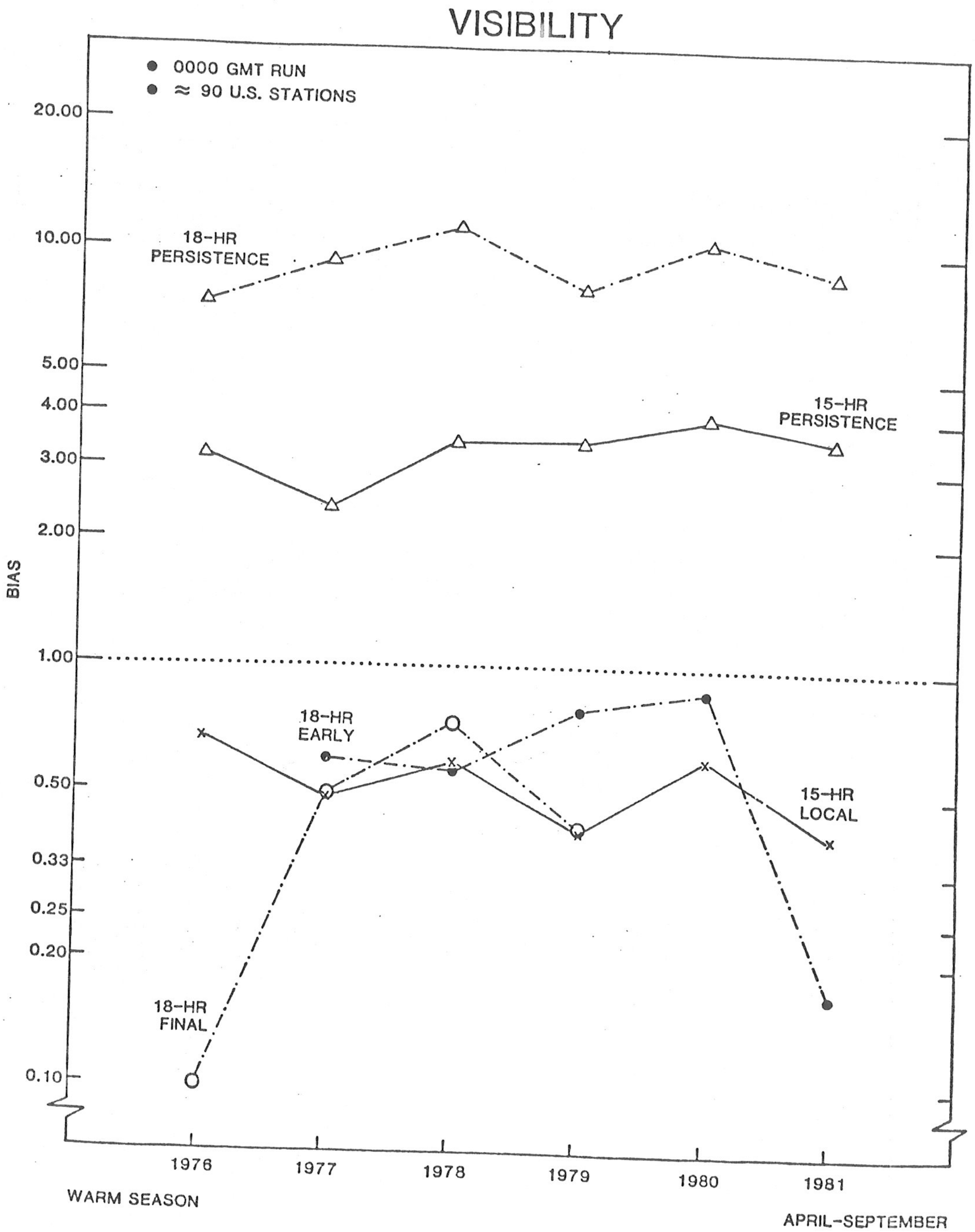

Figure 5.8. Same as Fig. 5.5 except for visibility and forecast projection.

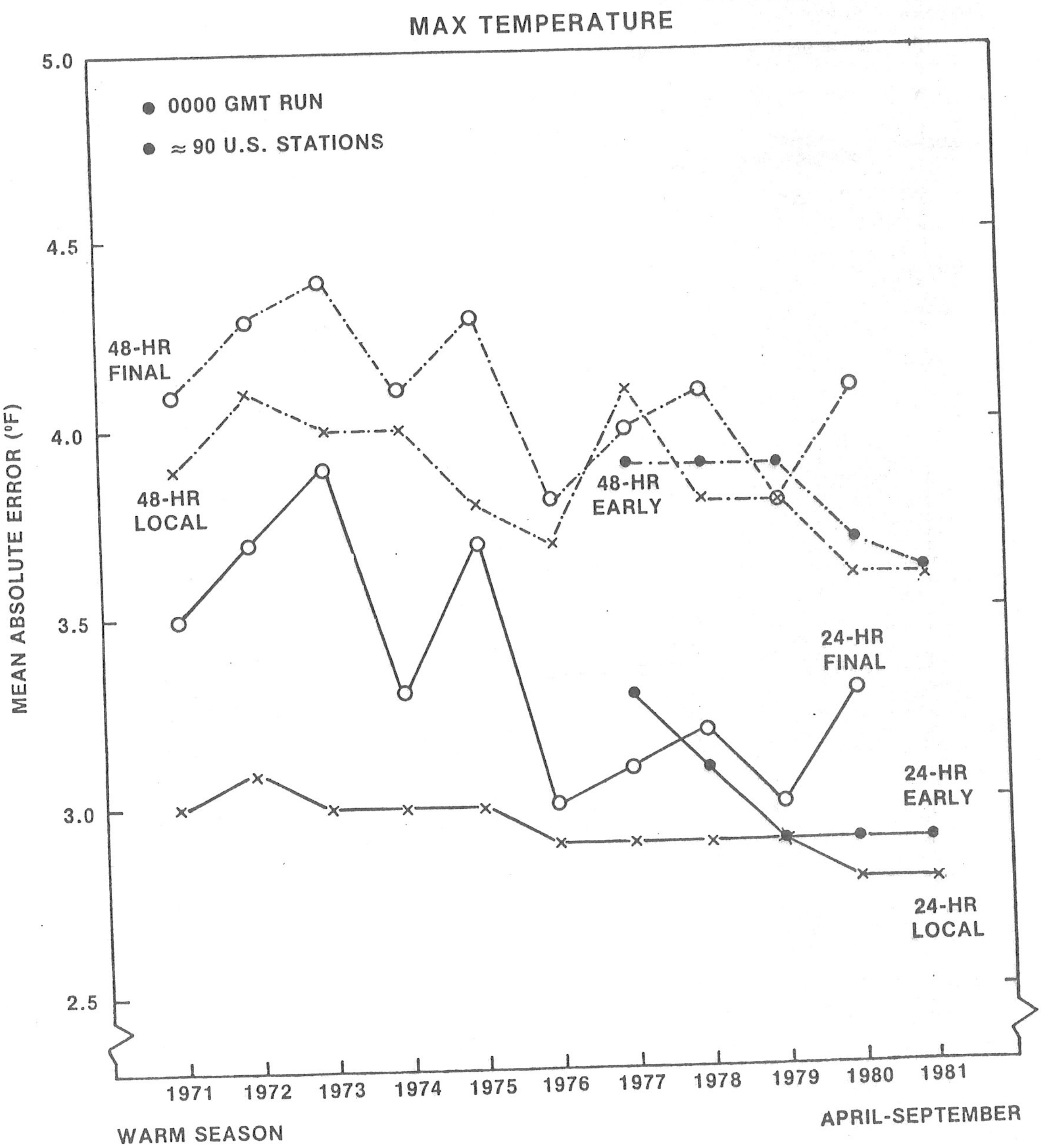

Figure 6.1. Mean absolute error for the local and the early and final guidance max temperature forecasts.

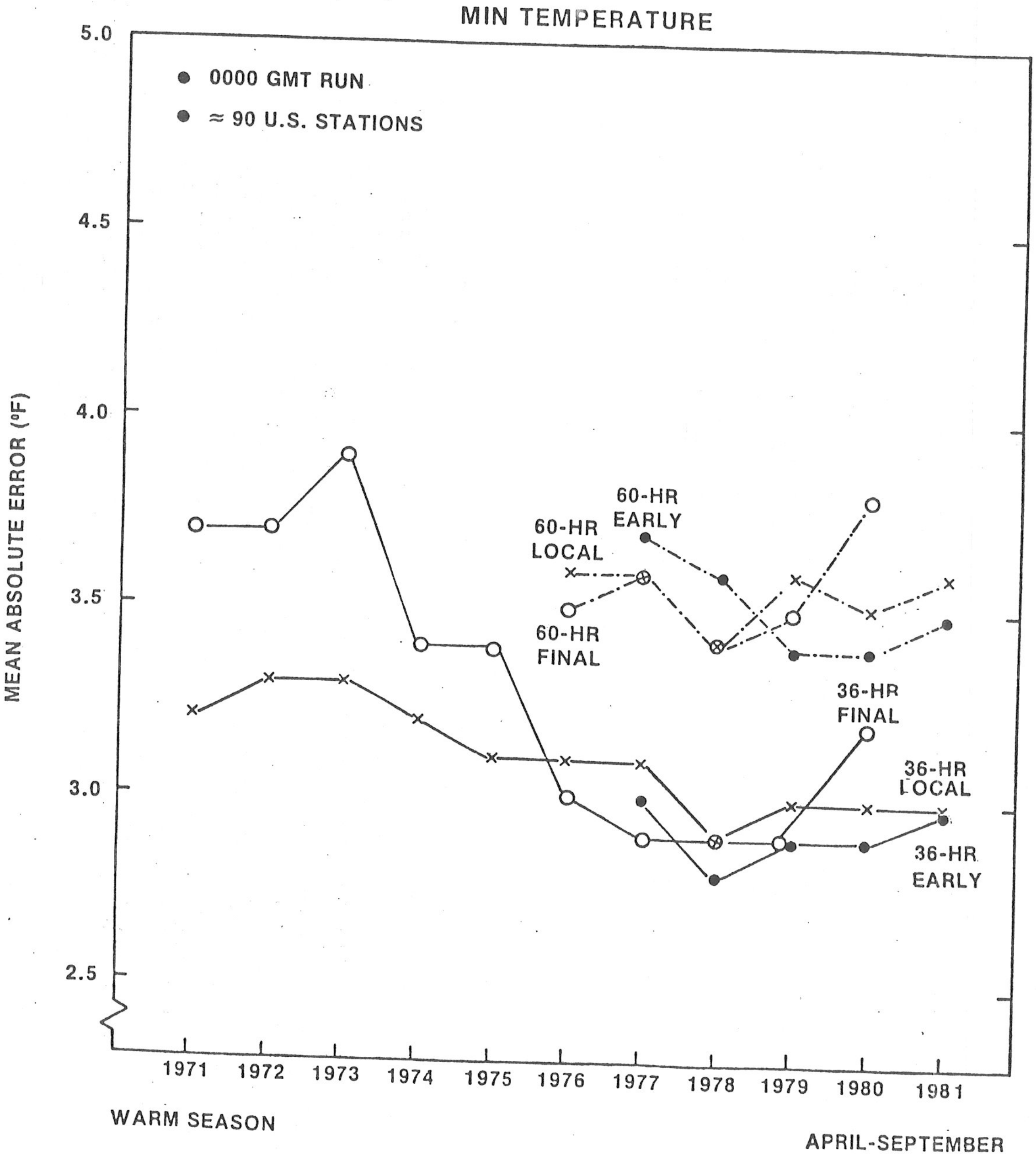

Figure 6.2. Same as Fig. 6.1 except for the min temperature.