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COMPARATIVE VERIFICATION OF GUIDANCE AND LOCAL AVIATION/PUBLIC WEATHER FORECASTS--No. 13
(October 1981-March 1982)

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1. INTRODUCTION

This is the thirteenth 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 cool season months of October 1981 through March 1982 for probability of precipitation (PoP), precipitation type (rain, freezing rain, or snow), 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 based primarily on PE 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. 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 aviation 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). 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.

The local public weather max/min and PoP forecasts used for this verification were official forecasts obtained from the Coded City Forecast (FPUS4) bulletin. Unfortunately, operational problems associated with implementation in 1982 of a new code for synoptic weather observations, and changes necessitated by the automated collection of FPUS4 bulletins from the AFOS communications system, caused the loss of much local public weather forecast data during January and

February of 1982. Hence, 1981-82 verification results for PoP, precipitation type, and max/min temperature are not compared with those for previous cool seasons.

We obtained all required observed verification data from the National Climatic Center in Asheville, North Carolina. These reports were carefully error-checked prior to computation of any of the verification scores.

2. PROBABILITY OF PRECIPITATION

Objective PoP forecasts were produced by the cool season prediction equations described in Technical Procedures Bulletin No. 289 (National Weather Service, 1980b). 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 or 1200 GMT. The predictors for the equations were forecast fields from the LFM-II model and surface variables observed at the forecast site at 0300 or 1500 GMT. Only early guidance was produced operationally during this cool season.

The 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 for PoP which is one-half the original score defined by Brier. Brier scores will vary from one station to the next and from one year to the next because of changes in the relative frequency of precipitation; 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).

As mentioned in the introduction, operational problems caused the loss of local forecast data during the months of January and February of 1982. The percent fewer cases compared to the previous cool season's verification varied by NWS region in the following manner: Eastern Region (19%), Southern Region (17%), Central Region (10%), and the Western Region (56%).

Tables 2.2 and 2.7 present the 1981-82 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. Comparison of the overall Brier scores and improvements over climate in Table 2.2 indicates the 0000 GMT cycle guidance forecasts were superior to local forecasts for the second and third periods. On the regional level for the 0000 GMT cycle (Tables 2.3-2.6), the local forecasts for the Southern and Western Regions were as good as or better than the guidance for all three periods. For the Eastern and Central Regions, the 0000 GMT cycle guidance forecasts were better for all three periods. As shown in Table 2.7, the 1200 GMT cycle local forecasts were superior overall to the guidance for the first and third periods. Regionally, for 1200 GMT (Tables 2.8-2.11), the local forecasts for the Eastern, Southern, and Western Regions were as good as or better than guidance forecasts for all three periods except for the second period Eastern Region local forecasts. For the Central Region, the 1200 GMT cycle guidance forecasts were better than the locals for the second and third periods.

Fig. 2.1 shows the trend since 1970-71 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 data, we did not feel justified in adding the results for the 1981-82 cool season, so Fig. 2.1 is a repeat of the graph which appeared in TDL Office Note 81-10 (Schwartz et al., 1981). In summary, both the guidance and local forecasts have improved over the years and the trend is most pronounced in the scores for the third-period forecasts.

3. PRECIPITATION TYPE

The early guidance conditional probability of precipitation type (PoPT) forecast system described in Technical Procedures Bulletin No. 243 (National Weather Service, 1978) provides categorical forecasts for three categories: frozen (snow or ice pellets), freezing (freezing rain or drizzle), and liquid (rain). Precipitation in the form of mixed snow and ice pellets is included in the frozen category; all other mixed precipitation types are included in the liquid category. In this report, the frozen, freezing, and liquid categories will be referred to as snow, freezing rain, and rain, respectively. The conditional probability of frozen precipitation (PoF) final guidance had been discontinued prior to the 1981-82 cool season.

For verification purposes, local categorical forecasts of precipitation type (made at about 1000 GMT) are recorded for three valid times, 1800 GMT (today), 0600 GMT (tonight), and 1800 GMT (tomorrow). Note, this is a conditional forecast; that is, it's a forecast of the type of precipitation if precipitation actually occurs. Therefore, a precipitation type forecast is always recorded. Similarly, the PoPT guidance forecasts are conditional and are available whether or not precipitation occurs.

Table 3.1 lists the 62 stations used for this verification study. Of course, the verification included only those cases in which precipitation actually occurred. Also, since we were concerned that some forecasters may not have put much effort into making the conditional forecasts when they considered precipitation to be unlikely, we used cases only when the local PoP was $\geq$30%. These PoP forecasts were valid for 12-h periods centered on the 18-, 30-, and 42-h projections from 0000 GMT. It should also be noted that because of operational trouble, much local PoP forecast data were lost during the months of January and February of 1982 which, in turn, reduced the size of the precipitation type verification sample.

We compared the PoPT guidance with local forecasts for the snow, freezing rain, and rain categories. Table 3.2 shows the verification results. The bias values for the freezing rain category are not shown because there weren't enough cases to provide meaningful results. The scores for all stations combined indicate: (1) the guidance was better than the local forecasts for both skill score[1] and percent correct for all three projections; and (2) as

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

shown by the bias by category[2] results, the guidance system tended to over-forecast the snow event, as did the local forecasts for the 30-h projection. Overall, the local forecasts had slightly better bias characteristics. In the regional breakdown, the results show: (1) the guidance generally was better than the local forecasts in the Eastern Region for all projections, the Southern and Central Regions for 18 hours, and the Central and Western Regions for 42 hours; and (2) the local forecasts were better than the guidance in the Western Region for 18 hours, the Central and Western Regions for 30 hours, and the Southern Region for 42 hours.

The percents correct shown in the verification tables are high because the sample included many "obvious" forecasts. For instance, on some days in the South, precipitation, if it occurred, would obviously be rain. Therefore, in order to isolate some of the more difficult forecasting situations, we verified cases in which the guidance and local forecasts of snow, freezing rain, or rain differed. Again, we used only those cases for which local PoP was $\geq$30%. The results, presented in Table 3.3, indicate the 18-, 30-, and 42-h guidance forecasts were correct 52.5%, 51.7%, and 54.7% of the time, respectively, while the corresponding local forecasts were correct 37.5%, 37.9%, and 45.3% of the time.

The skill scores for the guidance and local forecasts for the past nine seasons are shown in Fig. 3.1; only the scores for the 18- and 42-h forecasts are presented. Over these years, two changes in the verification procedure took place: (1) the number of stations changed from around 90 for the first 2 years to approximately 60 thereafter; and (2) starting with the 1975-76 season, we used cases only where the local PoP was $\geq$30% in order to isolate those situations where the forecaster was more confident precipitation would occur. As with PoP, we did not feel justified in including the results for the 1981-82 cool season because of the significant data loss which occurred. What is shown in Fig. 3.1 is a repeat of the figure which appeared in TDL Office Note 81-10 (Schwartz et al., 1981). The results show the guidance was consistently better than the locals during these 9 years except for the 1980-81 season when the 42-h local forecasts were better than the final guidance. The PoPT system, which replaced the PoF early guidance operationally during the 1978-79 season, has been consistently better than the final guidance.

4. SURFACE WIND

The objective surface wind forecasts were generated by the cool season, LFM-based equations described in Technical Procedures Bulletin No. 316 (National Weather Service, 1982a). Only the early guidance has been available since the 1978-79 cool 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. Prior to the 1980-81 cool season, a significant change occurred in the operational early guidance wind prediction system. New

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[2]In the discussion of precipitation type, 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.

equations were developed without screening as predictors any surface pressure or boundary layer fields from the LFM model. 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. 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, percent correct, and bias by category 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 4.1 lists the 88 stations used in this verification. 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 88 stations combined are shown in Tables 4.2 and 4.3. The MAE's in Table 4.2 for the direction forecasts reveal an advantage for the guidance that is 3° for the 18-h projection, 6° for the 30-h projection, and 5° for the 42-h projection. The speed MAE's, skill scores, and percents correct generally were better for the guidance. The bias by category values in Table 4.2 and the contingency tables in Table 4.3 indicate for all three projections the guidance generally overestimated winds stronger than 22 knots (i.e., categories 5, 6, and 7). Prior to the implementation of the new equations, the guidance had a tendency to underforecast the stronger winds. We think this reversal to overforecasting is the result of both the new equations and recent changes in the LFM model. The most important predictors in the new equations are 1000-mb geostrophic wind components which are sensitive to the accuracy of the LFM 1000-mb height forecasts. On several occasions last winter, we noticed unrealistic pressure gradients predicted by the LFM which, in turn, caused the MOS wind speed guidance to be too strong. Overall, the results for the 1981-82 cool season showed considerable deterioration in MAE, skill score, and percent correct in comparison to the 1980-81 cool season. We think this is directly related to the trouble the LFM model had last winter in forecasting both the movement and intensity of synoptic-scale weather systems throughout the central and eastern United States.

Tables 4.4-4.7 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 4.5), the MAE's for the local 30- and 42-h speed forecasts, and the percent correct for the 42-h forecasts, were slightly better than those for the guidance. For the Western Region (Table 4.7), the MAE of the local 18-h speed forecasts and the percents correct of the local 18- and 30-h forecasts were slightly better than the corresponding scores for the guidance.

Table 4.8 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 88 stations combined. Note that the guidance had about 5%, 8%, and 7% fewer errors of 40° or more than did the local forecasts for the 18-, 30-, and 42-h projections, respectively.

Distribution of direction errors for each of the four regions are given in Tables 4.9-4.12, respectively. In general, these results are much like those in Table 4.8 except, once again, the advantage of the guidance over local forecasts differs in magnitude from region to region.

A comparison of overall MAE's and skill scores during the past nine cool seasons for the 18- and 42-h guidance and local forecasts is presented in Figs. 4.1-4.4. 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's and skill scores in these figures indicate the consistent superiority of the early over the final guidance when both were available.

The MAE's for direction are given in Fig. 4.1. For the most part, the guidance and local forecasts for both projections generally improved over the 8 years prior to the 1981-82 cool season. However, the MAE's for the 1981-82 cool season deteriorated, especially for the 42-h projection.

The MAE's for speed in Fig. 4.2 show that the accuracy of the final guidance forecasts deteriorated after the introduction of inflation in July of 1975. We realized 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 the use of the inflation technique, the MAE's for the 18-h early guidance are generally as good as the 1973-74 and 1974-75 (pre-inflation) final guidance values. Note the consistent superiority of the early guidance forecasts over the local forecasts for the 18-h projection, and the increase in the MAE's for the early guidance during 1981-82.

Fig. 4.3 is a comparison of guidance and local skill scores computed on five (instead of seven) categories of wind speed; the fifth category included all speeds >22 knots. Of particular interest in Fig. 4.3 is the magnitude of the advantage in skill of the guidance over the locals for both projections. With the exception of the 18-h final guidance for 1978-79, the guidance outperformed the local forecasts throughout the entire period.

Fig. 4.4 depicts a comparison of guidance and local skill scores computed on two categories; the first category contained all wind speeds ≤22 knots, while the second category included speeds >22 knots. In this manner, we attempted to assess more directly the skill of the guidance and local forecasts in regard to predicting strong winds. Once again, the skill scores for the early guidance were consistently superior to those for the local forecasts. The skill scores for the 18-h forecasts improved while the skill scores for the 42-h early guidance deteriorated from 1980-81 to 1981-82.

5. OPAQUE SKY COVER

During the 1981-1982 cool season, the opaque sky cover forecasts were produced by the new prediction equations described in Technical Procedures

Bulletin No. 303 (National Weather Service, 1981). These equations used LFM-II model output and 0300 (1500) GMT surface observations to produce forecasts for 10 projections at 6-h intervals from 6 to 60 hours after 0000 and 1200 GMT. Regionalized equations produced probability forecasts of the four categories of opaque sky cover, more commonly known as cloud amount, shown in Table 5.1. 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 old equations used an inflation technique to obtain the best category, while the new equations use the threshold technique.

We compared the local forecasts with a matched sample of early guidance forecasts for the 88 stations listed in Table 4.1 for the 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 5.1. 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 5.2. For all three 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, except for the 18-h forecasts of the overcast category, the guidance forecasts were better (i.e., closer to 1.0) than the local forecasts for each projection and 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 5.3-5.6, respectively. In the regional breakdown, the percents correct, skill scores, and bias by category values for the guidance forecasts were in most cases better than those for the local forecasts.

Percents correct and skill scores for the past eight cool seasons are shown in Figs. 5.1 and 5.2, respectively, for the 18- and 42-h projections. These figures show that the 1981-82 guidance forecasts improved over those for the previous year. The scores for local forecasts decreased in accuracy or were about the same, except for the 42-h skill score which improved.

Figures 5.3-5.6 show bias values for categories 1 through 4, respectively, for the 18-h forecasts.[3] The local forecast biases for all four categories,

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[3]In past cool season verification reports (e.g., Schwartz et al., 1981), bias 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 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.

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 broken categories. The biases for the guidance forecasts have been consistently superior to the local forecasts during the past 8 years.

6. CEILING AND VISIBILITY

During the 1981-82 cool season, the ceiling and visibility guidance was produced by the new set of prediction equations described in Technical Procedures Bulletin No. 303 (National Weather Service, 1981). 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 88 stations listed in Table 4.1. 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 was used as a standard of comparison. Guidance forecasts were verified for both cycles for the 12-, 18-, 24-, 36-, and 48-h projections, while local forecasts were verified 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 6.1 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. Tables 6.2-6.5 present the results. We then collapsed the tables to two categories (categories 1 and 2 combined versus 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. These results are summarized in Tables 6.6-6.9. Skill scores and bias values for categories 1 and 2 combined for the past seven cool seasons are also shown in Figs. 6.1-6.8 for selected projections from 0000 GMT.

The scores in Tables 6.2-6.5 for the 12-h projections from 0000 and 1200 GMT indicate the skill of the guidance and the local ceiling and visibility forecasts did not exceed the skill of persistence. With the exception of the visibility forecasts for the 15-h projection from 0000 GMT (Table 6.3), the local forecasts of ceiling and visibility had higher skill scores than persistence for the 15- and 21-h projections for both forecast cycles. For the 18-, 24-, 36-, and 48-h projections, the guidance, in all cases, outperformed persistence by a wide margin in skill. Also, 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 both the guidance and persistence generally were better than those for the local forecasts.

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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.

Tables 6.6-6.9 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 0.017 to 0.069. This fact, plus lower skill scores for the two-category tables as compared to the six-category tables, indicate these events are quite difficult to forecast. For the 12-h projection, the skill of the persistence ceiling and visibility forecasts exceeded those for the local forecasts and were much better than those for the guidance forecasts in all cases. For the 15- and 21-h projections, persistence ceiling and visibility skill scores were superior to those for the 0000 GMT cycle local forecasts; however, for 1200 GMT cycle, the local skill scores for these projections generally were better than those for persistence forecasts. For the 18-, 24-, 36-, and 48-h projections, the guidance ceiling and visibility skill scores were superior to those for persistence.

Figs. 6.1-6.8 are trend graphs for skill score and bias by category for selected projections of the 0000 GMT cycle, two-category ceiling and visibility forecasts (see footnote 3 for more details about the new format of Figs. 6.5-6.8). Figs. 6.1-6.4 indicate that the guidance skill scores for the 12-h projection have remained about the same, while skill scores for the 18-h projection have been variable. In particular, during 1981-82 the ceiling guidance for the 18-h projection increased in skill, while the skill of visibility guidance decreased. Figs. 6.5-6.8 indicate that the 12-h persistence and local ceiling and visibility forecasts had better bias characteristics for categories 1 and 2 than during the previous year. For the first time, the guidance forecasts overforecast categories 1 and 2 by a considerable amount.

7. MAXIMUM/MINIMUM TEMPERATURE

The objective max/min temperature guidance for October 1981 through March 1982 was generated by the LFM-based regression equations described in Technical Procedures Bulletin No. 285 (National Weather Service, 1980a). 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 input data times of 0000 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). We used fall (September-November), winter (December-February), and spring (March-May) equations to produce the guidance for the cool 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.

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 valid for the calendar day starting at the subsequent midnight. The valid times for the max/min guidance for the other periods correspond to specific calendar day periods in an analogous manner. 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. The latter time, however, is extended to around 1800 GMT for forecasters in the Western Region and for other forecasters 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 synoptic max/min reports representing a 12-h period for a second set of verifications. For the 36-h min and 48-h max projections, the number of absolute errors $\geq 10^{\circ}$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 deteriorated by 0.4°F when the 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 presented the original comparative verification results for the cool season of 1980-81.

For the 1981-82 cool season, we verified the 0000 and 1200 GMT cycle local and objective forecasts by using calendar day max and min temperatures obtained from the National Climatic Center. Since, as we mentioned before, this method of verification is controversial, the 1981-82 cool season is the last period for which we will present comparative results for the max and min temperature forecasts until a more consistent verification system is available. This policy conforms with a recommendation from the 1982 NWS Line Forecasters Technical Advisory Committee. Because of data problems similar to those for PoP and precipitation type, the overall verification sample was nearly 25% smaller than that for the previous cool season. 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). 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 approximately 24 (min), 36 (max), 48 (min), and 60 (max) hours were verified.

The results for all stations combined for 0000 GMT are shown in Table 7.1. In terms of MAE, the local forecasts were 0.2°F more accurate than the guidance for the 60-h min. For the other projections, guidance and local MAE's were about the same. For all periods, the difference in the number of large absolute errors between the guidance and the local forecasts followed the trends in MAE. Tables 7.2-7.5 give the 0000 GMT verification scores for the Eastern, Southern, Central, and Western Regions, respectively. In regard to MAE, forecasters in the Southern and Western Regions were slightly more accurate than the guidance for all four projections.

Table 7.6 shows verification results for all stations combined for the 1200 GMT cycle. For the 24-h min, the guidance and local forecasts were equal in MAE although the guidance had fewer large absolute errors. We think this difference in the number of large errors between the local forecasts and the guidance may be related to the different forecast periods used in the subjective and objective forecasts. The 1200 GMT cycle regional verification scores shown in Tables 7.7-7.10 generally follow the trends for all stations combined. Forecasters in the Southern Region were better than the guidance at all projections except the 24-h min. Local forecasts in the Central and Western Regions were more accurate than the guidance for the 60-h max. Except for the Southern Region, the MAE's for similar projections (24-h max/min, 36-h max/min, and so forth) presented in Tables 7.1-7.10 are generally larger for the min forecast than for the max.

Max temperature forecast MAE's (0000 GMT cycle only) are shown in Fig. 7.1 for the last 10 cool seasons. Because of the reduced sample, the 1981-82 results are not plotted on Fig. 7.1. What is shown is a repeat of the graph that appeared in TDL Office Note 81-10 (Schwartz et al., 1981). The final guidance was ended in December 1980 because of the obvious poor performance compared to the LFM-based early guidance. The curves indicate that there has been improvement in the accuracy of both the local forecasts and the objective guidance during the 10-year period. In general, the lowest MAE's occurred during the 1980-81 cool season.

An analogous time series (0000 GMT only) is shown in Fig. 7.2 for the min temperature forecasts. Again, results from 1981-82 were not included. Verifications for the 60-h projection are available only for the last four cool seasons. For the 36- and 60-h projections, there has been an overall improvement in both the local forecasts and the objective guidance during the period of record; however, natural variability and the difficulty of predicting the min during the cool season results in irregular error curves.

8. SUMMARY

Highlights of the 1981-82 cool 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 GMT and 1200 GMT. The Brier scores for all stations combined and both forecast cycles indicate the local forecasts for the first period were better than the corresponding LFM-based guidance. In contrast, the second-period PoP guidance was better than the local forecasts for both cycles. For the third period, the local forecasts were better than the guidance for the 1200 GMT cycle only. No comparison was made with the scores for prior years because of the loss of local forecast data during January and February of 1982.

- Precipitation Type - Local and guidance forecasts for 62 stations and projections of 18, 30, and 42 hours from 0000 GMT comprised the comparative verification; only those cases where the local PoP $\geq$30% were verified. The results for all stations combined indicate the

PoPT guidance generally was better than the local forecasts. As with PoP, no comparison was made with the results for the 1980-81 cool season because of the loss of local forecast data.

- Surface Wind - The comparative verifications were conducted for 88 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 1981-82 cool season were not as good as those for 1980-81. We think this is related to changes in the operational version of the LFM model.

- Opaque Sky Cover - The 0000 GMT cycle verification results for all 88 stations combined indicate the LFM-based guidance was better than the local forecasts in terms of percent correct, skill score, and bias by category (clear, scattered, broken, and overcast) for all three projections of 18, 30, and 42 hours from 0000 GMT. The cloud amount guidance for the 1981-82 cool season was produced by new sets of prediction equations. In comparison to the previous cool season, the scores for the local and guidance forecasts generally were as good as those for the previous cool season; however, there were variations in the comparison depending on the type of forecast and the projection. The verification also shows the local forecasts had a tendency to overforecast the scattered and broken categories while underforecasting the clear and overcast categories.

- Ceiling and Visibility - The verification involved comparison of local forecasts, LFM-based guidance, and persistence forecasts for 88 stations, and for projections ranging from 12 to 48 hours from 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 local and persistence forecasts, and in this sense it is a 9-h projection for the guidance. The 12-h projection verification scores for both ceiling and visibility indicate the persistence and local forecasts were superior to the guidance. In contrast, for the longer range projections, the local and guidance forecasts were much better than persistence. As with opaque sky cover, new ceiling and visibility prediction equations were operational during the 1981-82 cool season.

- Maximum/Minimum Temperature - Local and guidance max/min temperature forecasts for both the 0000 and 1200 GMT cycles were verified for 87 stations. The LFM-based guidance is valid for calendar day periods while the local forecasts are for 12- to 18-h periods. All forecasts in this study were verified against calendar day max/min reports so caution is necessary when comparing scores for the local forecasts and the guidance. Generally, the local forecasters were able to improve upon the objective guidance for the 24-, 36-, and 60-h max temperature forecasts and also for the 48- and 60-h min prognoses. As shown by the mean absolute errors, the min temperature tends to be slightly more difficult to predict than the max during the cool season. This is the last report in which comparisons will be made between the accuracy of the guidance and local max/min temperature forecasts until the new verification system outlined in the NWS National Verification Plan (National Weather Service, 1982b) is implemented.

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

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
ALB	Albany, New York	DEN	Denver, Colorado
BUF	Buffalo, New York	ORD	Chicago (O'Hare), Illinois
JFK	New York (Kennedy), New York	EVV	Evansville, Indiana
SYR	Syracuse, New York	IND	Indianapolis, Indiana
AVL	Asheville, North Carolina	DSM	Des Moines, Iowa
CLT	Charlotte, North Carolina	ICT	Wichita, Kansas
RDU	Raleigh-Durham, North Carolina	TOP	Topeka, Kansas
CLE	Cleveland, Ohio	SDF	Louisville, Kentucky
CMH	Columbus, Ohio	DTW	Detroit, Michigan
CVG	Cincinnati, Ohio	SSM	Sault Ste. Marie, Michigan
DAY	Dayton, Ohio	DLH	Duluth, Minnesota
PHL	Philadelphia, Pennsylvania	MSP	Minneapolis, Minnesota
PIT	Pittsburgh, Pennsylvania	MCI	Kansas City, Missouri
PVD	Providence, Rhode Island	STL	St. Louis, Missouri
CAE	Columbia, South Carolina	LBF	North Platte, Nebraska
CHS	Charleston, South Carolina	OMA	Omaha, Nebraska
BTV	Burlington, Vermont	BIS	Bismarck, North Dakota
ORF	Norfolk, Virginia	FAR	Fargo, North Dakota
RIC	Richmond, Virginia	FSD	Sioux Falls, South Dakota
CRW	Charleston, West Virginia	RAP	Rapid City, South Dakota
BHM	Birmingham, Alabama	MKE	Milwaukee, Wisconsin
LIT	Little Rock, Arkansas	CPR	Casper, Wyoming
JAX	Jacksonville, Florida	CYS	Cheyenne, Wyoming
MIA	Miami, Florida	FLG	Flagstaff, Arizona
ORL	Orlando, Florida	PHX	Phoenix, Arizona
TPA	Tampa, Florida	TUS	Tucson, Arizona
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 87 stations, 0000 GMT cycle.

Projection (h)	Type of Forecast	Brier Score	Improvement Over Guidance (%)	Improvement Over Climate (%)	Number of Cases
12-24	Early	.0875		49.4	
(1st period)	Local	.0866	1.2	49.7	9539
24-36	Early	.1056		32.4	
(2nd period)	Local	.1068	-1.1	31.8	9539
36-48	Early	.1126		36.0	
(3rd period)	Local	.1155	-2.4	34.3	9538

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	Early	.0932		48.6	
(1st period)	Local	.0994	-6.6	45.2	2894
24-36	Early	.1078		43.9	
(2nd period)	Local	.1110	-2.9	42.3	2893
36-48	Early	.1224		33.5	
(3rd period)	Local	.1293	-5.7	29.8	2894

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	.0838		61.1	
(1st period)	Local	.0767	8.4	64.4	2976
24-36	Early	.0923		24.0	
(2nd period)	Local	.0920	0.3	24.3	2977
36-48	Early	.0985		52.8	
(3rd period)	Local	.0982	0.3	52.9	2975

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	.0837		40.6	
	Local	.0852	-1.9	39.5	2716
24-36 (2nd period)	Early	.1146		30.6	
	Local	.1206	-5.3	26.9	2717
36-48 (3rd period)	Early	.1152		24.0	
	Local	.1217	-5.6	19.7	2716

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 (1st period)	Early	.0929		40.4	
	Local	.0824	11.3	47.2	953
24-36 (2nd period)	Early	.1150		28.7	
	Local	.1008	12.4	37.5	952
36-48 (3rd period)	Early	.1197		25.1	
	Local	.1101	8.0	31.1	953

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	.0963		38.7	
(1st period)	Local	.0943	2.1	40.0	9230
24-36	Early	.1002		41.4	
(2nd period)	Local	.1022	-1.9	40.2	9233
36-48	Early	.1201		23.9	
(3rd period)	Local	.1190	1.1	24.8	9235

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	Early	.0975		46.8	
(1st period)	Local	.0973	0.2	46.8	2771
24-36	Early	.1060		38.9	
(2nd period)	Local	.1114	-5.1	35.8	2772
36-48	Early	.1232		34.5	
(3rd period)	Local	.1224	0.6	35.0	2772

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	Early	.0880		31.6	
(1st period)	Local	.0860	2.3	33.2	2947
24-36	Early	.0921		56.5	
(2nd period)	Local	.0920	0.1	56.6	2946
36-48	Early	.1076		16.7	
(3rd period)	Local	.1036	3.6	19.7	2947

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	.1047		37.4	
(1st period)	Local	.1042	0.4	37.7	2578
24-36	Early	.1010		31.5	
(2nd period)	Local	.1048	-3.7	29.0	2580
36-48	Early	.1302		21.9	
(3rd period)	Local	.1328	-2.0	20.3	2581

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	.0956		40.2	
(1st period)	Local	.0843	11.9	47.3	934
24-36	Early	.1064		28.1	
(2nd period)	Local	.0999	6.1	32.5	935
36-48	Early	.1230		20.6	
(3rd period)	Local	.1198	2.7	22.7	935

Table 3.1. Sixty-two stations used for comparative verification of guidance and local precipitation type forecasts.

DCA	Washington, D.C.	DFW	Dallas-Ft. Worth, Texas
PWM	Portland, Maine	IAH	Houston, 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	IND	Indianapolis, Indiana
JFK	New York (Kennedy), New York	DSM	Des Moines, Iowa
SYR	Syracuse, New York	TOP	Topeka, Kansas
CLT	Charlotte, North Carolina	DTW	Detroit, Michigan
RDU	Raleigh-Durham, North Carolina	SDF	Louisville, Kentucky
CLE	Cleveland, Ohio	MSP	Minneapolis, Minnesota
CMH	Columbus, Ohio	MCI	Kansas City, Missouri
PHL	Philadelphia, Pennsylvania	STL	St. Louis, Missouri
PIT	Pittsburgh, Pennsylvania	OMA	Omaha, Nebraska
PVD	Providence, Rhode Island	BIS	Bismarck, North Dakota
CHS	Charleston, South Carolina	FAR	Fargo, North Dakota
CAE	Columbia, South Carolina	FSD	Sioux Falls, South Dakota
ORF	Norfolk, Virginia	RAP	Rapid City, South Dakota
CRW	Charleston, West Virginia	MKE	Milwaukee, Wisconsin
BHM	Birmingham, Alabama	CYS	Cheyenne, Wyoming
LIT	Little Rock, Arkansas	PHX	Phoenix, Arizona
JAX	Jacksonville, Florida	LAX	Los Angeles, California
MIA	Miami, Florida	SAN	San Diego, California
ATL	Atlanta, Georgia	SFO	San Francisco, California
MSY	New Orleans, Louisiana	BOI	Boise, Idaho
SHV	Shreveport, Louisiana	GTF	Great Falls, Montana
JAN	Jackson, Mississippi	RNO	Reno, Nevada
ABQ	Albuquerque, New Mexico	PDX	Portland, Oregon
OKC	Oklahoma City, Oklahoma	SLC	Salt Lake City, Utah
TUL	Tulsa, Oklahoma	GEG	Spokane, Washington
MEM	Memphis, Tennessee	SEA	Seattle-Tacoma, Washington

Table 3.2 Comparative verification of early PoPT guidance and local forecasts for 62 stations, 0000 GMT cycle. Only cases where the local PoP was $\geq$30% are included.

Projection (h)	Region (No. Stns)	Type of Forecast	Bias Snow	Bias Rain	Percent Correct	Skill Score	Number of Cases
18	Eastern (19)	Early	1.05	.97	93.0	83.4	
		Local	.99	.99	92.6	82.3	284
	Southern (15)	Early	1.00	.98	97.5	68.9	
		Local	.50	1.01	97.5	56.1	118
	Central (17)	Early	.99	.95	90.8	82.1	
		Local	.93	1.00	85.9	72.8	163
	Western (11)	Early	1.57	.96	93.5	70.3	
		Local	1.29	.99	97.4	86.9	77
	All Stations	Early	1.04	.97	93.3	83.8	
		Local	.96	1.00	92.4	81.1	642
30	Eastern (19)	Early	1.10	.97	89.3	77.5	
		Local	1.10	.96	86.2	71.1	318
	Southern (15)	Early	.50	1.00	97.8	82.5	
		Local	1.25	1.00	97.8	82.4	92
	Central (17)	Early	1.13	.86	86.7	74.8	
		Local	1.09	.95	87.2	75.3	180
	Western (11)	Early	1.08	.99	86.0	53.9	
		Local	1.23	.97	87.2	58.6	86
	All Stations	Early	1.10	.96	89.3	77.0	
		Local	1.10	.97	88.2	74.2	676
42	Eastern (19)	Early	1.02	.98	88.2	74.4	
		Local	1.04	.98	87.9	73.5	280
	Southern (15)	Early	1.67	.95	92.8	37.3	
		Local	1.00	.99	96.4	55.5	83
	Central (17)	Early	1.17	.80	85.1	70.6	
		Local	1.01	.97	81.1	62.8	148
	Western (11)	Early	1.27	.97	93.4	77.0	
		Local	1.18	.98	92.1	71.5	76
	All Stations	Early	1.11	.94	88.8	75.3	
		Local	1.04	.98	87.9	72.7	587

Table 3.3. Comparative verification of early PoPT guidance and local forecasts for 62 stations, 0000 GMT cycle. Only those cases in which the locals and guidance differed, and the local PoP was $\geq$30%, are included.

Projection (h)	Type of Forecast	Percent Correct	Number of Cases
18	Early	52.5	40
	Local	37.5	
30	Early	51.7	58
	Local	37.9	
42	Early	54.7	53
	Local	45.3	

Table 4.1. Eighty-eight stations used for comparative verification of guidance and local surface wind, opaque sky cover, ceiling height, and visibility forecasts.

DCA	Washington, D.C.	SAT	San Antonio, Texas
PWM	Portland, Maine	DEN	Denver, Colorado
BOS	Boston, Massachusetts	GJT	Grand Junction, Colorado
CON	Concord, New Hampshire	ORD	Chicago (O'Hare), Illinois
ACY	Atlantic City, New Jersey	SPI	Springfield, Illinois
EWR	Newark, New Jersey	IND	Indianapolis, Indiana
ALB	Albany, New York	SBN	South Bend, Indiana
BUF	Buffalo, New York	DSM	Des Moines, Iowa
JFK	New York (Kennedy), New York	DDC	Dodge City, Kansas
SYR	Syracuse, New York	TOP	Topeka, Kansas
CLT	Charlotte, North Carolina	LEX	Lexington, Kentucky
RDU	Raleigh-Durham, North Carolina	SDF	Louisville, Kentucky
CLE	Cleveland, Ohio	APN	Alpena, Michigan
CMH	Columbus, Ohio	DTW	Detroit, Michigan
ERI	Erie, Pennsylvania	INL	International Falls, Minnesota
PHL	Philadelphia, Pennsylvania	MSP	Minneapolis, Minnesota
PIT	Pittsburgh, Pennsylvania	MCI	Kansas City, Missouri
PVD	Providence, Rhode Island	STL	St. Louis, Missouri
CAE	Columbia, South Carolina	BFF	Scottsbluff, Nebraska
CHS	Charleston, South Carolina	OMA	Omaha, Nebraska
ORF	Norfolk, Virginia	BIS	Bismarck, North Dakota
CRW	Charleston, West Virginia	FAR	Fargo, North Dakota
HTS	Huntington, West Virginia	FSD	Sioux Falls, South Dakota
BHM	Birmingham, Alabama	RAP	Rapid City, South Dakota
MOB	Mobile, Alabama	MKE	Milwaukee, Wisconsin
FSM	Fort Smith, Arkansas	MSN	Madison, Wisconsin
LIT	Little Rock, Arkansas	CYS	Cheyenne, Wyoming
JAX	Jacksonville, Florida	SHR	Sheridan, Wyoming
MIA	Miami, Florida	PHX	Phoenix, Arizona
ATL	Atlanta, Georgia	FAT	Fresno, California
SAV	Savannah, Georgia	LAX	Los Angeles, California
MSY	New Orleans, Louisiana	SAN	San Diego, California
SHV	Shreveport, Louisiana	SFO	San Francisco, California
JAN	Jackson, Mississippi	BOI	Boise, Idaho
MEI	Meridian, Mississippi	PIH	Pocatello, Idaho
ABQ	Albuquerque, New Mexico	GTF	Great Falls, Montana
TCC	Tucumcari, New Mexico	MSO	Missoula, Montana
OKC	Oklahoma City, Oklahoma	RNO	Reno, Nevada
TUL	Tulsa, Oklahoma	PDT	Pendleton, Oregon
MEM	Memphis, Tennessee	PDX	Portland, Oregon
TYS	Knoxville, Tennessee	CDC	Cedar City, Utah
ABI	Abilene, Texas	SLC	Salt Lake City, Utah
DFW	Dallas-Ft. Worth, Texas	GEG	Spokane, Washington
IAH	Houston, Texas	SEA	Seattle-Tacoma, Washington

Table 4.2. Comparative verification of early guidance and local surface wind forecasts for 88 stations, 0000 GMT cycle.

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	28	8723	3.3	13.2	12.0	8806	.313	52.3	0.97	0.99	1.03	1.09	1.30	1.29	0.80	15492
	Local	31		3.6	13.4			.269	49.0	0.72 (5803)	1.18 (5624)	1.21 (2868)	1.07 (911)	0.79 (225)	0.51 (51)	1.20 (10)	
30	Early	31	5601	3.9	12.3	10.4	5736	.316	60.0	0.94	1.05	1.18	1.02	1.12	0.74	0.00	15477
	Local	37		4.2	12.4			.256	55.1	0.83 (8968)	1.28 (4430)	1.24 (1549)	0.96 (426)	0.63 (81)	0.68 (19)	0.25 (4)	
42	Early	39	8573	4.1	13.5	11.6	8701	.224	45.7	0.92	0.98	1.07	1.27	1.35	1.35	1.73	15472
	Local	44		4.1	13.0			.192	44.4	0.75 (5797)	1.25 (5625)	1.12 (2847)	0.84 (908)	0.49 (232)	0.44 (52)	0.55 (11)	

Table 4.3. Contingency tables for early guidance and local surface wind speed forecasts for 88 stations, 0000 GMT cycle.

18-h Forecasts

Guidance

OBS	1	2	3	4	5	6	7	T
1	3750	1716	310	24	3	0	0	5803
2	1680	2714	1059	152	13	6	0	5624
3	196	991	1211	384	76	10	0	2868
4	12	109	332	334	108	13	3	911
5	3	11	31	79	76	23	2	225
6	0	2	5	18	13	11	2	51
7	0	0	0	3	3	3	1	10
T	5641	5543	2948	994	292	66	8	15492

Local

OBS	1	2	3	4	5	6	7	T
1	2897	2418	434	49	5	0	0	5803
2	1102	3055	1280	173	13	0	1	5624
3	161	1032	1286	338	46	2	3	2868
4	14	125	412	299	49	9	3	911
5	3	15	53	96	48	8	2	225
6	1	1	9	17	15	6	2	51
7	0	0	2	5	1	1	1	10
T	4178	6646	3476	977	177	26	12	15492

30-h Forecasts

Guidance

OBS	1	2	3	4	5	6	7	T
1	6617	1955	358	32	6	0	0	8968
2	1620	1988	707	96	18	1	0	4430
3	185	620	555	161	24	4	0	1549
4	12	95	179	109	27	4	0	426
5	0	11	26	30	10	4	0	81
6	0	3	6	5	4	1	0	19
7	0	0	2	0	2	0	0	4
T	8434	4672	1833	433	91	14	0	15477

Local

OBS	1	2	3	4	5	6	7	T
1	5756	2663	489	58	2	0	0	8968
2	1423	2167	721	108	6	5	0	4430
3	203	695	501	125	23	1	1	1549
4	27	130	162	91	12	4	0	426
5	3	15	34	20	6	3	0	81
6	3	1	8	6	1	0	0	19
7	0	0	2	1	1	0	0	4
T	7415	5671	1917	409	51	13	1	15477

42-h Forecasts

Guidance

OBS	1	2	3	4	5	6	7	T
1	3329	1867	510	74	13	3	1	5797
2	1684	2449	1145	289	49	7	2	5625
3	295	1020	980	429	102	18	3	2847
4	41	150	338	262	92	20	5	908
5	7	23	60	81	42	16	3	232
6	3	4	11	15	10	5	4	52
7	0	1	1	1	6	1	1	11
T	5359	5514	3045	1151	314	70	19	15472

Local

OBS	1	2	3	4	5	6	7	T
1	2684	2524	530	55	3	1	0	5797
2	1318	2967	1141	183	13	2	1	5625
3	311	1228	1004	259	37	6	2	2847
4	47	243	391	185	36	6	0	908
5	12	38	98	62	17	4	1	232
6	2	8	14	17	6	4	1	52
7	0	0	7	2	1	0	1	11
T	4374	7008	3185	763	113	23	6	15472

Table 4.4. Same as Table 4.2 except for 23 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	26	2540	3.0	12.9	12.1	2556	.311	51.9	1.01	0.99	0.98	1.03	1.48	0.79	*	3963
	Local	29		3.4	13.6			.262	48.4	0.63 (1232)	1.12 (1587)	1.29 (816)	1.11 (268)	0.98 (46)	0.57 (14)	** (0)	
30	Early	29	1634	3.6	12.2	10.4	1669	.347	60.9	0.95	1.01	1.18	1.14	1.09	0.50	0.00	3955
	Local	33		4.3	13.0			.254	52.6	0.76 (2185)	1.20 (1225)	1.57 (410)	1.51 (107)	0.91 (22)	0.50 (4)	0.00 (2)	
42	Early	34	2458	3.7	13.4	11.9	2485	.217	44.7	0.99	0.93	1.03	1.23	1.73	0.64	4.00	3967
	Local	38		3.9	13.4			.176	42.6	0.66 (1241)	1.15 (1581)	1.26 (806)	1.02 (272)	0.71 (52)	0.50 (14)	0.00 (1)	

*This category was neither forecast nor observed.
**This category was forecast once but was not observed.

Table 4.5. Same as Table 4.2 except for 22 stations in the Southern 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	2334	3.2	12.6	11.5	2358	.301	52.4	1.04	0.96	0.94	1.13	1.31	10.00	**	3925
	Local	32		3.3	12.7			.240	49.0	0.62 (1322)	1.27 (1614)	1.12 (753)	0.98 (196)	0.38 (39)	0.00 (1)	* (0)	
30	Early	30	1217	3.8	11.8	9.8	1254	.325	62.8	1.00	0.97	1.06	1.00	3.40	3.00	*	3916
	Local	35		3.7	11.6			.258	57.2	0.84 (2331)	1.34 (1168)	1.06 (344)	0.54 (67)	0.20 (5)	0.00 (1)	* (0)	
42	Early	41	2265	4.1	13.3	11.3	2293	.201	44.7	0.97	0.92	1.03	1.47	1.79	20.00	***	3906
	Local	44		3.7	12.3			.165	45.0	0.73 (1312)	1.30 (1613)	0.98 (751)	0.60 (190)	0.15 (39)	0.00 (1)	** (0)	

*This category was neither forecast nor observed.
**This category was forecast once but was not observed.
***This category was forecast five times but was not observed.

Table 4.6. Same as Table 4.2 except for 27 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	25	2927	3.4	13.8	12.6	2952	.309	50.5	1.04	0.90	1.04	1.08	1.35	1.87	0.78	4842
	Local	29		3.6	13.8			.237	45.6	0.71 (1578)	1.12 (1793)	1.24 (1001)	1.06 (332)	0.87 (106)	0.61 (23)	1.00 (9)	
30	Early	29	2003	3.9	12.7	11.0	2039	.314	.574	0.95	1.03	1.09	1.18	1.08	1.13	0.00	4842
	Local	36		4.1	12.6			.249	.523	0.81 (2575)	1.30 (1448)	1.13 (597)	0.93 (173)	0.54 (39)	1.13 (8)	0.00 (2)	
42	Early	38	2982	4.3	13.9	12.0	3034	.212	.432	0.92	0.94	1.07	1.33	1.38	1.78	1.11	4835
	Local	38		4.3	13.2			.154	.406	0.72 (1573)	1.22 (1798)	1.14 (998)	0.92 (328)	0.52 (106)	0.57 (23)	0.56 (9)	

Table 4.7. Same as Table 4.2 except for 16 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	42	922	4.6	13.5	11.4	940	.277	55.7	0.83	1.28	1.34	1.21	0.88	0.15	0.00	2762
	Local	44		4.5	13.5			.263	55.8	0.87 (1671)	1.29 (630)	1.11 (298)	1.19 (115)	0.74 (34)	0.31 (13)	2.00 (1)	
30	Early	44	747	4.6	12.0	9.6	774	.245	59.1	0.84	1.38	1.68	0.51	0.53	0.00	*	2764
	Local	49		4.9	12.2			.227	60.3	0.92 (1877)	1.27 (589)	1.18 (198)	0.63 (79)	0.60 (15)	0.33 (6)	** (0)	
42	Early	51	868	4.9	12.5	10.6	889	.217	52.8	0.85	1.37	1.26	0.87	0.23	0.00	0.00	2764
	Local	58		5.0	12.4			.197	52.6	0.88 (1671)	1.45 (633)	1.00 (292)	0.58 (118)	0.43 (35)	0.21 (14)	0.00 (1)	

*This category was neither forecast nor observed.
**This category was forecast once but was not observed.

Table 4.8. Distribution of absolute errors associated with early guidance and local forecasts of surface wind direction for 88 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	74.3	15.9	4.6	2.1	1.9	1.2
	Local	69.5	18.7	5.7	2.8	1.7	1.6
30	Early	71.7	16.1	5.4	2.7	2.2	1.8
	Local	63.5	20.1	7.4	4.2	2.9	1.8
42	Early	62.7	19.0	7.7	4.5	3.5	2.6
	Local	55.7	22.2	9.8	5.3	3.7	3.3

Table 4.9. Same as Table 4.8 except for 23 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	76.3	15.7	3.9	1.9	1.3	1.0
	Local	71.8	19.3	4.9	1.9	1.1	1.0
30	Early	73.3	16.5	5.4	2.3	1.5	1.1
	Local	66.2	20.9	6.4	3.2	2.2	1.0
42	Early	68.3	18.1	6.2	3.1	2.8	1.4
	Local	60.0	23.0	8.6	4.1	2.4	1.7

Table 4.10. Same as Table 4.8 except for 22 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	72.6	17.0	5.7	2.2	1.7	0.9
	Local	67.4	19.9	6.9	3.1	1.3	1.4
30	Early	72.8	15.9	4.9	2.3	1.6	2.4
	Local	66.5	17.9	7.2	3.2	3.2	2.0
42	Early	59.6	20.2	8.6	5.8	3.5	2.4
	Local	54.0	23.4	10.1	5.6	4.0	2.9

Table 4.11. Same as Table 4.8 except for 27 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	78.3	14.6	3.5	1.5	1.4	0.7
	Local	72.8	17.3	4.9	2.3	1.4	1.3
30	Early	74.1	15.0	5.2	2.5	2.0	1.1
	Local	63.5	21.1	7.3	4.3	2.4	1.3
42	Early	64.0	18.6	7.4	4.1	3.3	2.7
	Local	56.2	21.1	10.6	5.5	3.1	3.5

Table 4.12. Same as Table 4.8 except for 16 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	61.0	17.7	7.0	4.6	5.3	4.4
	Local	58.5	18.5	7.2	5.7	5.3	4.8
30	Early	60.2	18.5	6.8	5.0	5.4	4.1
	Local	53.0	19.1	10.3	7.8	5.1	4.7
42	Early	51.0	19.6	10.5	6.8	5.9	6.2
	Local	45.6	20.7	9.9	7.1	8.6	7.9

Table 5.1. Definitions of the cloud amount categories used for the guidance and local forecasts of opaque sky cover.

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

Table 5.2. Comparative verification of early guidance and local forecasts of four categories of opaque sky cover (clear, scattered, broken, and overcast) for 88 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	0.89	0.77	1.05	1.19	52.8	.354	15497
	Local	0.64	1.37	1.37	0.84	49.7	.330	
	No. Obs.	4011	3185	3082	5219			
30	Early	1.03	0.87	0.93	1.04	57.6	.379	15310
	Local	0.59	2.16	1.91	0.71	45.6	.277	
	No. Obs.	5693	2015	1838	5764			
42	Early	1.20	0.74	0.96	1.03	47.2	.281	15495
	Local	0.53	1.76	1.40	0.66	38.7	.194	
	No. Obs.	4016	3190	3090	5199			

Table 5.3. Same as Table 5.2 except for 23 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	0.84	0.71	1.05	1.20	54.2	.350	3962
	Local	0.52	1.41	1.61	0.78	51.2	.342	
	No. Obs.	889	748	750	1575			
30	Early	0.95	0.86	1.02	1.07	60.8	.397	3956
	Local	0.61	2.26	2.39	0.71	48.8	.303	
	No. Obs.	1372	411	390	1783			
42	Early	1.14	0.70	0.96	1.09	49.8	.297	3961
	Local	0.47	1.67	1.59	0.70	40.5	.207	
	No. Obs.	895	749	759	1558			

Table 5.4. Same as Table 5.2 except for 22 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	1.02	0.71	1.06	1.15	54.3	.379	3917
	Local	0.73	1.44	1.35	0.73	50.1	.339	
	No. Obs.	1132	860	730	1195			
30	Early	1.06	0.89	0.70	1.08	59.6	.396	3917
	Local	0.65	2.36	1.66	0.66	46.9	.290	
	No. Obs.	1705	519	474	1219			
42	Early	1.27	0.76	1.03	0.90	47.9	.294	3917
	Local	0.63	1.97	1.34	0.45	37.8	.187	
	No. Obs.	1131	853	733	1200			

Table 5.5. Same as Table 5.2 except for 27 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	0.83	0.83	1.06	1.21	52.2	.345	4879
	Local	0.53	1.48	1.36	0.90	48.7	.316	
	No. Obs.	1332	980	905	1662			
30	Early	1.06	0.89	0.95	1.00	56.2	.356	4658
	Local	0.51	2.25	1.92	0.76	43.6	.249	
	No. Obs.	1675	625	520	1838			
42	Early	1.21	0.75	0.89	1.04	46.0	.260	4838
	Local	0.39	1.80	1.48	0.75	37.6	.180	
	No. Obs.	1339	987	900	1612			

Table 5.6. Same as Table 5.2 except for 16 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	0.87	0.82	1.04	1.20	49.7	.322	2779
	Local	0.84	1.05	1.14	0.97	48.9	.315	
	No. Obs.	658	597	697	827			
30	Early	1.04	0.82	1.06	1.02	52.6	.339	2779
	Local	0.60	1.71	1.74	0.69	42.9	.246	
	No. Obs.	941	460	454	924			
42	Early	1.12	0.75	0.99	1.10	44.5	.254	2779
	Local	0.71	1.54	1.15	0.71	39.5	.196	
	No. Obs.	651	601	698	829			

Table 6.1. Definitions of the categories used for guidance forecasts of ceiling height 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 6.2. Comparative verification of early guidance, persistence, and local ceiling height forecasts for 88 stations, 0000 GMT cycle.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	5	6	Percent Correct	Skill Score
12	Early	1.14	1.49	0.97	1.02	1.14	0.92	58.9	.364
	Local	0.55	1.03	0.88	1.18	1.09	0.96	71.8	.553
	Persistence	0.86	0.95	0.91	0.96	1.00	1.03	74.0	.577
	No. Obs.	368	687	971	2379	2252	8832		
15	Local	0.33	0.58	0.78	1.29	1.25	0.94	64.2	.430
	Persistence	1.24	0.91	0.86	0.93	1.07	1.02	64.4	.419
	No. Obs.	254	723	1036	2465	2106	8928		
18	Early	0.62	1.03	1.08	1.21	1.22	0.89	60.3	.360
	Persistence	3.13	1.27	1.05	0.86	1.09	0.98	59.9	.329
	No. Obs.	101	515	848	2667	2077	9310		
21	Local	0.14	0.35	0.65	1.25	1.30	0.92	63.5	.372
	Persistence	4.76	1.69	1.23	0.95	0.99	0.94	56.6	.259
	No. Obs.	66	388	721	2392	2275	9667		
24	Early	0.68	1.19	0.97	1.10	1.20	0.93	63.0	.357
	Persistence	3.33	1.61	1.26	1.10	0.95	0.93	54.6	.219
	No. Obs.	95	408	706	2083	2385	9852		
36	Early	1.89	1.51	0.78	1.00	0.96	0.96	55.0	.295
	Persistence	0.84	0.94	0.91	0.96	1.00	1.03	47.4	.146
	No. Obs.	375	696	971	2384	2251	8834		
48	Early	0.99	1.18	0.93	0.88	1.01	1.02	60.4	.276
	Persistence	3.26	1.61	1.29	1.10	0.94	0.93	46.5	.079
	No. Obs.	97	408	688	2077	2403	9856		

Table 6.3. Same as Table 6.2 except for visibility, 0000 GMT cycle.

Projection (h)	Type of Forecast	Bias by Category						Percent Correct	Skill Score
		1	2	3	4	5	6		
12	Early	1.56	1.77	1.04	1.13	1.06	0.94	68.8	.292
	Local	0.61	1.57	0.76	1.46	1.63	0.92	73.3	.407
	Persistence	0.79	1.03	0.84	0.87	1.17	1.02	79.0	.478
	No. Obs.	409	236	961	987	1115	11638		
15	Local	0.37	0.75	0.43	1.21	1.27	1.04	69.1	.287
	Persistence	1.00	0.82	0.65	0.85	0.99	1.06	70.0	.291
	No. Obs.	325	296	1235	1002	1321	11186		
18	Early	0.73	1.01	1.02	1.10	1.21	0.98	74.0	.291
	Persistence	2.37	1.01	0.87	1.09	1.26	0.97	70.6	.214
	No. Obs.	139	243	924	786	1038	12291		
21	Local	0.09	0.38	0.40	1.35	1.53	1.00	76.9	.240
	Persistence	3.58	1.19	0.99	1.34	1.47	0.93	70.9	.171
	No. Obs.	91	205	810	637	885	12729		
24	Early	0.53	1.11	1.11	1.08	1.00	0.99	78.5	.292
	Persistence	3.02	1.46	1.06	1.28	1.51	0.92	70.3	.149
	No. Obs.	109	168	766	670	867	12851		
36	Early	1.42	2.08	1.17	0.99	0.86	0.96	66.6	.229
	Persistence	0.77	1.02	0.83	0.87	1.18	1.02	64.4	.116
	No. Obs.	427	240	979	982	1107	11679		
48	Early	0.75	1.59	1.08	0.99	1.03	0.99	75.6	.209
	Persistence	2.91	1.45	1.05	1.30	1.52	0.92	66.9	.057
	No. Obs.	113	169	768	661	861	12733		

Table 6.4. Same as Table 6.2 except for ceiling height, 1200 GMT cycle.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	5	6	Percent Correct	Skill Score
12	Early	0.86	1.23	0.93	1.13	1.19	0.93	65.4	.396
	Local	0.42	0.82	0.86	1.26	1.02	0.96	75.6	.565
	Persistence	0.80	0.93	1.01	1.14	0.93	0.99	76.7	.579
	No. Obs.	92	390	678	2035	2345	9729		
15	Local	0.27	0.73	0.87	1.36	0.93	0.97	69.5	.463
	Persistence	0.51	0.78	0.95	1.15	0.94	1.00	67.3	.417
	No. Obs.	149	467	727	2047	2350	9657		
18	Early	1.23	1.24	0.81	1.11	1.17	0.93	61.5	.363
	Persistence	0.33	0.66	0.88	1.12	0.93	1.04	61.8	.330
	No. Obs.	223	551	777	2092	2349	9316		
21	Local	0.23	0.70	0.98	1.41	0.95	0.96	60.5	.352
	Persistence	0.25	0.58	0.79	1.06	0.98	1.06	56.8	.257
	No. Obs.	310	632	874	2229	2247	9091		
24	Early	1.65	1.46	0.81	1.09	1.12	0.90	56.2	.324
	Persistence	0.20	0.54	0.72	1.00	0.99	1.10	53.5	.212
	No. Obs.	364	678	950	2336	2220	8755		
36	Early	0.65	1.10	0.92	1.09	1.01	0.98	62.2	.319
	Persistence	0.80	0.89	1.02	1.15	0.93	0.99	51.7	.126
	No. Obs.	93	407	674	2033	2360	9771		
48	Early	1.80	1.53	0.74	0.99	0.95	0.97	53.3	.265
	Persistence	0.20	0.53	0.73	1.00	0.98	1.11	45.1	.072
	No. Obs.	370	684	941	2340	2245	8739		

Table 6.5. Same as Table 6.2 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	0.85	1.42	1.07	1.11	1.06	0.98	79.3	.324
	Local	0.51	1.04	0.66	1.43	1.73	0.95	81.5	.431
	Persistence	0.95	1.23	1.09	0.92	1.42	0.97	83.5	.474
	No. Obs.	103	160	725	651	846	12662		
15	Local	0.48	1.14	0.84	1.74	1.80	0.92	77.8	.340
	Persistence	0.76	1.44	1.22	0.87	1.51	0.96	79.3	.333
	No. Obs.	127	139	654	695	803	12859		
18	Early	1.13	1.43	1.02	1.04	1.06	0.98	76.4	.285
	Persistence	0.42	1.15	1.09	0.81	1.40	0.99	75.8	.260
	No. Obs.	231	175	728	743	859	12480		
21	Local	0.34	1.14	1.04	1.98	1.60	0.90	68.9	.255
	Persistence	0.29	0.93	1.00	0.71	1.29	1.02	72.3	.203
	No. Obs.	335	218	801	848	940	12118		
24	Early	1.92	2.00	1.13	1.08	1.02	0.93	66.9	.265
	Persistence	0.23	0.87	0.84	0.62	1.11	1.07	68.5	.157
	No. Obs.	425	230	949	973	1091	11551		
36	Early	0.51	1.15	1.03	1.05	1.03	1.00	77.3	.248
	Persistence	0.92	1.24	1.06	0.91	1.43	0.97	71.2	.096
	No. Obs.	106	163	754	664	844	12592		
48	Early	1.39	1.62	1.18	0.86	0.90	0.98	65.9	.197
	Persistence	0.23	0.86	0.84	0.62	1.09	1.07	64.7	.061
	No. Obs.	423	236	954	978	1107	11537		

Table 6.6. Comparative verification for early guidance, persistence, and local ceiling height forecasts for 88 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	0.068	1.37	90.3	.350	.251
	Local		0.86	94.8	.561	.417
	Persistence		0.92	94.9	.583	.439
15	Local	0.063	0.51	93.9	.330	.218
	Persistence		0.99	93.0	.402	.282
18	Early	0.040	0.97	94.7	.294	.192
	Persistence		1.58	92.8	.260	.174
21	Local	0.029	0.32	96.8	.152	.089
	Persistence		2.14	92.6	.156	.105
24	Early	0.032	1.09	95.2	.270	.173
	Persistence		1.93	92.1	.134	.093
36	Early	0.069	1.64	87.7	.264	.196
	Persistence		0.91	89.4	.136	.107
48	Early	0.033	1.14	94.8	.229	.146
	Persistence		1.93	91.3	.046	.045

Table 6.7. Same as Table 6.6 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	0.042	1.64	92.2	.255	.172
	Local		0.96	96.1	.511	.362
	Persistence		0.88	96.5	.535	.382
15	Local	0.040	0.55	95.8	.309	.197
	Persistence		0.92	95.0	.329	.216
18	Early	0.025	0.91	96.2	.181	.111
	Persistence		1.50	95.1	.181	.114
21	Local	0.019	0.29	97.7	.070	.041
	Persistence		1.99	95.0	.095	.063
24	Early	0.018	0.88	97.1	.127	.076
	Persistence		2.07	95.1	.084	.056
36	Early	0.043	1.66	90.8	.159	.114
	Persistence		0.86	93.0	.093	.069
48	Early	0.018	1.25	96.4	.114	.071
	Persistence		2.03	94.7	.027	.026

Table 6.8. Same as Table 6.6 except for ceiling height, 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	0.032	1.16	95.4	.299	.192
	Local		0.75	97.5	.526	.369
	Persistence		0.91	97.3	.532	.376
15	Local	0.040	0.62	96.0	.366	.239
	Persistence		0.72	95.8	.370	.243
18	Early	0.051	1.24	92.8	.325	.222
	Persistence		0.56	94.5	.276	.178
21	Local	0.061	0.55	93.3	.263	.173
	Persistence		0.47	93.2	.212	.138
24	Early	0.068	1.52	88.9	.299	.217
	Persistence		0.42	92.2	.157	.105
36	Early	0.033	1.02	95.2	.243	.155
	Persistence		0.88	94.6	.087	.061
48	Early	0.069	1.62	87.0	.211	.162
	Persistence		0.42	91.1	.045	.043

Table 6.9. Same as Table 6.6 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	0.017	1.20	97.2	.256	.156
	Local		0.84	98.2	.434	.285
	Persistence		1.12	98.0	.445	.295
15	Local	0.017	0.82	97.7	.248	.149
	Persistence		1.11	97.3	.239	.145
18	Early	0.027	1.26	95.2	.179	.113
	Persistence		0.74	96.1	.148	.091
21	Local	0.036	0.65	95.2	.184	.116
	Persistence		0.54	95.1	.104	.068
24	Early	0.043	1.95	90.5	.203	.142
	Persistence		0.46	94.4	.076	.053
36	Early	0.018	0.90	97.0	.094	.058
	Persistence		1.12	96.5	.053	.036
48	Early	0.043	1.47	91.2	.128	.095
	Persistence		0.46	94.0	.017	.022

Table 7.1. Comparative verification of early guidance and local max/min temperature forecasts for 87 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	0.4	3.3	359 (3.5)	
	Local	-0.2	3.2	342 (3.4)	10130
36 (Min)	Early	-0.2	4.0	666 (6.6)	
	Local	0.8	4.0	701 (6.9)	10116
48 (Max)	Early	-0.1	4.3	897 (8.9)	
	Local	-0.4	4.4	939 (9.3)	10131
60 (Min)	Early	-0.9	5.1	1399 (13.8)	
	Local	-0.1	4.9	1264 (12.5)	10109

Table 7.2. Same as Table 7.1 except for 25 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	0.4	3.1	84 (2.7)	
	Local	-0.4	3.3	112 (3.6)	3088
36 (Min)	Early	0.1	4.0	180 (5.8)	
	Local	1.2	3.9	206 (6.7)	3088
48 (Max)	Early	-0.2	4.0	208 (6.7)	
	Local	-0.8	4.3	249 (8.1)	3087
60 (Min)	Early	-0.3	4.8	362 (11.7)	
	Local	0.5	4.8	351 (11.4)	3085

Table 7.3. Same as Table 7.1 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	-0.4	3.4	116 (3.9)	
	Local	-0.4	3.3	98 (3.3)	2956
36 (Min)	Early	-0.6	3.9	176 (6.0)	
	Local	0.2	3.8	180 (6.1)	2956
48 (Max)	Early	-0.7	4.6	313 (10.6)	
	Local	-0.6	4.5	322 (10.9)	2957
60 (Min)	Early	-1.2	5.1	381 (12.9)	
	Local	-0.5	4.8	325 (11.0)	2953

Table 7.4. Same as Table 7.1 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	1.1	3.5	121 (4.6)	2655
	Local	0.2	3.4	108 (4.1)	
36 (Min)	Early	0.1	4.4	230 (8.7)	2651
	Local	1.3	4.4	244 (9.2)	
48 (Max)	Early	0.6	4.6	278 (10.5)	2656
	Local	0.0	4.6	283 (10.7)	
60 (Min)	Early	-1.2	5.6	494 (18.6)	2651
	Local	-0.0	5.5	439 (16.6)	

Table 7.5. Same as Table 7.1 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	0.8	3.0	38 (2.7)	1431
	Local	0.2	2.8	24 (1.7)	
36 (Min)	Early	-0.5	3.6	80 (5.6)	1421
	Local	0.1	3.5	71 (5.0)	
48 (Max)	Early	0.4	4.0	98 (6.8)	1431
	Local	-0.0	3.8	85 (5.9)	
60 (Min)	Early	-1.1	4.5	162 (11.4)	1420
	Local	-0.6	4.4	149 (10.5)	

Table 7.6. Comparative verification of early guidance and local max/min temperature forecasts for 87 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	-0.3	3.7	473 (4.9)	9726
	Local	0.7	3.7	568 (5.8)	
36 (Max)	Early	-0.2	4.0	656 (6.7)	9745
	Local	-0.7	3.9	632 (6.5)	
48 (Min)	Early	-0.6	4.5	952 (9.8)	9729
	Local	0.3	4.4	945 (9.7)	
60 (Max)	Early	0.1	4.9	1248 (12.8)	9744
	Local	-0.2	4.8	1208 (12.4)	

Table 7.7. Same as Table 7.6 except for 25 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 (Min)	Early	-0.1	3.6	124 (4.2)	2962
	Local	0.8	3.6	157 (5.3)	
36 (Max)	Early	-0.5	3.9	170 (5.7)	2961
	Local	-1.0	4.0	214 (7.2)	
48 (Min)	Early	-0.1	4.4	242 (8.2)	2962
	Local	1.0	4.4	280 (9.5)	
60 (Max)	Early	0.2	4.4	279 (9.4)	2962
	Local	-0.2	4.5	302 (10.2)	

Table 7.8. Same as Table 7.6 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 (Min)	Early	-0.4	3.6	131 (4.7)	2811
	Local	0.6	3.6	159 (5.7)	
36 (Max)	Early	-1.1	4.3	247 (8.8)	2814
	Local	-0.9	4.0	198 (7.0)	
48 (Min)	Early	-1.1	4.5	276 (9.8)	2812
	Local	-0.2	4.2	222 (7.9)	
60 (Max)	Early	-0.7	5.1	397 (14.1)	2812
	Local	-0.6	5.0	384 (13.7)	

Table 7.9. Same as Table 7.6 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	-0.2	4.1	178 (7.0)	
	Local	1.0	4.1	208 (8.2)	2542
36 (Max)	Early	0.6	4.1	189 (7.4)	
	Local	-0.3	4.1	173 (6.8)	2549
48 (Min)	Early	-0.7	5.0	328 (12.9)	
	Local	0.5	4.9	343 (13.5)	2545
60 (Max)	Early	0.6	5.6	442 (17.3)	
	Local	0.2	5.3	399 (15.7)	2549

Table 7.10. Same as Table 7.6 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	-0.4	3.1	40 (2.8)	
	Local	0.1	3.2	44 (3.1)	1411
36 (Max)	Early	0.4	3.4	50 (3.5)	
	Local	-0.2	3.2	47 (3.3)	1421
48 (Min)	Early	-0.7	4.0	106 (7.5)	
	Local	-0.3	4.0	100 (7.1)	1410
60 (Max)	Early	0.4	4.3	130 (9.1)	
	Local	-0.3	4.1	123 (8.7)	1421

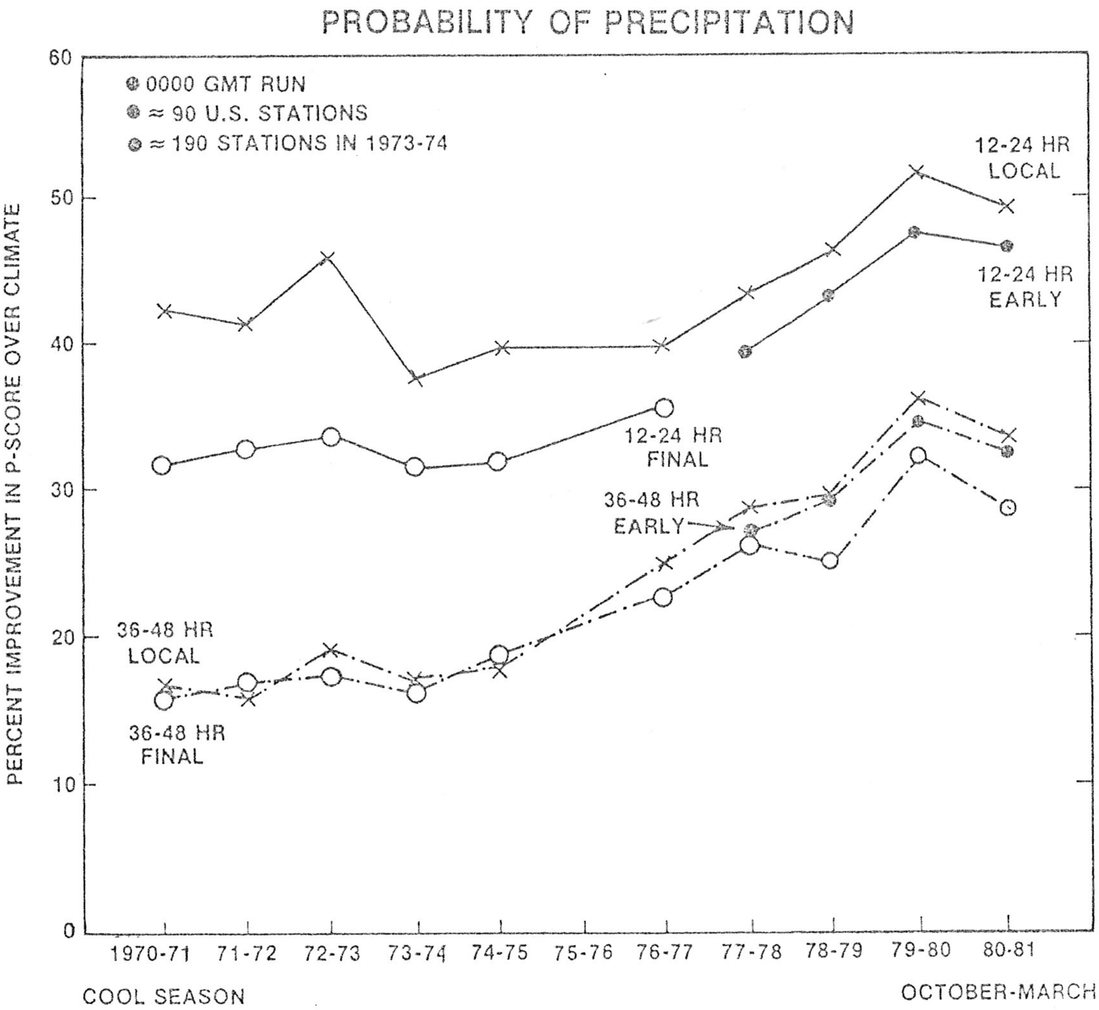

Figure 2.1. Percent improvement over climate in the Brier score of the local and the early and final guidance PoP forecasts. Results for 1975-76 are unavailable because of missing data.

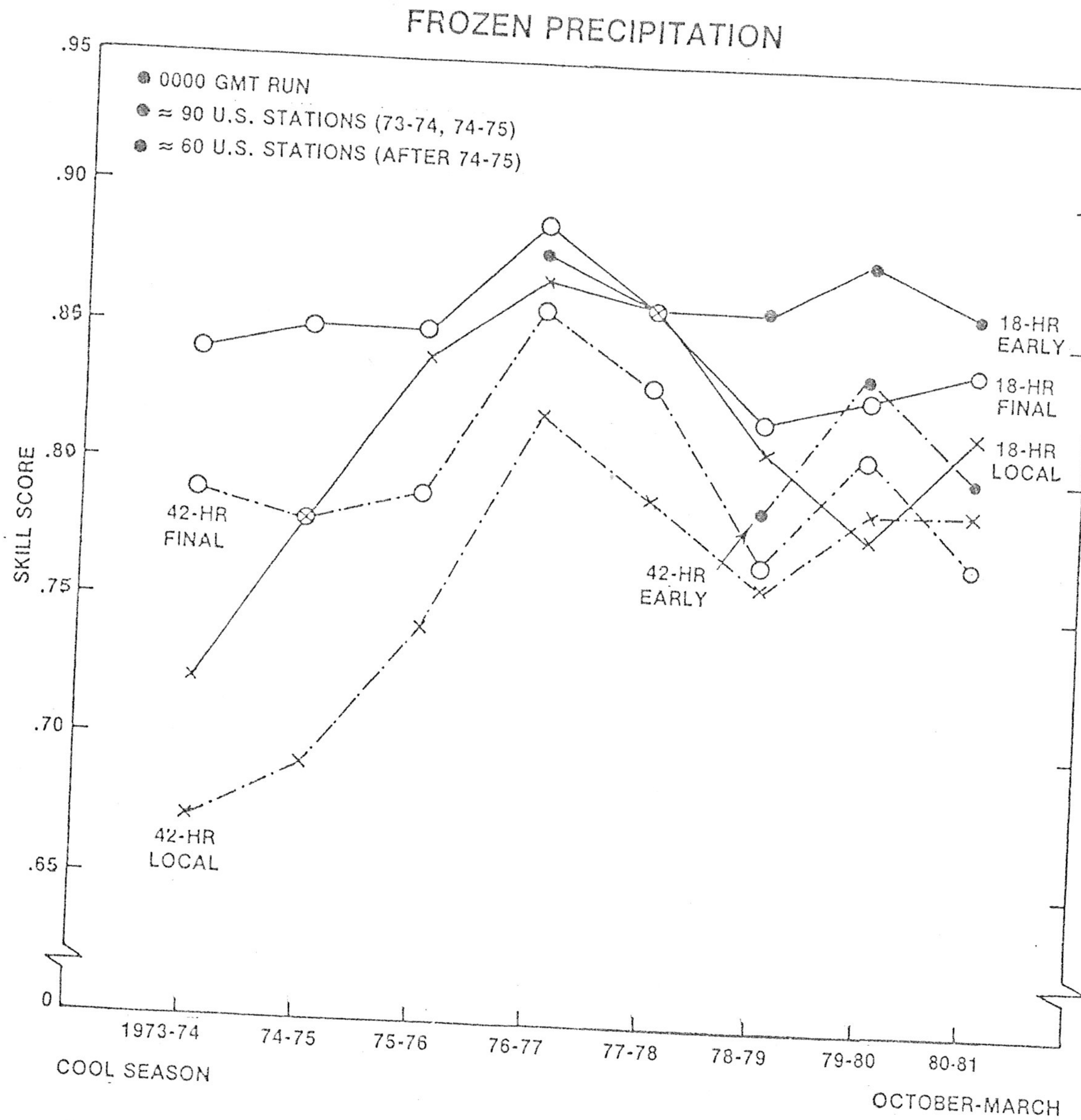

Figure 3.1. Skill score for the local and the early and final guidance frozen precipitation forecasts.

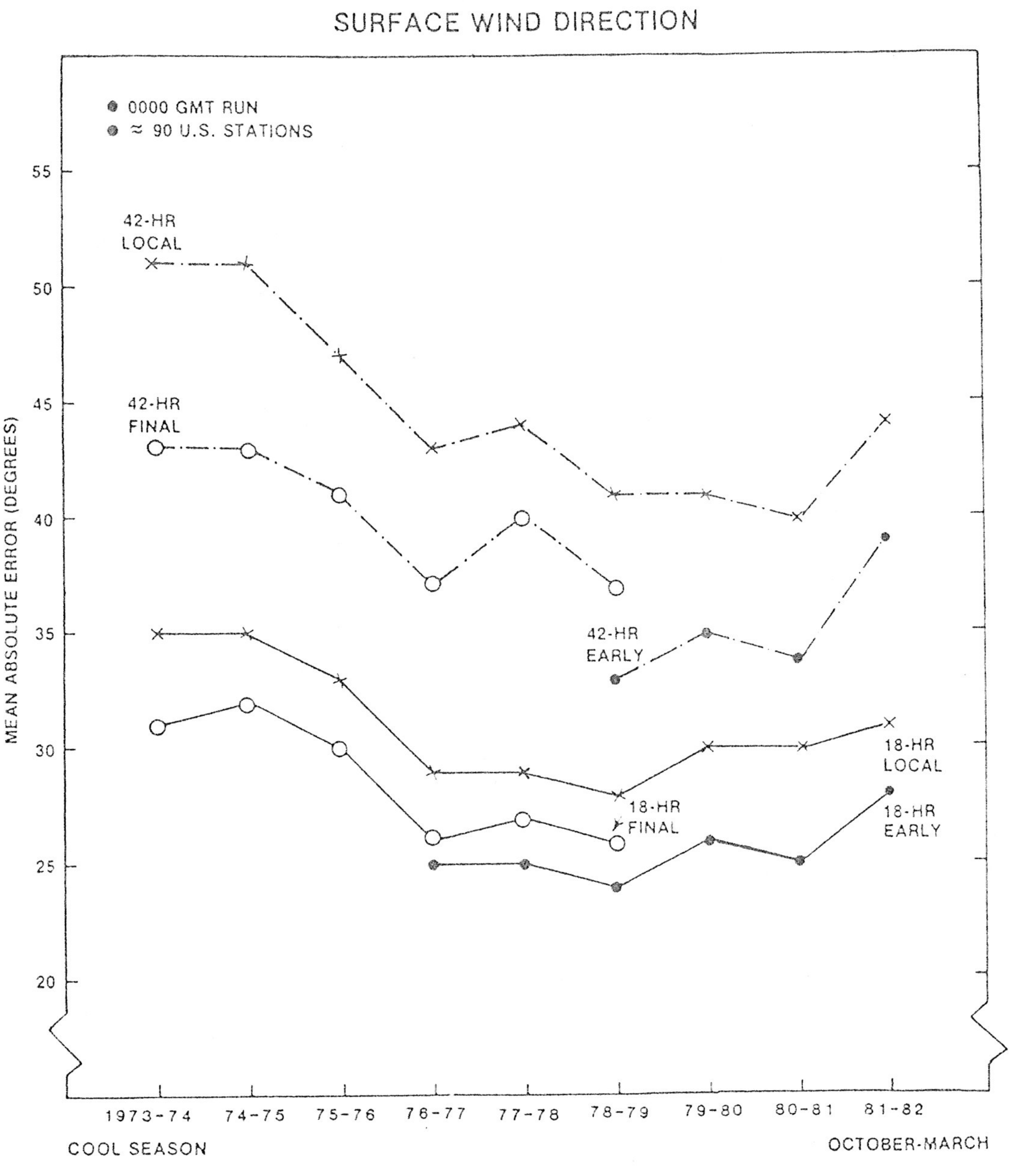

Figure 4.1. Mean absolute error for the local and the early and final guidance surface wind direction forecasts.

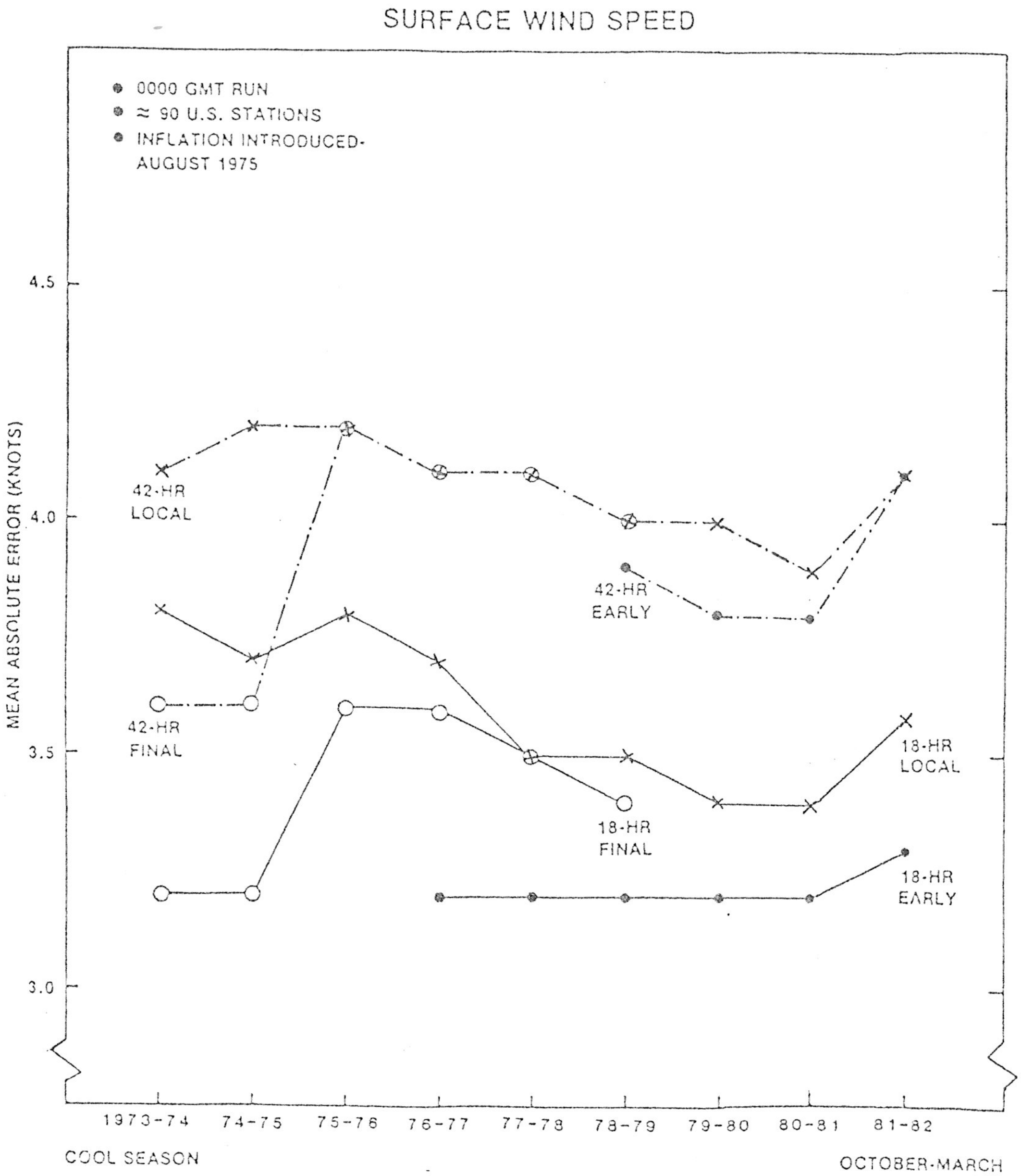

Figure 4.2. Same as Fig. 4.1 except for surface wind speed.

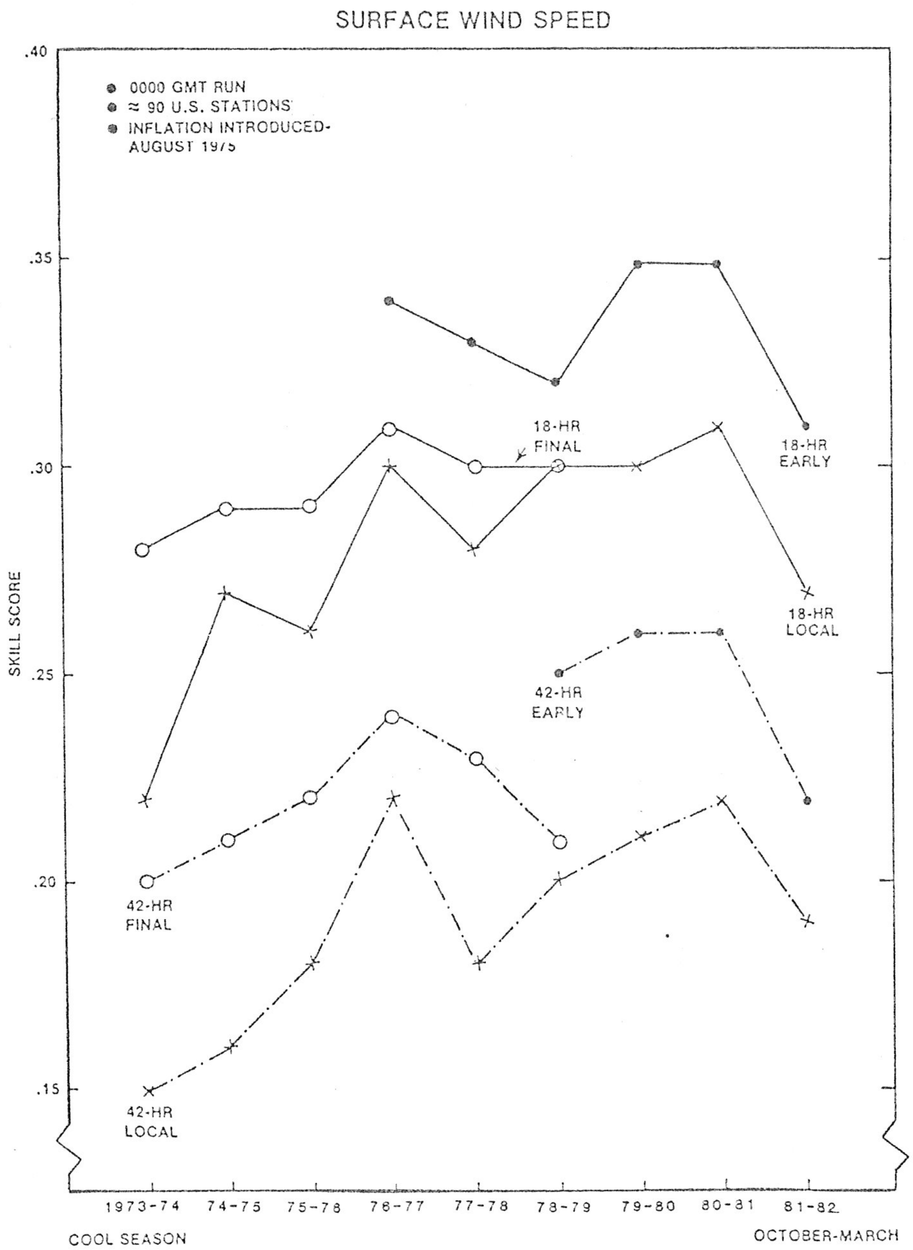

Figure 4.3. Skill score computed from five-category contingency tables for the local and the early and final guidance surface wind speed forecasts.

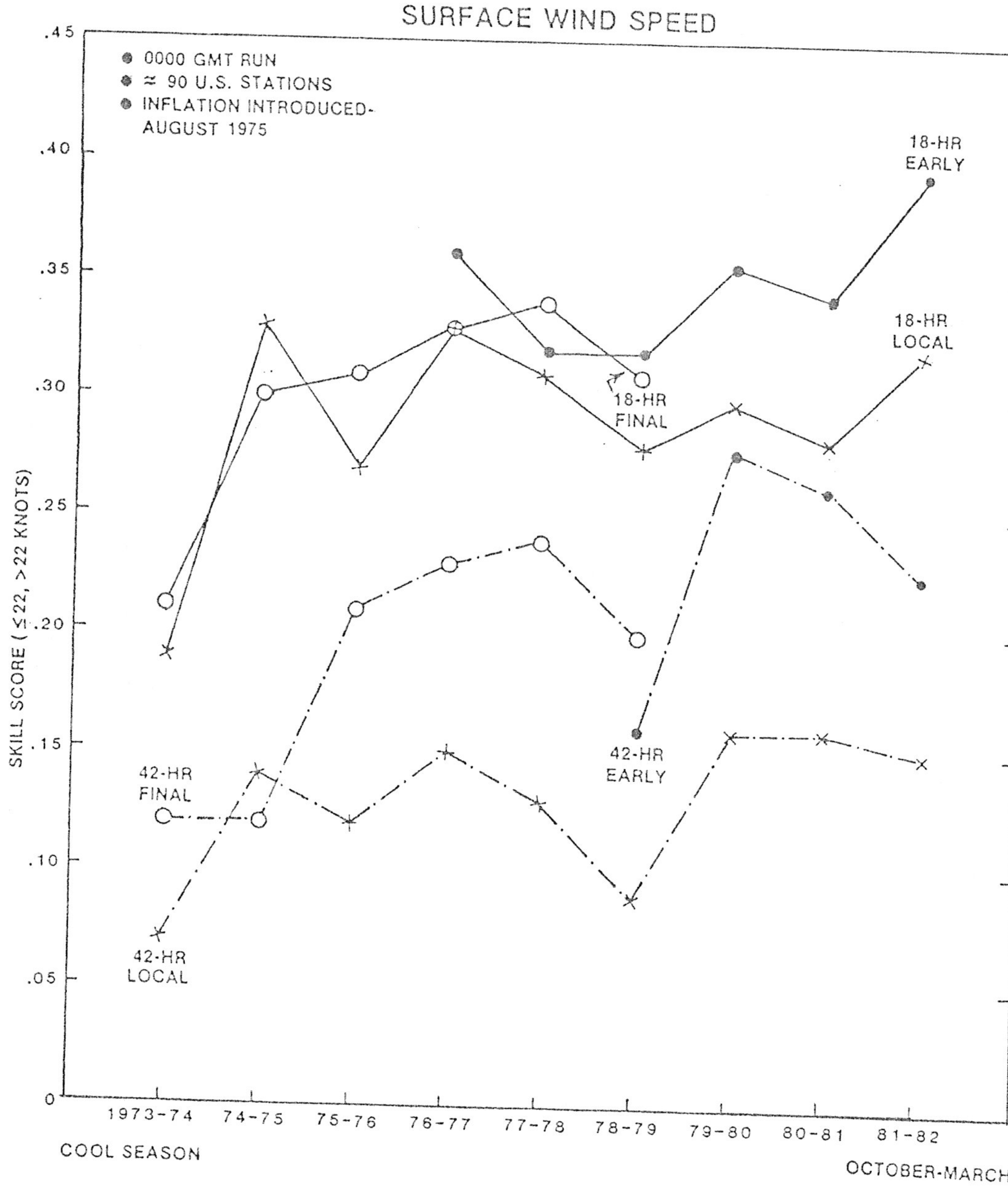

Figure 4.4. Same as Fig. 4.3 except for two-category contingency tables.

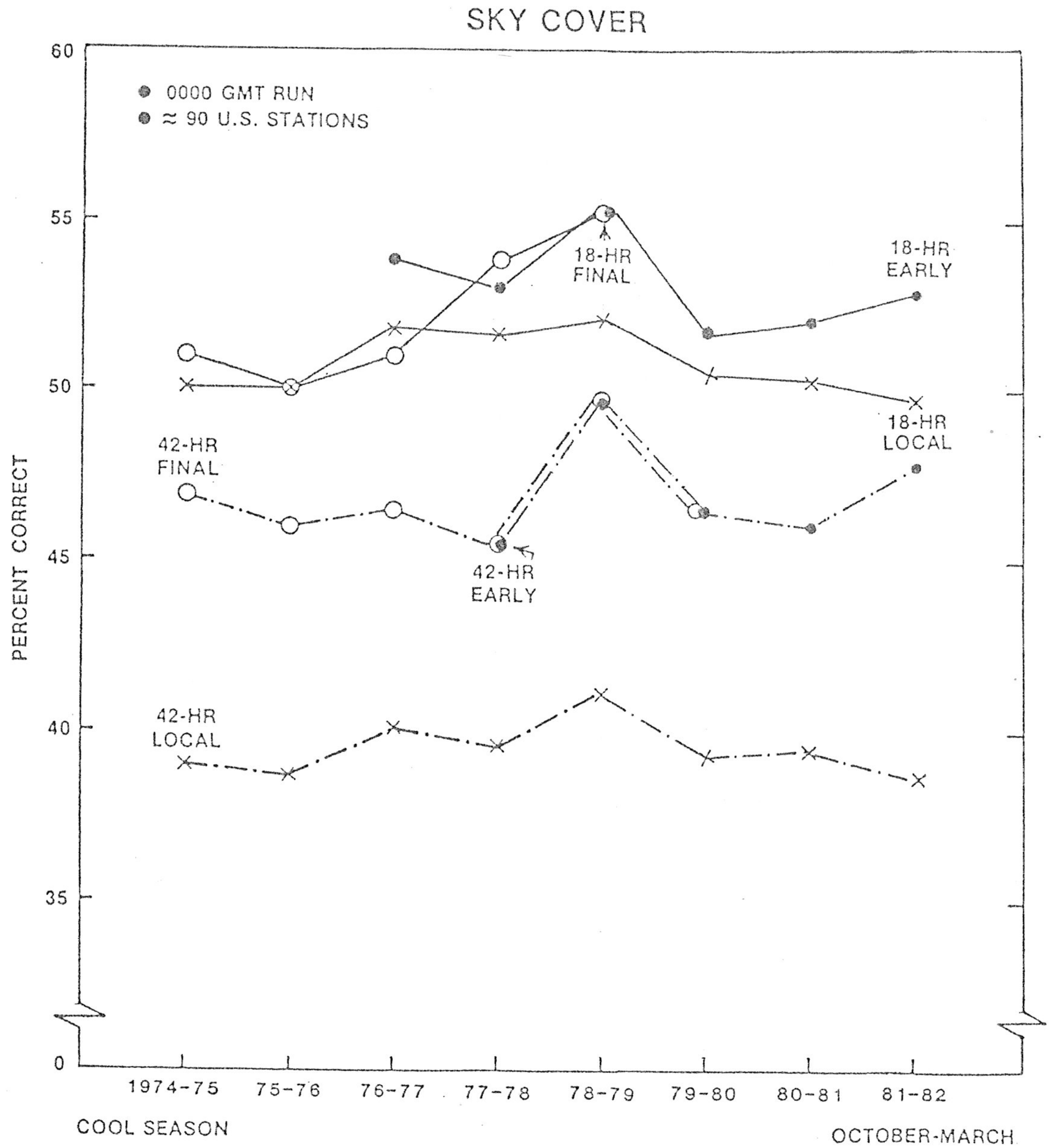

Figure 5.1. Percent correct for the local and the early and final guidance opaque sky cover forecasts.

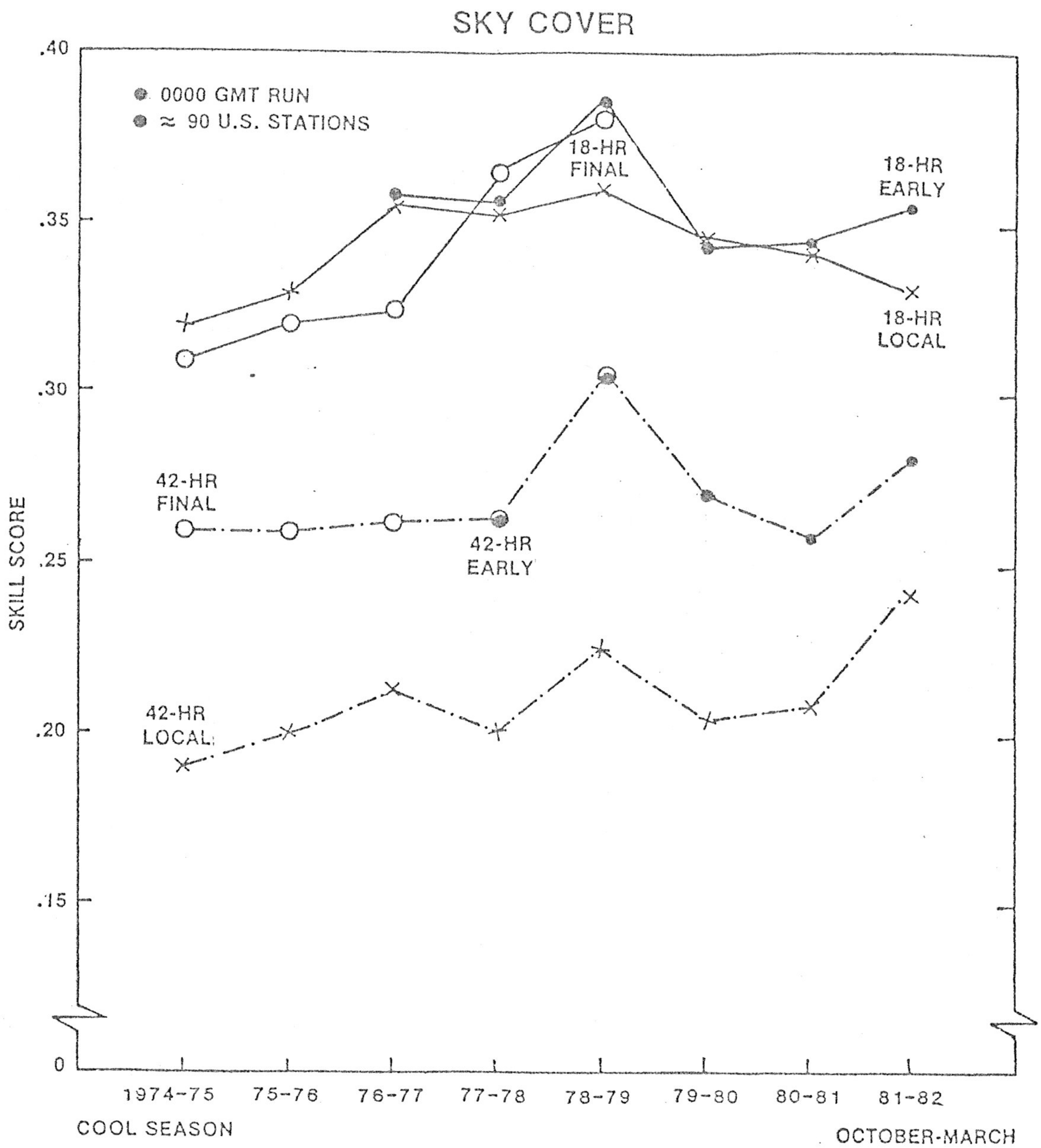

Figure 5.2. Skill score for the local and the early and final guidance opaque sky cover forecasts.

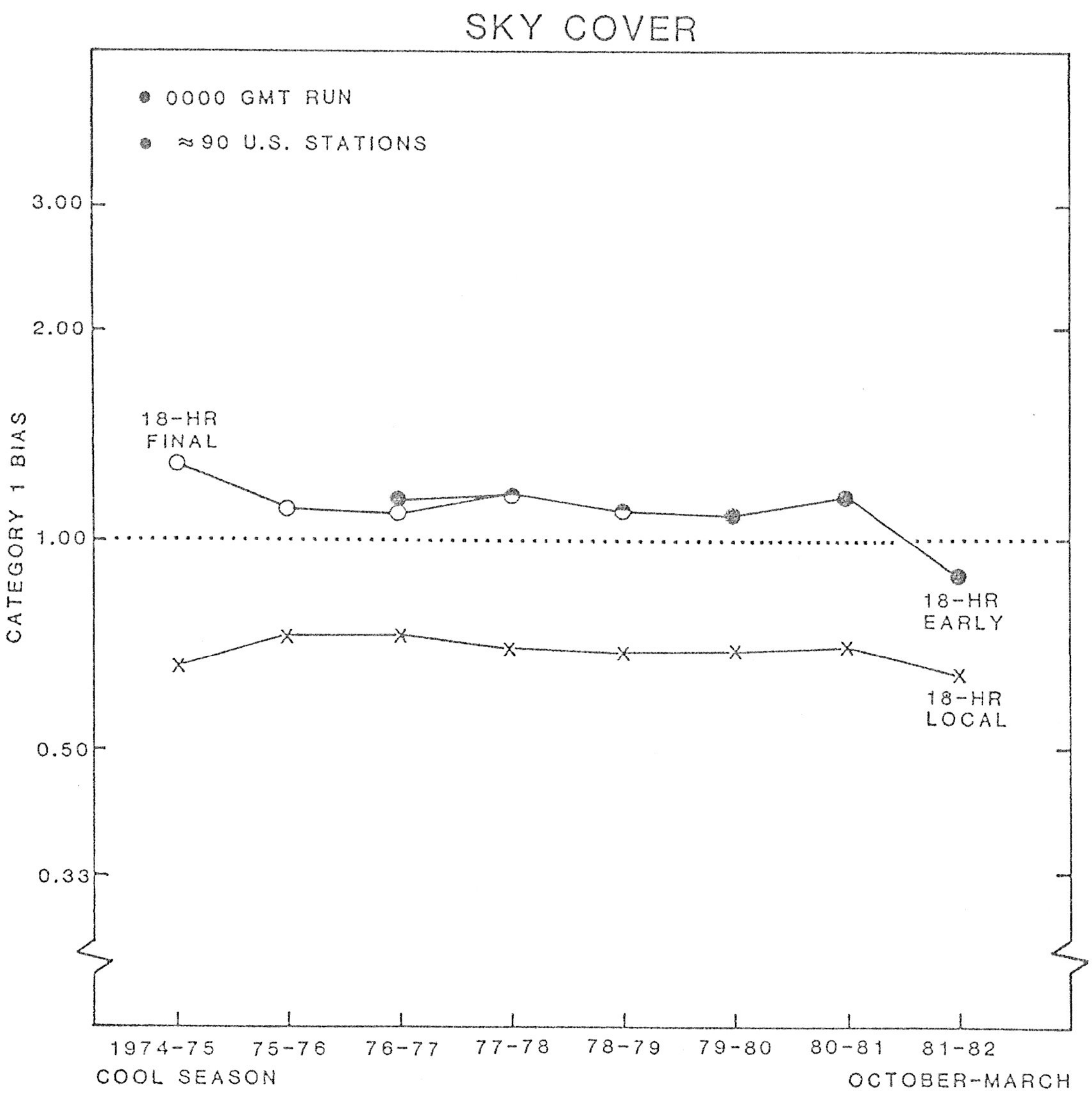

Figure 5.3. Category 1 bias for the local and the early and final guidance opaque sky cover forecasts.

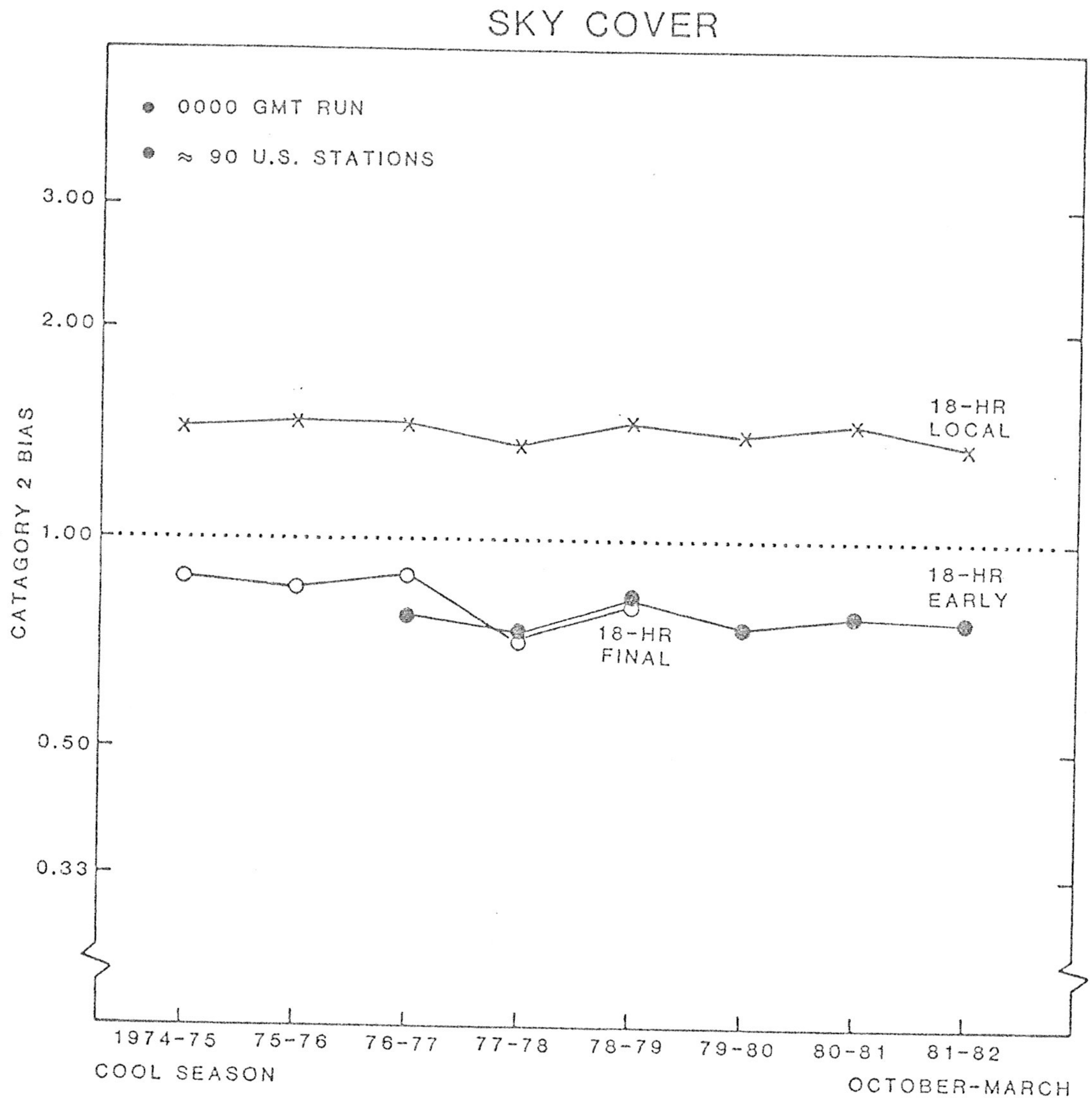

Figure 5.4. Same as Fig. 5.3 except for category 2 bias.

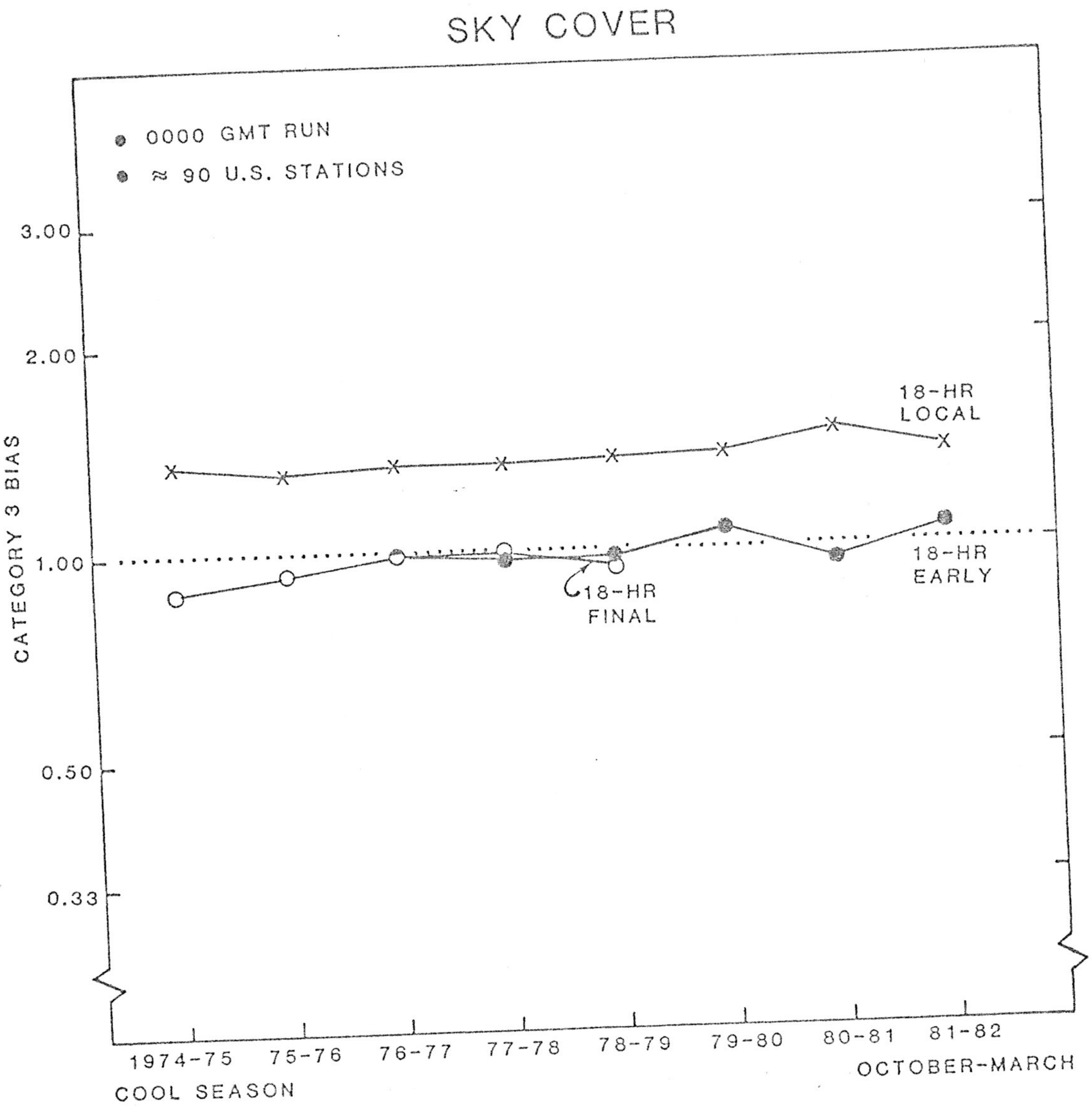

Figure 5.5. Same as Fig. 5.3 except for category 3 bias.

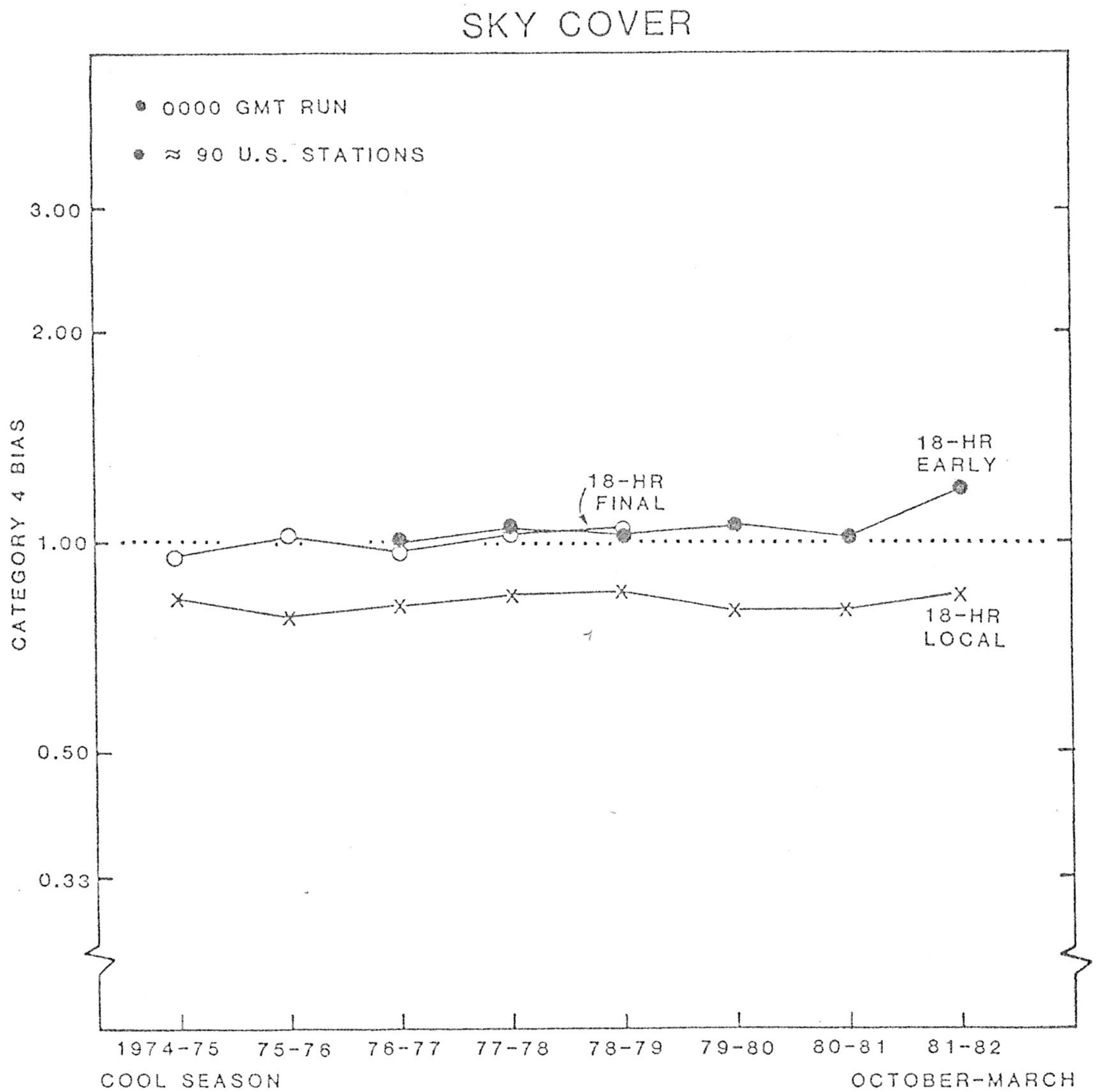

Figure 5.6. Same as Fig. 5.3 except for category 4 bias.

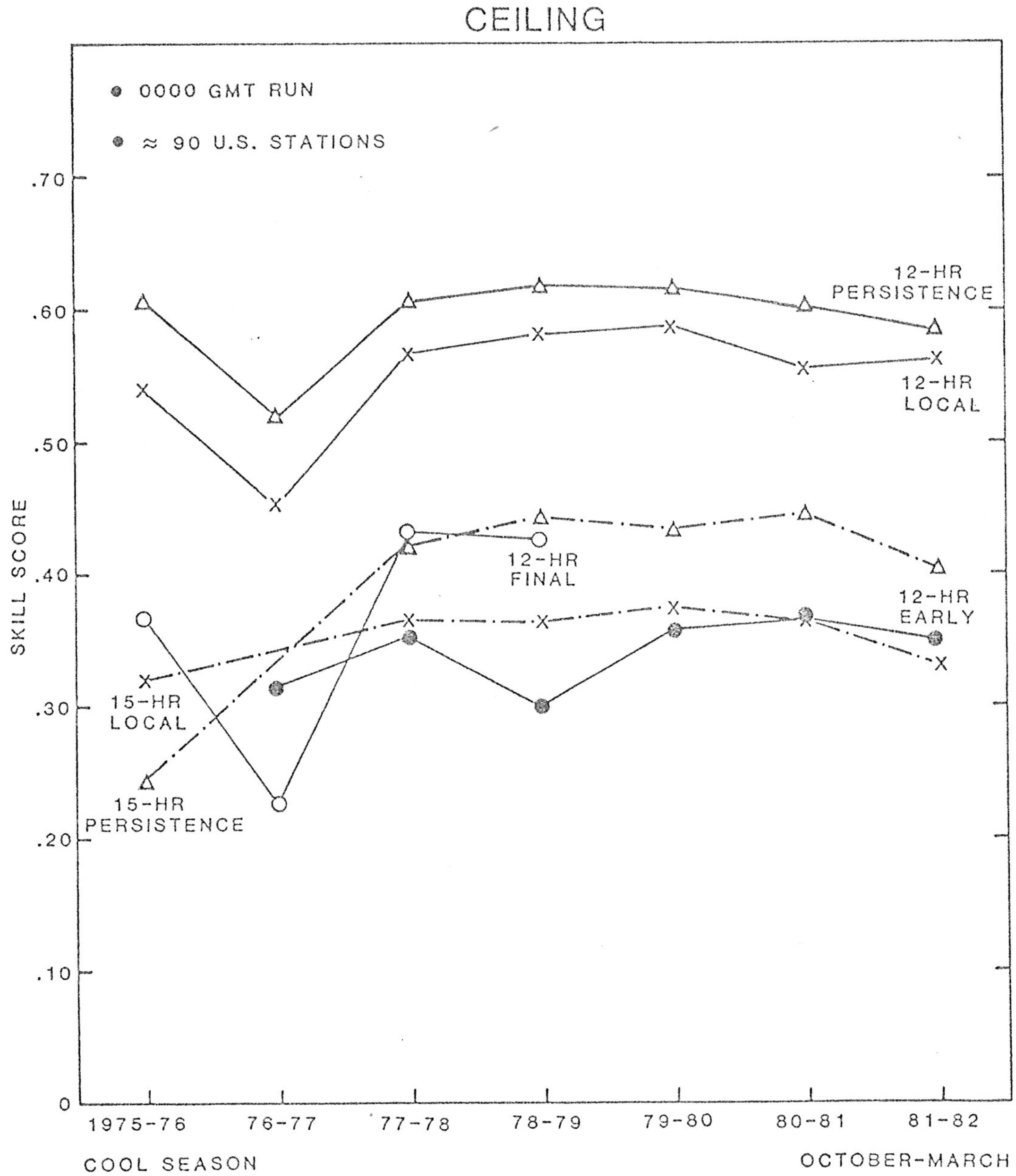

Figure 6.1. Skill score computed from two-category contingency tables for persistence, local, and guidance (early and final) ceiling height forecasts.

CEILING

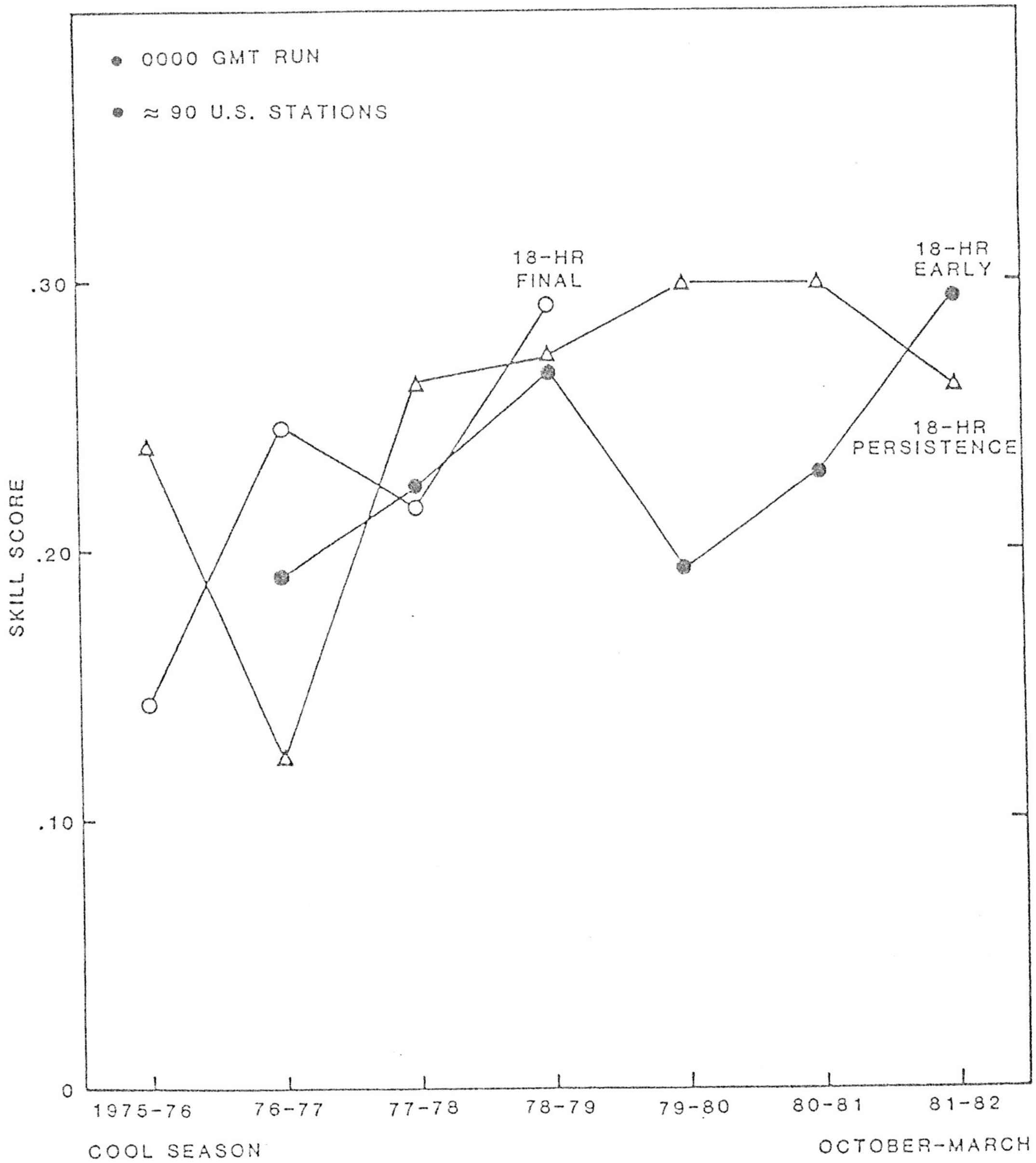

Figure 6.2. Same as Fig. 6.1 except for forecast projection.

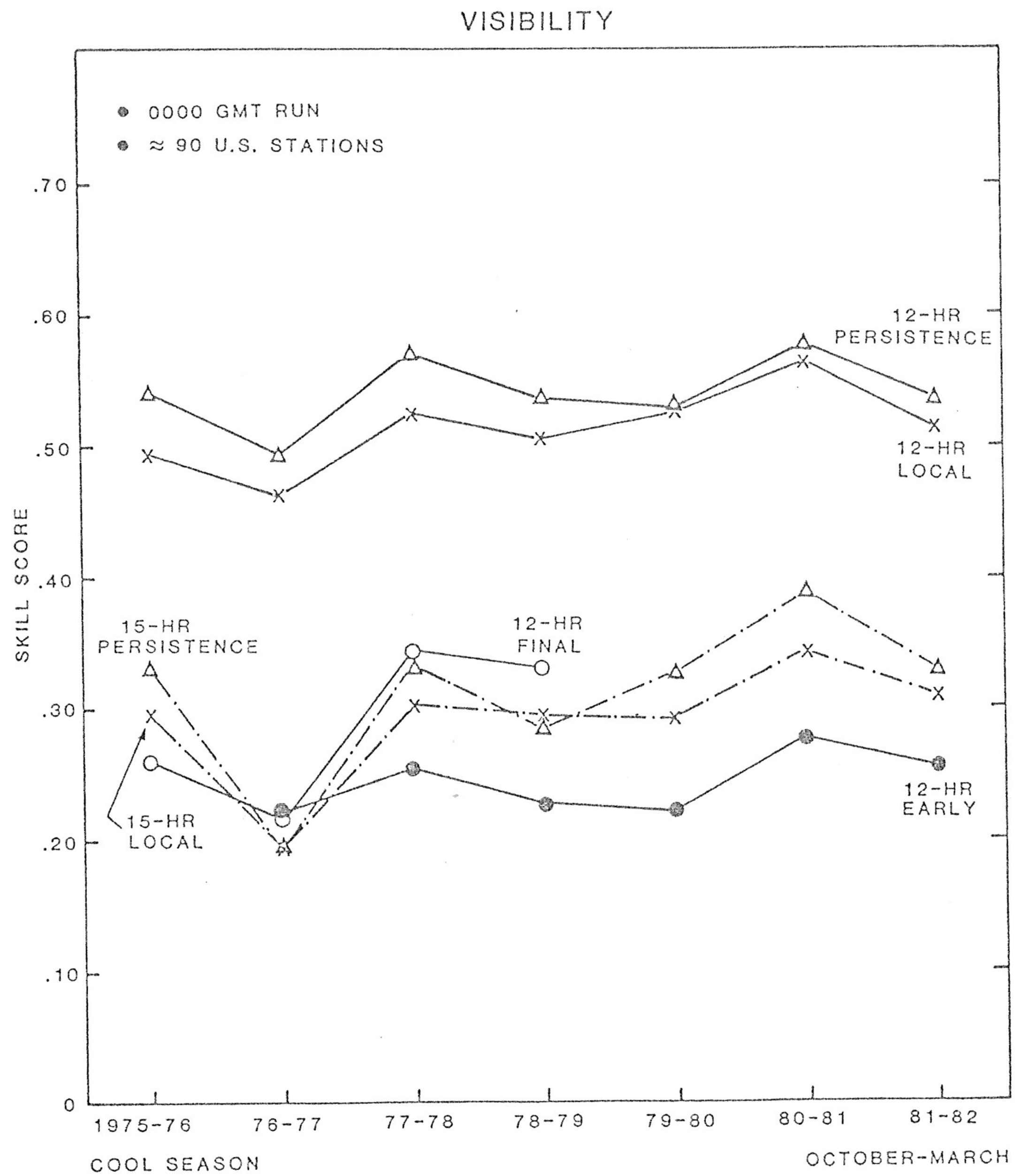

Figure 6.3. Same as Fig. 6.1 except for visibility.

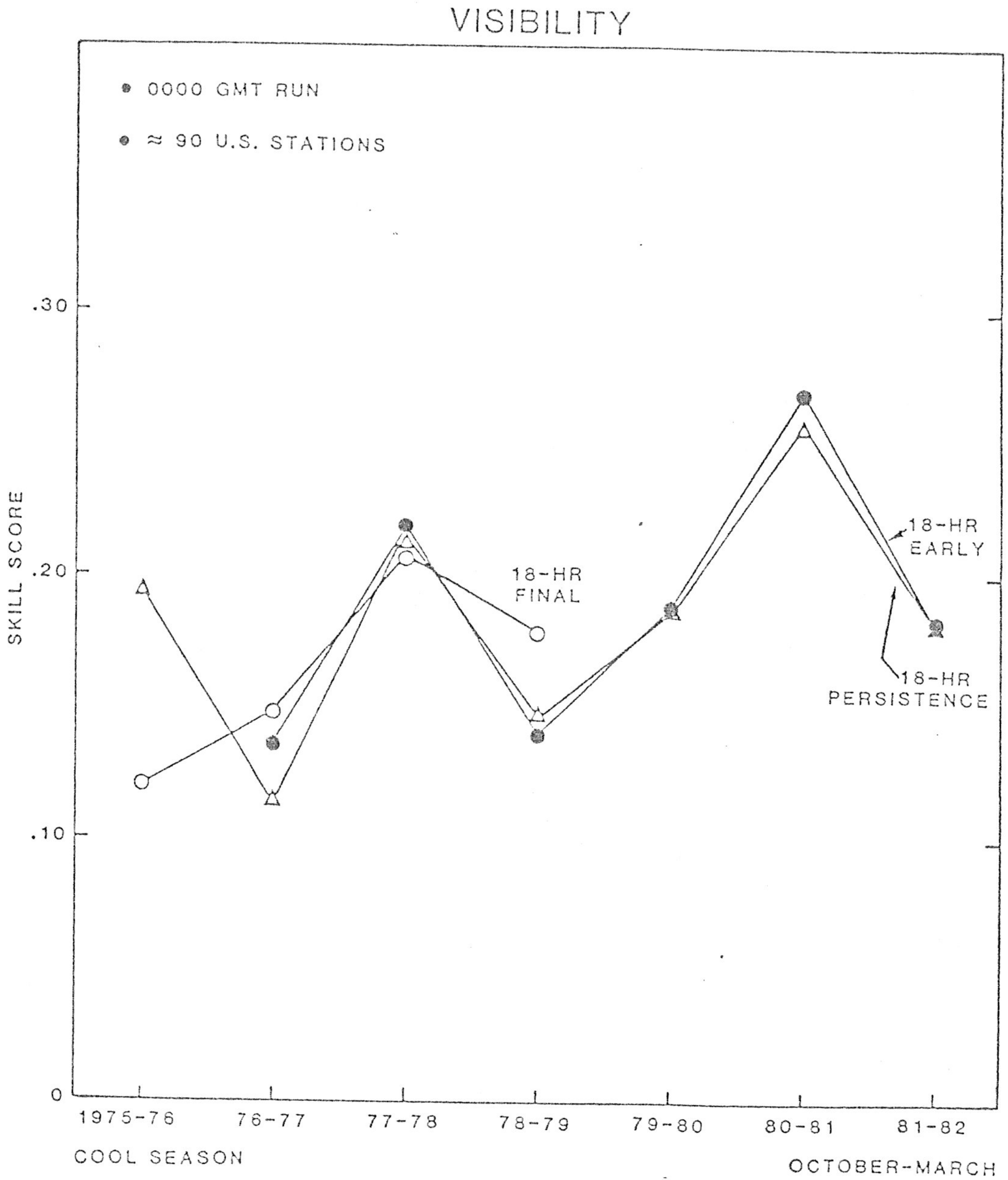

Figure 6.4. Same as Fig. 6.1 except for visibility and forecast projection.

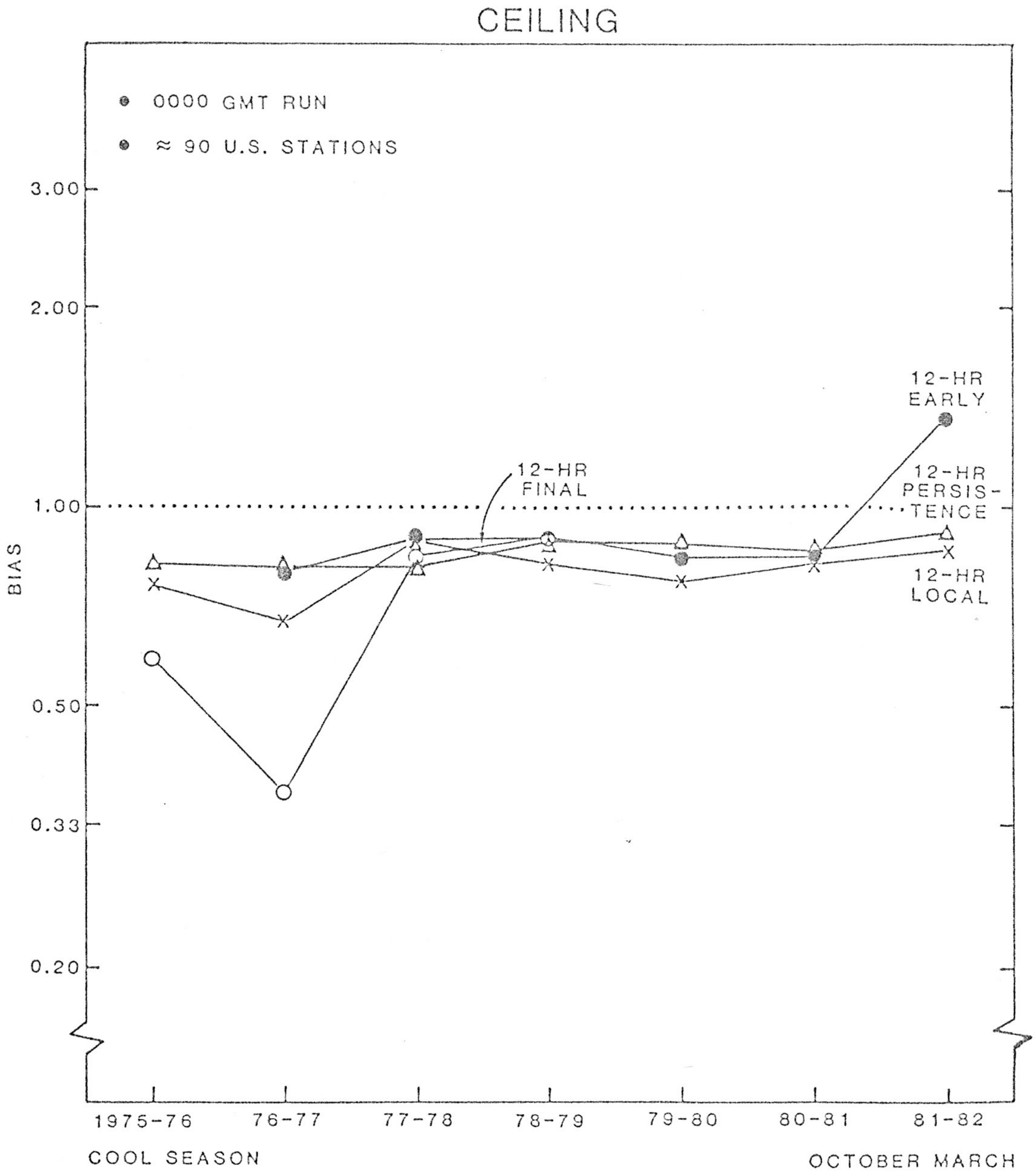

Figure 6.5. Bias for categories 1 and 2 combined for persistence, local, and guidance (early and final) ceiling height forecasts.

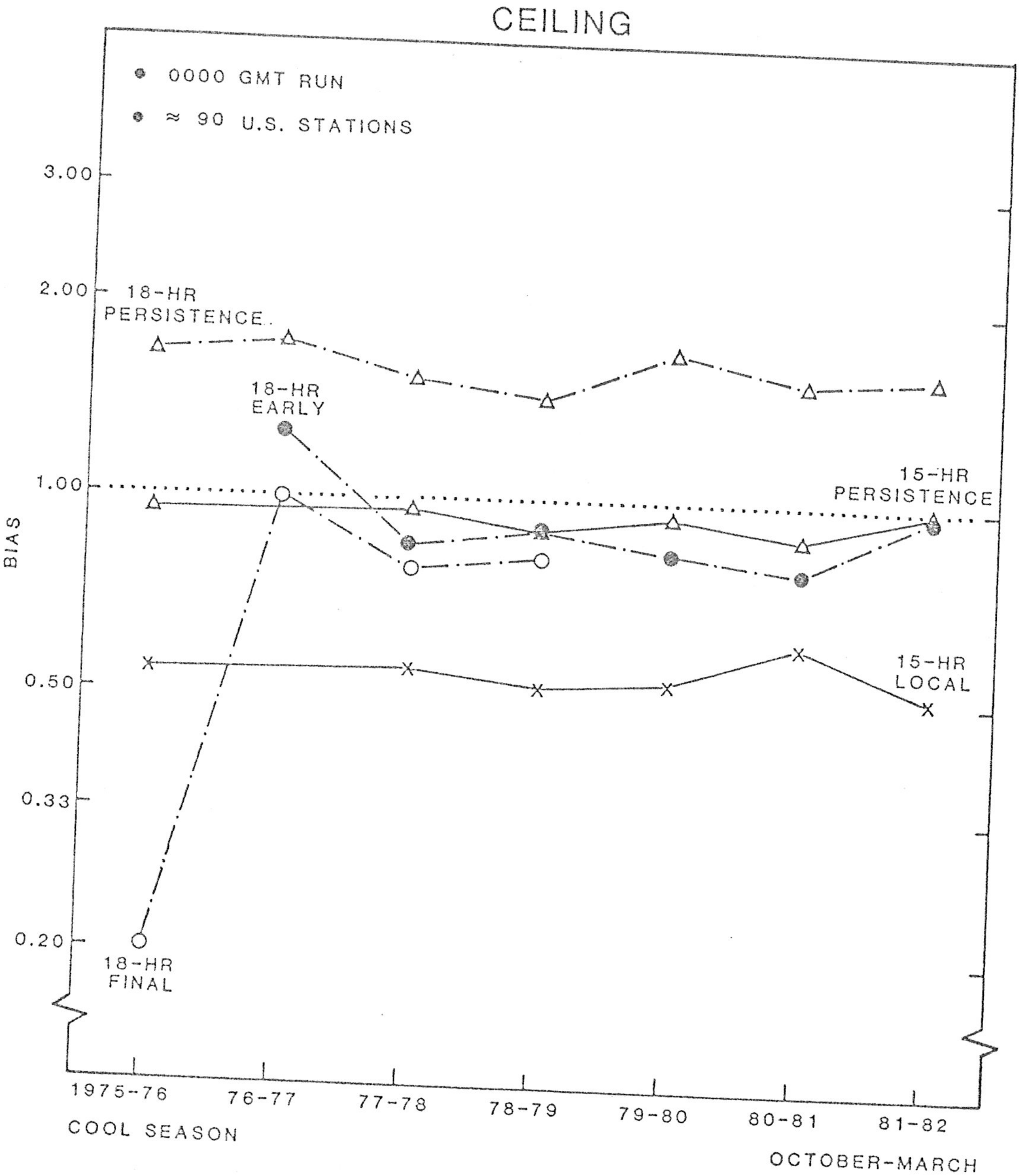

Figure 6.6. Same as Fig. 6.5 except for forecast projection.

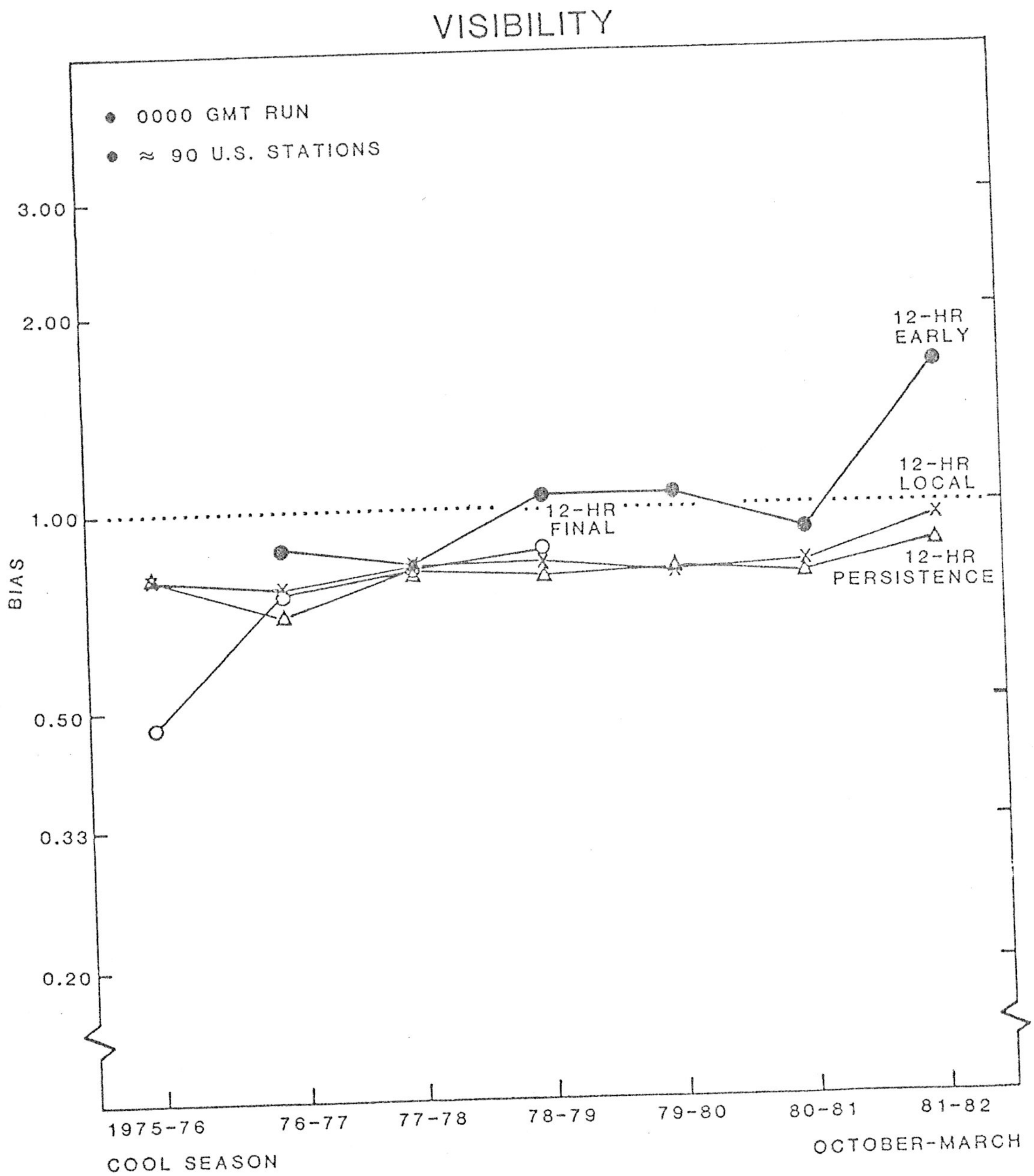

Figure 6.7. Same as Fig. 6.5 except for visibility.

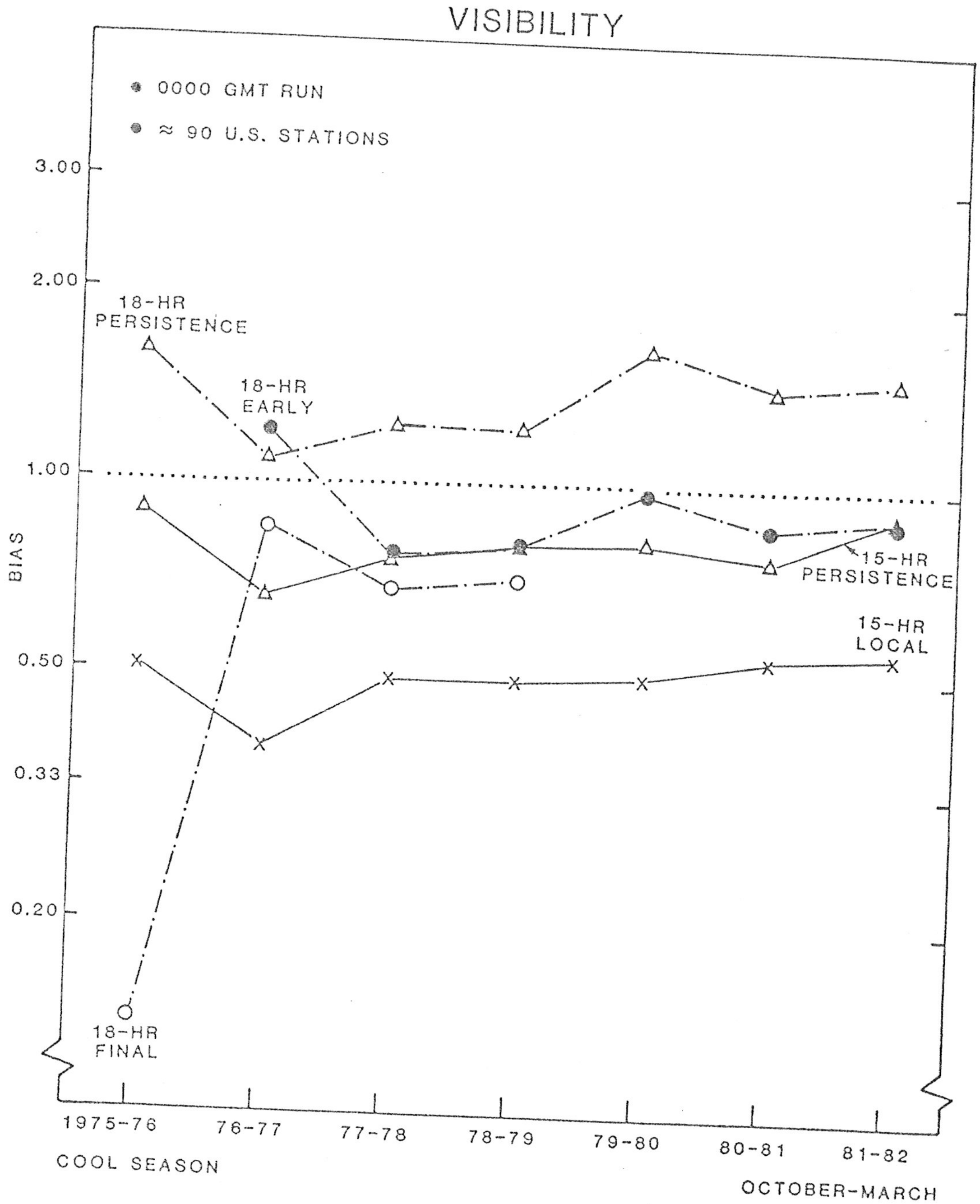

Figure 6.8. Same as Fig. 6.5 except for visibility and forecast projection.

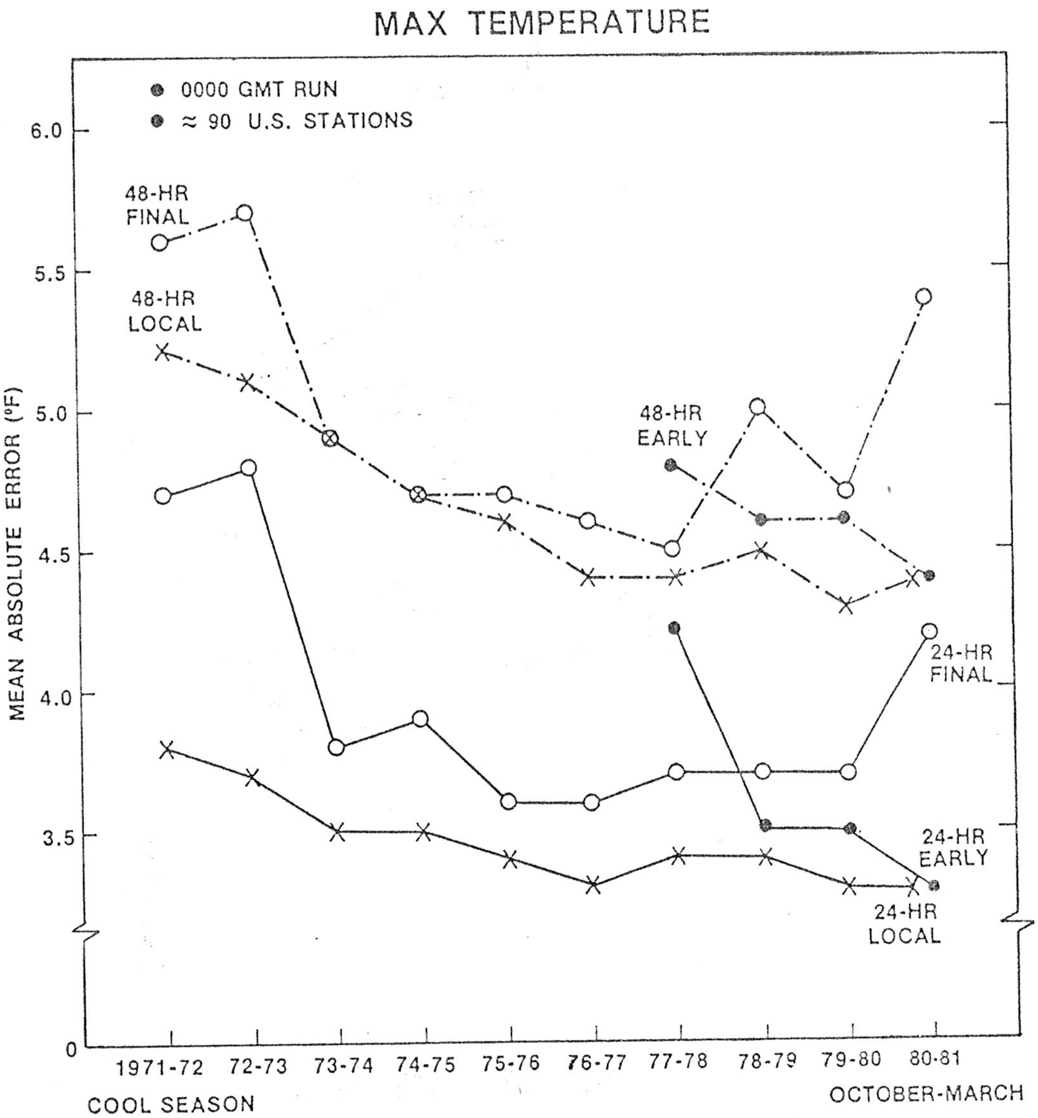

Figure 7.1. Mean absolute error for the local and the early and final guidance max temperature forecasts.

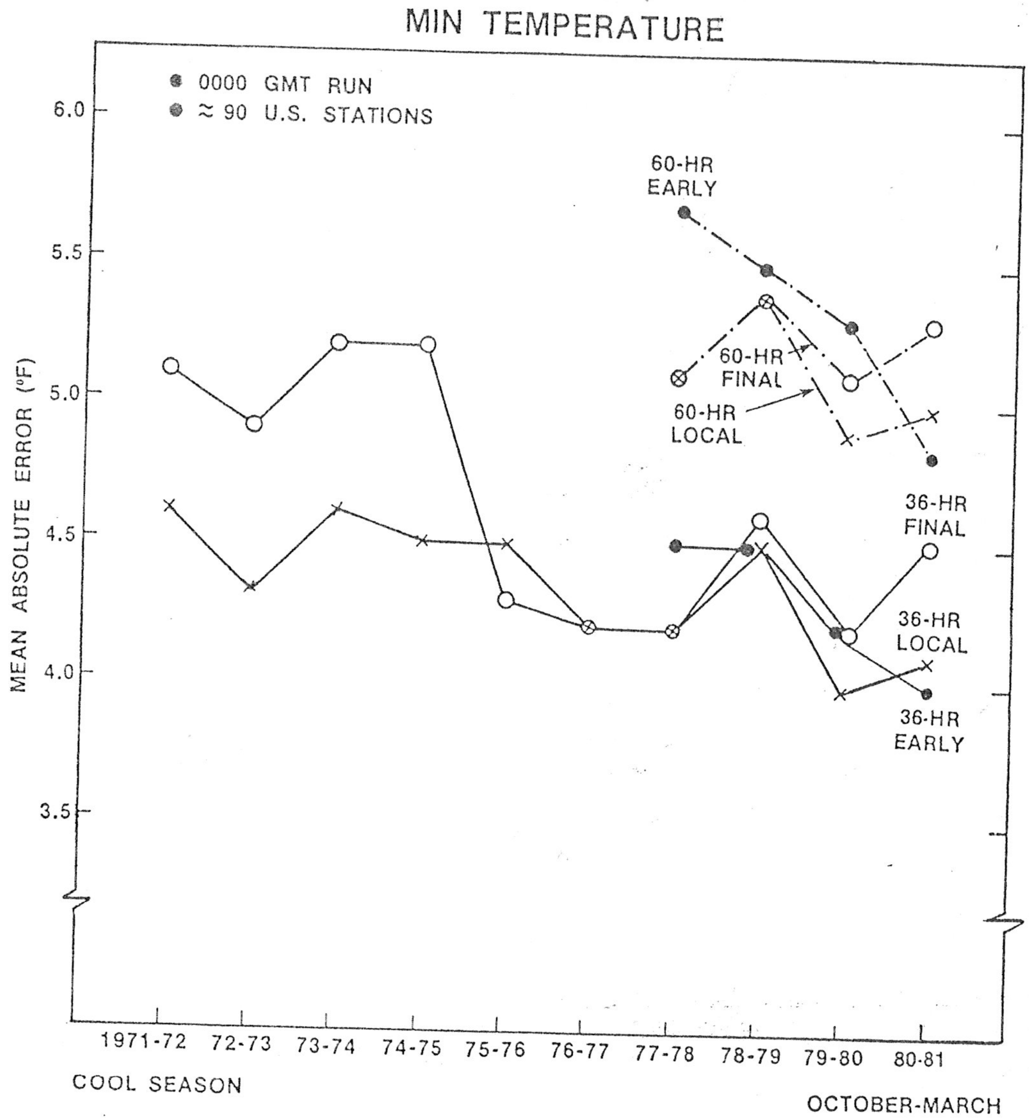

Figure 7.2. Same as Fig. 7.1 except for the min temperature.