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

TDL OFFICE NOTE 79-11

COMPARATIVE VERIFICATION OF GUIDANCE AND LOCAL AVIATION/PUBLIC WEATHER FORECASTS--NO. 6
(April 1978-September 1978)

J. Paul Dallavalle, Gary M. Carter, David B. Gilhousen,
Karl F. Hebenstreit, George W. Hollenbaugh,
John E. Janowiak, and David J. Vercelli

April 1979

COMPARATIVE VERIFICATION OF GUIDANCE AND LOCAL AVIATION/PUBLIC WEATHER FORECASTS--No. 6
(April 1978-September 1978)

J. Paul Dallavalle, Gary M. Carter, David B. Gilhousen,
Karl F. Hebenstreit, George W. Hollenbaugh,
John E. Janowiak, and David J. Vercelli

1. INTRODUCTION

This is another in a series of Techniques Development Laboratory (TDL) office notes that compare the performance of the automated guidance produced by TDL with the local forecasts prepared by National Weather Service (NWS) forecasters at the Weather Service Forecast Offices (WSFO's). The local forecasts, which are produced subjectively, may or may not be based on the automated guidance. Verification statistics for both the objective guidance and the local forecasts of the probability of precipitation, surface wind, opaque sky cover, ceiling height, visibility, and maximum/minimum temperature (max/min) are given here for the 1978 warm season (April through September).

The objective guidance is based on equations developed through 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 (National Weather Service, 1971), the Trajectory (TJ) model (Reap, 1972), and/or the 6-layer coarse mesh Primitive Equation (6LPE) model (Shuman and Hovermale, 1968). In operations, however, forecast fields from the LFM-II (National Weather Service, 1977a) and the 7-layer PE (7LPE) model (National Weather Service, 1977b) are employed in the MOS guidance equations when LFM or PE data, respectively, are required. This became necessary when the National Meteorological Center of the NWS replaced the LFM with the LFM-II on August 31, 1977 and the 6LPE with the 7LPE on January 19, 1978. Unless indicated otherwise, we usually refer to MOS forecasts based on the LFM-II as "early" guidance; "final" guidance indicates that the objective forecasts were dependent on the 7LPE. Also, the observation times of surface weather elements used as predictors in the early and final guidance generally differ.

The local forecasts from the WSFO's were provided 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 prognoses. 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 the observed verification data from the National Climatic Center in Asheville, North Carolina.

2. PROBABILITY OF PRECIPITATION (PoP)

The objective PoP forecasts were produced by the warm season prediction equations described in Technical Procedures Bulletin No. 233 (National Weather Service, 1978b). 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 the model input data time (0000 or 1200 GMT). The predictors for the first period equations were forecast fields from the LFM-II model and surface variables observed at the forecast site 3 hours after the initial model time.

Both early and final objective guidance were produced for the second and third periods while only early guidance was available for the first period. All of the early automated forecasts were based on the LFM-II model forecasts. The final guidance for the second period was based on fields from the LFM-II, 7LPE, and TJ models. Third period final guidance equations used 7LPE predictors only.

We verified the forecasts by computing the Brier score (Brier, 1950) for the 87 stations shown in Table 2.1. Please note that we used the standard NWS Brier score which is one-half the original score defined by Brier. Brier scores will naturally vary from one station to the next and from one year to the next because of changes in the relative frequency of precipitation. Therefore, we also computed the percent improvement over climatology, that is, the percent improvement of the Brier scores obtained from the local or guidance forecasts over the Brier scores produced by climatic forecasts. The latter are defined as relative frequencies of precipitation by month and by station determined from a 15-year sample (Jorgensen, 1967).

Table 2.2 shows the results for all 87 stations for 0000 GMT forecasts made from April through September of 1978. Tables 2.3 through 2.6 show scores for the NWS Eastern, Central, Southern, and Western Regions, respectively; the second and third period verifications are a three-way comparison between the early and final guidance, and the subjective local forecasts.

A major result of this verification is the fact that NWS forecasters were able to improve upon the early guidance for only the first period. Second and third period early MOS guidance was slightly better than the local forecasts for all stations combined. There were a few exceptions, however, when the scores for individual regions were examined. In the Southern Region, forecasters improved on the second period early guidance by two percent. Western Region forecasters improved on the third period early guidance by two percent and scored about the same as the guidance for second period forecasts. In contrast, the early MOS guidance was superior to the Eastern Region local forecasts for all three periods.

Another important result is that the early guidance was more accurate than the final guidance for both the second and third periods. The only exception to this occurred in the Western Region where the third period final MOS forecasts were slightly better than the early ones. The superiority of the early over the final guidance also was indicated by last summer's verification of second period forecasts (Zurndorfer et al., 1978).

Fig. 2.1 shows the trend since 1971 in the accuracy (expressed in terms of percent improvement over climatology) of the first and third period 0000 GMT PoP forecasts. During the 1978 warm season, the local forecasts and the final guidance were more accurate for both periods than in the previous season. Several general trends are evident. First, both the final guidance and the local forecasts have improved since the 1975 summer season. Secondly, as the 12-24 h MOS guidance has improved, the difference between the guidance and the local forecasts has decreased. Note that 190 stations were used to compute the scores for the 1973 summer season. Also, results were unavailable for the 1974 and 1976 warm seasons because of missing data.

3. SURFACE WIND

The objective wind forecasts were generated by early and final guidance equations valid for the warm season (National Weather Service, 1978a). Operationally, the early guidance was based on output from the LFM-II model, while the final guidance relied on 7LPE model forecasts. The sine and cosine of the day of the year were used as predictors in both sets of guidance equations; surface weather observations were not used as predictors. The definition of the objective surface wind forecast is the same as that of the observed wind: the one-minute average 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, we verified the wind forecasts in two ways. First, for all those cases in which both the local and objective (early and final) 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, Heidke skill score, percent correct, and bias by category[1] were computed from contingency tables of wind speed. The seven categories in the tables were: less than 8, 8-12, 13-17, 18-22, 23-27, 28-32, and greater than 32 knots. Table 3.1 lists the 94 stations used in the verification.

---

[1] In the discussion of surface wind, opaque sky cover, ceiling, and visibility, bias by category refers to the number of forecasts of a category divided by the number of observations of that category. A value of 1.0 means unbiased forecasts of that category.

Tables 3.2-3.12 show comparative verification scores (0000 GMT cycle only) for 18-, 30-, and 42-h projections. Note that all the objective forecasts of wind speed were adjusted by an "inflation" equation (Klein et al., 1959) involving the multiple correlation coefficient and the mean value of wind speed for a particular station and forecast valid time.

The results for all 94 stations combined are shown in Tables 3.2 and 3.3. The MAE's for the direction reveal an advantage for the guidance (early and final) that was approximately 4° for all three forecast projections. Overall, the MAE's, skill scores, and percent correct generally were better for the objective guidance. Also, the early guidance scores usually were superior to those for the final guidance. The biases by category in Table 3.2 and the contingency tables in Table 3.3 indicate that both the early and final guidance and the local forecasts tended to underestimate winds stronger than 22 knots (i.e., categories 5, 6, and 7).

Tables 3.4-3.7 show scores for the NWS Eastern, Southern, Central, and Western Regions, respectively. The regional values usually had the same general characteristics as those for the entire group of stations, except the advantage of the guidance over the local forecasts varied in magnitude from region to region. In contrast to the overall results, the scores in Table 3.7 for the Western Region indicate that the 30- and 42-h final guidance forecasts were better than those for the early 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 94 stations combined. For all three projections, we see that the early guidance had about 5% fewer errors of 40° or more than did the local forecasts. The final guidance was also superior to the local forecasts in this respect with approximately 4% fewer errors.

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 differed in magnitude from region to region. As before, the results for the Western Region (Table 3.12) show that the final guidance was superior to the early for the 30- and 42-h projections.

A comparison of the overall MAE's and skill scores during the past 5 warm seasons for the 18- and 42-h guidance and local forecasts is presented in Figs. 3.1-3.3. In general, the verification data throughout this period were relatively homogeneous since the number of stations varied only slightly from season to season while the basic set of verification stations remained the same. Early guidance scores were available only for the warm seasons of 1977 and 1978.

The MAE's for direction are shown in Fig. 3.1. Except for a slight increase in some of the MAE's during the 1975 warm season, the final guidance and local forecasts for both projections steadily improved over the span of 5 seasons.

In contrast, the MAE's in Fig. 3.2 indicate a decrease in accuracy for the final forecasts of wind speed. This was caused by the introduction of inflation in August of 1975. We realized that inflation would have this effect; however, the bias values shown in Table 3.2 were somewhat closer to 1.0 compared to the bias values in previous warm season surface wind verifications (Carter and Hollenbaugh, 1976). Despite the inflation technique, the MAE's for the guidance were generally as good as, or better than, those for the local forecasts.

Fig. 3.3 is a comparison of guidance and local skill scores computed on five (instead of seven) categories; the fifth category included all speeds greater than 22 knots. Here we see that the skill of the final guidance in both projections remained relatively constant from 1974 to 1978 despite the use of inflation. Of particular note in Fig. 3.3 is the superiority in skill of the guidance over the local forecasts for both projections.

The 18- and 42-h early guidance MAE and skill scores in Figs. 3.1-3.3 generally indicate the superiority of these forecasts over the final guidance. This is quite encouraging because the early forecasts are now the primary source of detailed surface wind guidance available to NWS field forecasters prior to issuance of the public weather forecast.

4. OPAQUE SKY COVER

For the 1978 warm season, we implemented the same regionalized prediction equations for early and final guidance that were used during the previous warm season. There was one major addition, namely, the extension of our early guidance package to 48 hours by applying PE-derived equations to LFM-II model output for the 30-, 36-, 42-, and 48-h projections (National Weather Service, 1978c). We continued to provide forecasts for projections of 12 through 48 hours in our final guidance package.

The regionalized equations produced probability forecasts of four categories of opaque sky cover, more commonly known as cloud amount, as shown in Table 4.1. For both the early and final guidance packages, we convert the probability estimates to a single "best category" forecast in a manner which produces good bias characteristics, that is, a bias value of approximately 1.0 for each category. For more details about our cloud amount forecast system, see Technical Procedures Bulletin No. 234 (National Weather Service, 1978c).

For the verification of the April-September warm season, we compared the local forecasts at the 94 stations listed in Table 3.1 with a matched sample of early and final objective forecasts. The comparison was conducted for 18-, 30-, and 42-h forecasts from the 0000 GMT cycle only. We converted the local forecasts and the surface observations used for verification from opaque sky cover amount to the categories in Table 4.1. Four-category, forecast-observed contingency tables were prepared from the transformed local and best-category objective predictions. Using these tables, we computed the percent correct, Heidke skill score, and bias by category.

The results for all stations combined are shown in Table 4.2. At both the 18- and 30-h projections, the percent correct and skill scores for the final guidance were slightly better than those for the early guidance; the opposite was true at the 42-h projection. Comparing the objective guidance with the local forecasts, we found that both the early and final guidance were superior to the locals at all projections in terms of percent correct and skill score.

The difference between the scores for our 18-h early and final guidance is quite interesting since both sets of prediction equations were derived from LFM data. The time of the observed surface predictors varies, of course, since the final guidance uses 0600 GMT observations, while the early guidance relies on either 0200 or 0300 GMT reports. Moreover, the conversion of almost identical objective probability forecasts to best category forecasts can yield different results because the early and final guidance transformations differ slightly. The biases for the automated guidance were better (i.e., closer to 1.0) than the local biases for all three projections and four categories.

The verification scores for stations in the NWS Eastern, Southern, Central, and Western Regions, are given in Tables 4.3-4.6, respectively. Comparing the early and final guidance for the 18-h projection, we found that the percent correct and skill score were higher for the final guidance in all but the Central Region. For the Central Region, the percent correct and skill score for the early guidance were slightly better than the final guidance. The final guidance scores for the 30-h projection were somewhat better than the early guidance scores, except in the Southern Region where the early guidance was slightly better. In general, the early guidance had a slight advantage over the final guidance at the 42-h projection in the Eastern and Southern Regions; the reverse was true in the Central and Western Regions. For all projections, the percent correct and skill scores for early and final guidance were superior to those of the local forecasts except in the Western Region.

For the Western Region, the 18-h local forecasts improved on both the early and final guidance with respect to skill score. Generally, the biases for early and final guidance were somewhat better (i.e., closer to 1.0) than the locals in all regions.

The percent correct and skill scores over the past 4 warm seasons are shown in Figs. 4.1 and 4.2, respectively, for the 18- and 42-h projections. Verification statistics are included for both the local forecasts and the final guidance for all 4 years; scores for the early guidance also are shown for the last 2 seasons. The 18- and 42-h final guidance scores improved steadily during the 4 warm seasons, while the 18-h early guidance improved from 1977 to 1978. The 1978 early and final guidance scores for the 42-h projection were almost identical. The local forecasts for both the 18- and 42-h projections improved from the 1977 to the 1978 season.

In Figs. 4.3 and 4.4, we show the biases over the past 4 warm seasons for category 1 and category 2, respectively. These figures are for the same projections as Figs. 4.1 and 4.2. Fig. 4.3 shows that, although the 18-h early and final category 1 biases improved during the most recent warm season, there was deterioration in the 42-h final guidance. The category 1 bias for the 42-h early was nearly identical to that of the 18-h early and final guidance. The category 2 bias (Fig. 4.4) for 18-h early and final guidance improved over the previous warm season, while the 42-h final guidance deteriorated slightly. In both Figs. 4.3 and 4.4, the 18- and 42-h locals remained about the same from 1977 to 1978.

The overall results of this comparative verification indicate that the forecast equations performed as well as they did during the previous warm season (Zurndorfer et al., 1978). Also, the extended early guidance forecasts compared favorably with the final guidance forecasts even though the former were prepared by using LFM-II output in PE-derived equations.

5. CEILING AND VISIBILITY

We used the same regionalized ceiling and visibility equations that were operational during the 1977 warm season (Zurndorfer et al., 1978). However, the early guidance was extended to forecast projections of 30, 36, 42, and 48 hours by applying LFM-II model output and surface observations 3 hours after cycle time to forecast equations that were developed from PE model fields and surface observations 6 hours after cycle time (National Weather Service, 1978c). Threshold probabilities derived from PE model fields were used to select the best category of ceiling and visibility for these extended projections. For both the early and final guidance, forecasts of the ceiling and visibility were produced for 6-h intervals from 12 to 48 hours after initial model time (0000 or 1200 GMT). The early guidance depended on LFM-II model output while the final guidance used both LFM-II and 7LPE forecast fields.

For the first time, we have included the 36- and 48-h early guidance projections in the ceiling and visibility verification. Early and final objective forecasts were verified for 12-, 18-, 24-, 36-, and 48-h projections while subjective local forecasts were verified for 12-, 15-, and 21-h projections. Persistence forecasts that were based on the 0900 GMT observation for the 0000 GMT cycle and the 2100 or 2200 GMT observation (depending on region) for the 1200 GMT cycle were also verified for all of these projections. A matched sample was used at each projection.

Six-category forecast-observed contingency tables were constructed for 94 stations (Table 3.1) for both the ceiling and visibility forecasts discussed above. Definitions of the categories are given in Table 5.1. These tables were then used for computing several scores: bias by category, percent correct, and Heidke skill score. Additionally, we collapsed the contingency tables to two categories (categories 1 and 2 combined along with categories 3 through 6 combined) and then calculated the bias and threat score for forecasts of ceiling less than 500 feet and for forecasts of visibility less than 1 mile. The Heidke skill score and percent correct were also computed for the reduced tables.

Tables 5.2-5.5 present the verifications of the six-category ceiling and visibility forecasts. At the 12-h projection, the persistence forecast had the highest skill score for ceiling for both cycles and for the visibility during the 1200 GMT cycle. The local subjective forecast of visibility was the most accurate in terms of skill score for the 0000 GMT cycle. The final guidance always had a higher skill score than the early guidance at the 12-h projection because the final guidance equations used observations 6 hours after cycle time, while the early equations used 3-h observations. With the exception of the 1200 GMT cycle visibility forecast, the locals outperformed persistence at both the 15- and 21-h projections. At the 18-h projection, the final guidance was generally better than the early, but there was little difference in skill between the two at the 24-, 36-, and 48-h projections where the early guidance was slightly more accurate overall.

The bias by category characteristics of the guidance were generally better (i.e., closer to 1.0) than either the local or persistence forecasts except at the 12- and 36-h projections. In regard to the 12-h projection of the objective guidance, persistence and the local forecasters essentially were making a 3-h forecast since surface observations valid 9 hours after either 0000 GMT or 1200 GMT were available. Similarly, for the 36-h projection, persistence actually was a 27-h forecast. Though this particular persistence prognosis lacked the skill of the guidance, its bias characteristics were, of course, good.

Tables 5.6-5.9 show the comparative verification for the reduced two-category situation. The relative frequency of the ceiling less than 500 feet and visibility less than 1 mile varied between .002 and .039, indicating these events are relatively rare and, hence, difficult to forecast. This difficulty was reflected in the lower overall skill scores.

At the 12-h projection, the persistence forecast generally had the highest skill, the exception being for the 1200 GMT cycle where the local forecast of visibility was best. Again, the final guidance at the 12-h projection was better than the early guidance because the final guidance used an observation closer to the verifying time. At the 15-h projection, the skill for persistence forecasts of both ceiling and visibility was greater than for the locals during the 0000 GMT cycle, but not during the 1200 GMT cycle. By the 21-h projection, the local forecasts were more accurate than persistence. The skill of the objective guidance was greater than persistence for both ceiling and visibility at the 24-, 36-, and 48-h projections except for the 36-h visibility forecast in the 1200 GMT cycle. The bias characteristics of the guidance for categories 1 and 2 combined were generally superior to both the local and persistence forecasts.

6. MAX/MIN TEMPERATURE

The objective max/min guidance for April through September of 1978 was generated from several different sets of seasonal regression equations. However, the predictand for both the early and final guidance was the local calendar day max or min valid approximately 24, 36, 48, and 60 hours after initial model time (0000 or 1200 GMT). The final automated forecasts were based on equations developed by stratifying archived 6LPE and TJ model output, station observations, and the first two harmonics of the day of the year into seasons of 3-month duration (Hammons et al., 1976). We used spring (March-May), summer (June-August), and fall (September-November) equations to produce the final guidance during the appropriate months of the 1978 warm season. Operationally, the equations employed output from the 7LPE and the TJ models as predictors. Station observations available 6 hours after the initial model time also were used in the final guidance equations for the first two projections.

In contrast, during April and May of 1978, the early max/min guidance was produced by using output from the LFM-II and from a TJ model (LFM-II dependent) in the appropriate 6LPE-derived equations. Station observations were not included in this type of early guidance. However, the early guidance system was completely revamped on June 1, 1978. At that time, we implemented new prediction equations (Carter et al., 1978) that had been derived from LFM model output, station observations available at 3 hours after initial model time, and the first two harmonics of the day of the year. For the first projection, forecast equations were available for 3-month seasons: spring (April-June) and summer (July-September). After the first projection, however, data were sufficient only for 6-month season equations. Thus, to produce the early guidance for the second, third, and fourth projections, we used warm season (April-September) equations. In operations, forecast fields from the LFM-II were employed as predictors in the LFM-derived equations. Surface observations at 3 hours after the initial model time were often used as input to many of the forecasts for the first two periods.

As mentioned earlier, the automated max/min forecasts are valid for local calendar day periods. The objective guidance--both early and final--is available on the FOUS22 teletype bulletin. The local forecasts are obtained from the FPUS4 teletypewriter message. However, the valid period of the local max/min is not identical to that for the objective max/min. The local forecaster predicts a max for the 1200 to 0000 GMT period and a min that is generally valid from 0000 to 1200 GMT. This latter period, however, is extended to 1800 GMT for forecasters in the Western Region and for many others in the western parts of the Central and Southern Regions. Since the MOS guidance is applicable for the local calendar day max or min, for example, the first period objective forecasts of the max based on 0000 GMT model data (Day 1) is valid for the calendar day that starts before 1200 GMT (Day 1) and ends after 0000 GMT the following day (Day 2). Hence, caution is necessary in comparing verification scores for the local forecasts and the objective guidance.

We verified local and objective forecasts from the 0000 GMT cycle only. Calendar day max and min obtained from the National Climatic Center were used as the verifying observations. We calculated the mean algebraic error (forecast minus observed temperature), the mean absolute error, and the number of absolute errors greater than 10°F for 87 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.

Verification results are shown in Table 6.1 for all 87 stations combined. The mean algebraic errors for both the local forecasts and early guidance were close to 0.0°F for all projections. The final guidance was similar for the second and fourth projections; however, the final forecasts of the max in the first and third projection exhibited a distinct cold bias of about 1.0°F. In terms of mean absolute error, the early guidance was more accurate than the final guidance at the first three projections. The final guidance, however, had a lower mean absolute error for the 60-h projection. Correspondingly, at all projections but the last, there were fewer large errors in the early than the final guidance. In contrast, for the 60-h projection, the early guidance had over 200 more large errors than the final max/min. Overall, these results contradict those of the 1977 warm season (Zurndorfer et al., 1978) when we observed that the early guidance was an inferior product (Dallavalle and Hammons, 1976) because of the use of LFM fields in 6LPE-derived equations. Recall that for two-thirds of the 1978 warm season, the early guidance depended on new LFM-derived equations. These seem to be responsible for the increase in accuracy (Carter et al., 1978). For the last projection, the final guidance was still better, at least in part because the older 3-month equations were based on 5 or 6 years of data while the early guidance depended on 6-month equations derived from 2 years of data.

For the 24- and 48-h max, the local forecasts had smaller mean absolute errors than either the early or final guidance. Also, the number of large absolute errors generally reflected the improvement of the local forecasters. We have noted previously (Hammons et al., 1976) that the max is much more difficult than the min to forecast during the warm season. For the 36- and 60-h projections, the local forecasts had identical mean absolute errors to the final guidance although the locals had substantially more large errors. The early guidance was better than the locals at 36 hours, but not at 60 hours. Overall, the mean absolute errors for the local and objective forecasts were lower than last warm season (Zurndorfer et al., op. cit.), but this is probably related to the climatic conditions.

Analagous verification scores are shown in Tables 6.2-6.5 for the Eastern, Southern, Central, and Western Regions, respectively. The trends are quite similar to those seen for all 87 stations combined. In the Eastern, Southern, and Central Regions, the early guidance was more accurate than the final for the first three projections though the differences were small except in the Eastern Region. For the 60-h projection, the final guidance was generally better than the early. However, in the Western Region, the final guidance was more accurate than the early by 0.1°F mean absolute error at all projections except for the 48-h max. Overall, though, in the Western Region there was little difference between the early and final objective forecasts. This is in sharp contrast to the 1977 warm season when the early guidance was very poor in comparison with the final.

The performance of the local forecasters with respect to the automated guidance varied somewhat from region to region. Forecasters in the Southern Region (Table 6.3) improved upon the early guidance by 0.3°F to 0.5°F mean absolute error in three of the four projections. The accuracy of the early guidance and local forecasts was identical only for the 36-h min. A similar trend was evident in the Central Region though the improvement in the local forecasts was not as large. Forecasters in the Eastern Region were unable to improve on the early guidance except by 0.1°F mean absolute error for the last projection. For the 36-h min, in fact, the early guidance was 0.2°F mean absolute error more accurate than the local forecasts. In the Western Region, there was very little difference between the local forecasts and the early or final objective guidance for the first three periods. Local forecasters, however, improved upon the early objective guidance by 0.2°F in the last projection.

7. CONCLUSIONS

This verification shows that TDL's aviation/public weather guidance continues to compare favorably with the local forecasts produced at the WSFO's. For the PoP forecasts, the second and third period early MOS guidance was more accurate than the local forecasters for all stations combined. For individual regions, there were several exceptions to this statement. In the first period, however, the NWS forecasters in all regions but the Eastern were able to improve upon the early guidance. In general, the early MOS PoP guidance was more accurate than the final for both the second and third periods. The only exception to this was in the Western Region where the third period final MOS forecasts were slightly better than the early guidance. Verification scores over the past several warm seasons indicate a general improvement in both the guidance and the local forecasts. In fact, as the first period PoP forecasts have improved, the difference in accuracy between the guidance and local forecasts has decreased.

For the wind speed and direction forecasts, both the early and final MOS guidance were more accurate than the local forecasts. The early guidance was generally superior to the final guidance in all areas and projections except for the 30- and 42-h projections in the Western Region where the final was more accurate. Both the early and final guidance and the local forecasts tended to underestimate winds stronger than 22 knots. Verifications for the past 5 warm seasons indicate the improvement in the MAE of the objective wind direction forecasts. Due to the introduction of the inflation technique in 1975, the MAE of the wind speed guidance has not decreased; however, the guidance skill scores have remained over the years consistently higher than those for the locals.

Both the early and the final opaque sky cover guidance were generally more accurate than the local forecasts in terms of percent correct and skill score for all projections verified here. In the Western Region, however, the local forecasts had greater skill scores for the 18-h projection. Overall, the final guidance was more accurate than the early guidance for the 18- and 30-h projections; the opposite was true at the 42-h projection despite the use of LFM-II fields in PE-derived equations. The comparison between the early and final guidance varied widely from region to region.

A direct comparison between local, MOS, and persistence forecasts of ceiling and visibility was possible only for the 12-h projection. For that projection, local forecasts were superior to the guidance for both elements while persistence was generally more accurate than the locals. The bias characteristics of the guidance were better than either the locals or persistence at most projections. There was no significant difference in performance between early and final guidance equations at, or beyond, the 24-h projection.

Finally, new early guidance max/min equations were implemented during the 1978 warm season. As a result, the early 0000 GMT max/min guidance was more accurate than the final at the first three projections. For the 60-h min forecast, however, the final guidance had lower mean absolute errors. These trends were generally evident in the four NWS regions discussed in this report. Though comparisons between the objective guidance and the local forecasts of the max/min are difficult to make because of the different forecast periods involved, we found that the local forecasts of the max valid approximately 24- and 48-h after 0000 GMT were generally more accurate in mean absolute error than the objective guidance. In particular, forecasters in the Southern Region were able to improve on the automated prognoses. We have noted before that the min is easier to predict during the warm season, and, in fact, there was little or no difference in mean absolute error between the guidance and local forecasts for the 36- and 60-h min.

ACKNOWLEDGMENTS

We wish to thank the Technical Procedures Branch of the Office of Meteorology and Oceanography for providing us with the local forecasts. In particular, we thank Gerry Cobb who processed the data. We are also grateful to Harry Akens, Fred Marshall, and Bill Herrmann of the Techniques Development Laboratory for assistance in archiving the guidance and error-checking the observations used for verification. Additional thanks are extended to Nancy Harrison, Mary Battle and Mercedes Bakon for typing the text and the numerous tables shown in this report.

REFERENCES

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

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

_____, A. L. Forst, W. H. Klein, and J. P. Dallavalle, 1978: Improved automated forecasts of maximum/minimum and 3-hourly temperatures. Preprints Conference on Weather Forecasting and Analysis and Aviation Meteorology, October 1978, Silver Spring, Md., Amer. Meteor. Soc., 171-178.

Dallavalle, J. P., and G. A. Hammons, 1976: Use of LFM data in PE-based max/min forecast equations. TDL Office Note 76-14, National Weather Service, NOAA, U.S. Department of Commerce, 10 pp.

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

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

Jorgensen, D. L., 1967: Climatological probabilities of precipitation for the conterminous United States. ESSA Tech. Report WB-5, 60 pp.

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

National Weather Service, 1971: The Limited-Area Fine Mesh (LFM) model NWS Technical Procedures Bulletin No. 67, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 11 pp.

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

_____, 1977a: High resolution LFM (LFM-II). NWS Technical Procedures Bulletin No. 206, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 6 pp.

_____, 1977b: The 7LPE model. NWS Technical Procedures Bulletin No. 218, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 14 pp.

_____, 1978a: The use of model output statistics for predicting surface wind. NWS Technical Procedures Bulletin No. 229, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 12 pp.

_____, 1978b: The use of model output statistics for predicting probability of precipitation. NWS Technical Procedures Bulletin No. 233, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 13 pp.

_____, 1978c: The use of model output statistics for predicting ceiling, visibility, and cloud amount. NWS Technical Procedures Bulletin No. 234, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, 14 pp.

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

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

Zurndorfer, E. A., G. M. Carter, J. P. Dallavalle, D. B. Gilhousen, K. F. Hebenstreit, G. W. Hollenbaugh, J. E. Janowiak, and D. J. Vercelli, 1978: Comparative verification of guidance and local aviation/public weather forecasts--No. 4. TDL Office Note 78-3, National Weather Service, NOAA, U.S. Department of Commerce, 49 pp.

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

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

Table 2.2. Comparative verification of early and final guidance and local PoP forecasts for 87 stations, 0000 GMT cycle only, for the period of April through September of 1978.

Projection	Type of Forecasts	Brier Score	Improvement Over Guidance (%)	Improvement Over Climatology (%)	Number of Cases
12-24 h (1st period)	Early/Final	.1068		29.4	12781
	Local	.1044	2.3	31.3	
24-36 h (2nd period)	Early	.1117		24.5	12746
	Final	.1179		20.4	
	Local	.1142	-2.2[1] (3.1)	23.2	
36-48 h (3rd period)	Early	.1244		18.0	12786
	Final	.1284		16.6	
	Local	.1265	-1.7[1] (1.5)	17.7	

[1] This is the percent improvement of the locals over the early guidance; the figure in parentheses is the percent improvement of the locals over the final guidance.

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

Projection	Type of Forecast	Brier Score	Improvement Over Guidance (%)	Improvement Over Climatology (%)	Number of Cases
12-24 h (1st period)	Early/Final	.1024		40.7	3644
	Local	.1051	-2.6	39.2	
24-36 h (2nd period)	Early	.1115		33.4	3631
	Final	.1208		27.9	
	Local	.1167	-4.6[1] (3.4)	30.3	
36-48 h (3rd period)	Early	.1292		27.0	3646
	Final	.1333		24.7	
	Local	.1313	-1.6[1] (1.5)	25.8	

[1] This is the percent improvement of the locals over the early guidance; the figure in parentheses is the percent improvement of the locals over the final guidance.

Table 2.4. Same as Table 2.2 except for 22 stations in the Central Region.

Projection	Type of Forecast	Brier Score	Improvement Over Guidance (%)	Improvement Over Climatology (%)	Number of Cases
12-24 h (1st period)	Early/Final	.1110		33.6	3373
	Local	.1084	2.3	35.2	
24-36 h (2nd period)	Early	.1346		26.9	3367
	Final	.1408		23.5	
	Local	.1405	-4.4[1] (0.2)	23.7	
36-48 h (3rd period)	Early	.1315		21.8	3374
	Final	.1364		18.9	
	Local	.1360	-3.5[1] (0.3)	19.2	

[1] This is the percent improvement of the locals over the early guidance; the figure in parentheses is the percent improvement of the locals over the final guidance.

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

Projection	Type of Forecast	Brier Score	Improvement Over Guidance (%)	Improvement Over Climatology (%)	Number of Cases
12-24 h (1st period)	Early/Final	.1262		15.8	3397
	Local	.1199	5.0	20.0	
24-36 h (2nd period)	Early	.1065		14.5	3386
	Final	.1103		11.5	
	Local	.1044	2.0[1] (5.3)	16.2	
36-48 h (3rd period)	Early	.1376		9.8	3399
	Final	.1434		6.0	
	Local	.1398	-1.6[1] (2.5)	8.4	

[1] This is the percent improvement of the locals over the early guidance; the figure in parentheses is the percent improvement of the locals over the final guidance.

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

Projection	Type of Forecast	Brier Score	Improvement Over Guidance (%)	Improvement Over Climatology (%)	Number of Cases
12-24 h (1st period)	Early/Final	.0800		25.4	2367
	Local	.0752	6.0	29.8	
24-36 h (2nd period)	Early	.0868		21.5	2362
	Final	.0915		17.2	
	Local	.0869	-0.1[1] (5.1)	21.4	
36-48 h (3rd period)	Early	.0882		14.0	2367
	Final	.0878		14.4	
	Local	.0864	2.0[1] (1.6)	15.8	

1 This is the percent improvement of the locals over the early guidance; the figure in parentheses is the percent improvement of the locals over the final guidance.

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

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

Table 3.2. Comparative verification of early and final guidance and local surface wind forecasts for 94 stations, 0000 GMT cycle only, for the period of April through September of 1978.

FCST PROJ (HOURS)	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-NO. FCST/NO. OBS: CAT1 (NO. OBS)	CAT2 (NO. OBS)	CAT3 (NO. OBS)	CAT4 (NO. OBS)	CAT5 (NO. OBS)	CAT6 (NO. OBS)	CAT7 (NO. OBS)	NO. OF CASES
18	EARLY	27	5768	3.0	12.0	12.2	5792	0.30	55	1.26	0.91	0.73	0.61	0.49	0.68	0.13	14912
	FINAL	29		3.1	12.1			0.27	53	1.22	0.93	0.73	0.74	0.43	0.37	0.63	
	LOCAL	31		3.3	12.9			0.25	51	0.90 (5880)	1.14 (5884)	0.97 (2457)	0.80 (576)	0.55 (88)	0.68 (19)	0.63 (8)	
30	EARLY	32	2399	3.6	11.5	10.2	2436	0.31	68	1.04	0.95	0.86	0.61	0.22	0.20	0.0	14688
	FINAL	31		3.6	11.4			0.30	68	1.06	0.89	0.84	0.53	0.13	0.20	0.0	
	LOCAL	36		3.7	11.8			0.27	64	0.95 (9952)	1.17 (3623)	0.94 (911)	0.60 (172)	0.09 (23)	0.60 (5)	1.0 (2)	
42	EARLY	36	5090	3.6	12.7	11.7	5134	0.23	50	1.13	0.92	0.87	0.99	0.93	1.0	0.56	14248
	FINAL	38		3.7	12.2			0.21	50	1.23	0.91	0.69	0.81	0.93	1.27	0.56	
	LOCAL	42		3.6	12.3			0.17	47	0.92 (5657)	1.19 (5687)	0.85 (2291)	0.58 (507)	0.33 (82)	0.40 (15)	0.11 (9)	

Table 3.3. Contingency tables for early and final guidance and local surface wind speed forecasts for 94 stations, 0000 GMT cycle only, for the period of April through September of 1978.

18-h Forecasts

EARLY

		1	2	3	4	5	6	7	T
	1	4486	1280	112	2	0	0	0	5880
	2	2568	2742	528	43	3	0	0	5884
	3	303	1164	840	135	13	2	0	2457
OBS	4	26	130	270	131	15	4	0	576
	5	2	10	34	32	7	2	1	88
	6	0	0	7	8	2	2	0	19
	7	0	0	1	1	3	3	0	8
	T	7385	5326	1792	352	43	13	1	14912

FINAL

		1	2	3	4	5	6	7	T
	1	4278	1456	134	12	0	0	0	5880
	2	2535	2718	565	63	3	0	0	5884
	3	325	1175	777	171	9	0	0	2457
OBS	4	26	127	270	139	12	2	0	576
	5	2	8	31	32	10	2	3	88
	6	0	2	4	9	2	2	0	19
	7	0	0	1	2	2	1	2	8
	T	7166	5486	1782	428	38	7	5	14912

LOCAL

		1	2	3	4	5	6	7	T
	1	3298	2289	266	23	1	0	3	5880
	2	1728	3190	869	92	5	0	0	5884
	3	247	1091	934	172	9	3	1	2457
OBS	4	16	143	261	137	16	3	0	576
	5	2	8	36	27	12	3	0	88
	6	0	3	4	7	4	1	0	19
	7	0	0	3	0	1	3	1	8
	T	5291	6724	2373	458	48	13	5	14912

30-h Forecasts

EARLY

		1	2	3	4	5	6	7	T
	1	8296	1475	162	17	1	1	0	9952
	2	1807	1461	327	26	2	0	0	3623
	3	222	425	228	34	2	0	0	911
OBS	4	23	66	64	19	0	0	0	172
	5	4	10	2	7	0	0	0	23
	6	2	1	0	2	0	0	0	5
	7	2	0	0	0	0	0	0	2
	T	10356	3438	783	105	5	1	0	14688

FINAL

		1	2	3	4	5	6	7	T
	1	8418	1329	187	18	0	0	0	9952
	2	1930	1385	285	22	1	0	0	3623
	3	212	444	225	30	0	0	0	911
OBS	4	26	67	61	16	2	0	0	172
	5	5	8	5	5	0	0	0	23
	6	2	0	2	0	0	1	0	5
	7	2	0	0	0	0	0	0	2
	T	10595	3233	765	91	3	1	0	14688

LOCAL

		1	2	3	4	5	6	7	T
	1	7585	2104	232	28	1	1	1	9952
	2	1650	1616	331	24	1	0	1	3623
	3	218	427	237	29	0	0	0	911
OBS	4	34	70	49	18	0	1	0	172
	5	6	6	8	3	0	0	0	23
	6	3	0	0	1	0	1	0	5
	7	1	1	0	0	0	0	0	2
	T	9497	4224	857	103	2	3	2	14688

42-h Forecasts

EARLY

		1	2	3	4	5	6	7	T
	1	3742	1621	249	44	1	0	0	5657
	2	2304	2514	750	108	10	1	0	5687
	3	334	976	749	197	30	4	1	2291
OBS	4	34	116	209	117	26	4	1	507
	5	3	8	31	31	4	4	1	82
	6	0	3	4	5	2	0	1	15
	7	0	0	2	1	3	2	1	9
	T	6417	5238	1994	503	76	15	5	14248

FINAL

		1	2	3	4	5	6	7	T
	1	3928	1481	212	30	6	0	0	5657
	2	2592	2438	531	112	13	1	0	5687
	3	406	1102	602	149	26	6	0	2291
OBS	4	40	140	220	81	18	6	2	507
	5	3	14	21	28	10	4	2	82
	6	0	3	3	7	1	1	0	15
	7	0	0	1	4	2	1	1	9
	T	6969	5178	1590	411	76	19	5	14248

LOCAL

		1	2	3	4	5	6	7	T
	1	2936	2396	300	25	0	0	0	5657
	2	1845	2995	756	85	4	1	1	5687
	3	373	1173	646	94	5	0	0	2291
OBS	4	47	182	201	67	7	3	0	507
	5	9	24	26	13	8	2	0	82
	6	0	3	5	6	1	0	0	15
	7	0	0	2	5	2	0	0	9
	T	5210	6773	1936	295	27	6	1	14248

Table 3.4. Same as Table 3.2 except for 24 stations in the Eastern Region.

FCST PROJ (HOURS)	TYPE OF FCST	DIRECTION: MEAN ABS ERROR (DEG)	DIRECTION: NO. OF CASES	SPEED: MEAN ABS ERROR (KTS)	MEAN FCST (KTS)	MEAN OBS (KTS)	NO. OF CASES	CONTINGENCY TABLE: SKILL SCORE	PERCENT FCST CORRECT	BIAS-NO. FCST/NO. OBS: CAT1 (NO. OBS)	CAT2 (NO. OBS)	CAT3 (NO. OBS)	CAT4 (NO. OBS)	CAT5 (NO. OBS)	CAT6 (NO. OBS)	CAT7 (NO. OBS)	NO. OF CASES
	EARLY	27		2.8	11.9			0.30	54	1.37	0.87	0.70	0.72	0.47	0.20	*	
18	FINAL	29	1595	2.9	12.0	12.1	1597	0.27	53	1.39	0.86	0.65	0.98	0.41	0.40	*	3790
	LOCAL	32		3.1	12.6			0.25	51	1.03 (1274)	1.03 (1677)	0.94 (693)	0.71 (124)	0.41 (17)	0.20 (5)	*** (0)	
	EARLY	32		3.3	11.0			0.32	74	1.08	0.79	0.72	1.22	1.0	0.0	0.0	
30	FINAL	32	510	3.6	11.6	9.7	517	0.31	73	1.06	0.80	0.92	2.67	0.0	1.0	0.0	3794
	LOCAL	35		3.8	12.0			0.28	69	0.94 (2795)	1.10 (806)	1.36 (180)	2.67 (9)	0.0 (2)	1.0 (1)	0.0 (1)	
	EARLY	35		3.2	12.1			0.25	51	1.32	0.88	0.74	0.86	0.43	0.0	*	
42	FINAL	37	1383	3.3	12.0	11.8	1384	0.21	49	1.38	0.86	0.65	0.95	0.93	0.33	*	3643
	LOCAL	40		3.3	12.3			0.17	47	1.12 (1236)	1.03 (1623)	0.78 (655)	0.70 (112)	0.21 (14)	0.0 (3)	* (0)	

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

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

FCST PROJ (HOURS)	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-NO. FCST/NO. OBS: CAT1 (NO. OBS)	CAT2 (NO. OBS)	CAT3 (NO. OBS)	CAT4 (NO. OBS)	CAT5 (NO. OBS)	CAT6 (NO. OBS)	CAT7 (NO. OBS)	NO. OF CASES
18	EARLY	27		3.0	11.9			0.31	58	1.26	0.82	0.74	0.64	0.75	**	0.0	
	FINAL	28	1260	3.0	11.9	11.8	1267	0.28	56	1.29	0.80	0.71	0.65	0.50	**	0.0	3832
	LOCAL	31		3.2	12.8			0.24	52	0.82 (1712)	1.19 (1481)	1.08 (514)	0.87 (112)	0.58 (12)	* (0)	1.0 (1)	
30	EARLY	34		3.6	11.6			0.35	73	1.04	0.97	0.79	0.42	0.50	*	*	
	FINAL	32	495	3.7	11.3	10.7	505	0.32	73	1.07	0.86	0.74	0.33	0.0	*	*	3835
	LOCAL	35		3.7	11.4			0.31	70	0.99 (2766)	1.21 (785)	0.61 (232)	0.25 (48)	0.0 (4)	* (0)	* (0)	
42	EARLY	37		3.5	12.4			0.23	53	1.22	0.80	0.83	1.02	0.91	*	0.0	
	FINAL	36	1076	3.5	11.9	11.3	1086	0.22	53	1.29	0.77	0.76	0.69	0.73	**	0.0	3610
	LOCAL	41		3.4	12.2			0.15	47	0.80 (1618)	1.29 (1419)	0.95 (466)	0.52 (95)	0.09 (11)	* (0)	0.0 (1)	

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

Table 3.6. Same as Table 3.2 except for 28 stations in the Central Region.

FCST PROJ (HOURS)	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-NO. FCST/NO. OBS CAT1 (NO. OBS)	CAT2 (NO. OBS)	CAT3 (NO. OBS)	CAT4 (NO. OBS)	CAT5 (NO. OBS)	CAT6 (NO. OBS)	CAT7 (NO. OBS)	NO. OF CASES
	EARLY	25		3.0	12.3			0.29	52	1.35	0.93	0.72	0.62	0.52	1.0	0.17	
18	FINAL	27	2090	3.2	12.4	12.7	2099	0.25	50	1.22	1.01	0.73	0.75	0.57	0.30	0.83	4453
	LOCAL	29		3.3	13.2			0.22	48	0.75 (1428)	1.25 (1803)	0.96 (922)	0.86 (242)	0.64 (42)	1.0 (10)	0.17 (6)	
	EARLY	31		3.8	11.9			0.29	63	1.03	0.96	0.99	0.79	0.10	**	*	
30	FINAL	31	937	3.8	11.5	10.4	954	0.29	64	1.09	0.90	0.81	0.51	0.30	*	*	4417
	LOCAL	37		3.9	12.0			0.23	57	0.85 (2749)	1.36 (1230)	1.04 (346)	0.68 (82)	0.10 (10)	*** (0)	** (0)	
	EARLY	36		3.8	13.5			0.21	45	1.04	0.94	1.0	1.25	1.12	1.40	0.71	
42	FINAL	38	1981	3.9	12.5	12.0	2006	0.19	45	1.24	0.99	0.64	0.90	1.24	1.70	0.71	4266
	LOCAL	42		3.7	12.6			0.15	44	0.72 (1372)	1.33 (1766)	0.89 (864)	0.62 (206)	0.41 (41)	0.50 (10)	0.14 (7)	

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

Table 3.7. Same as Table 3.2 except for 18 stations in the Western Region.

FCST PROJ (HOURS)	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-NO. FCST/NO. OBS: CAT1 (NO. OBS)	CAT2 (NO. OBS)	CAT3 (NO. OBS)	CAT4 (NO. OBS)	CAT5 (NO. OBS)	CAT6 (NO. OBS)	CAT7 (NO. OBS)	NO. OF CASES
18	EARLY	34		3.3	11.7			0.28	57	1.06	1.05	0.80	0.43	0.24	0.25	0.0	
	FINAL	33	823	3.5	12.1	11.7	829	0.27	56	0.99	1.12	0.91	0.54	0.06	0.25	0.0	2837
	LOCAL	35		3.8	12.6			0.24	54	1.02 (1466)	1.07 (923)	0.85 (328)	0.67 (98)	0.41 (17)	0.50 (4)	1.0 (1)	
30	EARLY	30		3.2	10.9			0.24	61	1.0	1.07	0.84	0.27	0.0	0.0	0.0	
	FINAL	30	457	3.2	11.2	10.1	460	0.27	63	1.02	1.01	0.96	0.27	0.0	0.0	0.0	2642
	LOCAL	34		3.5	11.4			0.24	63	1.10 (1642)	0.89 (802)	0.72 (153)	0.33 (33)	0.14 (7)	0.0 (4)	1.0 (1)	
42	EARLY	42		4.1	12.2			0.20	52	0.97	1.16	0.85	0.56	0.88	0.50	0.0	
	FINAL	39	650	4.0	12.2	11.4	658	0.22	53	1.03	1.08	0.84	0.57	0.25	0.0	0.0	2729
	LOCAL	44		4.2	12.1			0.15	51	1.08 (1431)	1.05 (879)	0.70 (306)	0.43 (94)	0.38 (16)	0.50 (2)	0.0 (1)	

Table 3.8. Distribution of absolute errors associated with early and final guidance and local forecasts of surface wind direction for 94 stations, 0000 GMT cycle only, for the 1978 warm season (April-September).

FORECAST PROJECTION (HOURS)	TYPE OF FORECAST	PERCENTAGE FREQUENCY OF ABSOLUTE ERRORS BY CATEGORY					
		0-30°	40-60°	70-90°	100-120°	130-150°	160-180°
18	EARLY	75.1	15.9	4.4	2.2	1.2	1.2
	FINAL	72.7	17.6	4.9	2.4	1.4	1.0
	LOCAL	69.5	18.8	5.9	2.6	1.8	1.4
30	EARLY	70.9	15.5	6.1	3.2	2.1	2.2
	FINAL	71.8	15.1	5.6	3.4	2.1	1.9
	LOCAL	66.6	17.6	6.9	4.5	2.2	2.2
42	EARLY	64.5	18.6	7.4	4.1	3.1	2.3
	FINAL	62.8	19.6	7.8	4.4	3.0	2.4
	LOCAL	58.4	20.7	8.9	5.1	4.1	2.8

Table 3.9. Same as Table 3.8 except for 24 stations in the Eastern Region.

FORECAST PROJECTION (HOURS)	TYPE OF FORECAST	PERCENTAGE FREQUENCY OF ABSOLUTE ERRORS BY CATEGORY					
		0-30°	40-60°	70-90°	100-120°	130-150°	160-180°
18	EARLY	75.1	16.9	4.6	1.9	0.8	0.7
	FINAL	72.2	19.0	5.0	2.1	1.0	0.7
	LOCAL	66.6	22.3	6.4	2.6	0.9	1.1
30	EARLY	67.3	20.2	6.9	3.3	1.2	1.2
	FINAL	69.4	18.0	5.9	3.7	1.4	1.6
	LOCAL	66.1	19.6	6.1	5.7	1.2	1.4
42	EARLY	64.8	20.1	7.8	3.0	2.5	1.8
	FINAL	62.9	21.2	7.5	3.5	2.7	2.2
	LOCAL	59.4	20.8	9.5	4.3	4.0	2.0

Table 3.10. Same as Table 3.8 except for 24 stations in the Southern Region.

FORECAST PROJECTION (HOURS)	TYPE OF FORECAST	PERCENTAGE FREQUENCY OF ABSOLUTE ERRORS BY CATEGORY					
		0-30°	40-60°	70-90°	100-120°	130-150°	160-180°
18	EARLY	75.5	16.2	3.6	2.2	1.4	1.1
	FINAL	73.5	17.5	4.5	2.2	1.5	0.8
	LOCAL	70.5	18.3	4.8	2.9	2.1	1.4
30	EARLY	69.9	12.9	7.9	4.0	1.8	3.4
	FINAL	71.5	14.6	5.3	3.4	3.2	2.0
	LOCAL	66.9	16.0	7.5	4.8	3.2	1.6
42	EARLY	65.3	17.3	6.2	5.2	3.4	2.6
	FINAL	65.1	17.8	7.5	3.9	3.3	2.4
	LOCAL	60.0	20.4	7.3	5.9	3.5	2.9

Table 3.11. Same as Table 3.8 except for 28 stations in the Central Region.

FORECAST PROJECTION (HOURS)	TYPE OF FORECAST	PERCENTAGE FREQUENCY OF ABSOLUTE ERRORS BY CATEGORY					
		0-30°	40-60°	70-90°	100-120°	130-150°	160-180°
18	EARLY	77.0	15.3	4.6	1.3	0.9	1.0
	FINAL	74.0	17.7	4.6	1.9	0.9	0.9
	LOCAL	71.4	18.1	5.9	2.3	1.5	0.8
30	EARLY	71.8	15.8	5.3	2.7	2.4	2.0
	FINAL	71.0	16.1	6.0	3.2	1.7	2.0
	LOCAL	66.0	18.1	6.5	4.6	1.9	2.9
42	EARLY	64.0	19.7	7.9	4.0	2.4	1.9
	FINAL	60.7	21.3	8.7	4.8	2.6	1.9
	LOCAL	56.3	22.2	10.2	4.9	3.9	2.5

Table 3.12. Same as Table 3.8 except for 18 stations in the Western Region.

FORECAST PROJECTION (HOURS)	TYPE OF FORECAST	PERCENTAGE FREQUENCY OF ABSOLUTE ERRORS BY CATEGORY					
		0-30°	40-60°	70-90°	100-120°	130-150°	160-180°
18	EARLY	69.9	14.8	4.7	5.1	2.7	2.8
	FINAL	69.5	14.9	6.0	4.5	3.0	2.1
	LOCAL	68.8	14.9	6.6	3.0	3.7	3.0
30	EARLY	74.4	12.7	4.8	3.1	2.8	2.2
	FINAL	76.6	10.5	4.8	3.5	2.6	2.0
	LOCAL	68.3	15.8	7.9	2.8	2.8	2.4
42	EARLY	64.1	14.0	6.5	4.9	6.2	4.3
	FINAL	65.7	14.0	5.8	6.0	4.5	4.0
	LOCAL	60.5	16.3	6.5	6.3	5.4	5.1

Table 4.1. Definitions of the categories used for guidance 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 and final guidance and local forecasts of four categories of cloud amount (clear, scattered, broken, and overcast) for 94 stations, 0000 GMT cycle, for the 1978 warm season.

PROJECTION (HRS)	TYPE OF FORECAST	BIAS - NO. FCST/NO. OBS				PERCENT CORRECT	SKILL SCORE	NO. OF CASES
		CAT 1 (No. Obs.)	CAT 2 (No. Obs.)	CAT3 (No. Obs)	CAT4 (No. Obs.)			
18	EARLY	0.89	1.13	1.07	0.89	50.9	.335	14662
	FINAL	0.90	1.12	1.03	0.94	51.3	.341	
	LOCAL	0.68 (4476)	1.47 (4265)	1.10 (3216)	0.67 (2705)	47.8	.292	
30	EARLY	0.94	1.60	0.61	0.86	51.9	.295	14324
	FINAL	0.89	1.56	0.55	1.04	52.3	.306	
	LOCAL	0.67 (6842)	2.06 (2500)	1.55 (1732)	0.60 (3250)	44.7	.245	
42	EARLY	0.88	1.21	0.92	0.96	45.6	.264	14579
	FINAL	0.79	1.10	1.05	1.14	45.0	.262	
	LOCAL	0.54 (4441)	1.70 (4190)	1.12 (3205)	0.53 (2743)	40.4	.191	

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

PROJECTION (HRS)	TYPE OF FORECAST	BIAS - NO. FCST/NO. OBS				PERCENT CORRECT	SKILL SCORE	NO. OF CASES
		CAT 1 (No. Obs.)	CAT 2 (No. Obs.)	CAT3 (No. Obs)	CAT4 (No. Obs.)			
18	EARLY	0.69	1.07	1.25	0.93	48.9	.312	3714
	FINAL	0.63	1.09	1.17	1.03	50.3	.330	
	LOCAL	0.64 (786)	1.41 (1121)	1.20 (913)	0.60 (894)	46.2	.269	
30	EARLY	1.14	1.08	0.82	0.86	53.1	.328	3720
	FINAL	0.94	1.03	0.81	1.12	53.8	.341	
	LOCAL	0.76 (1439)	1.82 (637)	1.77 (451)	0.56 (1193)	45.2	.269	
42	EARLY	0.92	0.98	0.95	1.13	45.9	.274	3692
	FINAL	0.71	0.78	1.19	1.33	43.3	.241	
	LOCAL	0.47 (779)	1.53 (1118)	1.28 (888)	0.53 (907)	40.4	.187	

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

PROJECTION (HRS)	TYPE OF FORECAST	BIAS - NO. FCST/NO. OBS				PERCENT CORRECT	SKILL SCORE	NO. OF CASES
		CAT 1 (No. Obs.)	CAT 2 (No. Obs.)	CAT3 (No. Obs)	CAT4 (No. Obs.)			
18	EARLY	0.73	1.19	1.21	0.72	50.7	.317	3741
	FINAL	0.70	1.25	1.16	0.71	51.0	.320	
	LOCAL	0.61 (1037)	1.51 (1264)	1.04 (909)	0.49 (531)	47.8	.264	
30	EARLY	0.85	1.93	0.45	0.77	50.1	.257	3762
	FINAL	0.86	1.80	0.40	0.96	49.8	.252	
	LOCAL	0.68 (1938)	2.10 (737)	1.25 (476)	0.49 (611)	44.8	.218	
42	EARLY	0.69	1.31	1.05	0.79	44.9	.236	3737
	FINAL	0.57	1.15	1.24	1.07	44.2	.236	
	LOCAL	0.48 (1035)	1.71 (1252)	1.00 (922)	0.34 (528)	42.3	.180	

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

PROJECTION (HRS)	TYPE OF FORECAST	BIAS - NO. FCST/NO. OBS				PERCENT CORRECT	SKILL SCORE	NO. OF CASES
		CAT 1 (No. Obs.)	CAT 2 (No. Obs.)	CAT3 (No. Obs)	CAT4 (No. Obs.)			
18	EARLY	0.95	1.20	0.94	0.86	48.8	.307	4405
	FINAL	1.01	1.13	0.90	0.91	48.6	.304	
	LOCAL	0.61 (1345)	1.57 (1246)	1.08 (914)	0.71 (900)	44.2	.247	
30	EARLY	0.94	1.60	0.60	0.89	52.3	.295	4246
	FINAL	0.92	1.65	0.50	0.94	52.9	.306	
	LOCAL	0.54 (2057)	2.28 (707)	1.83 (463)	0.67 (1019)	41.8	.225	
42	EARLY	0.95	1.24	0.85	0.90	43.2	.234	4375
	FINAL	0.88	1.23	0.93	0.95	43.9	.246	
	LOCAL	0.46 (1334)	1.84 (1191)	1.11 (922)	0.59 (928)	36.6	.149	

Table 4.6. Same as Table 4.2 except for 1[illegible] stations in the Western Region.

PROJECTION (HRS)	TYPE OF FORECAST	BIAS - NO. FCST/NO. OBS				PERCENT CORRECT	SKILL SCORE	NO. OF CASES
		CAT 1 (No. Obs.)	CAT 2 (No. Obs.)	CAT3 (No. Obs)	CAT4 (No. Obs.)			
18	EARLY	1.09	0.95	0.70	1.15	56.8	.357	2802
	FINAL	1.10	0.92	0.76	1.11	57.1	.361	
	LOCAL	0.84 (1308)	1.29 (634)	1.08 (480)	0.98 (380)	55.8	.370	
30	EARLY	0.87	1.81	0.58	0.97	52.0	.273	2596
	FINAL	0.85	1.78	0.49	1.15	52.9	.291	
	LOCAL	0.75 (1408)	1.95 (419)	1.31 (342)	0.65 (427)	48.8	.257	
42	EARLY	0.94	1.37	0.72	0.94	49.6	.267	2775
	FINAL	0.91	1.28	0.68	1.22	50.2	.281	
	LOCAL	0.70 (1293)	1.73 (629)	1.09 (473)	0.69 (380)	44.1	.218	

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 and final guidance, persistence, and local ceiling forecasts for 94 stations, 0000 GMT cycle, 1978 warm season.

Projection (h)	Type of Forecast	Bias by Category[1]						Percent Correct	Heidke Skill Score
		1	2	3	4	5	6		
12	Early	0.39	0.80	0.95	0.97	1.08	1.01	73.2	0.385
	Final	0.70	0.89	0.90	0.96	1.04	1.01	73.9	0.401
	Local	0.48	0.89	0.84	1.10	1.06	1.00	78.1	0.503
	Persistence	0.99	0.80	0.82	0.90	0.99	1.03	79.3	0.516
	No. Obs.	152	398	625	1198	1472	10547		
15	Local	0.36	0.42	0.51	0.91	1.28	1.02	74.9	0.426
	Persistence	6.04	1.43	0.83	0.62	1.10	1.04	73.0	0.378
	No. Obs.	25	237	628	1779	1384	10671		
18	Early	0.00	0.86	0.89	0.95	1.11	0.99	71.7	0.369
	Final	0.00	0.84	0.99	0.92	1.15	0.99	71.6	0.371
	Persistence	21.86	3.93	1.56	0.67	0.72	1.05	69.3	0.285
	No. Obs.	7	83	332	1612	2050	10618		
21	Local	0.50	0.27	0.42	0.96	1.08	1.00	72.1	0.322
	Persistence	25.83	4.11	2.27	1.01	0.64	1.01	67.9	0.231
	No. Obs.	6	82	230	1094	2368	10956		
24	Early	0.54	0.73	0.98	0.90	0.99	1.01	77.4	0.337
	Final	0.92	0.73	1.02	0.90	1.02	1.01	77.3	0.340
	Persistence	11.77	2.88	2.53	1.37	0.79	0.95	69.4	0.194
	No. Obs.	13	113	204	793	1881	11699		
36	Early	0.74	0.98	1.17	0.95	1.02	1.00	68.3	.288
	Final	0.98	1.16	1.22	1.11	1.14	0.95	66.6	.287
	Persistence	1.03	0.79	0.79	0.89	0.99	1.03	64.6	.170
	No. Obs.	149	411	652	1224	1493	10772		
48	Early	0.50	1.04	2.23	0.93	0.94	0.99	74.2	0.271
	Final	0.22	0.84	2.39	1.03	1.05	0.97	73.0	0.265
	Persistence	8.50	3.10	2.39	1.33	0.80	0.95	65.4	0.089
	No. Obs.	18	105	216	816	1852	11696		

[1] Bias by category refers to the number of forecasts of a category divided by the number of observations of that category. A value of 1.0 means unbiased forecasts of that category.

Table 5.3. Same as 5.2 except for visibility.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	5	6	Percent Correct	Heidke Skill Score
12	Early	0.75	1.01	1.06	1.07	1.22	0.96	67.5	0.333
	Final	0.74	0.78	1.03	1.08	1.28	0.96	69.0	0.365
	Local	0.45	0.90	0.47	1.42	1.38	0.98	72.8	0.433
	Persistence	0.80	0.58	0.41	0.75	0.98	1.11	75.1	0.407
	No. Obs.	234	185	1214	1205	1350	10321		
15	Local	0.35	0.75	0.25	0.93	1.19	1.02	75.9	0.332
	Persistence	5.71	2.07	0.84	0.91	0.88	1.01	75.4	0.333
	No. Obs.	34	55	607	1038	1562	11644		
18	Early	0.00	0.68	0.97	1.04	1.12	0.99	79.7	0.298
	Final	0.00	0.91	0.91	1.19	1.01	0.99	79.4	0.280
	Persistence	47.25	5.00	1.59	1.36	1.03	0.94	76.2	0.260
	No. Obs.	4	22	317	671	1313	12406		
21	Local	1.29	0.37	0.22	0.63	1.07	1.03	82.8	0.260
	Persistence	27.86	4.22	2.01	1.65	1.11	0.92	76.3	0.236
	No. Obs.	7	27	254	573	1225	12819		
24	Early	0.63	0.63	1.10	1.20	1.05	0.99	81.4	.283
	Final	0.44	0.61	1.07	1.36	0.97	0.99	81.3	.279
	Persistence	11.81	2.89	1.67	1.64	1.20	0.92	76.1	.221
	No. Obs.	16	38	301	557	1125	12696		
36	Early	0.75	0.82	1.02	1.15	1.20	0.96	64.8	.279
	Final	1.20	0.99	1.29	1.30	1.28	0.89	62.7	.286
	Persistence	0.86	0.57	0.40	0.74	0.98	1.12	66.6	.206
	No. Obs.	211	193	1251	1244	1370	10453		
48	Early	1.60	0.71	1.56	1.44	1.10	0.96	78.1	0.229
	Final	0.90	0.68	1.37	1.54	1.09	0.96	77.8	0.214
	Persistence	9.45	3.24	1.65	1.60	1.18	0.92	73.3	0.137
	No. Obs.	20	34	304	572	1145	12658		

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

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	5	6	Percent Correct	Heidke Skill Score
12	Early	0.67	0.74	1.07	0.96	1.02	1.00	77.8	0.374
	Final	0.42	0.70	0.84	0.98	1.06	1.00	78.7	0.403
	Local	0.67	0.38	0.79	1.37	1.21	0.95	79.8	0.471
	Persistence	0.83	0.65	1.04	1.28	1.20	0.95	79.9	0.473
	No. Obs.	12	110	208	790	1839	11150		
15	Local	0.35	0.37	0.83	1.37	1.04	0.98	78.6	0.411
	Persistence	0.30	0.46	0.84	1.27	1.30	0.95	74.7	0.338
	No. Obs.	37	162	260	813	1736	11473		
18	Early	0.82	0.84	1.03	0.93	0.98	1.01	76.7	0.359
	Final	0.61	0.74	0.88	0.98	0.96	1.02	77.6	0.375
	Persistence	0.15	0.30	0.59	1.15	1.44	0.96	71.8	0.273
	No. Obs.	67	240	373	882	1538	11225		
21	Local	0.17	0.44	0.78	1.38	0.94	1.01	73.6	0.352
	Persistence	0.07	0.23	0.43	0.96	1.52	1.00	68.3	0.228
	No. Obs.	150	327	504	1076	1447	10767		
24	Early	0.63	0.85	1.07	0.90	1.09	1.01	70.4	0.332
	Final	0.45	0.93	0.94	0.98	1.11	1.00	70.2	0.331
	Persistence	0.07	0.18	0.34	0.84	1.53	1.03	65.5	0.194
	No. Obs.	150	412	650	1205	1466	10510		
36	Early	0.39	1.20	1.20	0.87	0.92	1.02	75.6	0.284
	Final	0.28	0.85	1.08	0.83	1.09	1.00	75.4	0.296
	Persistence	0.56	0.68	1.02	1.26	1.23	0.95	67.2	0.134
	No. Obs.	18	108	217	811	1837	11529		
48	Early	0.65	1.06	1.07	1.01	1.02	0.99	67.3	0.263
	Final	0.64	0.99	1.02	1.08	1.16	0.97	66.6	0.264
	Persistence	0.07	0.19	0.34	0.85	1.55	1.02	60.8	0.078
	No. Obs.	148	393	644	1193	1444	10570		

Table 5.5. Same as Table 5.3 except for 1200 GMT cycle.

Projection (h)	Type of Forecast	Bias by Category 1	2	3	4	5	6	Percent Correct	Heidke Skill Score
12	Early	0.47	0.88	1.10	1.18	1.12	0.98	83.0	0.357
	Final	0.33	0.56	0.91	1.06	1.11	0.99	86.1	0.457
	Local	0.47	0.56	0.37	1.19	1.38	0.97	86.8	0.505
	Persistence	0.53	0.91	0.86	0.95	1.12	1.00	89.0	0.565
	No. Obs.	15	32	292	551	1108	12380		
15	Local	0.46	0.89	0.61	1.48	1.53	0.95	83.4	.388
	Persistence	0.32	0.81	1.03	0.99	1.23	0.98	86.0	.427
	No. Obs.	28	37	248	552	1033	12911		
18	Early	0.77	1.06	1.10	1.22	1.15	0.97	80.8	.321
	Final	0.60	0.89	0.96	1.05	1.22	0.98	82.2	.359
	Persistence	0.09	0.57	0.87	0.78	1.25	1.00	82.9	.349
	No. Obs.	93	54	292	681	1031	12304		
21	Local	0.23	0.88	1.04	1.65	1.32	0.93	74.2	0.319
	Persistence	0.05	0.31	0.55	0.60	1.08	1.06	78.4	0.280
	No. Obs.	191	100	460	896	1174	11733		
24	Early	0.76	1.01	1.16	1.20	1.22	0.93	65.9	.322
	Final	0.70	0.85	1.10	1.15	1.25	0.95	66.5	.325
	Persistence	0.04	0.17	0.21	0.43	0.95	1.21	69.4	.195
	No. Obs.	226	186	1239	1229	1338	10289		
36	Early	0.80	1.14	1.35	1.49	1.25	0.95	78.9	0.268
	Final	0.50	0.94	1.15	1.32	1.17	0.97	80.0	0.268
	Persistence	0.40	0.89	0.86	0.95	1.12	1.00	79.8	0.204
	No. Obs.	20	35	296	560	1129	12596		
48	Early	1.04	0.83	1.53	1.25	1.10	0.89	62.8	0.287
	Final	1.06	0.84	1.38	1.36	1.20	0.89	62.2	0.279
	Persistence	0.04	0.16	0.20	0.43	0.95	1.21	66.8	0.129
	No. Obs.	225	190	1249	1228	1340	14506		

Table 5.6. Comparative verification of early and final guidance, persistence, and local ceiling forecasts for 94 stations, 0000 GMT cycle, during the 1978 warm season. Scores are computed from two-category contingency tables.

Projection	Type of Forecast	Rel Freq Cats. 1&2 combined	Bias Cats. 1&2 combined	Percent correct	Heidke Skill Score	Threat Score
12	Early	.038	0.69	95.3	0.241	0.153
	Final		0.84	95.6	0.346	0.226
	Local		0.78	96.5	0.460	0.315
	Persistence		0.86	96.7	0.514	0.362
15	Local	.018	0.42	98.0	0.213	0.124
	Persistence		1.87	96.3	0.264	0.164
18	Early	.006	0.79	99.1	0.194	0.110
	Final		0.78	99.1	0.208	0.119
	Persistence		5.32	96.6	0.100	0.058
21	Local	.006	0.28	99.3	0.086	0.046
	Persistence		5.59	96.3	0.063	0.038
24	Early	.009	0.71	98.8	0.180	0.103
	Final		0.75	98.7	0.148	0.084
	Persistence		3.80	96.3	0.077	0.047
36	Early	.038	0.92	94.0	0.148	0.098
	Final		1.11	93.5	0.159	0.107
	Persistence		0.86	94.0	0.127	0.086
48	Early	.008	0.96	98.7	0.209	0.121
	Final		0.75	98.8	0.152	0.086
	Persistence		3.89	96.0	0.020	0.017

Table 5.7. Same as Table 5.6 except for visibility..

Projection	Type of Forecast	Rel Freq Cats. 1&2 combined	Bias Cats. 1&2 combined	Percent correct	Heidke Skill Score	Threat Score
12	Early Final Local Persistence	.029	0.86 0.76 0.65 0.70	95.9 96.6 97.3 97.6	0.212 0.303 0.423 0.492	0.132 0.191 0.279 0.337
15	Local Persistence	.006	0.60 3.46	99.1 97.7	0.095 0.118	0.052 0.067
18	Early Final Persistence	.002	0.58 0.77 11.50	99.8 99.7 97.9	0.145 0.042 0.028	0.079 0.022 0.016
21	Local Persistence	.002	0.56 9.09	99.7 97.8	0.036 0.031	0.019 0.018
24	Early Final Persistence	.004	0.63 0.56 5.54	99.4 99.5 97.7	0.043 0.045 0.022	0.023 0.024 0.014
36	Early Final Persistence	.028	0.78 1.11 0.72	95.7 94.9 96.0	0.111 0.118 0.148	0.071 0.078 0.092
48	Early Final Persistence	.004	1.04 0.76 5.54	99.3 97.6 97.6	0.069 0.081 0.011	0.038 0.044 0.009

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

Projection	Type of Forecast	Rel Freq Cats. 1&2 combined	Bias Cats. 1&2 combined	Percent correct	Heidke Skill Score	Threat Score
12	Early Final Local Persistence	.009	0.73 0.67 0.41 0.66	98.8 99.0 99.2 99.2	0.212 0.289 0.357 0.430	0.122 0.172 0.220 0.277
15	Local Persistence	.014	0.37 0.43	98.7 98.5	0.281 0.225	0.167 0.131
18	Early Final Persistence	.021	0.83 0.71 0.27	97.0 97.3 97.8	0.230 0.261 0.177	0.140 0.159 0.102
21	Local Persistence	.033	0.35 0.18	96.3 96.5	0.178 0.097	0.106 0.056
24	Early Final Persistence	.039	0.79 0.80 0.15	94.4 94.4 95.8	0.176 0.169 0.062	0.114 0.110 0.037
36	Early Final Persistence	.009	1.09 0.77 0.66	98.6 98.7 98.7	0.198 0.164 0.061	0.114 0.093 0.035
48	Early Final Persistence	.038	0.95 0.90 0.15	93.7 94.0 95.8	0.110 0.135 0.032	0.077 0.090 0.021

Table 5.9. Same as Table 5.7 except for 1200 GMT cycle.

Projection	Type of Forecast	Rel Freq Cats. 1&2 combined	Bias Cats. 1&2 combined	Percent correct	Heidke Skill Score	Threat Score
12	Early Final Local Persistence	.003	0.75 0.49 0.53 0.79	99.5 99.6 99.7 99.6	0.071 0.141 0.304 0.236	0.038 0.077 0.180 0.135
15	Local Persistence	.004	0.71 0.60	99.4 99.4	0.195 .170	0.110 0.095
18	Early Final Persistence	.010	0.88 0.71 0.27	98.5 98.6 98.9	0.217 0.168 0.104	.127 .096 0.057
21	Local Persistence	.020	0.45 0.14	97.7 97.9	0.208 0.062	0.122 0.034
24	Early Final Persistence	.028	0.87 0.77 0.10	95.5 95.9 97.0	0.138 0.155 0.031	0.087 0.096 0.018
36	Early Final Persistence	.004	1.02 0.78 0.71	99.3 99.4 99.4	0.069 0.099 0.018	0.037 0.054 0.011
48	Early Final Persistence	.029	0.94 0.96 0.09	95.2 95.1 96.9	0.109 0.105 0.008	0.072 0.070 0.007

Table 6.1. Comparative verification of early and final guidance and local max/min temperature forecasts for 87 stations (0000 GMT cycle only) for April through September of 1978.

FORECAST PROJECTION (HOURS)	TYPE OF FORECAST	MEAN ALGEBRAIC ERROR (°F)	MEAN ABSOLUTE ERROR (°F)	NUMBER (%) OF ABSOLUTE ERRORS ≥ 10°	NUMBER OF CASES
24 (MAX)	EARLY	-0.1	3.1	420 (3.1)	13476
	FINAL	-0.8	3.2	447 (3.3)	
	LOCAL	0.0	2.9	397 (2.9)	
36 (MIN)	EARLY	0.1	2.8	203 (1.5)	13484
	FINAL	-0.1	2.9	231 (1.7)	
	LOCAL	0.4	2.9	302 (2.2)	
48 (MAX)	EARLY	-0.5	3.9	887 (6.5)	13543
	FINAL	-1.4	4.1	904 (6.7)	
	LOCAL	-0.3	3.8	894 (6.6)	
60 (MIN)	EARLY	0.0	3.6	687 (5.1)	13533
	FINAL	0.0	3.4	478 (3.5)	
	LOCAL	0.3	3.4	544 (4.0)	

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

FORECAST PROJECTION (HOURS)	TYPE OF FORECAST	MEAN ALGEBRAIC ERROR (°F)	MEAN ABSOLUTE ERROR (°F)	NUMBER (%) OF ABSOLUTE ERRORS ≥ 10°	NUMBER OF CASES
24 (MAX)	EARLY	-0.2	3.0	105 (2.6)	4022
	FINAL	-1.0	3.3	138 (3.4)	
	LOCAL	-0.2	3.0	115 (2.9)	
36 (MIN)	EARLY	0.3	2.9	70 (1.7)	4029
	FINAL	0.4	3.0	76 (1.9)	
	LOCAL	0.8	3.1	115 (2.9)	
48 (MAX)	EARLY	-0.2	3.8	234 (5.8)	4048
	FINAL	-1.1	4.0	248 (6.1)	
	LOCAL	-0.3	3.8	263 (6.5)	
60 (MIN)	EARLY	0.5	3.8	215 (5.3)	4044
	FINAL	1.0	3.6	165 (4.1)	
	LOCAL	1.0	3.7	190 (4.7)	

Table 6.3. Same as Table 6.1 except for 23 stations in the Southern Region.

FORECAST PROJECTION (HOURS)	TYPE OF FORECAST	MEAN ALGEBRAIC ERROR (°F)	MEAN ABSOLUTE ERROR (°F)	NUMBER (%) OF ABSOLUTE ERRORS ≥ 10°	NUMBER OF CASES
24 (MAX)	EARLY	-0.5	2.7	52 (1.5)	3564
	FINAL	-1.3	2.8	69 (1.9)	
	LOCAL	0.0	2.3	43 (1.2)	
36 (MIN)	EARLY	-0.3	2.6	42 (1.2)	3563
	FINAL	-0.4	2.6	53 (1.5)	
	LOCAL	0.3	2.6	62 (1.7)	
48 (MAX)	EARLY	-1.2	3.5	142 (4.0)	3584
	FINAL	-1.9	3.6	154 (4.3)	
	LOCAL	-0.3	3.0	115 (3.2)	
60 (MIN)	EARLY	-0.5	3.3	171 (4.8)	3581
	FINAL	-0.6	3.0	99 (2.8)	
	LOCAL	-0.0	3.0	120 (3.4)	

Table 6.4. Same as Table 6.1 except for 22 stations in the Central Region.

FORECAST PROJECTION (HOURS)	TYPE OF FORECAST	MEAN ALGEBRAIC ERROR (°F)	MEAN ABSOLUTE ERROR (°F)	NUMBER (%) OF ABSOLUTE ERRORS ≥ 10°	NUMBER OF CASES
24 (MAX)	EARLY	0.3	3.5	166 (4.9)	3406
	FINAL	-0.4	3.6	163 (4.8)	
	LOCAL	0.2	3.4	139 (4.1)	
36 (MIN)	EARLY	0.3	3.1	58 (1.7)	3408
	FINAL	-0.6	3.2	67 (2.0)	
	LOCAL	0.4	3.2	82 (2.4)	
48 (MAX)	EARLY	0.2	4.3	320 (9.4)	3416
	FINAL	-1.0	4.4	316 (9.3)	
	LOCAL	-0.1	4.2	296 (8.7)	
60 (MIN)	EARLY	-0.2	4.0	223 (6.5)	3417
	FINAL	-0.4	3.7	148 (4.3)	
	LOCAL	0.1	3.8	158 (4.6)	

Table 6.5. Same as Table 6.1 except for 16 stations in the Western Region.

FORECAST PROJECTION (HOURS)	TYPE OF FORECAST	MEAN ALGEBRAIC ERROR (°F)	MEAN ABSOLUTE ERROR (°F)	NUMBER (%) OF ABSOLUTE ERRORS ≥ 10°	NUMBER OF CASES
24 (MAX)	EARLY	-0.1	3.2	97 (3.9)	2484
	FINAL	-0.7	3.1	77 (3.1)	
	LOCAL	0.0	3.1	100 (4.0)	
36 (MIN)	EARLY	0.1	2.8	33 (1.3)	2484
	FINAL	-0.1	2.7	35 (1.4)	
	LOCAL	0.1	2.8	43 (1.7)	
48 (MAX)	EARLY	-0.9	4.1	191 (7.7)	2495
	FINAL	-1.7	4.3	186 (7.5)	
	LOCAL	-0.7	4.2	220 (8.8)	
60 (MIN)	EARLY	0.0	3.3	78 (3.1)	2491
	FINAL	-0.1	3.2	66 (2.6)	
	LOCAL	-0.1	3.1	76 (3.1)	

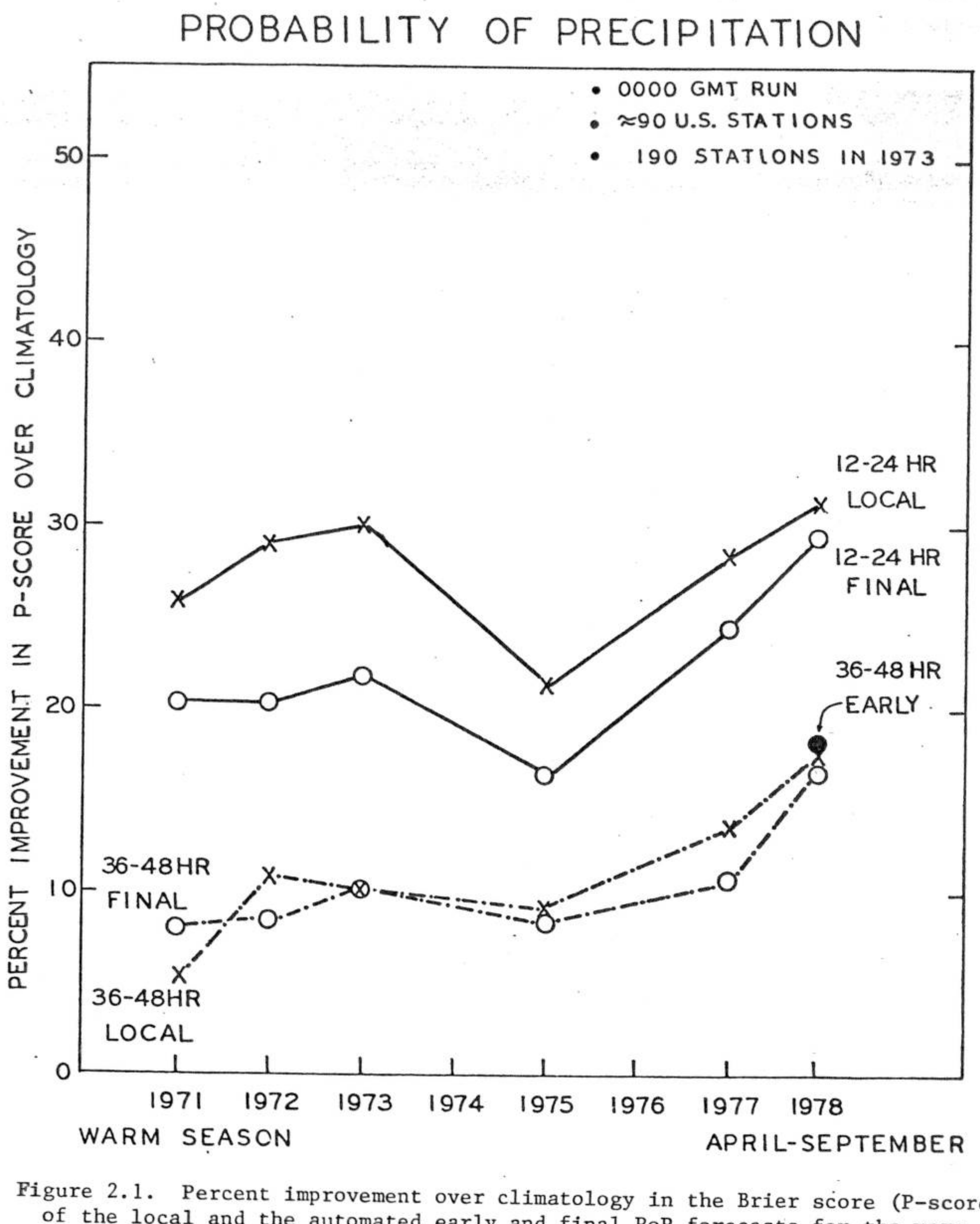

Figure 2.1. Percent improvement over climatology in the Brier score (P-score) of the local and the automated early and final PoP forecasts for the warm season. Results during 1974 and 1976 were unavailable because of missing data.

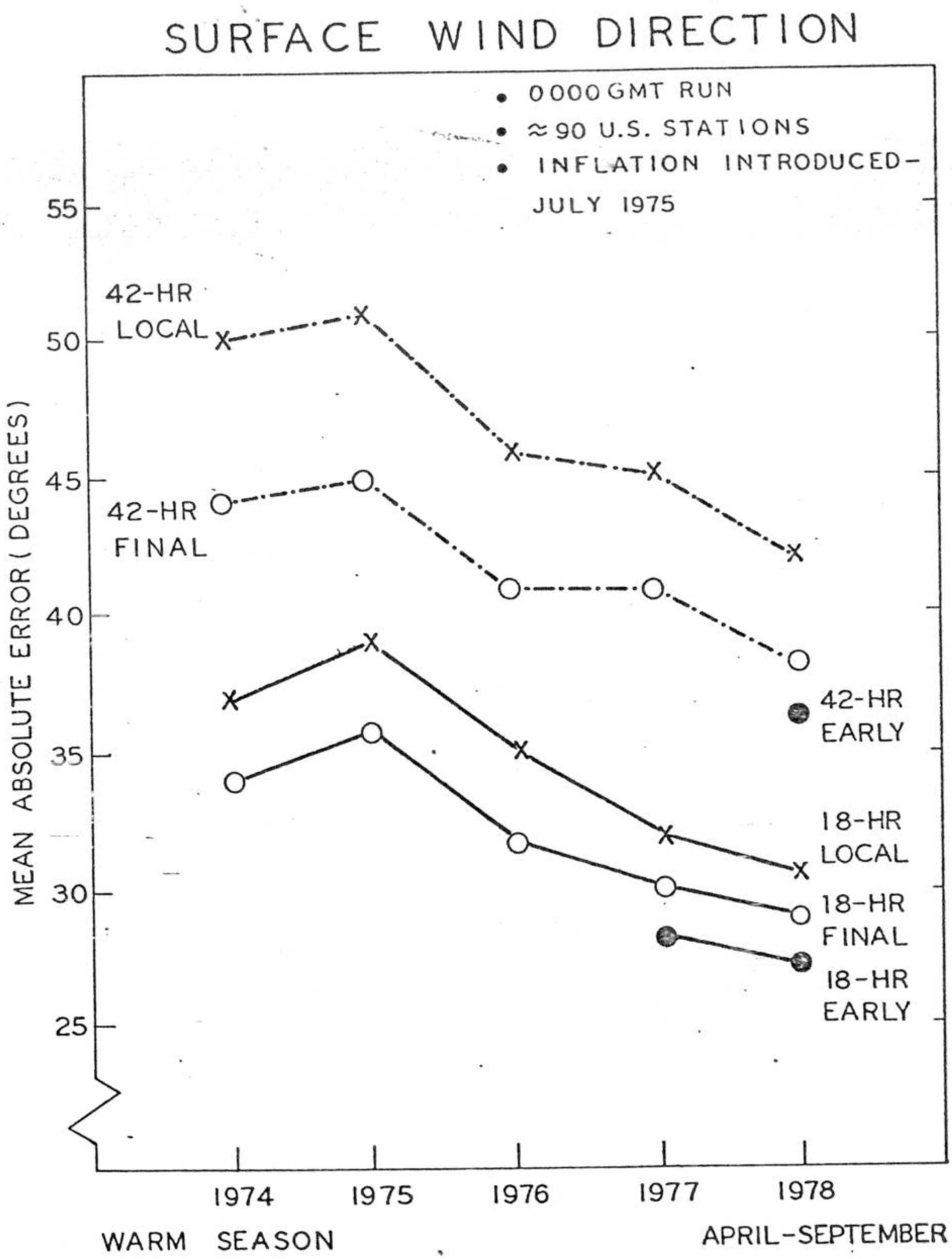

Figure 3.1. Mean absolute errors for subjective local and objective (early and final) surface wind direction forecasts for approximately 90 U.S. stations.

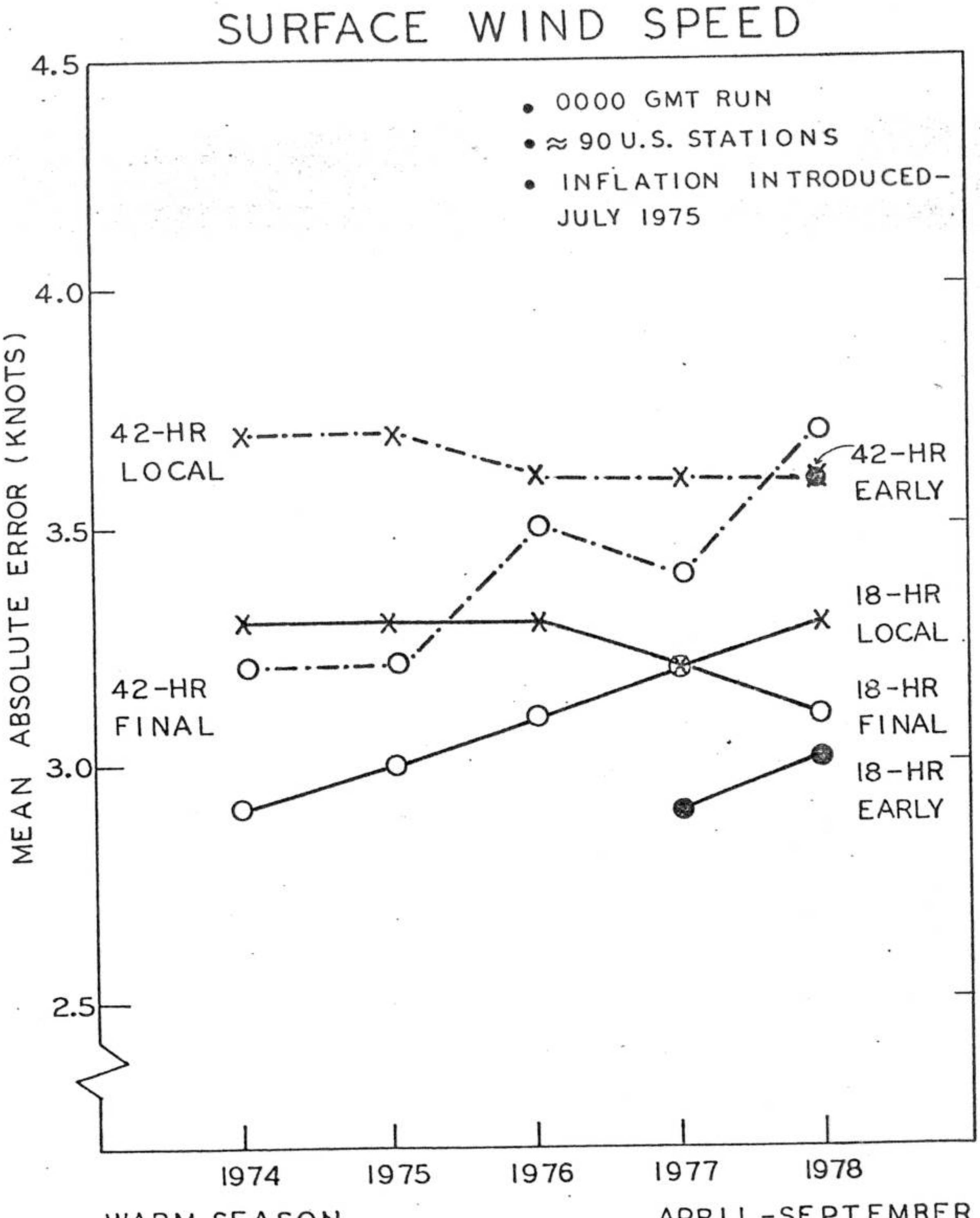

Figure 3.2. Same as Fig. 3.1 except for wind speed forecasts.

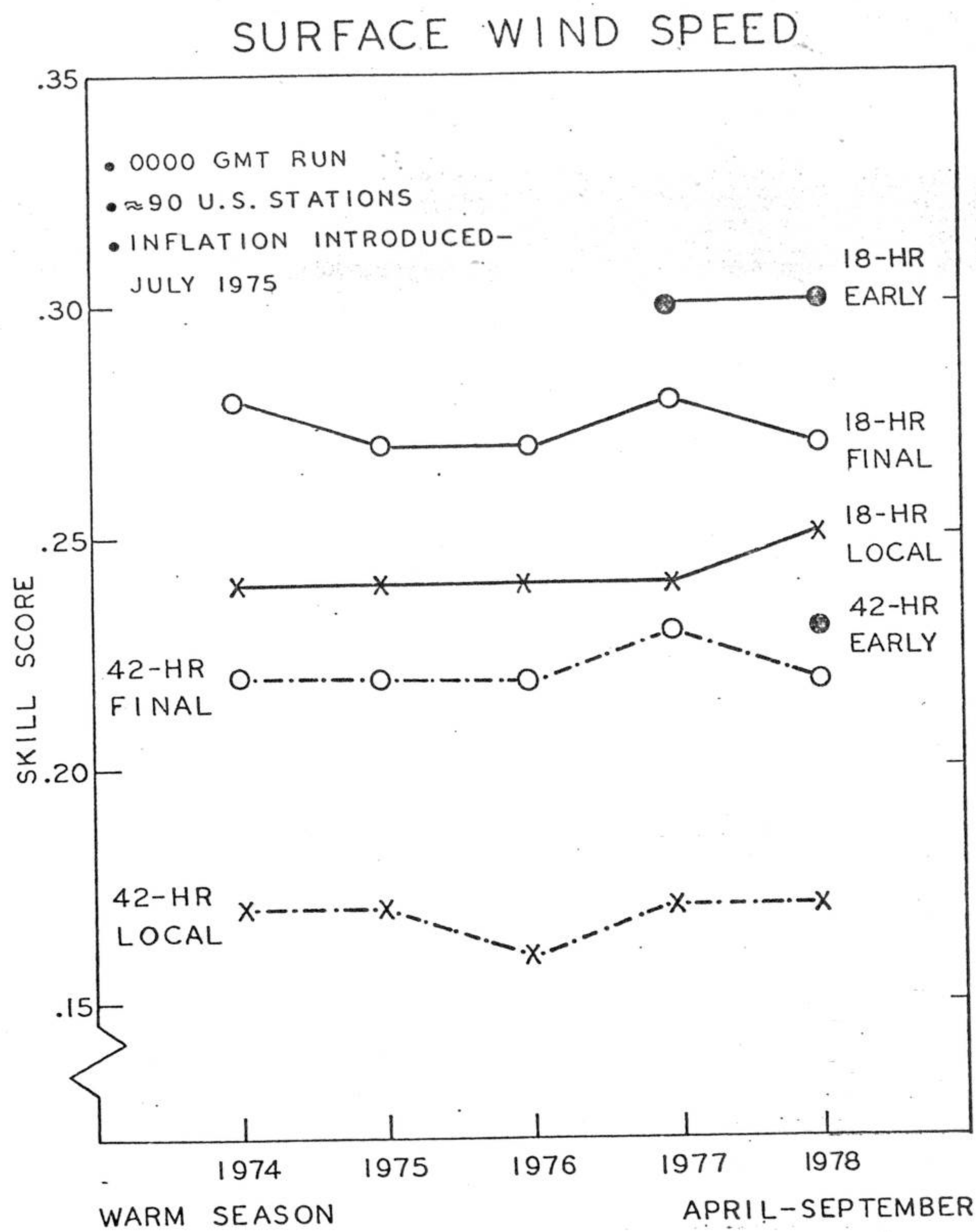

Figure 3.3. Skill scores computed from five-category contingency tables for subjective local and objective (early and final) surface wind speed forecasts for approximately 90 U.S. stations.

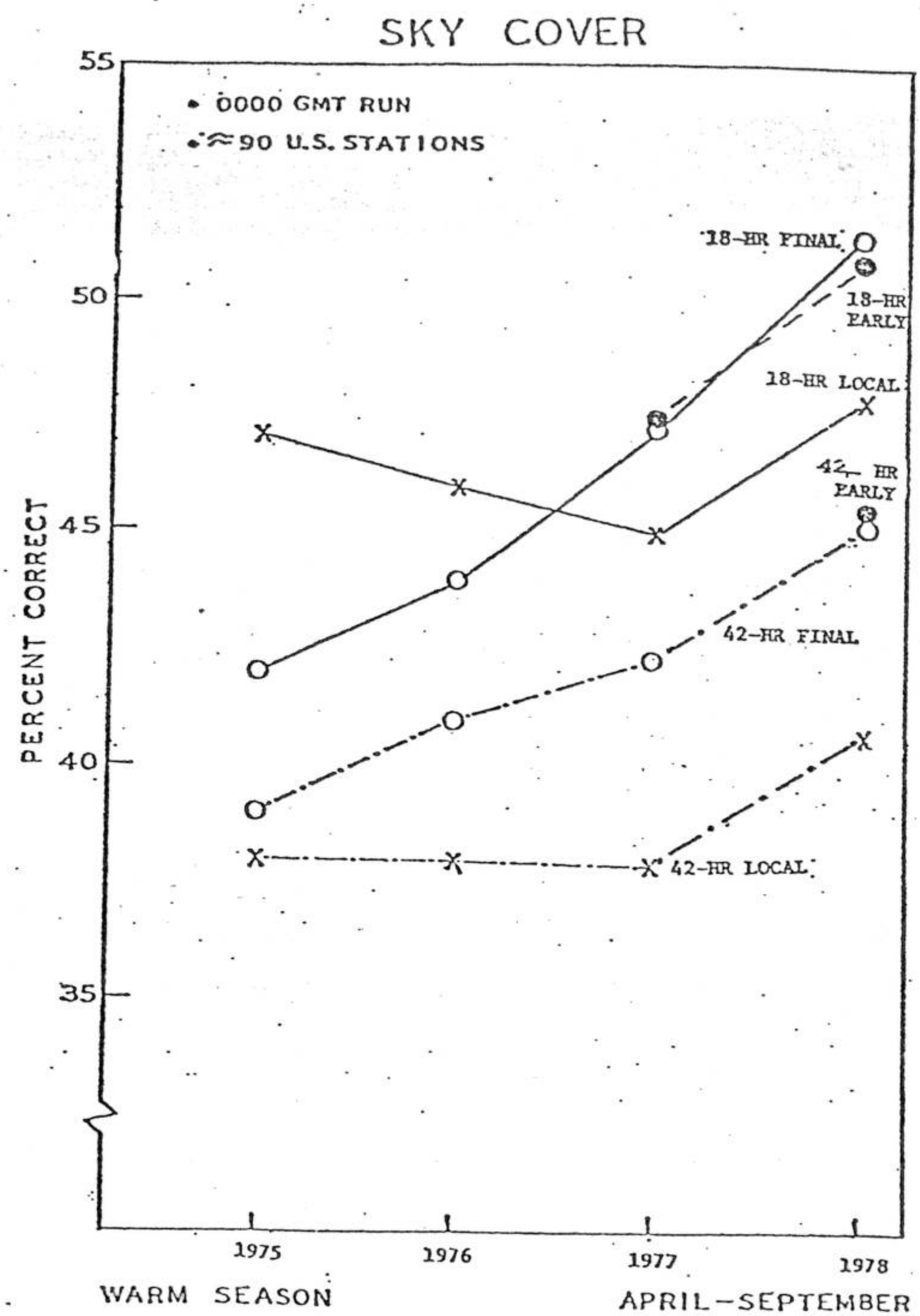

Figure 4.1. Percent correct of local and guidance cloud amount forecasts for the warm season.

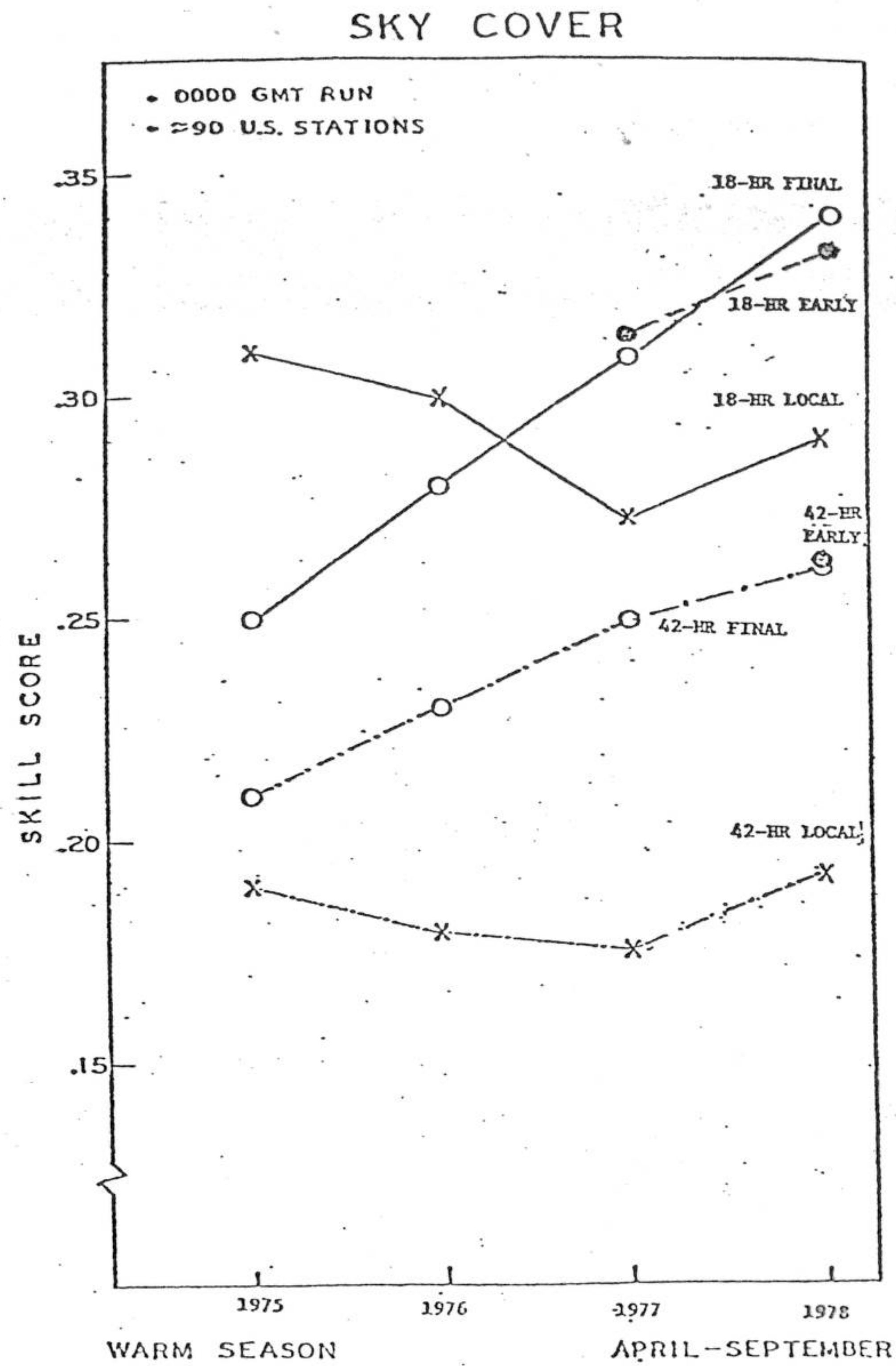

Figure 4.2. Skill score of local and guidance cloud amount forecasts for the warm season.

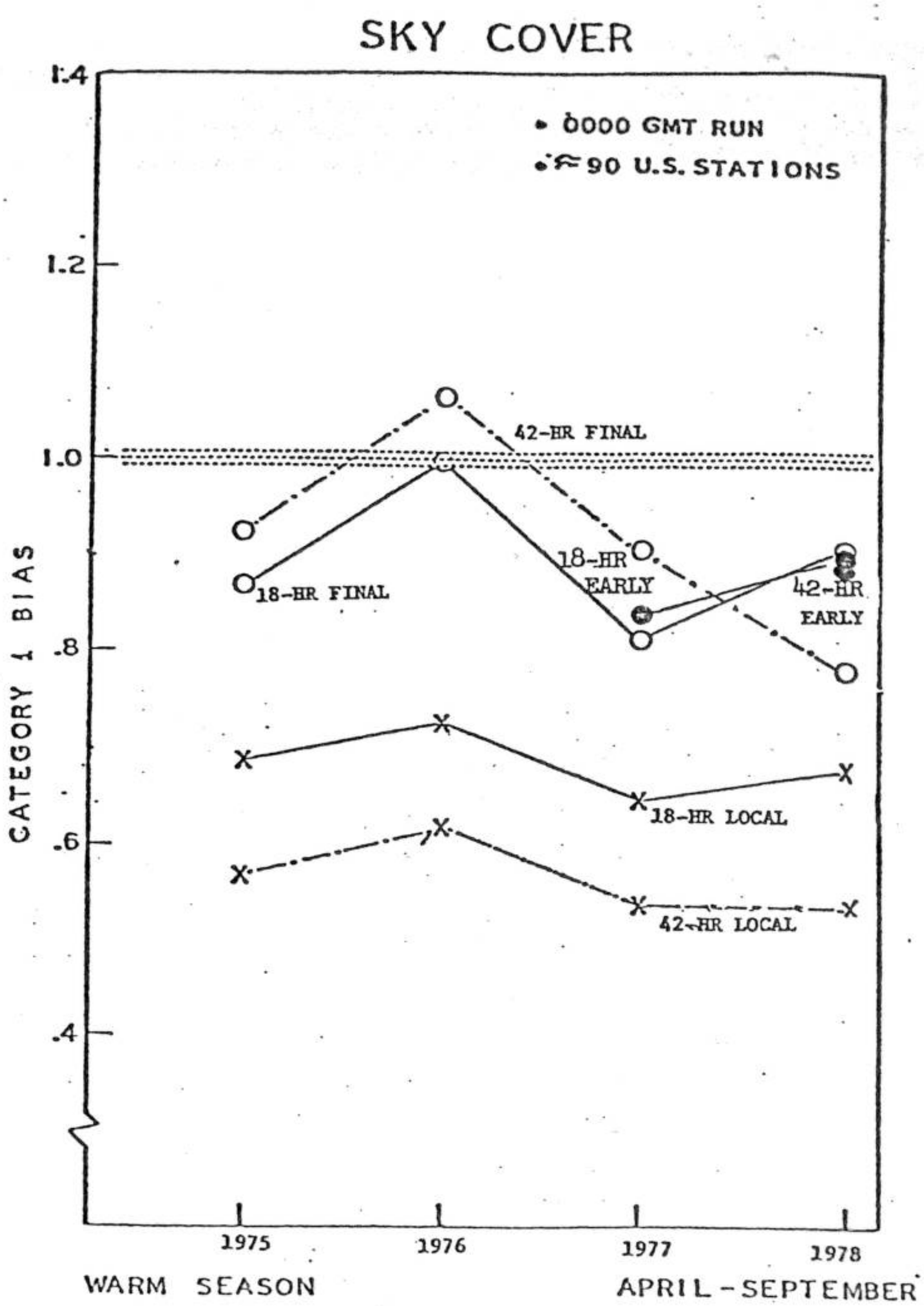

Figure 4.3. Bias of the local and guidance cloud amount forecasts of category 1 for the warm season.

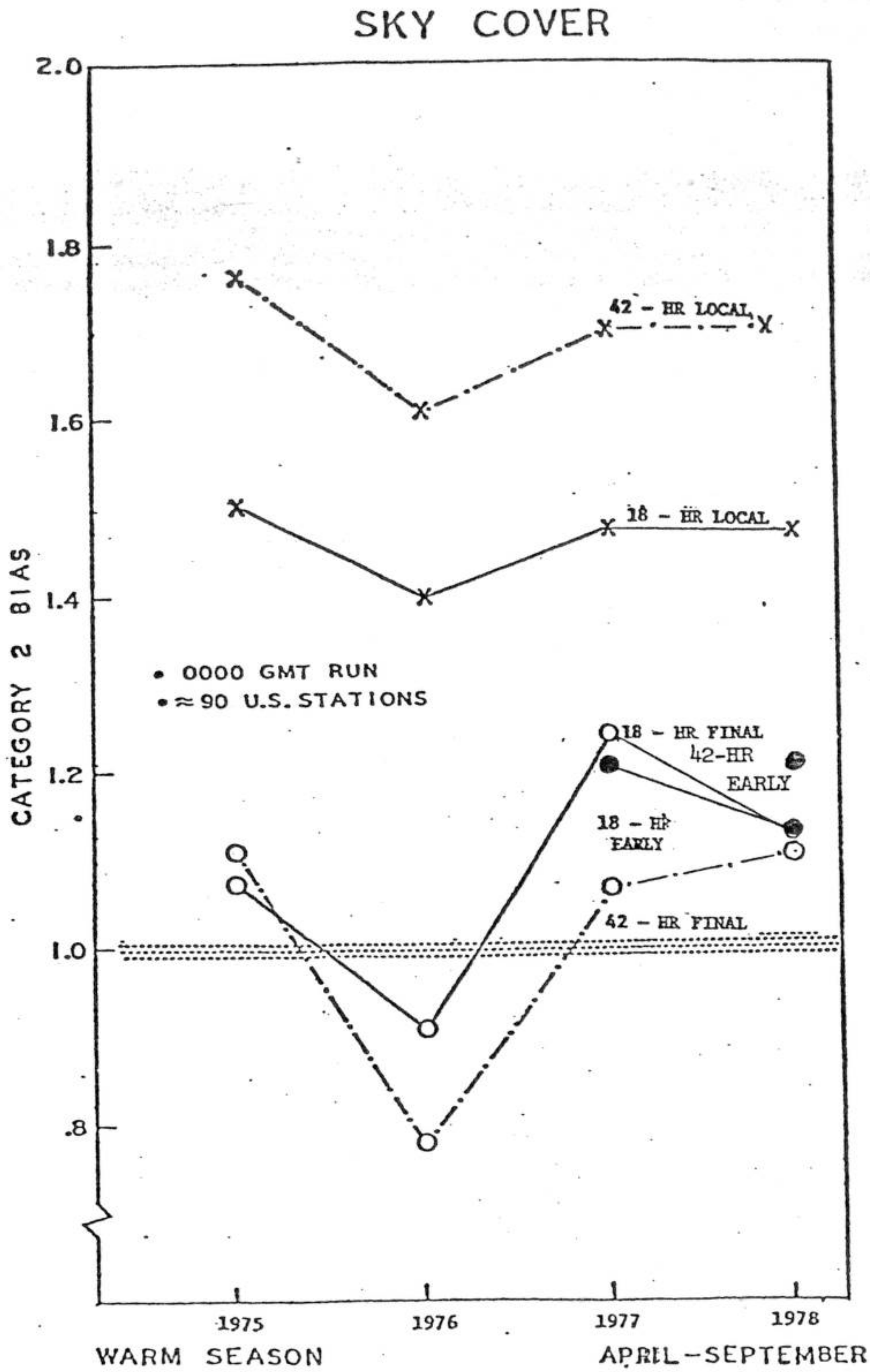

Figure 4.4. Same as Fig. 4.3 except for category 2 bias.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL WEATHER SERVICE
Silver Spring, Md. 20910

May 24, 1979 OA/W42/DBG

TO: Recipients of TDL Office Notes

FROM: OA/W42 - Harry R. Glahn

SUBJECT: Revision of TDL Office Note 79-11 "Comparative Verification of Guidance and Local Aviation/Public Weather Forecasts--No. 6"

Dr. Wayne Sangster discovered some errors we made in the PoP verification for the Central Region. I'm attaching a corrected copy of Table 2.4.

The errors were in the improvement over climatology scores for the 36-48h (3rd period). The improvement over climatology scores for the early, final, and local forecasts were inconsistent with the Brier scores presented for those forecasts. The corrected values indicate the early guidance forecasts were superior to the local forecasts for this projection.

Since the mistake occurred when we misread a computer printout, none of the other calculations were in error. We regret any inconvenience this error caused you.

Attachment