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An Operational Evaluation of 500-mb Type Stratified Regression Equations

ALEXANDER E. MAC DONALD

Western Region

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U. S. DEPARTMENT OF COMMERCE
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AN OPERATIONAL EVALUATION OF 500-MB TYPE STRATIFIED REGRESSION EQUATIONS

Alexander E. MacDonald
Scientific Services Division
Salt Lake City, Utah

WESTERN REGION
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EDITOR'S NOTE

This study was started as part of the work assignment given to Mr. Alexander E. MacDonald during his summer trainee tour at Scientific Services Division from June to September 1973. The specific assignment was to take the results of the Paegle-Kierulff [1] study, engineer them for operational use and test their usefulness. We are indebted to Dr. Frederick Shuman, Director of National Meteorological Center, Suitland, Maryland, and members of his staff for making it possible to carry out the verification phase of the study. Because we wanted the verification period to cover the past winter season (i.e., 1973-74), Mr. MacDonald, assisted by Mr. Glenn Rasch, Regional Warning Coordination Center, continued to work parttime on the study for several months after returning to his graduate studies at University of Utah in September 1973.

Mr. MacDonald is a doctoral candidate in meteorology at the University of Utah and expects to complete his requirements for the PhD degree in late 1974.

L. W. Snellman

L. W. Snellman, Chief
Scientific Services Division

AN OPERATIONAL EVALUATION OF 500-MB TYPE STRATIFIED REGRESSION EQUATIONS

ABSTRACT

A test of the operational utility of the 500-mb type stratified regression equations developed by Paegle and Kierulff [1] is presented. It is found that in development of the equations, there were three major data discrepancies. These discrepancies, which qualitatively do not affect Paegle's and Kierulff's results or detract from their conclusions, do have a bearing on the operational usability of the equations--they are: (1) the threshold value of precipitation actually used was .02 inches rather than .01 inches, (2) the precipitation data valid period was 12 hours earlier than had been thought, and (3) the 700-mb and 500-mb dew-point depression fields used in screening were erroneous. A two-year test on independent data (December 68 - February 69, December 69 - February 70) is presented which indicates the regression equations improve on climatology by about 7%. The results are found not to compare favorably with NMC and WSFO PoP verifications for the winter of 69 - 70. It is concluded that the Paegle and Kierulff [1] type stratified regression equations are not suitable for operational use.

I. INTRODUCTION

In recent years interest has developed in objective forecasts of precipitation probabilities using the computer. For example, Klein [2] outlined the development of regression equations to predict probabilities of precipitation (PoPs) at 108 stations over the United States. Using predictors such as geopotential heights, dew points, and past precipitation, plus making the "perfect prog" assumption (i.e., that the numerical forecasts have no systematic errors) allowed PoP forecasts for future times for which numerical forecasts were available.

In a different approach, Augulis [3] classified 500-mb maps over the western United States into a series of map types and compiled the observed frequency of precipitation at western stations for each type. Using the computer to assess which of the 500-mb map types correlates most highly with a current or forecast height field again allows a prediction of the precipitation probability.

As a result of the success of the 500-mb map typing, a further investigation was suggested. Unstratified linear regression equations were developed and compared with similar equations derived using 500-mb flow type stratification. The comparison was done by Paegle and Kierulff and is described in detail in their Western Region Technical Memorandum, "Objective Forecast of Precipitation Over the Western Region of the United States" [1]. They demonstrated that the stratification led to a significant improvement of the regression equations and that "the method (could) be applied in operational forecasting at very minimal computer cost".

Thus the Paegle and Kierulff study showed that <u>any</u> regression equations can be improved by stratifying within map types. The purpose of this Technical Memorandum is to outline the results of a test of these particular type-stratified regression equations developed by Paegle and Kierulff for suitability in operational use.

II. METHOD OF EVALUATION

In order to get an operational assessment, the map typing and development of PoPs from the regression equations had to be included in one computer program. This program was used to generate PoPs for 42 western stations in three separate testing periods.

A. Precipitation Probability Program

The program required for operational use did the following: Accepted height and precipitation data, used the data to generate predictor fields and to pick the appropriate 500-mb map type, inserted the predictor fields into the proper type-stratified regression equations to yield probabilities of precipitation. It was organized in the following manner:

(1) Data Input - Needed were the 850-, 700-, 500-, and 300-mb height fields on a 182-point grid centered over western United States (see Figure 1), and the previous 12-hour precipitation at 43 western stations. (A detailed description of most aspects alluded to in this section is given in Paegle and Kierulff [1]. For example, Table 4, page 20, of Technical Memorandum WRTM 89, lists the 43 stations used for past precipitation.) Of the 21 fields used as predictors (Table 2 of Tech Memo WRTM 89), 17 are derivable from the four height fields. The three moisture fields, 850-, 700-, and 500-mb dew-point depressions, were not included; this will be further discussed below.

(2) Generation of Predictor Fields - Exactly the same two-level model described in the Technical Memorandum (WRTM 89) was used to generate fields such as vertical velocity and thickness advection. From an operational standpoint, the requirement of using derived fields was a slight disadvantage because of the computer time required to obtain them and because the results are "model dependent". The "model dependency" thwarts use of the regression equations by forecasters in the field, since model-derived parameters are not available to them. In the real-time test at NMC, the two-level model-derived fields had to be used rather than similar fields available from the six-layer model. Part of the reason for this is that some of the fields (e.g., vertical velocity at 500 mb due to vorticity advection only) are not obtainable from the six-layer model. A more compelling reason for only using exactly the same model is that its small area boundary problems result in large systematic errors which are automatically compensated for in the regression equations. This automatic compensation harms forecasts made with derived fields from other models.

(3) Map Typing - For two reasons a subprogram had to be developed which classified map types. First, the program which was used in the original typing was not easily adaptable to this application, and second, some of the data points used would not be generally available (see Figure 1). Of the 52 points used, only 45 of the points were elements of the 182-point set that was to be used as a data base. Since the seven points which were not elements of the 182-point grid were on the extreme northwestern periphery of the map-type correlation area, it was decided to omit these and produce map correlations using only the 45 available data points. As will be shown below the omission of the seven points did not harm the validity of the typing.

The method of typing consisted of storing the most representative 500-mb map for each of the six types on magnetic tape. The 500-mb map to be typed was used to compute a coefficient of correlation (r) with each of the six maps. The formula used to compute r was:

$$r(MT) = (\overline{Z_{MT}Z} - \overline{Z}_{MT}\overline{Z})/(\ (\overline{Z^2_{MT}} \ - \ (\overline{Z}_{MT})^2\ (\overline{Z^2} \ - (\overline{Z})^2\ )\ )^{\frac{1}{2}}.$$

where MT refers to the standard map type. The six correlation coefficients are then compared, and the highest is selected as the characteristic map type.

Fortunately, one season was available to compare this typing scheme with that done by Paegle and Kierulff [1]. Table 1 shows the results of the comparison. Most of the days were typed the same, and for the few which were different, an examination of the actual maps showed they were intermediate to the two types. Thus, it is felt that the typing was representative and justified its use with the regression equations to obtain operational forecasts.

(4) PoP Generation - The final step of the program was to substitute the proper fields into the dependent variable positions of the appropriate regression equation. To the extent that the precipitation process (within types) can be represented by linear regression and were derived using a large enough sample size, the result can be multiplied by 100 and interpreted as a PoP. The PoPs were categorized; for example, all of them from 55% to 64%, inclusive, were grouped into the 60% category; those above 95% (including some which were numerically generated to be over 100%) were set to 100%, etc.

B. Operational Tests

There were three major operational tests performed (see Table 2 for a summary of the three tests). The first two tests used historical data and consisted of forecasts for just a 12-hour period based on the analyzed charts and actual occurrence of precipitation (since past precipitation was used as a predictor). The third test used height fields obtained from the National Meteorological Center's (NMC) six-layer model together with the perfect prog assumption to forecast PoPs for 60 hours in 12-hour increments. The following is a short discussion of the purpose of each test.

Test 1. The main purpose of this test was to establish that the program developed for operational use generated exactly the same fields as those used to develop the regression equations. This was possible because the last winter of data (December 67 - February 68) used by Paegle and Kierulff was not used in the equation development, but the necessary fields were saved for independent testing.

Comparison of the fields generated indicated identical results and lend confidence to the verification.

Test 2. This test was done using data which was completely independent of the earlier study. Since it comprised of two years with almost no data missing (a total of 341 forecast periods) it was the major operational test. Clearly, if the PoPs generated from actual data do not verify well then use of the perfect prog assumption to lengthen the forecast period will further degrade the results.

The height data needed for this test came from charts analyzed by the Navy's Fleet Numerical Weather Facility (FNWF). This data includes the required levels (850, 700, 500, and 300 mb) on the NMC grid and was obtained on magnetic tape from the National Climatic Center.

The precipitation data came from two sources. The Techniques Development Laboratory (TDL) of the National Weather Service supplied most stations, and the remaining ones were obtained from the station records.

Test 3. A real-time test was performed for the winter of December 73 - February 74, using the NMC six-layer model for prognostic height fields out to 60 hours. Originally an attempt was made to get historical prog data, but some of the required fields (e.g., 300-mb height field) were not available.

The PoP program was run on a computer at NMC which had access to the required precipitation and height data. Forecasts beyond the first 12 hours required an assumption for past precipitation. Similar to Klein (2), the binary input for past precipitation (1 for rain, 0 for no rain) was substituted for by a fraction ($0 < P < 1$) equal to the generated PoP at the predictor station. This introduced a further difficulty since forecasts for one of the previous precipitation stations (Idaho Falls) were not being made (due to insufficient data). In that case the PoP of the nearest station, Pocatello, was used.

C. Brier Score Verification

The half Brier score in current use by the National Weather Service was the main parameter used in the verification. All 42 stations were scored and compared against a climatology of precipitation probability compiled by Miller [4]. Although the forecast system does not distinguish between which period of the day is being forecast for, the climatology used does. This allows comparison with other forecasts similarly scored.

Each station was scored in each test and the results were printed as percent improvement over climatology. In addition to a total score, the Brier scores were stratified as follows:

(1) Map Type - Since there was a substantial variation in the sample sizes of the developmental map types (e.g., see Table I of Paegle and Kierulff), it was felt that separation by map type would reveal any deficiencies due to insufficient sample sizes. Also, since certain map types are "wet" and others are "dry", this allowed inferences on how the total score is distributed between the two.

(2) Correlation Coefficients - This was done to find out if the height fields which correlated very highly with the map-type fields resulted in better forecasts than those not so well correlated.

(3) Precipitation Probabilities - For each of the 13 possible forecasts for the probability of precipitation (e.g., the allowed categories are 0%, 2%, 5%, 10%, 20%, etc.), each station was scored for the aggregate of forecasts of that probability.

In addition to the Brier scoring described above, for the main test (Test 2), the frequency of precipitation for each probability was tabulated. This, together with the stratification of the scores into probabilities, allows an assessment of the reliability of the probability forecasts.

D. Data Discrepancies

In the data checks made for Test 1, it was discovered that the data used by Paegle and Kierulff had three major discrepancies which bear directly on the suitability of their equations for operational use. The following is a discussion of the three discrepancies:

(1) Precipitation Occurrence Value - The amount of precipitation which constitutes an "occurrence" (to be assigned binary value 1) is normally taken to be .01 inches; however, in the data used the actual cutoff was .02 inches. Since more than one out of every five events of measurable precipitation amounts to only .01 inches, this is a very substantial difference.

Evidence of the discrepancy is in Figure 2 of Paegle and Kierulff. The nonstratified precipitation frequencies can be construed as a climatology for the occurrence of .02 or more inches of rain. In Table 3 of this paper, the frequencies of the .01 and .02 inch cutoffs are compared for several stations.

This discrepancy affects the operational utility of the equations in two ways. First, the past precipitation predictor must be based on .02 inches rather than .01. This would not be a significant handicap operationally, since that information is readily available. Second, .01 inches of precipitation did not count as an occurrence in the development of the regression equations; they forecast the probability of .02 inches or more. Thus, the main problem is that the operational forecaster must forecast the probability of .01 inches (or greater), and this probability is significantly different from the chance of .02 or more which is produced by the Paegle-Kierulff regression equations.

(2) Data Valid Period - The precipitation data used to derive the equations was valid for the 12 hours previous to what had been thought. This is illustrated in Figure 2. Similar to Klein (2), the equations were developed with what was thought to be height data between the observed and forecast precipitation periods (Figure 2a). With the discovery that the verifying period was actually 12 hours earlier, the observed precipitation predictor is then valid for the period -24 to -12 hours before the height field valid time, and the forecast is being made for the 12 hours previous to the height field valid time (Figure 2b). Alternately, it can be assumed that a perfect prog for 12-hour heights is available and then use of the most recent precipitation data is made (Figure 2c).

The interpretation which was made in order to test the equations is that of Figure 2c. For a perfect 12-hour prog, the use of height data valid at +12 hours is just as good as using the 00-hour data; both are six hours from the center of the verifying period. In one operational sense, this constitutes a disadvantage. The validity of forecasts decrease as they are carried forward in time, and consequently the forecast error in the 12-hour progs make them less valid as predictors than the 00-hour fields. On the other hand, the height tendency fields, which were used as predictors, are better since they are centered on the forecast period.

(3) Dew-Point Depressions - It was found that although the 850-mb dew-point depressions were correct, the 700- and 500-mb moisture fields were wrong. The error was not of a systematic type, which would have been automatically compensated for in the development of the regression equations. Rather, they were random and uncorrelated with the actual dew-point depression fields.

Examination of Paegle and Kierulff's Figure 9 shows dew-point depression mean fields which are somewhat unrealistic. A direct result of this problem was the fact that 700-mb and 500-mb depressions were almost never selected as predictors (see Table 18 of Paegle and Kierulff). Since it was apparent that the dew-point fields were of no help in reducing the variance (except the 850 mb) all three moisture fields were omitted in deriving the regression equations.

Table 4a, taken from Klein, shows the mean reduction of variance for single predictor fields over western United States. Note that the dew-point spread ranks high in the reduction of variance. Thus, while the failure to use the moisture fields does not bias the theoretical results, it is felt they seriously compromise its operational usability.

III. RESULTS OF EVALUATION

As noted in Chapter II, three major tests of the forecast system were made. Test I used .02 inches or more as constituting precipitation and is therefore not helpful as an indicator of the operational utility of the Paegle-Kierulff equations. Consequently, this section will mainly present the results of Test 2, which is a valid operational test using historical data. The outcome of Test 2 indicates the Paegle-Kierulff equations do not do well even in the first period (0-12 hours), a fact which practically guarantees poorer results for forecasts beyond 12 hours. For this reason the results of Test 3 are not included in this report, except to note that preliminary findings do indicate the system doesn't forecast well for subsequent periods either.

A. Comparison of Results of Test I and Test 2.

Table 5 is a summary of the results of Test I as scored by the (1/2) Brier Score. It shows that over the winter 67 - 68, the system was slightly over 10% better than climatology. It is surprising that it didn't beat climatology more substantially because (of necessity) a .01 inch climatology was used, and in the verification .02 inches constituted precipitation.

Of interest, in Table 5, is the variability of the results. For example at Flagstaff (FLG), Arizona, it beat climatology by more than 60%; yet, at Havre (HVR), Montana, and Pendleton (PDT), Oregon, it was more than 50% poorer than climatology. Each month was scored separately and the results were found to be very consistent from month to month.

Figure 3 displays the outcome of Tests 1 and 2 as a function of the probability forecasted. It very clearly demonstrates the effect of verifying with .01 inch rather than .02. For Test 1 the system did best for the low PoP forecasts: 5%, 2%, and 0%. This is a normal pattern; forecasters can often call for no precipitation with a high degree of certainty. Notice that Test 2 loses to climatology in the low ranges. This is undoubtedly due to the large number of precipitation events which amounted to only .01 inches. Likewise, in the first test forecasts of greater than 20% verified quite poorly, but did quite well in the second test. A system which forecasts a significant chance of .02 or greater will do even better when verified with .01, since most stations tend to be dry.

B. Results of Test 2.

To be worthwhile for operational use, the accuracy of the forecasts should be comparable to other PoPs currently in use. Figure 4 compares the improvement over climatology obtained by (1) the Paegle-Kierulff system, (2) TDL's NMC objective PoPs, and (3) the PoPs issued by the Weather Service Forecast Offices (WSFOs). All stations forecasted for by each WSFO are included, and the comparison is for the first-period forecasts of the winter 1969 - 1970. The NMC PoPs were consistently better than the Paegle-Kierulff PoPs, with the WSFOs doing the best in all areas.

Figure 4 is meant to be only a general comparison, since the input parameters are not exactly the same. For example, the "first period" objective forecast from NMC is actually from a data base 12 hours old at the beginning of the forecast period; whereas, the Paegle-Kierulff equations were verified assuming "on-time" data. Counterbalancing this is the fact that the NMC and FP PoPs were verified over a six-month period (November 1969 - November 1970), rather than a three-month period (December 1969 - February 1970). Presumably, the shorter "winter only" period is slightly more difficult to forecast.

Figure 5 is a reliability curve for the Paegle-Kierulff system. The lower reliability at the upper end (80%, 90%, and 100%) is normal for most forecast systems, although it is noteworthy that precipitation fell more often on 90% forecasts than on PoPs of 100%. A more serious deficiency is the low reliability for forecasts of 0%, 2%, and 5%. Precipitation fell more than 10% of the time the PoP was forecast to be 0%. This is another manifestation of the .01 cutoff being used.

When the Brier Scores are tabulated as a function of map type (see Figure 6), it is apparent that the regression equations for map types 1, 3, and 4 do fairly well while map types 2 and 5 do very poorly (actually losing to climatology). There is no obvious reason for this disparity. One possibility is that regression euqations for 2 and 5 were based on less data (although 2 had more data than 4). Map type 4 is associated with heavy precipitation, but 2 is relatively dry, so apparently it's not closely related to precipitation.

A priori, one would expect better scores for map types which were highly correlated with the original map type. Figure 7, showing scores as a function of map correlation coefficients, does not strongly show this. There is a slight improvement in socres with higher map correlations, with the highest socres for maps of coefficients between 940 and 960. Note that the improvement over climatology was essentially the same between maps of correlation less than 880 and those greater than 960.

Figure 8a shows the improvement over climatology for the total test analyzed on a map of western United States. The system does best over western Oregon, California, and southern Arizona. It is quite poor in a band from northern Montana to central Washington. A possible reason for the poor performance in the north, especially northeast Montana, may be that the map types are not representative of the weather regimes in those areas. Much of the weather during winter in that area is due to systems coming down from Canada on the east side of the mountains. Neither upstream precipitation nor height fields are used which would be adequate predictors for this type system.

There is a definite similarity in the results shown on Figure 8a and those obtained by Klein. The high predictability of weather over southern Arizona and up along the West Coast are features of both, as well as the lower predictability of the northern sections. Apparently with current data, precipitation is intrinsically much harder to forecast in some areas than others.

Geographic dependence appeared in the verification of all map types. For example, Figure 8b shows that the map type 1 regression equations did poorly in an area from southern Nevada to western Oregon. With generally west flow, the areas where the system did poorly appear to correspond to areas of downslope winds, while the upslope areas were areas where it did better.

There is no clear-cut explanation for most of the geographic anomalies found. An attempt was made to correlate the performance of the equations with the precipitation regime (i.e., did it do better in wet areas than dry areas or vice versa?), but no strong correlation was found. There was a slight relationship to the variance of the predictor fields (see Figure 4 of Paegle-Kierulff). Figures 8c and 8d show the geographic verification pattern for selected other stratifications.

Tables 6 - 13 present the complete results of Test 2. Each station is scored by the Brier Score for the Paegle-Kierulff equations (the column labeled BRIER) and climatology (column CLIM). All Brier Scores are normalized. The percentage improvement (IMP PC) over climatology is listed, as well as the number of forecasts (NUM). The bottom line lists the total (TOT) scores for each category.

Notice that a total of over 14,000 forecasts were scored, with a sufficient number of forecasts for each station within each map type to make the results statistically stable. Examination of these tables, along with the appropriate regression equations, results in a wealth of information. For example, in map type I Tucson's regression equation beat climatology by almost 60%. The proper regression equation shows then that past precipitation at Yuma, warm advection, and 700-mb height to the west are very important predictors for that particular flow regime.

IV. CONCLUSIONS

Three data discrepancies were described in Chapter II which bear directly on the suitability of the regression equations for operational use. For a multiple regression which maximizes reduction of variance with a minimum of terms, all major independent predictors should be represented. For example, Klein [2] found maximal reduction of variance for three-predictor-field equations by including each of three basic parameters: height, moisture, and past precipitation (see Table 4b). He cited the appreciable reductions in variance made as evidence of the significance and independence of these three predictors. In operational use all three of these basic independent predictors are compromised in the Paegle-Kierulff regression equations.

In Chapter III results of an independent test were shown which confirmed that the system does not do well in comparison with current operational forecasting.

It is, therefore, the conclusion of this study that the Paegle-Kierulff type-stratified regression equations are not adaptable to operational forecasting.

It should be pointed out that the main thrust of the Paegle-Kierulff study was a comparison of regression equations stratified by map type with non-stratified equations. Their conclusion that the map typing is a significant improvement in the development of forecast equations is certainly still true; this implies that while this particular set of regression equations may not be suitable for operational use, map typing is still an excellent approach to the precipitation forecast problem.

V. ACKNOWLEDGMENTS

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VI. REFERENCES

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[2] KLEIN, W. H. *Computer Predictor of Precipitation Probability in the United States.* JAM, Volume 10, No. 5, p. 903, 1971.

[3] AUGULIS, R. P. *Precipitation Probabilities in the Western Region Associated with Winter 500-mb Types.* ESSA Technical Memorandum WBTM WR 45-1, 91 pp., 1969.

[4] MILLER, L. (Compiled by.) *Climatological Precipitation Probabilities.* ESSA Technical Memorandum WRTM 2, 25 pp., 1965.

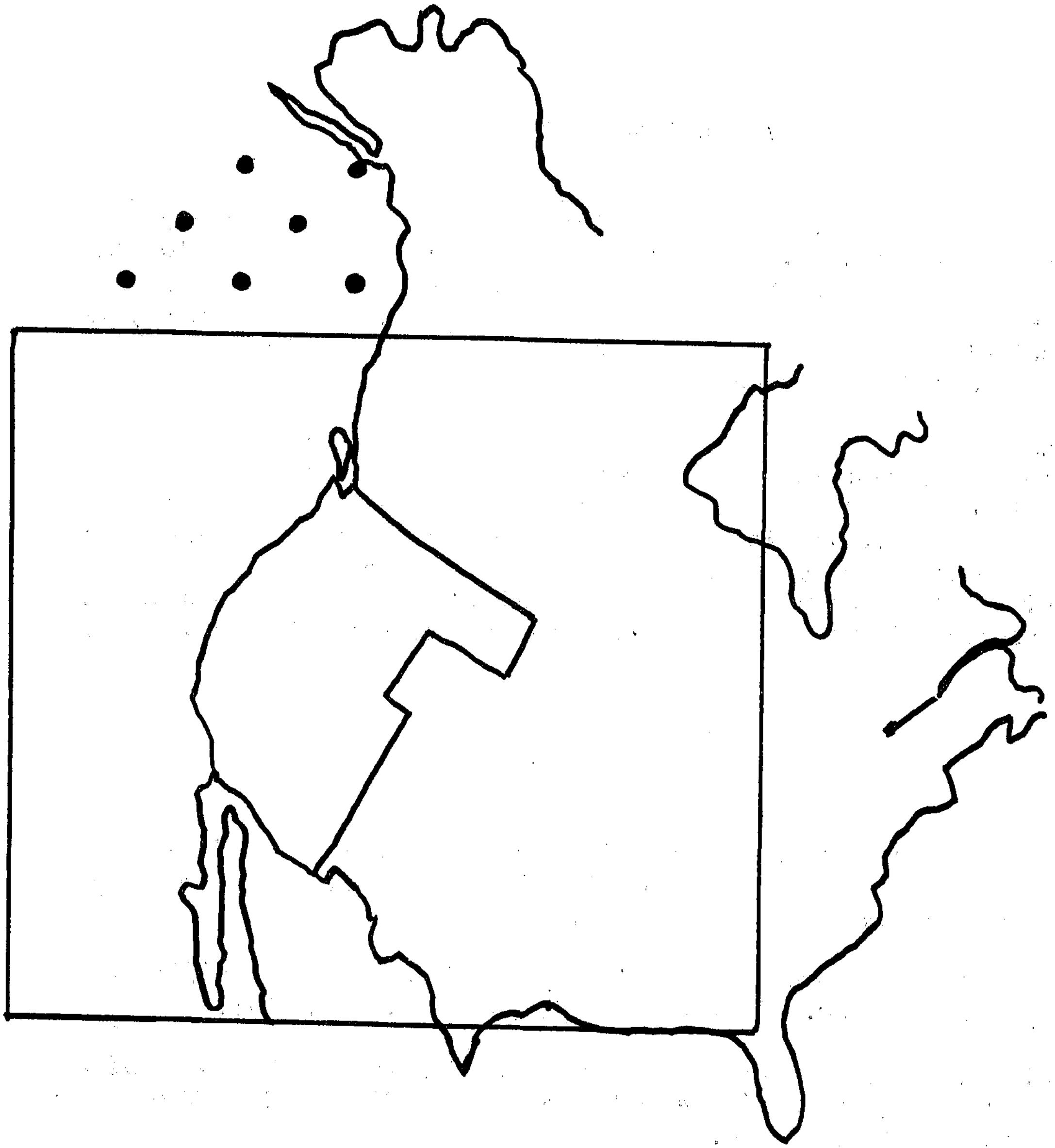


FIGURE 1. THE SQUARE IS INCLUSIVE OF THE 182 POINTS FOR WHICH DATA WAS AVAILABLE. THE SEVEN GRID POINTS MARKED IN THE GULF OF ALASKA WERE USED IN THE PAEGLE-KIERULFF MAP TYPING, BUT NOT IN THE CURRENT STUDY.

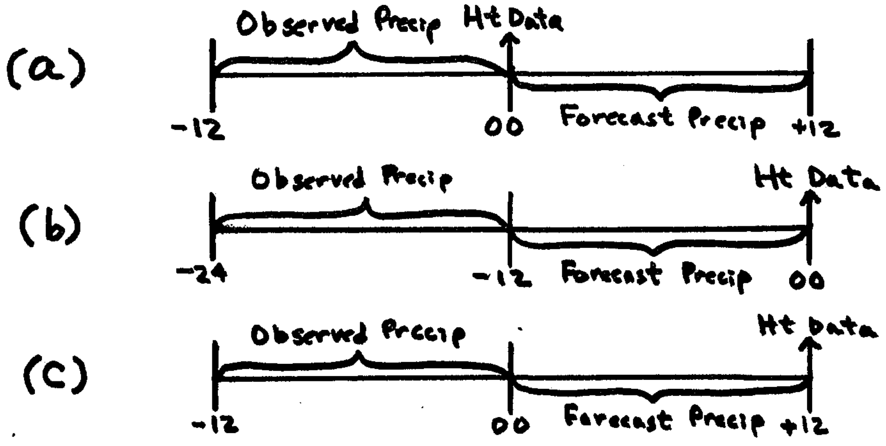


FIGURE 2. SCHEMATIC OF HEIGHT DATA AND PRECIPITATION VALID PERIODS. SEE TEXT FOR DETAILED EXPLANATION.

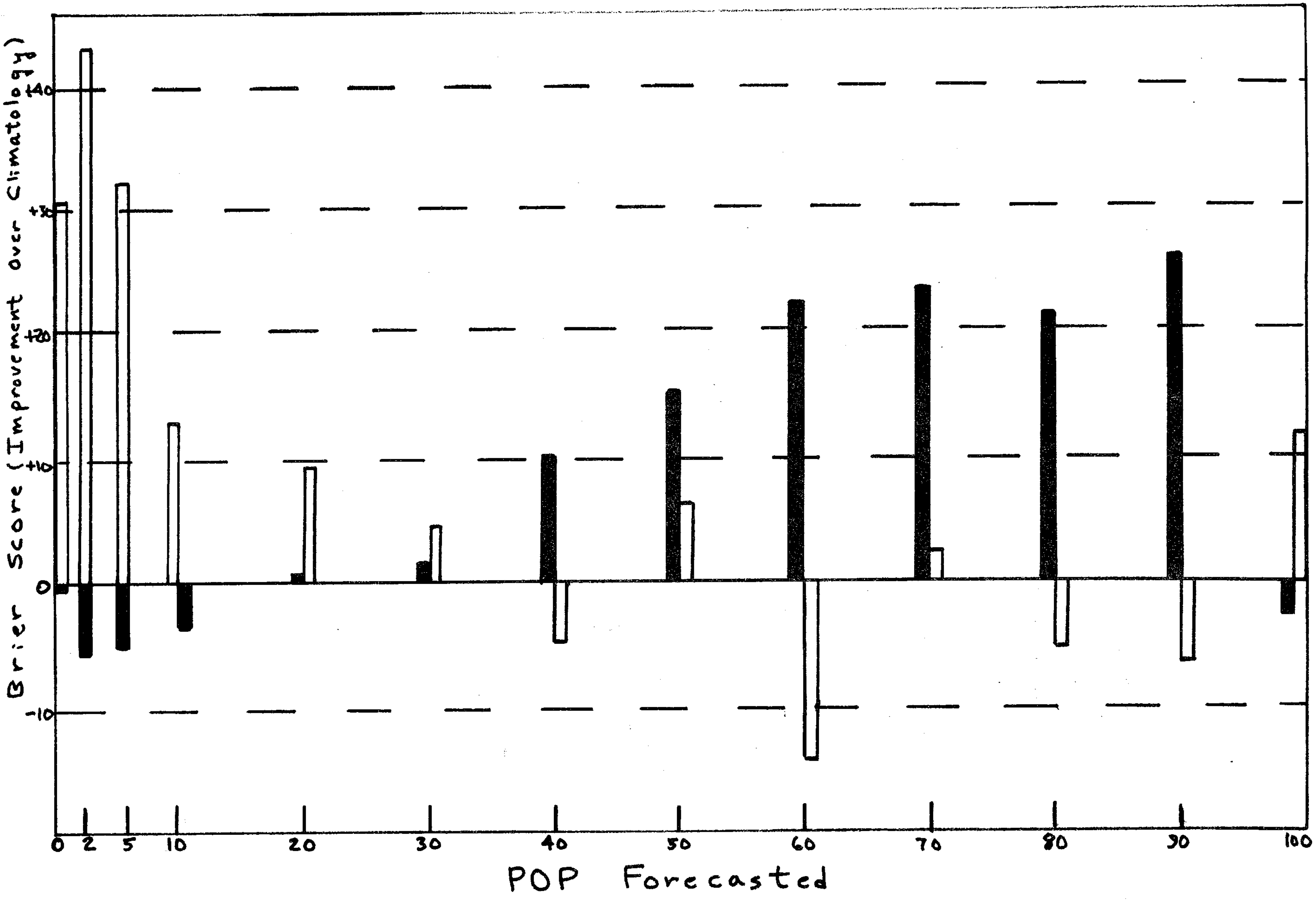


FIGURE 3. TOTAL BRIER SCORES AS A FUNCTION OF THE PRECIPITATION PROBABILITY FORECASTED FOR (1) TEST 1 WHERE .02 INCHES CONSTITUTED PRECIPITATION (WHITE BARS) AND (2) TEST 2 WHERE .01 CONSTITUTED PRECIPITATION (BLACK BARS).

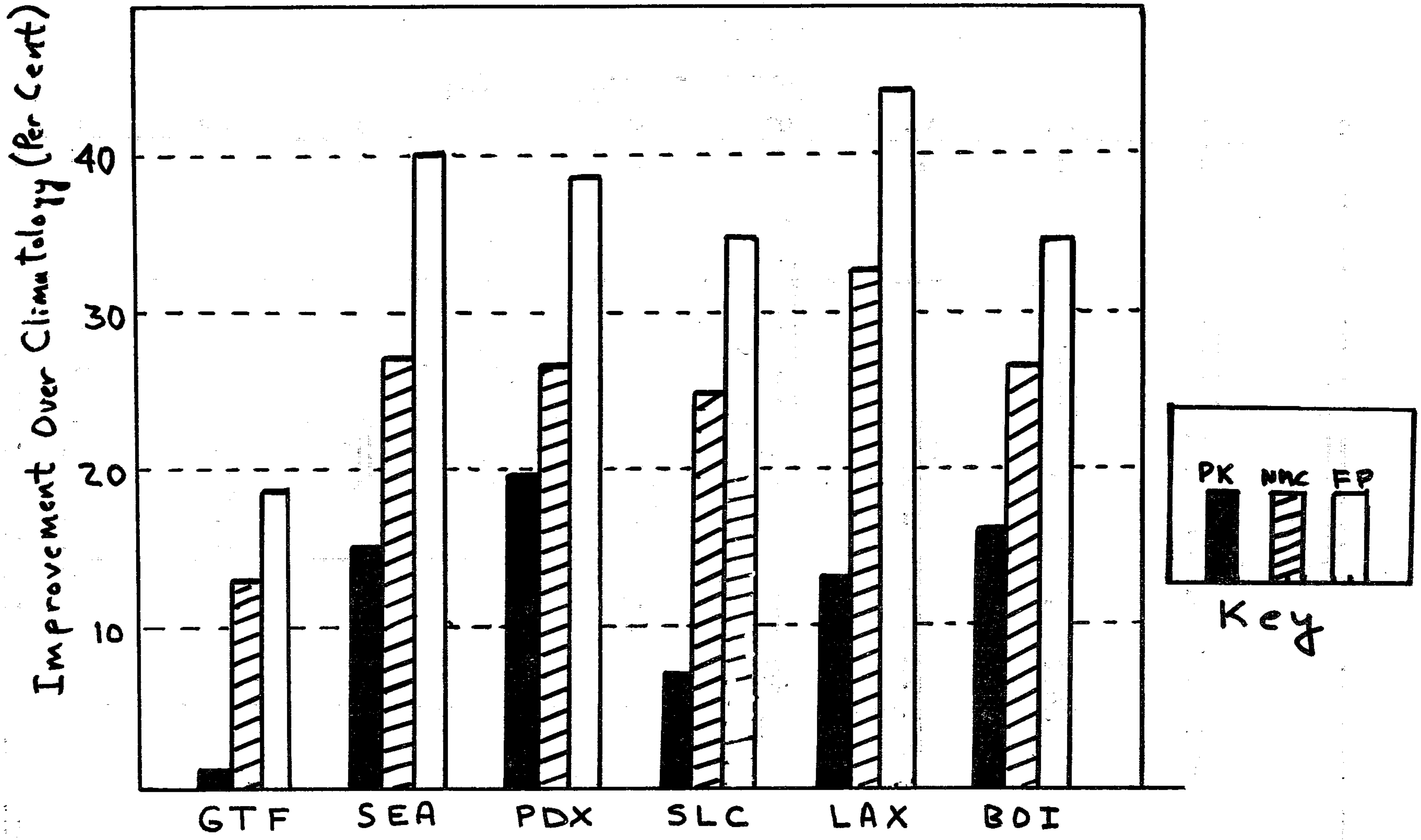


FIGURE 4. A COMPARISON OF FORECAST SKILL FOR THE WINTER OF 69 - 70. ALL STATIONS FORECASTED FOR BY A WSFO ARE INCLUDED IN THE PAEGLE-KIERULFF (SOLID), NMC (HATCHED), AND FP (OPEN) SCORES.

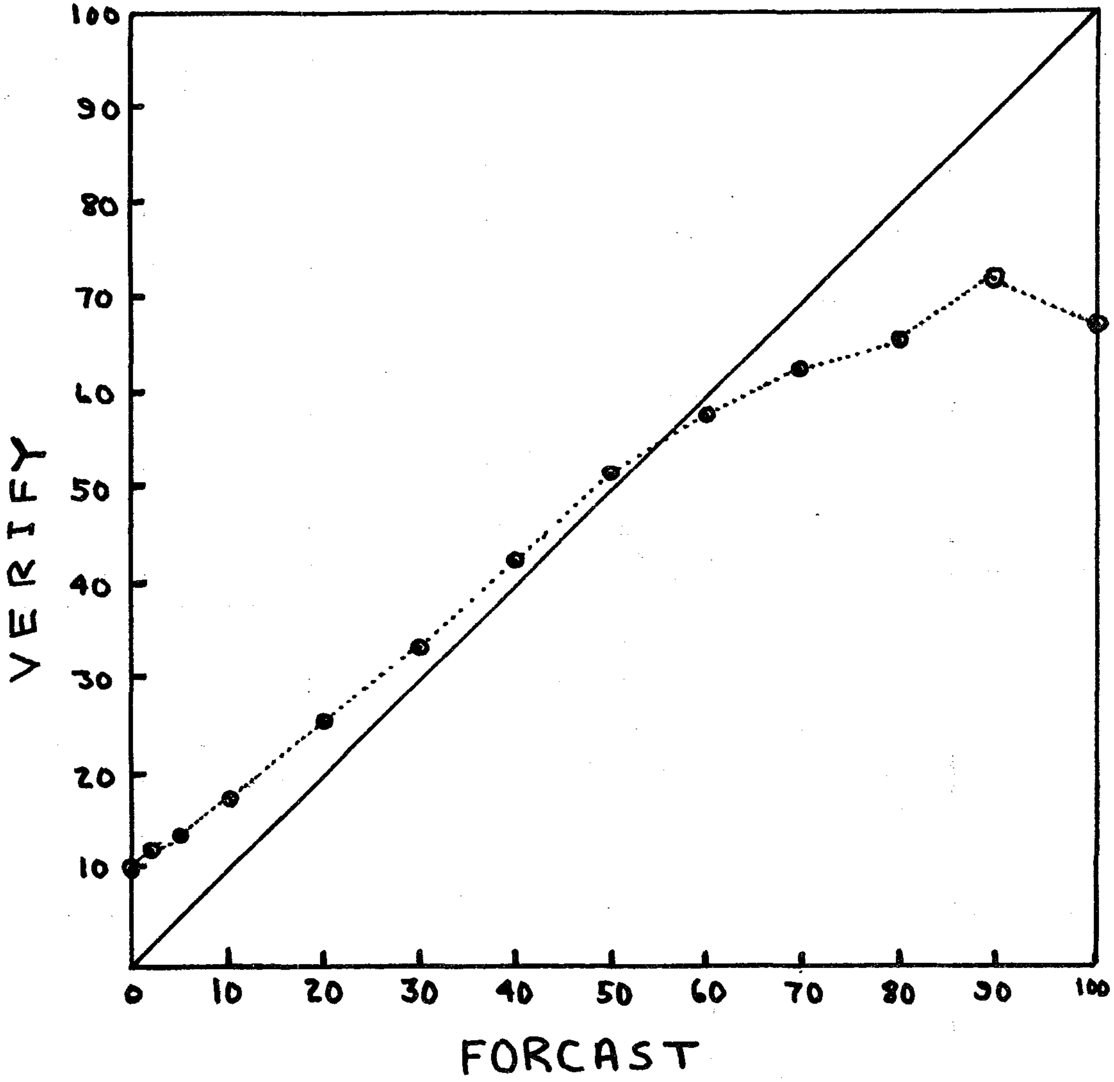


FIGURE 5. RELIABILITY OF THE PAEGLE-KIERULFF SYSTEM. THE DIAGONAL LINE CORRESPONDS TO PERFECT RELIABILITY.

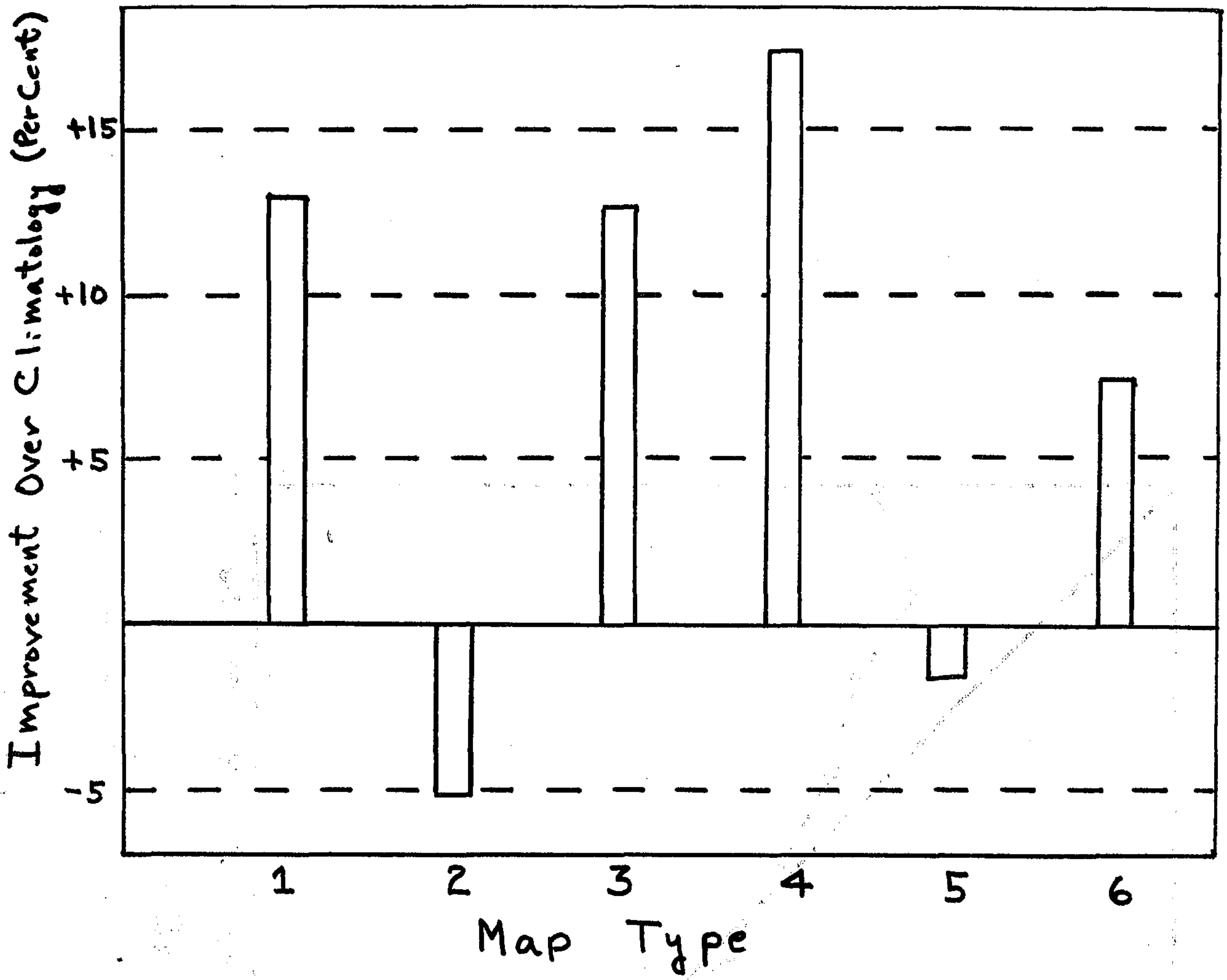


FIGURE 6. BRIER SCORES FOR ALL FORECASTS FOR EACH MAP TYPE.

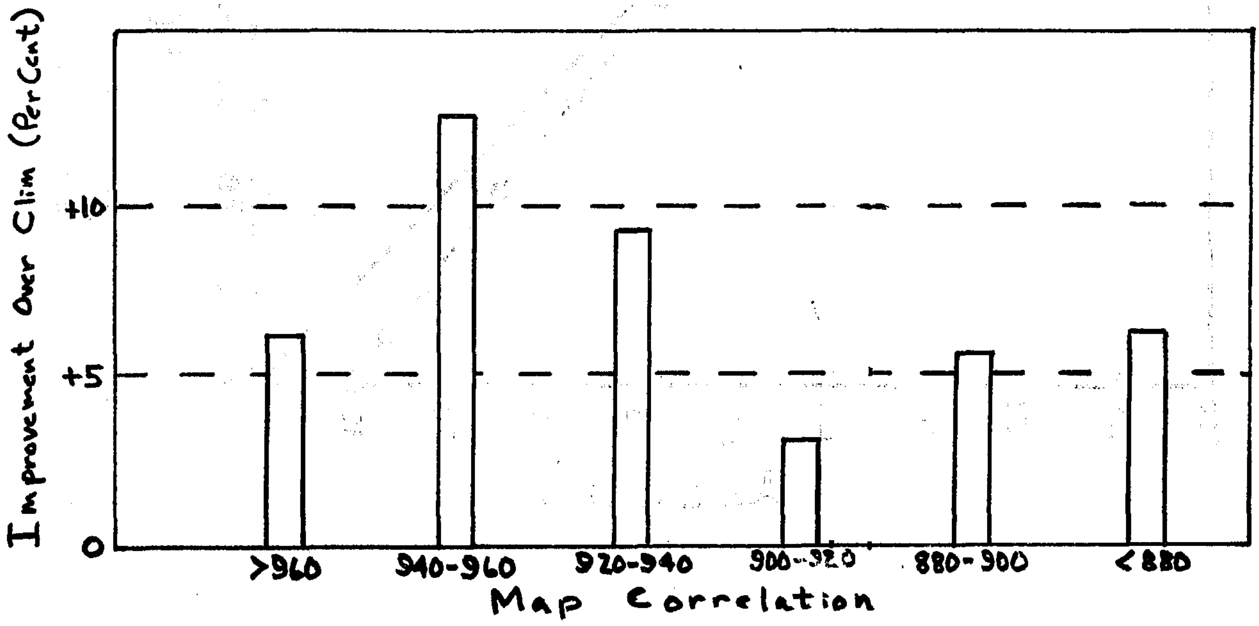
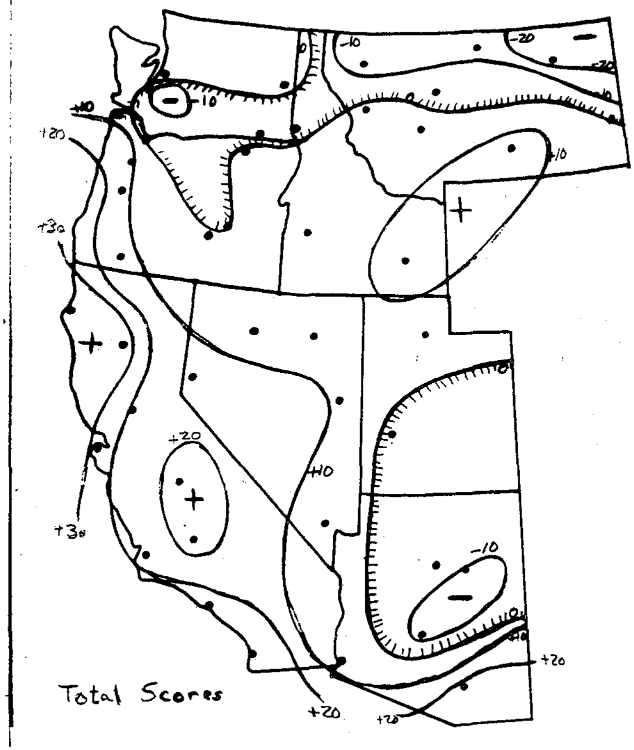


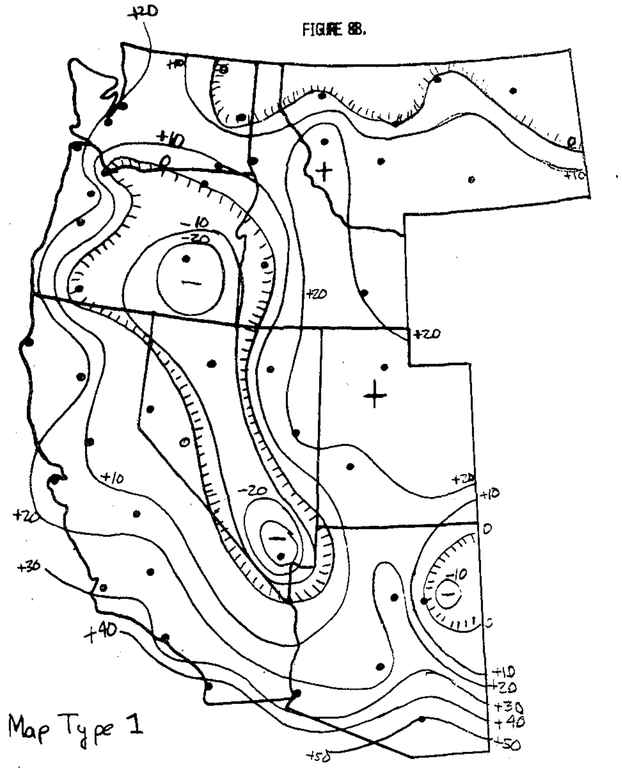
FIGURE 7. BRIER SCORES ASSOCIATED WITH MAP CORRELATION COEFFICIENTS.

FIGURE 8A.



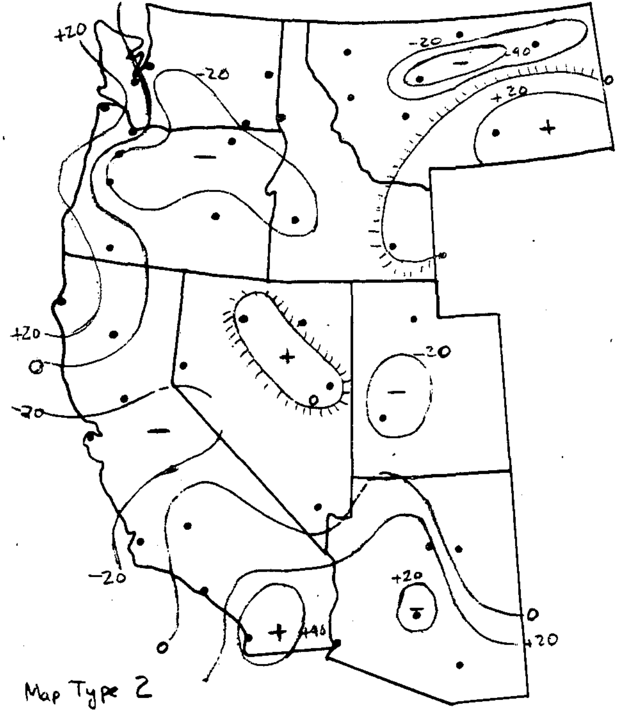
Total Scores

FIGURE 8B.



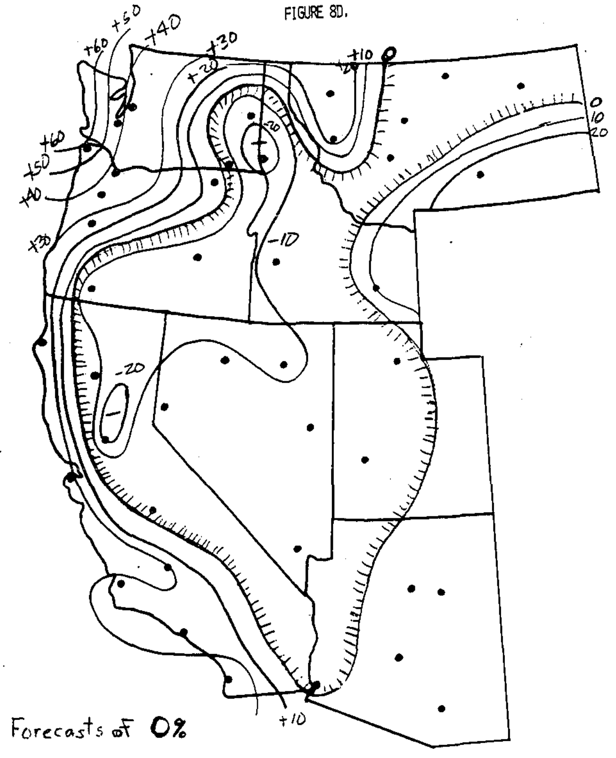
Map Type 1

FIGURE 8C.



Map Type 2

FIGURE 8D.



Forecasts of 0%

FIGURE 8. BRIER SCORE PERCENT IMPROVEMENT OVER CLIMATOLOGY.

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
DEC 67	PK		3	3	3	3	3	3	1	1	1	1	2	2	M	M	M	M	M	M	5	5	1	3	1	1	2	2	2	2	2	M
	CS		3	3	5	5	5	5	1	1	1	1	2	2	6	6	6	2	2	5	5	6	1	3	1	1	2	2	2	2	2	M
JAN 68	PK		2	2	2	2	2	1	5	5	5	5	1	3	3	3	3	3	3	3	1	1	1	4	1	1	5	M	5	5	5	M
	CS		2	2	2	2	2	1	1	1	5	5	1	3	3	3	3	5	1	3	1	1	2	4	1	1	1	5	5	5	5	M
FEB 68	PK		1	3	3	1	M	→																								
	CS		1	3	3	1	M	→																								

TABLE I. "PK" ARE THE PAEGLE-KIERULFF MAP TYPES. "CS" ARE THE MAP TYPES GENERATED IN THE CURRENT STUDY (OOZ). "M" STANDS FOR MISSING MAP TYPES.

TEST	PERIOD	TYPE	PRECIP DATA	HEIGHT DATA
1	Dec 67- Feb 68	Historical	Peagle & Kierulff	Peagle & Kierulff
2	Dec 68- Feb 69 Dec 69 - Feb 70	Historical	TDL, HPD	FNWF
3	Dec 73 - Feb 74	Real Time	NMC	FNWF

TABLE 2. SPECIFICATIONS OF THE OPERATIONAL TESTS.

	ELY	BFL	TUS	LAS	PHX	YUM	SAC	SMX	BIL
.01	14	12	9	5	8	4	24	17	17
.02	8	7	9	3	7	4	14	10	14

	SLC	BOI	GTF	EKA	MFR	SEA	LAX	SAN	SFO
.01	20	28	19	43	34	50	12	12	27
.02	15	18	17	29	21	41	8	9	16

TABLE 3. A COMPARISON OF THE FREQUENCIES (PERCENT) OF PRECIPITATION AMOUNTING TO .01 INCHES OR MORE AND .02 INCHES OR MORE.

4a. Mean reductions of variance (RV, %) obtained by screening winter precipitation occurrence between 1200 and 2400 GMT as a function of single predictor fields observed at beginning of period. Results are averaged for 48 western and 50 eastern cities for 5-term equations.

Predictors	RV West	 East
1000-mb height	23.6	29.5
850-mb height	28.8	31.1
700-mb height	26.3	24.5
500-mb height	23.9	20.5
850-mb dew-point spread	25.7	27.4
700-mb dew-point spread	25.9	30.3
500-mb dew point spread	16.8	18.3
850–700 mb mean spread	27.1	33.7
Prior 12-hr precipitation	30.5	32.0

4b Mean reductions of variance obtained by screening winter precipitation occurrence between 1200 and 2400 GMT as function of *three or four* predictor fields in combinations. Results are given for 5-term equations at 48 stations in western half of the United States.

Predictors	RV
850-mb height, 850-mb spread, and 700-mb spread	33.7
850-mb height, 700-mb spread, and prior precipitation	39.1
700-mb height, 700-mb spread, and prior precipitation	38.0
850-mb height, 850-mb spread, and prior precipitation	39.0
850-mb height, 850-700 mb mean spread, and prior precipitation	39.2
850-mb height, 850-mb spread, 700-mb spread, and prior precipitation	38.6

TABLE 4. MEAN REDUCTION OF VARIANCE OBTAINED BY SCREENING WINTER PRECIPITATION OCCURRENCE. (TAKEN FROM KLEIN [2].)

TOTAL BRIER SCORES

	BRIER	CLIM	IMP(PC)	NUM	*
ELY	9.96	10.64	6.4	127	*
BFL	7.95	10.11	21.4	127	*
TUS	10.07	14.30	29.6	127	*
LAS	4.42	4.82	8.3	127	*
PHX	12.59	17.74	29.0	127	*
YUM	6.90	6.69	-3.1	127	*
SAC	13.60	16.79	19.0	127	*
SMX	10.22	11.85	13.7	127	*
BIL	15.49	16.36	5.3	127	*
SLC	20.37	17.68	-15.2	127	*
BOI	14.64	17.22	15.0	127	*
BNO	18.98	18.43	-3.0	127	*
GTF	19.14	20.71	7.6	127	*
MSO	22.16	23.23	4.6	127	*
PDT	24.79	16.43	-50.9	127	*
EKA	12.84	28.38	54.8	127	*
MFR	17.93	23.02	22.1	127	*
SEA	35.54	31.68	-12.2	127	*
FAT	10.06	13.73	26.7	127	*
LAX	9.76	11.03	11.5	127	*
MLF	15.81	13.63	-16.0	127	*
RNO	8.29	10.47	20.8	127	*
SAN	14.20	13.44	-5.6	127	*
INW	14.46	10.12	-42.9	127	*
SFO	16.33	21.62	24.5	127	*
PIH	16.80	18.26	8.0	127	*
GEG	29.50	26.91	-9.6	127	*
RBL	13.54	22.51	39.8	127	*
PUX	24.30	31.84	23.7	127	*
OLM	21.79	31.59	31.0	127	*
ALW	32.14	25.43	-26.4	127	*
AST	22.33	28.97	22.9	127	*
SLE	20.21	31.99	36.8	127	*
EUG	21.02	31.19	32.6	127	*
FCA	29.75	27.32	-8.9	127	*
HVR	21.26	13.85	-53.5	127	*
HLN	17.98	24.49	26.6	127	*
GGW	18.98	15.19	-24.9	127	*
LWS	26.60	24.07	-10.5	127	*
EKO	18.00	15.02	-19.8	127	*
WMC	10.20	10.25	.4	127	*
FLG	8.26	21.06	60.8	127	*
TOT	719.14	800.05	10.1	5334	*

TABLE 5. COLUMN LABELED "BRIER" IS THE UNNORMALIZED TOTAL BRIER SCORE OBTAINED BY THE PAEGLE-KIERULFF REGRESSION EQUATIONS DURING THE WINTER 67 - 68. "CLIM" IS THE CLIMATOLOGY SCORE, "IMP(PC)" IS THE PERCENT IMPROVEMENT OVER CLIMATOLOGY, AND "NUM" IS THE NUMBER OF FORECASTS. THE COLUMN TOTALS ARE THE BOTTOM ROW, LABELED "TOT".

TOTAL BRIER SCORES

	BRIER	CLIM	IMP(PC)	NUM	*
ELY	.113	.125	9.6	341	*
BFL	.119	.151	20.9	341	*
TUS	.056	.076	25.3	341	*
LAS	.079	.084	6.6	341	*
PHX	.096	.083	-15.7	341	*
YUM	.051	.053	3.7	341	*
SAC	.225	.252	10.9	341	*
SMX	.169	.200	15.6	341	*
BIL	.133	.148	10.2	341	*
SLC	.160	.174	8.1	341	*
BOI	.220	.230	4.5	341	*
BNO	.250	.242	-3.2	341	*
GTF	.199	.190	-4.9	341	*
MSO	.182	.224	18.7	341	*
PDT	.227	.240	5.5	341	*
EKA	.155	.252	38.7	341	*
MFR	.217	.242	10.3	341	*
SEA	.236	.248	4.8	341	*
FAT	.147	.190	22.5	341	*
LAX	.114	.145	21.4	341	*
MLF	.146	.145	-.5	341	*
RNO	.139	.155	10.2	341	*
SAN	.109	.150	27.5	341	*
INW	.089	.081	-10.1	341	*
SFO	.183	.255	28.2	341	*
PIH	.171	.197	13.5	341	*
GEG	.238	.240	1.0	341	*
RBL	.175	.251	30.2	341	*
PDX	.274	.251	-9.0	341	*
OLM	.280	.247	-13.3	341	*
ALW	.265	.260	-1.9	341	*
AST	.212	.226	6.3	341	*
SLE	.208	.255	18.6	341	*
EUG	.232	.252	8.2	341	*
FCA	.249	.222	-12.2	341	*
HVR	.182	.158	-15.5	341	*
HLN	.174	.181	3.5	341	*
GGW	.190	.156	-21.6	341	*
LWS	.221	.219	-.7	341	*
EKO	.201	.198	-1.7	341	*
WMC	.163	.176	7.3	341	*
FLG	.173	.168	-2.8	341	*
TOT	.177	.190	7.2	14322	*

BRIER SCORES FOR MAP TYPE 1

	BRIER	CLIM	IMP(PC)	NUM	*
ELY	.095	.122	22.2	106	*
BFL	.073	.102	27.7	106	*
TUS	.019	.046	58.8	106	*
LAS	.041	.028	-44.8	106	*
PHX	.045	.054	16.0	106	*
YUM	.014	.019	23.8	106	*
SAC	.172	.180	4.8	106	*
SMX	.111	.140	21.1	106	*
BIL	.150	.170	12.1	106	*
SLC	.156	.204	23.6	106	*
BOI	.239	.233	-2.5	106	*
BNO	.268	.214	-25.4	106	*
GTF	.201	.198	-1.6	106	*
MSO	.185	.252	26.7	106	*
PDT	.231	.244	5.7	106	*
EKA	.159	.234	32.3	106	*
MFR	.234	.220	-6.1	106	*
SEA	.205	.252	18.4	106	*
FAT	.117	.134	12.8	106	*
LAX	.081	.108	24.9	106	*
MLF	.133	.159	16.6	106	*
RNO	.108	.113	4.4	106	*
SAN	.087	.156	44.1	106	*
INW	.076	.064	-19.4	106	*
SFO	.171	.194	11.5	106	*
PIH	.167	.207	19.5	106	*
GEG	.254	.242	-4.7	106	*
RBL	.149	.194	23.5	106	*
PDX	.258	.257	-.2	106	*
OLM	.202	.243	16.7	106	*
ALW	.241	.269	10.6	106	*
AST	.130	.198	34.3	106	*
SLE	.168	.261	35.5	106	*
EUG	.211	.255	17.2	106	*
FCA	.234	.234	.1	106	*
HVR	.127	.132	3.7	106	*
HLN	.196	.234	16.2	106	*
GGW	.171	.147	-16.3	106	*
LWS	.194	.235	17.5	106	*
EKO	.176	.201	12.5	106	*
WMC	.173	.147	-17.9	106	*
FLG	.107	.135	20.6	106	*
TOT	.155	.177	12.2	4452	*

BRIER SCORES FOR MAP TYPE 2

	BRIER	CLIM	IMP(PC)	NUM	*
ELY	.173	.180	4.1	40	*
BFL	.123	.127	3.7	40	*
TUS	.044	.070	36.6	40	*
LAS	.050	.047	-5.3	40	*
PHX	.125	.133	5.6	40	*
YUM	.056	.071	22.1	40	*
SAC	.140	.132	-6.1	40	*
SMX	.147	.130	-13.1	40	*
BIL	.164	.238	31.1	40	*
SLC	.309	.295	-4.7	40	*
BOI	.328	.272	-20.5	40	*
BNO	.217	.217	-.4	40	*
GTF	.423	.298	-42.2	40	*
MSO	.197	.189	-4.5	40	*
PDT	.251	.206	-22.0	40	*
EKA	.143	.229	37.7	40	*
MFR	.216	.231	6.2	40	*
SEA	.260	.238	-9.1	40	*
FAT	.201	.162	-23.7	40	*
LAX	.065	.072	9.5	40	*
MLF	.262	.209	-25.2	40	*
RNO	.150	.129	-16.2	40	*
SAN	.050	.092	45.4	40	*
INW	.171	.169	-.9	40	*
SFO	.221	.177	-25.1	40	*
PIH	.226	.241	6.3	40	*
GEG	.249	.217	-14.6	40	*
RBL	.125	.128	2.0	40	*
PDX	.197	.244	19.3	40	*
OLM	.343	.256	-33.9	40	*
ALW	.272	.240	-13.5	40	*
AST	.150	.238	37.1	40	*
SLE	.315	.250	-26.1	40	*
EUG	.305	.244	-25.2	40	*
FCA	.273	.251	-8.7	40	*
HVR	.296	.262	-13.2	40	*
HLN	.279	.234	-18.9	40	*
GGW	.419	.328	-27.8	40	*
LWS	.239	.225	-6.2	40	*
EKO	.280	.254	-10.2	40	*
WMC	.200	.211	5.1	40	*
FLG	.154	.232	33.6	40	*
TOT	.210	.199	-5.2	1680	*

TABLE 6. RESULTS OF TEST 2.

BRIER SCORES FOR MAP TYPE 3

	BRIER	CLIM	IMP(PC)	NUM	*
ELY	.064	.070	8.9	119	*
BFL	.084	.105	19.3	119	*
TUS	.049	.048	-1.2	119	*
LAS	.054	.063	14.0	119	*
PHX	.035	.034	-1.4	119	*
YUM	.031	.032	3.7	119	*
SAC	.320	.270	-18.7	119	*
SMX	.159	.166	4.3	119	*
BIL	.109	.110	.1	119	*
SLC	.101	.106	4.6	119	*
BOI	.159	.205	22.2	119	*
BNO	.239	.251	4.6	119	*
GTF	.068	.101	33.0	119	*
MSO	.178	.212	16.1	119	*
PDT	.186	.229	18.7	119	*
EKA	.150	.257	41.6	119	*
MFR	.166	.255	35.1	119	*
SEA	.189	.249	23.9	119	*
FAT	.107	.141	24.4	119	*
LAX	.111	.110	-.4	119	*
MLF	.067	.091	27.0	119	*
RNO	.112	.122	7.7	119	*
SAN	.079	.098	19.9	119	*
INW	.038	.050	23.8	119	*
SFO	.187	.280	33.3	119	*
PIH	.123	.153	19.9	119	*
GEG	.207	.236	12.1	119	*
RBL	.149	.318	53.0	119	*
PDX	.276	.254	-8.8	119	*
OLM	.341	.244	-39.5	119	*
ALW	.232	.251	7.5	119	*
AST	.230	.220	-4.6	119	*
SLE	.156	.259	39.6	119	*
EUG	.224	.253	11.4	119	*
FCA	.203	.198	-2.5	119	*
HVR	.103	.118	12.5	119	*
HLN	.114	.105	-8.6	119	*
GGW	.093	.100	6.8	119	*
LWS	.184	.193	5.0	119	*
EKO	.140	.150	6.7	119	*
WMC	.109	.140	22.4	119	*
FLG	.114	.111	-3.2	119	*
TOT	.144	.166	13.2	4998	*

BRIER SCORES FOR MAP TYPE 4

	BRIER	CLIM	IMP(PC)	NUM	*
ELY	.071	.072	1.3	14	*
BFL	.000	.025	100.0	14	*
TUS	.088	.066	-34.6	14	*
LAS	.000	.002	100.0	14	*
PHX	.071	.067	-6.3	14	*
YUM	.143	.135	-5.7	14	*
SAC	.102	.088	-15.8	14	*
SMX	.000	.032	100.0	14	*
BIL	.253	.257	1.6	14	*
SLC	.182	.126	-44.9	14	*
BOI	.147	.144	-2.5	14	*
BNO	.011	.052	77.9	14	*
GTF	.322	.259	-24.4	14	*
MSO	.069	.114	39.2	14	*
PDT	.020	.069	71.0	14	*
EKA	.043	.178	75.8	14	*
MFR	.062	.118	47.2	14	*
SEA	.055	.225	75.5	14	*
FAT	.071	.080	11.5	14	*
LAX	.000	.017	100.0	14	*
MLF	.012	.031	62.7	14	*
RNO	.034	.018	-89.2	14	*
SAN	.001	.021	96.3	14	*
INW	.214	.185	-16.1	14	*
SFO	.018	.070	74.4	14	*
PIH	.088	.103	13.9	14	*
GEG	.005	.104	95.3	14	*
RBL	.014	.068	79.5	14	*
PDX	.031	.225	86.5	14	*
OLM	.110	.266	58.7	14	*
ALW	.074	.109	32.2	14	*
AST	.212	.313	32.3	14	*
SLE	.141	.223	36.9	14	*
EUG	.079	.217	63.6	14	*
FCA	.750	.189	-296.8	14	*
HVR	.088	.078	-12.8	14	*
HLN	.148	.169	12.3	14	*
GGW	.015	.038	61.2	14	*
LWS	.006	.054	88.1	14	*
EKO	.104	.083	-25.7	14	*
WMC	.000	.029	100.0	14	*
FLG	.148	.122	-20.9	14	*
TOT	.095	.115	17.3	588	*

BRIER SCORES FOR MAP TYPE 5

	BRIER	CLIM	IMP(PC)	NUM	*
ELY	.238	.241	1.6	54	*
BFL	.278	.368	24.6	54	*
TUS	.128	.148	13.8	54	*
LAS	.203	.236	14.1	54	*
PHX	.283	.163	-73.3	54	*
YUM	.146	.140	-4.5	54	*
SAC	.179	.474	62.2	54	*
SMX	.338	.464	27.2	54	*
BIL	.050	.073	30.6	54	*
SLC	.201	.207	2.6	54	*
BOI	.268	.292	8.4	54	*
BNO	.359	.377	4.8	54	*
GTF	.263	.250	-4.9	54	*
MSO	.224	.264	15.3	54	*
PDT	.372	.353	-5.4	54	*
EKA	.179	.317	43.5	54	*
MFR	.336	.305	-10.4	54	*
SEA	.422	.254	-66.4	54	*
FAT	.243	.443	45.1	54	*
LAX	.238	.359	33.9	54	*
MLF	.263	.211	-24.3	54	*
RNO	.234	.330	29.1	54	*
SAN	.259	.284	8.8	54	*
INW	.110	.056	-96.9	54	*
SFO	.213	.436	51.2	54	*
PIH	.271	.279	2.8	54	*
GEG	.351	.316	-11.3	54	*
RBL	.343	.352	2.7	54	*
PDX	.425	.250	-70.2	54	*
OLM	.296	.244	-21.0	54	*
ALW	.468	.345	-35.7	54	*
AST	.366	.249	-46.8	54	*
SLE	.329	.255	-29.1	54	*
EUG	.288	.263	-9.4	54	*
FCA	.261	.251	-4.0	54	*
HVR	.408	.247	-64.9	54	*
HLN	.264	.264	.4	54	*
GGW	.310	.197	-57.5	54	*
LWS	.424	.308	-38.0	54	*
EKO	.354	.276	-28.4	54	*
WMC	.267	.309	13.7	54	*
FLG	.451	.269	-67.8	54	*
TOT	.282	.278	-1.5	2268	*

TABLE 7. RESULTS OF TEST 2.

FORECASTS OF 5 PER CENT

	BRIER	CLIM	IMP(PC)	NUM	*
ELY	.035	.048	27.8	28	*
BFL	.092	.093	.9	40	*
TUS	.022	.025	9.3	45	*
LAS	.077	.077	.0	36	*
PHX	.038	.040	3.4	25	*
YUM	.125	.129	3.0	22	*
SAC	.248	.201	-23.3	22	*
SMX	.143	.134	-6.4	32	*
BIL	.145	.135	-7.0	38	*
SLC	.091	.099	8.2	51	*
BOI	.067	.119	44.1	14	*
BNO	.227	.190	-19.7	16	*
GTF	.084	.098	14.0	33	*
MSO	.137	.152	9.5	20	*
PDT	.137	.143	3.7	20	*
EKA	.102	.216	52.6	9	*
MFR	.371	.252	-47.0	22	*
SEA	.002	.221	98.9	4	*
FAT	.082	.094	12.9	34	*
LAX	.099	.096	-2.9	28	*
MLF	.096	.093	4.0	31	*
RNO	.182	.159	-14.6	15	*
SAN	.047	.057	17.3	40	*
INW	.042	.044	6.4	46	*
SFO	.242	.197	-23.2	15	*
PIH	.141	.139	-1.1	26	*
GEG	.050	.128	61.1	19	*
RBL	.108	.124	12.6	17	*
PDX	.122	.226	45.8	15	*
OLM	.626	.247	-153.3	13	*
ALW	.267	.210	-27.1	17	*
AST	.453	.245	-84.8	2	*
SLE	.602	.265	-127.4	3	*
EUG	.227	.232	1.8	8	*
FCA	.242	.211	-14.9	15	*
HVR	.119	.112	-5.5	31	*
HLN	.047	.058	18.5	20	*
GGW	.092	.100	7.8	30	*
LWS	.137	.141	2.3	20	*
EKO	.115	.114	-1.1	24	*
WMC	.227	.191	-19.1	16	*
FLG	.072	.076	6.0	26	*
TOT	.122	.117	-4.4	988	*

FORECASTS OF 10 PER CENT

	BRIER	CLIM	IMP(PC)	NUM	*
ELY	.060	.067	10.7	64	*
BFL	.117	.115	-1.5	45	*
TUS	.050	.049	-2.8	60	*
LAS	.061	.060	-1.9	47	*
PHX	.101	.103	1.4	35	*
YUM	.096	.102	5.8	28	*
SAC	.245	.213	-15.1	51	*
SMX	.241	.221	-9.1	45	*
BIL	.154	.148	-3.9	50	*
SLC	.196	.179	-9.2	56	*
BOI	.188	.174	-8.1	36	*
BNO	.143	.142	-.6	30	*
GTF	.164	.154	-6.6	52	*
MSO	.341	.253	-34.6	29	*
PDT	.108	.129	16.4	49	*
EKA	.114	.200	42.7	23	*
MFR	.162	.168	3.1	42	*
SEA	.155	.236	34.2	11	*
FAT	.136	.134	-1.4	38	*
LAX	.114	.113	-.8	23	*
MLF	.146	.141	-3.5	47	*
RNO	.197	.186	-5.5	30	*
SAN	.057	.064	10.2	51	*
INW	.041	.042	1.9	52	*
SFO	.104	.126	17.1	34	*
PIH	.215	.193	-11.6	39	*
GEG	.292	.233	-25.6	34	*
RBL	.115	.131	11.8	38	*
PDX	.299	.242	-23.3	36	*
OLM	.383	.251	-52.6	15	*
ALW	.178	.172	-3.9	38	*
AST	.010	.410	97.6	2	*
SLE	.195	.230	15.4	13	*
EUG	.250	.236	-6.1	20	*
FCA	.205	.200	-2.3	37	*
HVR	.040	.051	22.5	54	*
HLN	.268	.255	-4.9	31	*
GGW	.170	.160	-6.3	45	*
LWS	.210	.197	-6.7	40	*
EKO	.133	.132	-.6	52	*
WMC	.038	.053	29.1	29	*
FLG	.090	.092	2.7	30	*
TOT	.150	.144	-3.7	1561	*

FORECASTS OF 20 PER CENT

	BRIER	CLIM	IMP(PC)	NUM	*
ELY	.129	.126	-2.6	47	*
BFL	.177	.187	5.0	48	*
TUS	.156	.171	8.5	31	*
LAS	.140	.152	8.2	36	*
PHX	.115	.111	-4.0	24	*
YUM	.064	.038	-66.2	25	*
SAC	.230	.226	-1.9	41	*
SMX	.178	.182	2.2	52	*
BIL	.160	.159	-.5	45	*
SLC	.233	.233	.0	28	*
BOI	.249	.230	-8.5	43	*
BNO	.280	.274	-2.2	45	*
GTF	.229	.231	.7	57	*
MSO	.205	.211	2.6	40	*
PDT	.277	.262	-5.6	38	*
EKA	.102	.197	48.3	29	*
MFR	.164	.174	6.0	34	*
SEA	.154	.231	33.2	21	*
FAT	.199	.205	2.9	34	*
LAX	.160	.165	3.0	30	*
MLF	.147	.148	.5	28	*
RNO	.220	.234	6.2	30	*
SAN	.245	.262	6.6	41	*
INW	.086	.073	-20.5	25	*
SFO	.230	.219	-5.2	60	*
PIH	.118	.131	10.2	54	*
GEG	.211	.203	-4.2	35	*
RBL	.197	.193	-1.9	46	*
PDX	.284	.244	-16.4	27	*
OLM	.386	.248	-55.6	26	*
ALW	.283	.255	-10.3	42	*
AST	.107	.356	70.1	9	*
SLE	.169	.229	26.3	14	*
EUG	.256	.240	-6.5	25	*
FCA	.234	.217	-7.4	31	*
HVR	.135	.133	-1.6	57	*
HLN	.190	.197	3.6	52	*
GGW	.108	.108	-.1	44	*
LWS	.161	.175	-3.3	34	*
EKO	.244	.247	1.6	56	*
WMC	.163	.164	.6	44	*
FLG	.197	.206	4.2	42	*
TOT	.193	.194	.5	1570	*

TABLE 8. RESULTS OF TEST 2.

BRIER SCORES FOR MAP TYPE 6						FORECASTS OF 0 PER CENT						FORECASTS OF 2 PER CENT					
	BRIER	CLIM	IMP(PC)	NUM	*		BRIER	CLIM	IMP(PC)	NUM	*		BRIER	CLIM	IMP(PC)	NUM	*
ELY	.025	.024	-3.6	8	*	ELY	.099	.093	-7.0	121	*	ELY	.060	.068	11.7	16	*
BFL	.374	.368	-1.7	8	*	BFL	.041	.053	22.4	98	*	BFL	.000	.026	96.5	26	*
TUS	.189	.428	55.9	8	*	TUS	.023	.025	6.6	133	*	TUS	.029	.031	5.0	33	*
LAS	.397	.453	12.2	8	*	LAS	.049	.047	-5.2	163	*	LAS	.040	.040	-1.0	24	*
PHX	.314	.430	27.0	8	*	PHX	.034	.035	2.1	146	*	PHX	.034	.035	5.2	29	*
YUM	.016	.001	-999.0	8	*	YUM	.023	.022	-2.1	221	*	YUM	.042	.042	-.9	23	*
SAC	.453	.328	-37.9	8	*	SAC	.238	.182	-31.1	130	*	SAC	.180	.153	-17.6	16	*
SMX	.347	.355	2.3	8	*	SMX	.093	.091	-2.2	75	*	SMX	.034	.056	40.7	29	*
BIL	.434	.272	-59.3	8	*	BIL	.048	.067	27.9	104	*	BIL	.046	.065	29.2	21	*
SLC	.023	.040	42.8	8	*	SLC	.118	.111	-6.4	102	*	SLC	.088	.095	7.3	22	*
BOI	.139	.096	-45.0	8	*	BOI	.167	.156	-6.5	78	*	BOI	.175	.173	-1.3	11	*
BNO	.020	.049	59.3	8	*	BNO	.164	.140	-17.0	67	*	BNO	.288	.217	-33.0	10	*
GTF	.372	.339	-10.0	8	*	GTF	.124	.116	-6.7	69	*	GTF	.192	.164	-17.5	10	*
MSO	.056	.140	59.7	8	*	MSO	.031	.108	71.0	64	*	MSO	.120	.134	10.3	8	*
PDT	.061	.074	17.4	8	*	PDT	.108	.120	10.2	37	*	PDT	.160	.145	-10.4	6	*
EKA	.254	.227	-12.0	8	*	EKA	.029	.185	84.6	35	*	EKA	.000	.162	99.8	6	*
MFR	.240	.189	-27.1	8	*	MFR	.203	.172	-17.9	69	*	MFR	.096	.129	25.4	10	*
SEA	.285	.223	-27.6	8	*	SEA	.156	.229	31.8	92	*	SEA	.222	.236	5.8	13	*
FAT	.364	.280	-30.3	8	*	FAT	.098	.096	-2.7	122	*	FAT	.203	.166	-22.3	19	*
LAX	.207	.294	29.5	8	*	LAX	.036	.043	17.6	168	*	LAX	.144	.128	-12.9	20	*
MLF	.362	.193	-88.1	8	*	MLF	.094	.092	-2.5	138	*	MLF	.096	.095	-1.5	20	*
RNO	.429	.384	-11.6	8	*	RNO	.072	.072	-.8	160	*	RNO	.096	.092	-4.5	20	*
SAN	.316	.462	31.6	8	*	SAN	.027	.040	33.4	113	*	SAN	.000	.021	98.1	20	*
INW	.252	.317	20.5	8	*	INW	.042	.043	3.6	120	*	INW	.138	.126	-8.9	21	*
SFO	.182	.188	3.6	8	*	SFO	.047	.092	49.3	43	*	SFO	.275	.208	-32.2	7	*
PIH	.133	.122	-9.0	8	*	PIH	.102	.115	11.2	68	*	PIH	.192	.144	-33.5	10	*
GEG	.055	.110	50.1	8	*	GEG	.204	.176	-15.8	54	*	GEG	.226	.184	-23.1	17	*
RBL	.302	.248	-21.9	8	*	RBL	.139	.134	-3.6	79	*	RBL	.000	.068	99.4	13	*
FLX	.241	.223	-8.0	8	*	FLX	.159	.231	31.1	44	*	FLX	.138	.228	39.7	7	*
OLM	.279	.280	.4	8	*	OLM	.156	.271	42.3	32	*	OLM	.549	.250	-120.0	7	*
ALW	.021	.084	74.6	8	*	ALW	.333	.224	-48.9	96	*	ALW	.138	.140	1.6	7	*
AST	.305	.331	7.8	8	*	AST	.077	.364	78.8	13	*	AST	.960	.160	-500.2	1	*
SLE	.266	.222	-20.1	8	*	SLE	.136	.223	38.7	22	*	SLE	.000	.212	99.8	4	*
EUG	.128	.232	44.9	8	*	EUG	.140	.223	37.4	43	*	EUG	.160	.225	28.7	6	*
FCA	.059	.129	53.9	8	*	FCA	.071	.147	51.5	42	*	FCA	.412	.251	-64.2	7	*
HVR	.159	.107	-48.2	8	*	HVR	.215	.171	-26.1	65	*	HVR	.092	.087	-6.2	21	*
HLN	.116	.199	41.1	8	*	HLN	.118	.105	-12.2	144	*	HLN	.138	.124	-10.6	7	*
GGW	.234	.191	-22.4	8	*	GGW	.194	.156	-24.2	139	*	GGW	.170	.145	-17.3	17	*
LWS	.039	.063	37.0	8	*	LWS	.223	.178	-25.9	94	*	LWS	.160	.146	-9.5	12	*
EKO	.199	.272	27.0	8	*	EKO	.141	.123	-14.4	78	*	EKO	.180	.151	-19.7	16	*
WMC	.241	.280	13.8	8	*	WMC	.098	.094	-4.4	122	*	WMC	.240	.189	-27.2	4	*
FLG	.181	.547	66.9	8	*	FLG	.065	.068	4.6	124	*	FLG	.226	.187	-20.9	17	*
TOT	.216	.233	7.4	336	*	TOT	.103	.103	-.4	3927	*	TOT	.116	.110	-5.6	613	*

TABLE 9. RESULTS OF TEST 2.

FORECASTS OF 30 PER CENT

	BRIER	CLIM	IMP(PC)	NUM *
ELY	.193	.202	4.5	35 *
BFL	.183	.184	.2	30 *
TUS	.137	.105	-30.1	17 *
LAS	.195	.239	18.4	19 *
PHX	.162	.157	-2.8	39 *
YUM	.199	.257	22.6	11 *
SAC	.253	.277	8.5	27 *
SMX	.204	.212	3.8	35 *
BIL	.196	.206	4.9	34 *
SLC	.223	.240	6.9	27 *
BOI	.267	.268	.3	43 *
BNO	.239	.262	8.8	35 *
OTH	.241	.267	9.5	37 *
MSO	.175	.173	-1.0	47 *
PDT	.204	.210	2.9	14 *
EKA	.172	.217	20.4	34 *
MFR	.234	.235	.5	39 *
SEA	.200	.237	15.5	29 *
FAT	.237	.271	12.4	19 *
LAX	.301	.406	26.0	19 *
MLF	.165	.166	.5	21 *
RNO	.250	.308	18.9	25 *
SAN	.213	.239	11.0	13 *
INW	.155	.140	-10.8	37 *
SFO	.196	.194	-.9	49 *
PIH	.232	.243	4.5	45 *
GEG	.231	.237	2.9	37 *
RBL	.306	.327	6.4	37 *
PDX	.330	.259	-27.4	30 *
OLM	.322	.250	-28.6	38 *
ALW	.280	.285	1.6	40 *
AST	.223	.310	27.9	6 *
SLE	.260	.246	-5.9	40 *
EUG	.296	.253	-17.1	33 *
FCA	.209	.215	2.7	47 *
HVR	.207	.227	8.6	41 *
HLN	.233	.268	13.0	28 *
GGW	.215	.228	5.8	32 *
LWS	.245	.263	6.9	49 *
EKO	.214	.226	5.2	29 *
WMC	.223	.250	10.6	48 *
FLG	.173	.168	-3.0	24 *
TOT	.226	.234	3.6	1339 *

FORECASTS OF 40 PER CENT

	BRIER	CLIM	IMP(PC)	NUM *
ELY	.260	.368	29.4	14 *
BFL	.269	.402	33.1	11 *
TUS	.217	.246	11.7	7 *
LAS	.227	.302	25.1	12 *
PHX	.202	.186	-8.9	19 *
YUM	.160	.001	-999.0	4 *
SAC	.285	.398	28.5	8 *
SMX	.253	.328	22.9	28 *
BIL	.227	.241	5.8	24 *
SLC	.205	.176	-16.5	22 *
BOI	.252	.279	9.6	37 *
BNO	.250	.301	16.8	42 *
OTH	.269	.364	26.1	22 *
MSO	.222	.217	-2.3	32 *
PDT	.237	.244	2.9	31 *
EKA	.257	.250	-2.8	33 *
MFR	.262	.295	11.0	41 *
SEA	.207	.234	11.8	30 *
FAT	.208	.188	-10.7	25 *
LAX	.240	.313	23.3	10 *
MLF	.253	.333	24.0	15 *
RNO	.246	.328	25.0	14 *
SAN	.260	.374	30.5	14 *
INW	.212	.223	4.9	23 *
SFO	.260	.307	15.2	36 *
PIH	.252	.290	13.1	26 *
GEG	.267	.295	9.5	43 *
RBL	.260	.308	15.5	22 *
PDX	.286	.257	-11.3	19 *
OLM	.260	.250	-4.0	32 *
ALW	.250	.277	9.5	31 *
AST	.293	.225	-30.6	21 *
SLE	.230	.240	4.0	20 *
EUG	.250	.247	-.9	29 *
FCA	.247	.252	1.9	53 *
HVR	.218	.228	4.3	24 *
HLN	.242	.304	20.5	22 *
GGW	.260	.341	23.8	10 *
LWS	.240	.259	7.2	40 *
EKO	.219	.218	-.6	17 *
WMC	.238	.287	16.8	23 *
FLG	.268	.399	33.0	13 *
TOT	.245	.272	10.0	999 *

FORECASTS OF 50 PER CENT

	BRIER	CLIM	IMP(PC)	NUM *
ELY	.250	.374	33.2	8 *
BFL	.250	.400	37.5	9 *
TUS	.250	.221	-13.3	4 *
LAS	.250	.002	-999.0	3 *
PHX	.250	.326	23.3	8 *
YUM	.250	.314	20.4	6 *
SAC	.250	.422	40.7	6 *
SMX	.250	.384	34.9	18 *
BIL	.250	.321	22.0	15 *
SLC	.250	.340	26.5	16 *
BOI	.250	.288	13.1	37 *
BNO	.250	.329	23.9	28 *
OTH	.250	.294	14.8	19 *
MSO	.250	.307	18.6	28 *
PDT	.250	.285	12.2	34 *
EKA	.250	.270	7.5	40 *
MFR	.250	.311	19.6	27 *
SEA	.250	.252	.9	32 *
FAT	.250	.517	51.6	16 *
LAX	.250	.387	35.4	12 *
MLF	.250	.322	22.3	9 *
RNO	.250	.263	5.0	6 *
SAN	.250	.452	44.7	10 *
INW	.250	.010	-999.0	3 *
SFO	.250	.404	38.1	17 *
PIH	.250	.235	-6.3	18 *
GEG	.250	.292	14.3	32 *
RBL	.250	.394	36.5	25 *
PDX	.250	.274	8.9	37 *
OLM	.250	.241	-3.9	45 *
ALW	.250	.319	21.7	34 *
AST	.250	.255	2.1	28 *
SLE	.250	.251	.2	41 *
EUG	.250	.250	.1	31 *
FCA	.250	.225	-11.0	36 *
HVR	.250	.173	-44.8	14 *
HLN	.250	.399	37.4	17 *
GGW	.250	.125	-100.6	7 *
LWS	.250	.192	-29.9	16 *
EKO	.250	.264	5.3	22 *
WMC	.250	.318	21.4	36 *
FLG	.250	.329	24.0	16 *
TOT	.250	.295	15.3	806 *

TABLE 10 RESULTS OF TEST 2

FORECASTS OF 60 PER CENT

	BRIER	CLIM	IMP(PC)	NUM	*
ELY	.227	.485	53.2	3	*
BFL	.305	.207	-47.4	11	*
TUS	.210	.641	67.2	4	*
LAS	.000	.000	.0	0	*
PHX	.303	.249	-21.8	7	*
YUM	.160	.941	83.0	1	*
SAC	.189	.528	64.3	7	*
SMX	.240	.410	41.5	10	*
BIL	.160	.660	75.8	4	*
SLC	.200	.520	61.5	5	*
BOI	.235	.367	36.0	11	*
BNO	.256	.331	22.7	23	*
GTF	.274	.292	6.0	7	*
MSO	.246	.331	25.7	26	*
PDT	.245	.343	28.7	26	*
EKA	.213	.280	23.8	30	*
MFR	.233	.345	32.5	22	*
SEA	.252	.254	.7	26	*
FAT	.260	.351	25.9	14	*
LAX	.260	.387	32.8	6	*
MLF	.289	.263	-9.7	14	*
RNO	.285	.295	3.4	8	*
SAN	.285	.298	4.3	8	*
INW	.298	.258	-15.6	13	*
SFO	.245	.343	28.7	26	*
PIH	.231	.403	42.8	17	*
GEG	.269	.265	-1.5	22	*
RBL	.206	.437	52.8	26	*
PDX	.213	.268	20.6	19	*
OLM	.231	.243	5.3	34	*
ALW	.210	.410	48.8	16	*
AST	.220	.219	-.5	47	*
SLE	.257	.253	-1.8	37	*
LOG	.222	.267	17.0	26	*
FCA	.264	.267	.6	23	*
HVR	.285	.275	-3.7	8	*
HLN	.320	.170	-88.6	10	*
GGW	.274	.300	8.6	7	*
LWS	.227	.421	46.2	15	*
EKO	.260	.346	24.9	24	*
WMC	.280	.294	4.7	10	*
FLG	.217	.522	58.4	7	*
TOT	.244	.315	22.4	662	*

FORECASTS OF 70 PER CENT

	BRIER	CLIM	IMP(PC)	NUM	*
ELY	.223	.479	53.4	3	*
BFL	.140	.608	77.0	8	*
TUS	.223	.578	61.4	3	*
LAS	.000	.000	.0	0	*
PHX	.490	.006	-999.0	3	*
YUM	.000	.000	.0	0	*
SAC	.134	.546	75.4	9	*
SMX	.250	.423	40.9	5	*
BIL	.223	.463	51.8	3	*
SLC	.157	.540	71.0	6	*
BOI	.302	.279	-8.1	17	*
BNO	.330	.269	-22.6	15	*
GTF	.390	.179	-117.7	4	*
MSO	.223	.346	35.5	18	*
PDT	.307	.286	-7.2	24	*
EKA	.176	.296	40.7	28	*
MFR	.184	.401	54.1	17	*
SEA	.246	.258	4.5	41	*
FAT	.190	.523	63.7	4	*
LAX	.223	.510	56.2	3	*
MLF	.319	.308	-3.4	7	*
RNO	.290	.368	21.3	2	*
SAN	.223	.489	54.3	18	*
INW	.000	.000	.0	0	*
SFO	.184	.430	57.2	17	*
PIH	.290	.314	7.7	4	*
GEG	.254	.318	20.3	22	*
RBL	.204	.410	50.2	14	*
PDX	.257	.259	1.1	12	*
OLM	.223	.243	8.2	30	*
ALW	.213	.379	43.8	13	*
AST	.221	.221	-.2	64	*
SLE	.227	.264	14.3	41	*
LOG	.209	.268	22.2	27	*
FCA	.336	.238	-41.3	13	*
HVR	.240	.432	44.4	8	*
HLN	.319	.320	.4	7	*
GGW	.490	.036	-999.0	4	*
LWS	.303	.304	.1	15	*
EKO	.290	.354	18.2	6	*
WMC	.410	.166	-147.5	5	*
FLG	.223	.489	54.3	6	*
TOT	.242	.314	23.1	546	*

FORECASTS OF 80 PER CENT

	BRIER	CLIM	IMP(PC)	NUM	*
ELY	.000	.000	.0	0	*
BFL	.280	.414	32.3	5	*
TUS	.040	.846	95.3	1	*
LAS	.000	.000	.0	0	*
PHX	.490	.221	-121.7	4	*
YUM	.000	.000	.0	0	*
SAC	.040	.608	93.4	3	*
SMX	.160	.545	70.6	10	*
BIL	.340	.334	-1.8	2	*
SLC	.040	.640	93.8	3	*
BOI	.240	.399	39.9	9	*
BNO	.367	.307	-19.6	11	*
GTF	.190	.480	60.4	4	*
MSO	.290	.347	16.5	12	*
PDT	.363	.289	-25.7	26	*
EKA	.170	.303	43.8	23	*
MFR	.440	.221	-96.7	6	*
SEA	.200	.265	24.6	30	*
FAT	.211	.493	57.1	7	*
LAX	.440	.264	-66.9	9	*
MLF	.400	.288	-39.0	5	*
RNO	.040	.723	94.5	3	*
SAN	.340	.380	10.5	6	*
INW	.000	.000	.0	0	*
SFO	.115	.480	76.1	8	*
PIH	.040	.538	92.6	7	*
GEG	.340	.290	-17.4	12	*
RBL	.100	.500	80.0	10	*
PDX	.340	.247	-37.4	28	*
OLM	.215	.239	10.1	24	*
ALW	.240	.371	35.3	3	*
AST	.188	.204	8.1	61	*
SLE	.194	.271	28.3	35	*
LOG	.256	.263	2.6	25	*
FCA	.280	.302	7.4	10	*
HVR	.340	.346	1.8	2	*
HLN	.040	.689	94.2	1	*
GGW	.040	.038	-999.0	2	*
LWS	.340	.298	-13.9	2	*
EKO	.160	.518	69.1	5	*
WMC	.340	.366	7.0	2	*
FLG	.340	.373	8.7	4	*
TOT	.244	.311	21.5	420	*

TABLE II. RESULTS OF TEST 2.

FORECASTS OF 90 PER CENT

	BRIER	CLIM	IMP(PC)	NUM	*
ELY	.010	.706	98.6	1	*
BFL	.330	.425	22.3	5	*
TUS	.010	.865	98.8	1	*
LAS	.010	.903	98.9	1	*
PHX	.810	.006	-999.0	1	*
YUM	.000	.000	.0	0	*
SAC	.010	.608	98.4	6	*
SMX	.810	.040	-999.0	1	*
BIL	.000	.000	.0	0	*
SLC	.410	.340	-20.6	2	*
BOI	.810	.116	-600.7	1	*
BNO	.454	.291	-56.2	9	*
GTF	.810	.036	-999.0	1	*
MSO	.239	.374	36.2	7	*
PDT	.010	.546	98.2	7	*
EKA	.136	.305	55.4	19	*
MFR	.010	.495	98.0	6	*
SEA	.239	.258	7.7	21	*
FAT	.010	.669	98.5	4	*
LAX	.410	.387	-6.0	6	*
MLF	.277	.469	41.0	3	*
RNO	.010	.757	98.7	3	*
SAN	.010	.706	98.6	1	*
INW	.000	.000	.0	0	*
SFO	.099	.489	79.8	9	*
PIH	.000	.000	.0	0	*
GEG	.467	.261	-78.9	7	*
RBL	.124	.479	74.1	7	*
PDX	.277	.262	-5.6	36	*
OLM	.245	.233	-5.3	17	*
ALW	.010	.519	98.1	3	*
AST	.140	.180	22.3	43	*
SLE	.131	.279	53.1	33	*
EUG	.192	.273	29.8	22	*
FCA	.410	.263	-55.7	6	*
HVR	.543	.237	-129.0	3	*
HLN	.410	.353	-16.2	2	*
GGW	.810	.038	-999.0	4	*
LWS	.410	.298	-37.4	2	*
EKO	.810	.036	-999.0	4	*
WMC	.010	.689	98.5	2	*
FLG	.490	.302	-62.0	5	*
TOT	.229	.309	26.0	311	*

FORECASTS OF 100 PER CENT

	BRIER	CLIM	IMP(PC)	NUM	*
ELY	1.000	.026	-999.0	1	*
BFL	.200	.585	65.8	5	*
TUS	.000	.856	100.0	2	*
LAS	.000	.000	.0	0	*
PHX	1.000	.005	-999.0	1	*
YUM	.000	.000	.0	0	*
SAC	.133	.534	75.0	15	*
SMX	.000	.040	100.0	1	*
BIL	1.000	.044	-999.0	1	*
SLC	1.000	.040	-999.0	1	*
BOI	.250	.419	40.3	4	*
BNO	.600	.274	-118.9	10	*
GTF	1.000	.040	-999.0	6	*
MSO	.000	.472	100.0	8	*
PDT	.414	.352	-17.6	29	*
EKA	.094	.321	70.6	32	*
MFR	.167	.425	60.8	6	*
SEA	.392	.258	-51.9	51	*
FAT	.000	.679	100.0	5	*
LAX	.000	.757	100.0	7	*
MLF	.667	.251	-165.4	3	*
RNO	.600	.320	-87.5	5	*
SAN	.333	.493	32.4	6	*
INW	1.000	.012	-999.0	1	*
SFO	.150	.466	67.8	20	*
PIH	.286	.407	29.8	7	*
GEG	.143	.399	64.2	7	*
RBL	.000	.548	100.0	7	*
PDX	.452	.254	-77.7	31	*
OLM	.250	.241	-3.9	28	*
ALW	.000	.490	100.0	1	*
AST	.273	.214	-27.7	44	*
SLE	.158	.279	43.4	38	*
EUG	.261	.271	3.6	46	*
FCA	.619	.241	-157.0	21	*
HVR	.692	.221	-213.9	13	*
HLN	.000	.000	.0	0	*
GGW	.000	.000	.0	0	*
LWS	.000	.656	100.0	2	*
EKO	.500	.351	-42.6	8	*
WMC	.000	.000	.0	0	*
FLG	.593	.308	-92.6	27	*
TOT	.326	.317	-2.7	500	*

CORRELATION COEFFICIENTS GREATER THAN 960

	BRIER	CLIM	IMP(PC)	NUM	*
ELY	.088	.082	-8.3	24	*
BFL	.036	.083	56.8	24	*
TUS	.003	.006	46.2	24	*
LAS	.003	.002	-5.5	24	*
PHX	.026	.006	-352.0	24	*
YUM	.000	.001	96.1	24	*
SAC	.241	.212	-14.1	24	*
SMX	.071	.086	17.9	24	*
BIL	.087	.089	2.6	24	*
SLC	.013	.040	67.6	24	*
BOI	.214	.212	-.7	24	*
BNO	.230	.285	19.3	24	*
GTF	.087	.091	4.6	24	*
MSO	.256	.328	22.0	24	*
PDT	.261	.271	3.5	24	*
EKA	.167	.285	41.6	24	*
MFR	.294	.322	8.6	24	*
SEA	.145	.264	45.1	24	*
FAT	.070	.086	19.0	24	*
LAX	.009	.046	80.6	24	*
MLF	.017	.031	45.6	24	*
RNO	.084	.079	-6.2	24	*
SAN	.023	.021	-7.3	24	*
INW	.011	.009	-20.7	24	*
SFO	.238	.225	-5.6	24	*
PIH	.080	.106	24.7	24	*
GEG	.296	.344	13.8	24	*
RBL	.105	.208	52.9	24	*
PDX	.330	.274	-20.1	24	*
OLM	.390	.234	-66.4	24	*
ALW	.338	.301	-12.1	24	*
AST	.133	.156	15.3	24	*
SLE	.163	.282	42.1	24	*
EUG	.227	.272	16.4	24	*
FCA	.381	.279	-36.6	24	*
HVR	.225	.140	-61.5	24	*
HLN	.134	.140	4.0	24	*
GGW	.108	.088	-22.9	24	*
LWS	.278	.260	-7.0	24	*
EKO	.185	.164	-12.6	24	*
WMC	.112	.139	19.3	24	*
FLG	.063	.022	-179.6	24	*
TOT	.149	.158	6.0	1008	*

TABLE 12. RESULTS OF TEST 2.

COEFFICIENTS LESS THAN 960 BUT GREATER THAN 940

	BRIER	CLIM	IMP(PC)	NUM	*
ELY	.021	.024	12.6	35	*
BFL	.084	.106	20.8	35	*
TUS	.032	.030	-9.4	35	*
LAS	.006	.002	-235.7	35	*
PHX	.019	.006	-242.4	35	*
YUM	.001	.001	24.6	35	*
SAC	.239	.240	.6	35	*
SMX	.139	.147	5.4	35	*
BIL	.104	.106	2.7	35	*
SLC	.100	.091	-9.9	35	*
BOI	.141	.241	41.5	35	*
BNO	.281	.256	-10.0	35	*
GTF	.106	.094	-13.3	35	*
MSO	.248	.233	-6.7	35	*
PDT	.202	.283	28.6	35	*
EKA	.105	.260	59.7	35	*
MFR	.202	.297	31.9	35	*
SEA	.222	.253	12.4	35	*
FAT	.133	.145	8.5	35	*
LAX	.041	.080	48.9	35	*
MLF	.099	.068	-45.1	35	*
RNO	.073	.125	42.0	35	*
SAN	.032	.043	25.7	35	*
INW	.005	.009	41.5	35	*
SFO	.138	.246	44.1	35	*
PIH	.194	.179	-8.5	35	*
GEG	.245	.250	1.9	35	*
RBL	.189	.273	31.0	35	*
PDX	.235	.258	8.8	35	*
OLM	.276	.239	-15.4	35	*
ALW	.261	.290	9.8	35	*
AST	.165	.205	19.3	35	*
SLE	.163	.262	37.6	35	*
EUG	.196	.262	25.2	35	*
FCA	.217	.195	-11.3	35	*
HVR	.111	.064	-74.2	35	*
HLN	.146	.141	-3.4	35	*
GGW	.112	.073	-53.5	35	*
LWS	.221	.227	2.6	35	*
EKO	.131	.161	18.7	35	*
WMC	.120	.143	16.2	35	*
FLG	.041	.022	-80.5	35	*
TOT	.136	.156	12.5	1470	*

COEFFICIENTS BETWEEN 900 AND 920

	BRIER	CLIM	IMP(PC)	NUM	*
ELY	.087	.089	2.4	53	*
BFL	.070	.077	9.6	53	*
TUS	.071	.086	17.2	53	*
LAS	.042	.036	-14.9	53	*
PHX	.084	.070	-19.6	53	*
YUM	.043	.054	21.3	53	*
SAC	.243	.281	13.4	53	*
SMX	.149	.153	2.6	53	*
BIL	.168	.178	5.5	53	*
SLC	.268	.221	-21.3	53	*
BOI	.286	.270	-6.1	53	*
BNO	.305	.259	-17.8	53	*
GTF	.203	.199	-2.2	53	*
MSO	.192	.252	23.8	53	*
PDT	.264	.269	1.7	53	*
EKA	.207	.259	20.1	53	*
MFR	.267	.263	-1.6	53	*
SEA	.287	.257	-11.6	53	*
FAT	.131	.143	8.8	53	*
LAX	.078	.087	10.1	53	*
MLF	.135	.104	-29.3	53	*
RNO	.109	.142	22.7	53	*
SAN	.105	.114	8.0	53	*
INW	.068	.040	-71.1	53	*
SFO	.204	.283	28.1	53	*
PIH	.192	.233	17.5	53	*
GEG	.317	.315	-.7	53	*
RBL	.215	.285	24.6	53	*
PDX	.311	.259	-20.2	53	*
OLM	.264	.234	-12.7	53	*
ALW	.291	.316	7.7	53	*
AST	.133	.177	24.8	53	*
SLE	.186	.267	30.6	53	*
EUG	.243	.261	7.0	53	*
FCA	.283	.245	-15.4	53	*
HVR	.169	.179	5.6	53	*
HLN	.195	.221	12.0	53	*
GGW	.163	.153	-6.3	53	*
LWS	.249	.264	5.7	53	*
EKO	.198	.167	-18.6	53	*
WMC	.190	.191	.7	53	*
FLG	.155	.115	-34.7	53	*
TOT	.186	.192	3.1	2226	*

COEFFICIENTS LESS THAN 880

	BRIER	CLIM	IMP(PC)	NUM	*
ELY	.134	.136	1.3	136	*
BFL	.169	.196	13.7	136	*
TUS	.080	.118	31.9	136	*
LAS	.134	.148	9.2	136	*
PHX	.139	.137	-1.5	136	*
YUM	.091	.091	-.7	136	*
SAC	.199	.234	14.9	136	*
SMX	.200	.235	14.8	136	*
BIL	.134	.146	8.6	136	*
SLC	.137	.172	20.3	136	*
BOI	.187	.198	5.8	136	*
BNO	.202	.202	.0	136	*
GTF	.223	.221	-.9	136	*
MSO	.142	.177	19.8	136	*
PDT	.212	.188	-12.5	136	*
EKA	.133	.233	43.2	136	*
MFR	.172	.187	7.9	136	*
SEA	.239	.234	-1.9	136	*
FAT	.163	.218	25.4	136	*
LAX	.179	.235	23.8	136	*
MLF	.169	.164	-2.6	136	*
RNO	.180	.178	-1.1	136	*
SAN	.143	.219	34.6	136	*
INW	.135	.105	-29.0	136	*
SFO	.171	.253	32.6	136	*
PIH	.165	.191	13.5	136	*
GEG	.180	.176	-2.1	136	*
RBL	.169	.209	19.2	136	*
PDX	.241	.236	-2.4	136	*
OLM	.202	.203	.6	136	*
ALW	.188	.202	6.7	136	*
AST	.313	.291	-7.6	136	*
SLE	.237	.237	.1	136	*
EUG	.203	.236	13.8	136	*
FCA	.237	.198	-19.9	136	*
HVR	.189	.147	-28.7	136	*
HLN	.161	.157	-2.8	136	*
GGW	.187	.168	-11.3	136	*
LWS	.177	.160	-10.7	136	*
EKO	.222	.200	-10.6	136	*
WMC	.146	.159	8.6	136	*
FLG	.261	.254	-2.6	136	*
TOT	.181	.194	6.2	5712	*

TABLE 13. RESULTS OF TEST 2.

Western Region Technical Memoranda: (Continued)

No. 45/2 Precipitation Probabilities in the Western Region Associated with Spring 500-mb Map Types. Richard P. Augulis. January 1970. (PB-189434) (Out of Print.)

No. 45/3 Precipitation Probabilities in the Western Region Associated with Summer 500-mb Map Types. Richard P. Augulis. January 1970. (PB-189414) (Out of Print.)

No. 45/4 Precipitation Probabilities in the Western Region Associated with Fall 500-mb Map Types. Richard P. Augulis. January 1970. (PB-189435) (Out of Print.)

No. 46 Applications of the Net Radiometer to Short-Range Fog and Stratus Forecasting at Eugene, Oregon. L. Yee and E. Bates. December 1969. (PB-190476)

No. 47 Statistical Analysis as a Flood Routing Tool. Robert J. C. Burnash . December 1969. (PB-188744)

No. 48 Tsunami. Richard A. Augulis. February 1970. (PB-190157)

No. 49 Predicting Precipitation Type. Robert J. C. Burnash and Floyd E. Hug. March 1970. (PB-190962)

No. 50 Statistical Report of Aeroallergens (Pollens and Molds) Fort Huachuca, Arizona 1969. Wayne S. Johnson. April 1970. (PB-191743)

No. 51 Western Region Sea State and Surf Forecaster's Manual. Gordon C. Shields and Gerald B. Burdwell. July 1970. (PB-193102)

No. 52 Sacramento Weather Radar Climatology. R. G. Pappas and C. M. Veliquette. July 1970. (PB-193347)

No. 53 Experimental Air Quality Forecasts in the Sacramento Valley. Norman S. Benes. August 1970. (PB-194128)

No. 54 A Refinement of the Vorticity Field to Delineate Areas of Significant Precipitation. Barry B. Aronovitch. August 1970.

No. 55 Application of the SSARR Model to a Basin Without Discharge Record. Vail Schermerhorn and Donald W. Kuehl. August 1970. (PB-194394).

No. 56 Areal Coverage of Precipitation in Northwestern Utah. Philip Williams, Jr., and Werner J. Heck. September 1970. (PB-194389)

No. 57 Preliminary Report on Agricultural Field Burning vs. Atmospheric Visibility in the Willamette Valley of Oregon. Earl M. Bates and David O. Chilcote. September 1970. (PB-194710)

No. 58 Air Pollution by Jet Aircraft at Seattle-Tacoma Airport. Wallace R. Donaldson. October 1970. (COM-71-00017)

No. 59 Application of P.E. Model Forecast Parameters to Local-Area Forecasting. Leonard W. Snellman. October 1970. (COM-71-00016)

NOAA Technical Memoranda NWS

No. 60 An Aid for Forecasting the Minimum Temperature at Medford, Oregon. Arthur W. Fritz, October 1970. (COM-71-00120)

No. 61 Relationship of Wind Velocity and Stability to SO$_2$ Concentrations at Salt Lake City, Utah. Werner J. Heck, January 1971. (COM-71-00232)

No. 62 Forecasting the Catalina Eddy. Arthur L. Eichelberger, February 1971. (COM-71-00223)

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