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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Weather Service



# National Weather Service Heavy Snow Forecast Verification 1962-1972

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and GERALDINE F. COBB

Office of Meteorological Operations

Weather Analysis and Prediction Division

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FIGURES

# NATIONAL WEATHER SERVICE HEAVY SNOW FORECAST VERIFICATION 1962-1972

Alexander F. Sadowski and Geraldine F. Cobb

ABSTRACT. The National Weather Service's heavy snow verification program is presented from its inception for the winter of 1962-1963 through the winter of 1971-1972. During these 10 winters, verification was performed on an areal basis. The scores show fluctuations with a trend of gradual improvement in heavy snow forecasts. The National Meteorological Center scored higher than the field offices in this comparative heavy snow verification program.

## 1. INTRODUCTION

The verification of heavy snow forecasts was begun by the Quantitative Precipitation Branch (at that time in the Analysis and Forecast Branch, A&FB), of the National Meteorological Center for the winter of 1962-1963. Specifically, during November 1962 - April 1963, the A&FB transmitted over the National Facsimile (NAFAX) Circuit experimental heavy snow forecasts (defined as 4 inches or more in a 12-hour period). The forecasts were issued at 0920 and 2120 GMT for the respective periods of 1200-2400 and 0000-1200 GMT, i.e., periods beginning 2 1/2 hours following issuance. Due to their late transmissions, the A&FB charts were competitive with the forecasts issued by the FP centers rather than guidance.

Heavy snow forecasts were transmitted on teletypewriter circuit Service "C" in the form of a coded 4-inch isoline in the FSNA message at 1156 GMT and in the FSUS-1 message at 0138 GMT. These messages carried some discussion of the expectations and probabilities of heavy snow.

A threat score verification of these forecasts was maintained as well as comparative evaluations with the heavy snow forecasts issued by the FP Centers. The verification was on an areal basis comparing the forecast and observed 4-inch snow areas as shown in figure 1. The A&FB forecast gave no problem in determining the exact area because it was outlined on the charts transmitted over NAFAX Circuit. However, the forecasts of FP Centers were not given as outlined areas on charts but the areas had to be determined from FP-1 guidance and FP forecasts.

All areas were measured in square degrees of latitude, for the first heavy snow ($\geq$ 4 inches or more for 12-hour periods 12Z-00Z and 00Z-12Z) of the year until the last.

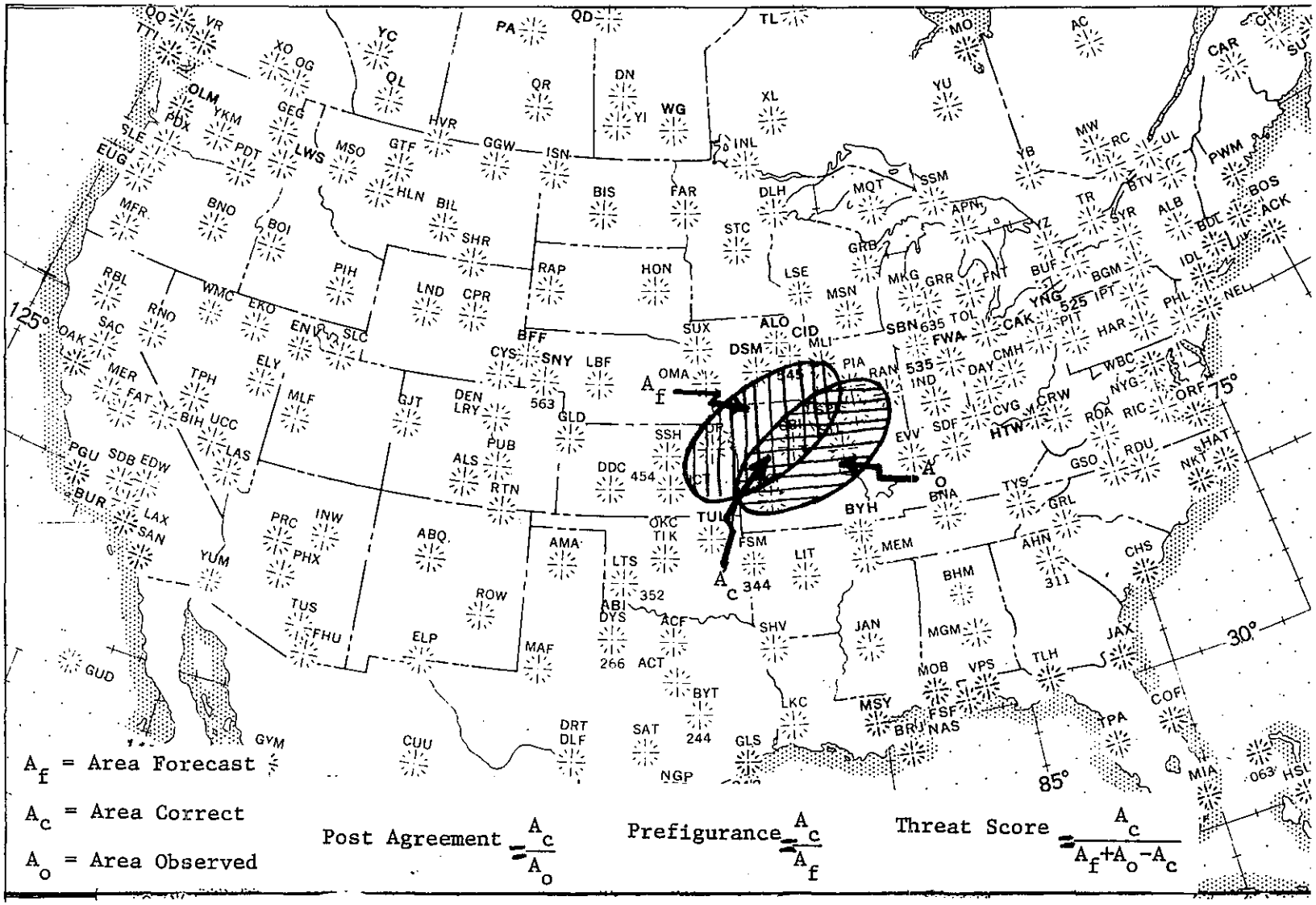


Figure 1.--Verification of heavy snow forecast

$$\text{Bias} = \frac{F}{O} \quad \frac{\text{(Area Forecast)}}{\text{(Area Observed)}}$$

$$\text{Post Agreement} = \frac{C}{F} \quad \frac{\text{(Area Correct)}}{\text{(Area Forecast)}}$$

$$\text{Prefigurance} = \frac{C}{O} \quad \frac{\text{(Area Correct)}}{\text{(Area Observed)}}$$

$$\text{Threat} = \frac{C}{F+O-C} \quad \frac{\text{(Area Correct)}}{\text{(Area Forecast \& Area Observed - Area Correct)}}$$

The scores are shown in Table 1.

## 2. NATIONAL METEOROLOGICAL CENTER

During the winter of 1963-1964, the National Meteorological Center (NMC) prepared heavy snow forecast guidance as follows: Whenever 4 inches or more of snow was expected, it was indicated on NAFAX Chart No. 43 (36-hour 500 mb prog issued at 0840 GMT) or No. 104 (36-hour 500 mb prog issued at 2050 GMT). Stippling was used to delineate the heavy snow area. The heavy snow forecast on NAFAX Chart No. 43 verified from 1200-0000 GMT and NAFAX Chart No. 104 verified from 0000-1200 GMT. The guidance was intended to give the broad-scale picture and did not attempt to indicate local effects, such as heavy snow associated with the flow off the Great Lakes or small-scale orographic peculiarities.

As was done during the previous season, a coded four inch isoline was carried in the FSNA messages transmitted on Service "C" at 1156 GMT and in the FSUS-1 messages transmitted at 0138 GMT. These messages carried some discussion of the expectations and probabilities of heavy snow.

During the 1963-1964 season, the FP Centers sent in their forecasts, mapped, and with verifying times, on maps that were provided to Technical Procedures Branch. (See figure 2 for an example.) Technical Procedures Branch reviewed the mapped forecasts and sent them to A&FB where they were compared with their forecasts and scores were computed.

As in the previous years, the guidelines for verification for the 1964-1965 season were as follows:

A. Only forecasts issued at prescribed times and for specific 12-hour periods were verified.

B. The times for which the forecasts were accepted were as follows:

(1) Times of issuance: 0930 or 1010 GMT
(2) 2130 or 2210 GMT

Table 1

| | Area Observed | Area Forecast | Area Correct | Post Agreement | Prefigurance | Threat Score |
|---|---|---|---|---|---|---|
| 0000Z - Entire U.S. | | | | | | |
| FP | 176.72 | 342.60 | 38.15 | 0.111 | 0.216 | 0.079 |
| FP1 | " | 306.89 | 27.36 | .089 | .150 | .060 |
| A&FB | " | 418.64 | 51.15 | .122 | .289 | .094 |
| 000Z - U.S. E. of 105° | | | | | | |
| FP | 151.94 | 294.99 | 35.00 | .119 | .230 | .085 |
| FP1 | " | 275.53 | 27.36 | .099 | .180 | .068 |
| A&FB | " | 341.16 | 44.89 | .132 | .295 | .100 |
| 1200Z - Entire U.S. | | | | | | |
| FP | 277.65 | 451.67 | 56.91 | .126 | .205 | .085 |
| FP1 | " | 424.06 | 41.81 | .122 | .187 | .080 |
| A&FB | " | 698.24 | 127.28 | .182 | .458 | .150 |
| 1200Z - U.S. E. of 105° | | | | | | |
| FP | 199.87 | 407.84 | 53.62 | .131 | .268 | .097 |
| FP1 | " | 396.15 | 47.33 | .119 | .237 | .086 |
| A&FB | " | 504.84 | 95.98 | .190 | .480 | .158 |
| 0000Z + 1200Z - Entire U.S. | | | | | | |
| FP | 454.37 | 794.27 | 95.06 | .120 | .209 | .082 |
| FP1 | " | 730.95 | 79.17 | .108 | .174 | .072 |
| A&FB | " | 1116.88 | 178.43 | .160 | .393 | .128 |
| 0000Z + 1200Z U.S. E. of 105° | | | | | | |
| FP | 351.81 | 702.83 | 88.62 | .126 | .252 | .092 |
| FP1 | " | 671.78 | 74.69 | .111 | .212 | .079 |
| A&FB | " | 846.00 | 140.87 | .167 | .400 | .133 |

Verification scores of heavy snow forecasts for period from Nov. 1, 1962 - April 15, 1963. The FP forecasts are those issued by State Forecast Centers; FPI are those issued by District Forecast Centers; and A&FB by the Analysis and Forecast Branch, NMC. Areas were measured by planimeter and converted to square degrees of latitude (3600 N.M.). The prefigurance is column 3 ÷ column 1; the post agreement is column 3 ÷ column 2; and the threat score column 3 ÷ columns [1 + 2 - 3].

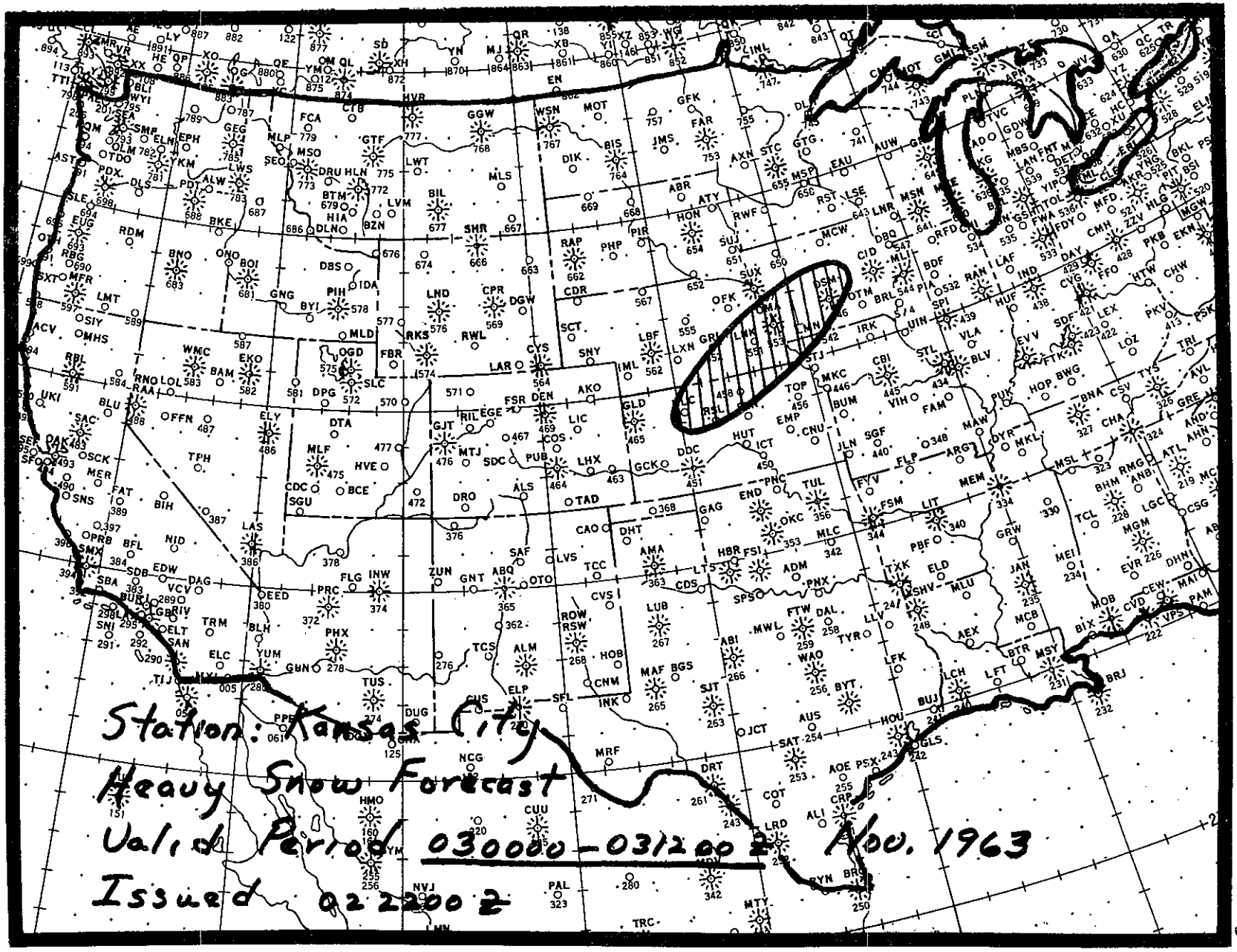


Figure 2.-- Mapped Heavy Snow Area.

(3) Times of verification: 0000 and 1200 GMT Charts sent in by field stations showed areas for which heavy snow was forecast. These areas were traced on a chart for identical time on which A&FB guidance forecast (if any) had already been entered. Next, the area of observed heavy snow was entered on the same chart. Then, all areas were measured by planimeter, recorded and computed for areas forecast, areas observed, and areas correct. A summary was made for each region versus A&FB for each month. Then, a final summary was made showing the relative skill for all regions versus A&FB for the entire season.

The verification for the 1964-1965 season was disappointing in that the lack of organization of the program did not permit a truly comprehensive comparative verification. There were 211 forecasts sent in, of which only 59 qualified (even by giving every possible benefit of doubt) for verification. The 152 eliminated forecasts were for the following reasons (in addition to the off-time special forecasts):

A. Omission of issuance time.
B. Failure to state the period of the forecast.
C. Negligence in specifying the date of the forecast.
D. Forecasts for 6-hour, 18-hour, and even 36-hour periods.
E. Issuance time after the beginning of the forecast periods.

## 3. TECHNICAL PROCEDURES BRANCH

For the 1965-1966 season, NMC transferred the responsibility for the monitoring of the NMC and FP Centers heavy snow forecasts to the Technical Procedures Branch (TPB) of the Weather Analysis and Prediction (WXAP) Division in the Office of Meteorological Operations. As in previous years, only the first regular 12-hour period forecasts (valid for 0000-1200 and 1200-0000 GMT) and made in the early morning and late afternoon were verified. The NMC and field forecasters outlined their heavy snow forecast areas and attached time-stamped copies of the corresponding worded forecasts sent on teletype. NMC provided the observed data for verification.

Areas of heavy snow were divided according to the FP areas, that is, area of heavy snow, observed and/or forecast by NMC and/or forecast by the FP Center of the area involved. After division, a total of 421 cases resulted.

### A. Misses

Several misses were prevalent. Of the 421 cases, 245 cases, 58% were missed in one way or another.

#### 1. Observed only

In 87 cases, 35% of the 245 cases, heavy snow was observed and not forecast by either NMC or the FP center involved.

2. NMC only

In 103 cases, 42% of the 245 cases, heavy snow was forecast by NMC, not forecast by FP Center and not observed.

3. FP only

In 30 cases, 12% of the 245 cases, heavy snow was forecast by FP Center, not forecast by NMC and not observed.

4. NMC & FP

In 25 cases, 10% of the 245 cases, heavy snow was forecast by NMC and the FP Center involved, not observed.

B. Hits by either NMC or FP Center

NMC or the FP Center involved forecast, and heavy snow was observed in the FP area.

Of the 421 cases, 104 cases were in this class, 25%.

1. NMC

*Hits: 71 cases, 68% of 104 cases
**Miss: 19 cases, 18% of the cases

2. FP

*Hits: 11 cases, 11%
**Miss: 3 cases, 3%

C. Hits by both

NMC and FP Center forecast and heavy snow was observed. Of the 421 cases, 72 cases were in this class, 17%.

1. NMC and FP

*Hit: 60 cases, 83% of the hits
**Miss: 3 cases, 4% of the near miss

2. NMC (Hit), FP (Miss): 6 cases, 8%

3. NMC (Miss), FP (Hit): 3 cases, 4%

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*some part verified
**in the FP area but none of the area verified

D. Observed Heavy Snow

Of the 421 cases, forecast and observed, there are 263 cases of observed heavy snow.

Of the 263 cases, the FP Center and NMC failed to forecast in the FP area in 87 cases, 33%. In the remaining 176 cases, NMC and/or the FP Center forecast in the FP area.

NMC: 162 cases, hit: 137 cases 85%
FP: 86 cases, hit: 74 cases, 86%
NMC forecast 290 times
FP forecast 141 times (49 maps couldn't verify).

During the 1966-1967 and 1967-1968 seasons, the comparative heavy snow forecast verification program used only the heavy snow forecasts issued for the two 12-hour periods 0000-1200 and 1200-0000 GMT. More specifically, these were the heavy snow forecasts of 4 inches or more issued at 2200 GMT for the following 0000-1200 GMT period and at 1000 GMT for the following 1200-0000 GMT period. FP Centers delineated on Chart No. 20P20 (figure 2) the areas of heavy snow forecast in their areas of responsibility and sent them to Technical Procedures Branch (TPB) as soon as possible after the issuance of the heavy snow forecast. These forecasts were compared with the 12-hour heavy snow forecasts for similar periods made by NMC and transmitted on National Facsimile at 0830 and 2034 GMT, respectively. Observed snowfall areas of 4 inches or more in these two 12-hour periods were used to verify both forecasts.

During the following years, the Quantitative Precipitation Forecast Branch (QPFB) at NMC produced heavy snow forecast guidance during the winter period four times per day at 0830, 1200, 2034, and 2344 GMT that was available for each of the forecasts by the FP Centers. The forecasts were areas of 4 inches or more of snow for one 12-hour period in each of the four forecasts. The forecast transmitted at 0830Z covered the period from 1200 to 0000 GMT and was updated by the chart transmitted at 1200 GMT for the same period. Similarly, the 2034 GMT forecast for 0000-1200 GMT was updated by the 2344 GMT one for the same period. However, only two 12-hour periods were verified by TPB. These were the 12-hour heavy snow forecasts made by QPFB and transmitted on the National Facsimile Circuit at 0830 GMT and 2034 GMT. (In 1970, the transmission times were changed to 0856 and 2058 GMT for NAFAX charts 44 and 104, respectively.)

On September 29, 1971, times were changed to 0731 and 1931 GMT for NAFAX charts 40 and 104, respectively. The FP Centers delineated areas of heavy snow forecasts for their area of responsibility on Chart No. 20P20 (figure 2), the same chart used by the Quantitative Precipitation Forecast Branch for forecasts of heavy snow. Also, only those heavy snow forecasts for 4 inches or more issued at 1000 GMT and 2200 GMT for the 12-hour periods of 1200-0000 GMT and 0000-1200 GMT respectively were verified. The charts delineating these heavy snow forecasts were again sent to TPB soon after the issuance of

heavy snow forecast by the FP Center. These forecasts were compared with the 12-hour forecasts transmitted on facsimile by the National Meteorological Center at 0830 GMT and 2034 GMT, respectively. Then, both forecasts were compared by TPB with the observed snowfalls of 4 inches or more during these periods.

While these comparative heavy snow forecast verifications did not include all the heavy snow forecasts issued, a sufficient sample was obtained to yield significant results.

Verification scores were determined by measuring the areas by a planimeter and, then, converting to square degrees of latitude. The heavy snow verification statistics were by areas, that is, total area forecast, total area observed, total area correct, etc., as shown in Appendix A.

Starting with the winter season of 1967-1968, verification statistics were added for FP Centers and by regions as given in Appendix B. The number of heavy snow forecasts received from each FP Center that was verified is shown in parentheses in the column of the FP Area Forecast. As shown, no forecasts for either of the two valid periods were received from several FP Centers where heavy snow was observed. Also, the number of forecasts from FP Centers in the west that was verified was less than those received in TPB. The reason is that heavy snow forecasts by FP Centers for the mountainous areas only were not evaluated unless they were a part of a more general area of a heavy snow forecast. This was necessary to make possible comparison with the heavy snow forecasts issued by QPFB which dealt only with general areas in its heavy snow forecasts, and, also, observations of heavy snow from the higher elevations were not available routinely for the periods concerned.

On November 3, 1969, QPFB commenced issuing additional heavy snow guidance twice daily during the winter season. This guidance was transmitted over FOFAX at 0235 GMT and 1440 GMT daily. These 5-minute transmissions consisted of specific heavy snow forecasts for the 0600-1800 GMT and 1800-0600 GMT, and probability forecasts of heavy snow during the 36-hour periods following 0600 and 1800 GMT. The 12-hour heavy snow forecasts were for the periods intermediate to those provided on the National Facsimile (NAFAX) Circuit (Charts No. 59 and 104). The probability of heavy snow charts portrayed, at intervals of 10%, a subjective evaluation of all the various forecast materials available at the National Meteorological Center in terms of probability of heavy snow during the 36-hour periods. This guidance was intended to provide assistance to the Forecast Offices in issuing Heavy Snow Watches.

During the winter season of 1970-1971, the FP Centers were required to state on the 20P20 chart any locally heavy snow forecast in the Rockies. Such locally heavy snow forecast was not verified by TPB unless reports were available indicating a general area of snow. However, this one winter's attempt at verification proved unsatisfactory due to the relatively large distances between regular reporting synoptic stations and the extreme variability of snowfall in the Rockies and was abandoned.

## 4. SCORES

For the 10 winter seasons, the following scores were computed:

$$\text{Bias} = \frac{\text{Area Forecast}}{\text{Area Observed}}$$

$$\text{Post Agreement} = \frac{\text{Area Correct}}{\text{Area Forecast}}$$

$$\text{Threat} = \frac{\text{Area Correct}}{\text{Area Forecast \& Observed} - \text{Area Correct}}$$

$$\text{Prefigurance} = \frac{\text{Area Correct}}{\text{Area Observed}}$$

The computed values are given in Appendix A as yearly averages and are plotted on the graphs presented in figures 3-6 of bias, post agreement, threat, and prefigurance. The FP forecasts are those issued by the WSFOs. The NMC forecasts represent the guidance issued to the WSFOs.

## 5. SUMMARY AND CONCLUSION

This study reveals a slow improvement in the forecasting of heavy snows by both echelons during the 10 winters from 1962 to 1972. The FP forecasts were not quite as good as the NMC guidance. Generally, the opposite is true. Using NMC guidance, the WSFO Centers had been able to issue improved FP forecasts. This is true in the Public Forecast Verification Program started in 1966. This program consists of forecasting the probability of measurable precipitation and temperatures (minimum and maximum). A possible explanation for the FP forecasts being not quite as good as the NMC guidance is that a large number of FP forecasts had to be rejected from verification because they were not submitted properly. Another possible explanation is that there were more FP forecasts than NMC forecasts for the mountainous areas of the western United States where there are fewer reporting stations to verify occurrences of heavy snow.

## 6. ACKNOWLEDGMENTS

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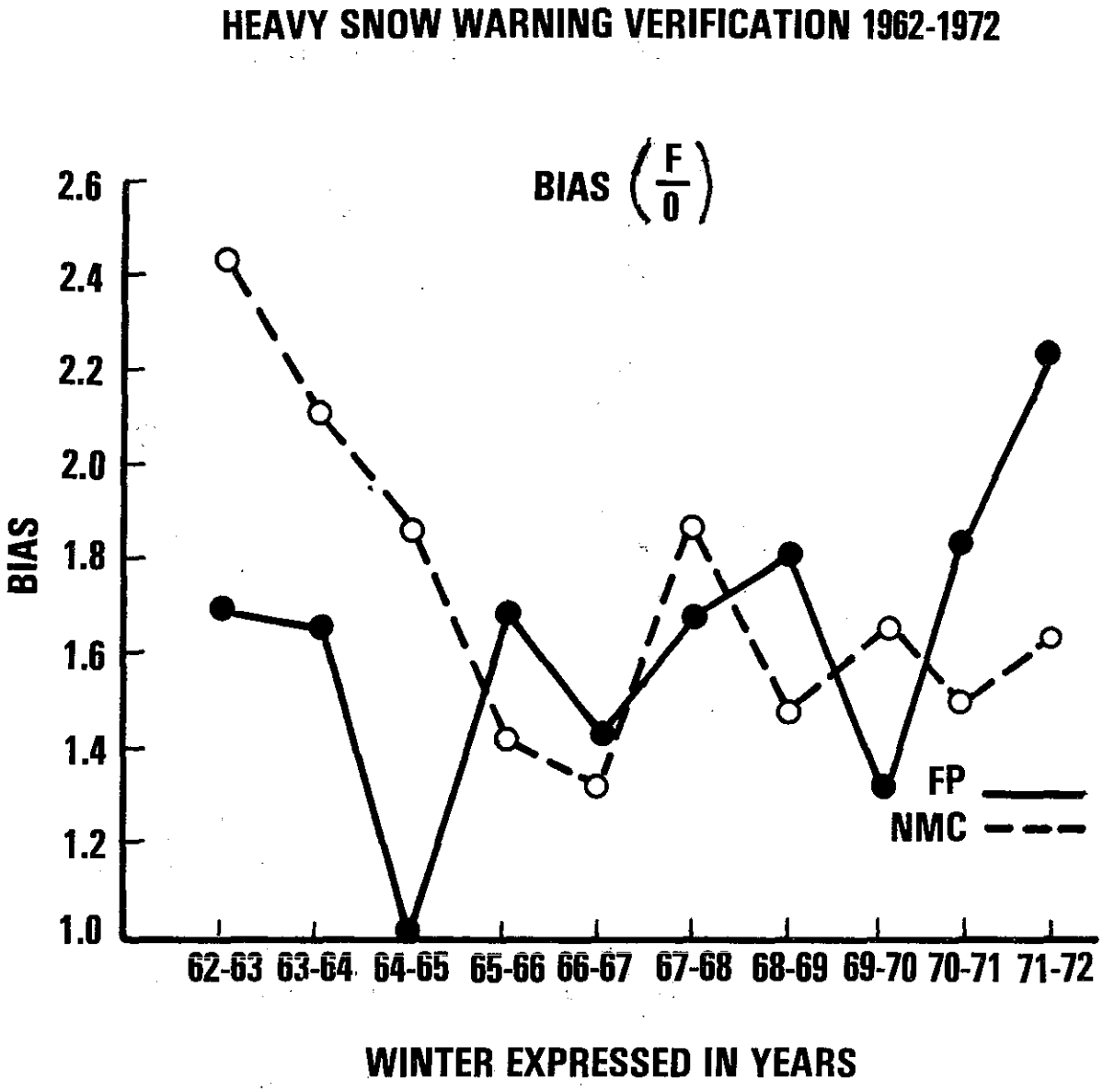



Figure 3.--Bias.

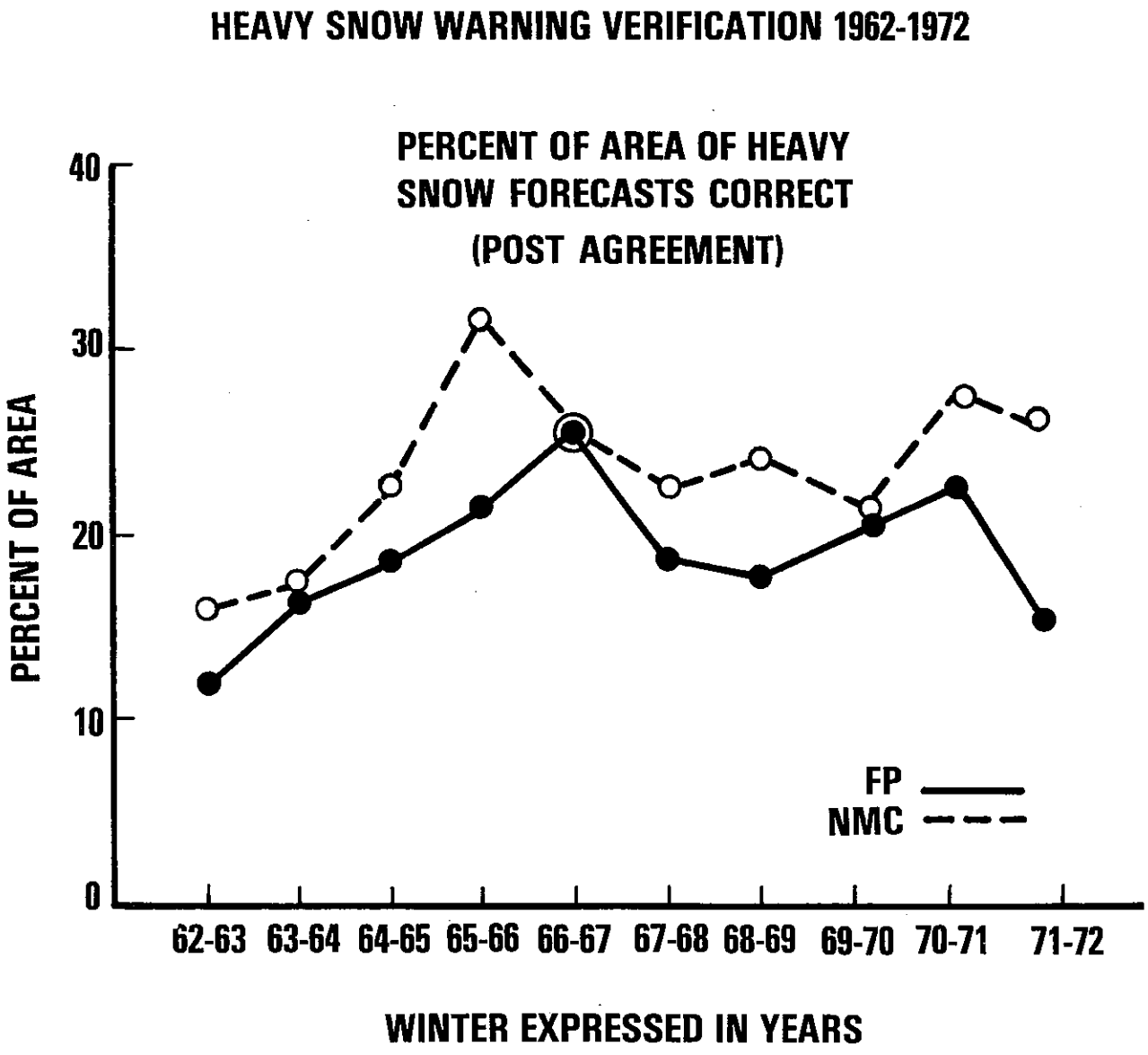



Figure 4.--Post Agreement.

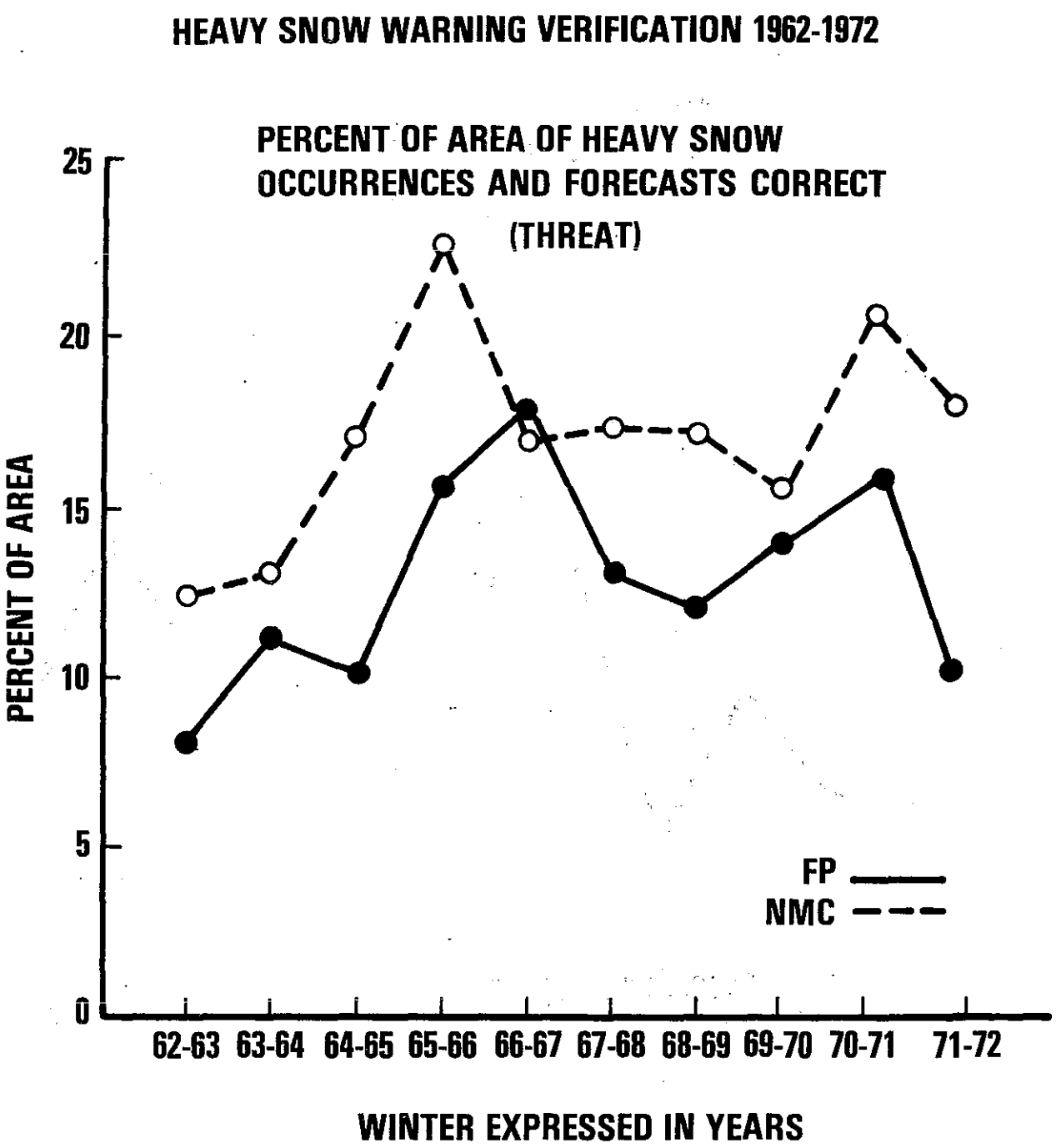



Figure 5.--Threat.

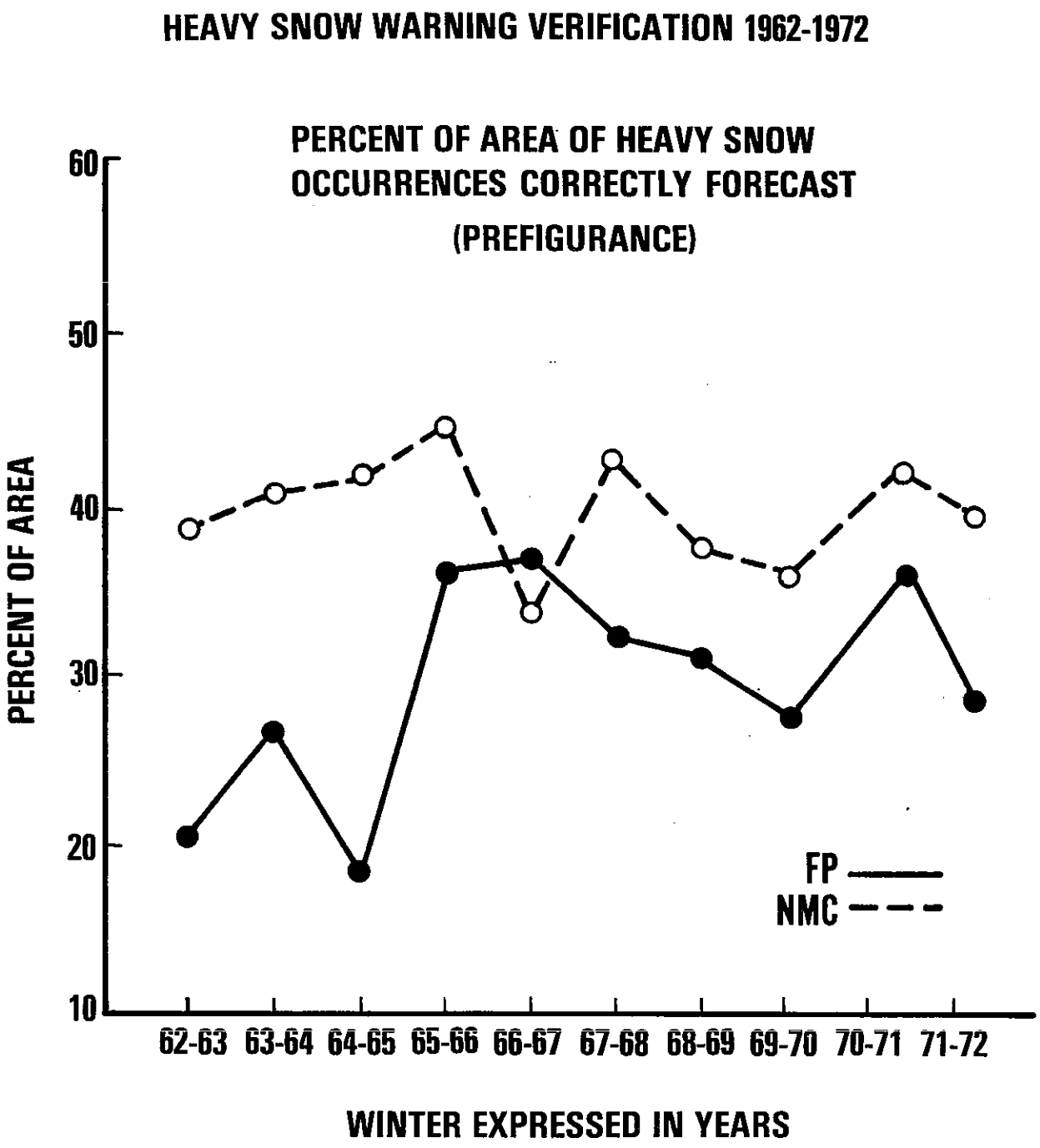



Figure 6.--Prefigurance.

# APPENDIX A

## HEAVY SNOW FORECAST VERIFICATION BY TOTAL AREA
## 1962-1972

All areas are measured in square degrees of latitude, for the first heavy snow (≥ 4 inches or more for 12-hour periods 12Z-00Z and 00Z-12Z) of the year until the last.

$$\text{Bias} = \frac{F}{O} \quad \frac{\text{(Area Forecast)}}{\text{(Area Observed)}}$$

$$\text{Post Agreement} = \frac{C}{F} \quad \frac{\text{(Area Correct)}}{\text{(Area Forecast)}}$$

$$\text{Prefigurance} = \frac{C}{O} \quad \frac{\text{(Area Correct)}}{\text{(Area Observed)}}$$

$$\text{Threat} = \frac{C}{F+O-C} \quad \frac{\text{(Area Correct)}}{\text{(Area Forecast + Area Observed - Area Correct)}}$$

HEAVY SNOW WARNING VERIFICATIONS

| | 1962-63 | | 1963-64 | | 1964-65 | | 1965-66 | | 1966-67 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FP | NMC | FP | NMC | FP | NMC | FP | NMC | FP | NMC |
| Total Area Forecast* | 794.3 | 1116.9 | 811.8 | 1046.7 | 564.4 | 1052.9 | 1125.9 | 924.4 | 1075.6 | 1007.9 |
| Total Area Observed | 454.4 | 454.4 | 490.4 | 490.4 | 563.7 | 563.7 | 625.2 | 625.2 | 748.0 | 748.0 |
| Total Area Correct | 95.1 | 178.43 | 132.3 | 181.5 | 104.2 | 237.4 | 238.9 | 292.4 | 277.7 | 259.5 |
| Post Agreement | .120 | .160 | .163 | .172 | .185 | .225 | .213 | .317 | .258 | .257 |
| Prefigurance | .209 | .393 | .270 | .411 | .185 | .421 | .325 | .448 | .371 | .347 |
| Threat | .082 | .128 | .113 | .133 | .102 | .173 | .158 | .228 | .180 | .173 |
| Bias | 1.74 | 2.46 | 1.66 | 2.13 | 1.00 | 1.87 | 1.73 | 1.42 | 1.44 | 1.35 |

*Areas were measured by planimeter and converted to square degrees of latitude where 1 square degree of latitude is 3600 N.M.

HEAVY SNOW WARNING VERIFICATIONS (continued)

| | 1967-68 | | 1968-69 | | 1969-70 | | 1970-71 | | 1971-72 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FP | NMC | FP | NMC | FP | NMC | FP | NMC | FP | NMC |
| Total Area Forecast* | 803.2 | 874.4 | 1300.6 | 1118.2 | 755.7 | 916.9 | 1296.1 | 1106.2 | 1193.5 | 824.4 |
| Total Area Observed | 461.4 | 461.4 | 715.9 | 715.9 | 556.6 | 556.6 | 738.4 | 738.4 | 530.4 | 530.4 |
| Total Area Correct | 148.8 | 198.7 | 222.5 | 270.7 | 158.8 | 200.9 | 268.5 | 317.5 | 157.3 | 204.0 |
| Post Agreement | .185 | .227 | .171 | .243 | .210 | .219 | .207 | .287 | .132 | .247 |
| Prefigurance | .322 | .431 | .310 | .379 | .285 | .361 | .363 | .429 | .297 | .385 |
| Threat | .133 | .175 | .122 | .172 | .138 | .158 | .152 | .207 | .100 | .177 |
| Bias | 1.74 | 1.90 | 1.81 | 1.56 | 1.36 | 1.65 | 1.76 | 1.50 | 2.25 | 1.55 |

Note

Heavy snow forecasts by FP Centers for mountain areas only were not evaluated unless they were a part of a more general area of a heavy snow forecast. This was necessary in order to compare with NMC forecasts which only dealt with general areas in their heavy snow forecasts and the fact that observations of heavy snow from these higher elevations were not routinely available for the periods concerned. Western FP Centers were primarily affected by this restriction.

# APPENDIX B

## HEAVY SNOW FORECAST VERIFICATION BY FP CENTERS AND BY REGIONS 1967-1972

HEAVY SNOW VERIFICATION

| 1967-1968 | FP | | | NMC | | |
|---|---|---|---|---|---|---|
| | Area Forecast | Area Observed | Area Correct | Area Forecast | Area Observed | Area Correct |
| BOS | 40.2 (5) | 67.0 | 23.6 | 103.6 | 67.0 | 40.7 |
| NYC | - (0) | 14.5 | - | 31.2 | 14.5 | 6.9 |
| CLE | 24.3 (5) | 21.5 | 6.8 | 39.4 | 21.5 | 7.9 |
| DCA | 18.5 (2) | 36.1 | - | 44.2 | 36.1 | 16.6 |
| RDU | 10.4 (4) | 1.4 | .1 | 9.2 | 1.4 | 0.1 |
| MIA | - (0) | - | - | - | - | - |
| ATL | - (0) | 0.3 | - | 2.0 | 0.3 | 0.1 |
| MSY | - (0) | 2.5 | - | 4.8 | 2.5 | 0.2 |
| SAT | - (0) | - | - | - | - | - |
| FTW | 26.5 (3) | 8.4 | 1.8 | 26.6 | 8.4 | 0.9 |
| MEM | 59.5 (9) | 30.1 | 9.0 | 29.3 | 30.1 | 17.5 |
| ABQ | 167.9 (15) | 42.1 | 18.6 | 84.7 | 42.1 | 20.6 |
| STL | 32.7 (3) | 6.5 | 6.1 | 22.3 | 6.5 | 0.0 |
| CHI | 39.1 (5) | 19.0 | 6.9 | 52.5 | 19.0 | 8.1 |
| MKC | 12.1 (2) | 2.5 | - | 10.1 | 2.5 | - |
| MSP | 168.4 (10) | 46.3 | 31.2 | 79.6 | 46.3 | 22.6 |
| DEN | 121.1 (17) | 58.7 | 24.4 | 161.8 | 58.7 | 17.1 |
| GTF | 33.4 (5) | 17.3 | .6 | 45.9 | 17.3 | 5.1 |
| SLC | - | 24.8 | - | 44.4 | 24.8 | 2.1 |
| LAX | - | - | - | - | - | - |
| SFO | 49.1 (10) | 36.8 | 19.7 | 41.9 | 36.8 | 20.8 |
| SEA | - (0) | 7.4 | - | 7.1 | 7.4 | 1.5 |
| ER | 93.4 | 140.5 | 30.5 | 227.6 | 140.5 | 72.2 |
| SR | 253.9 | 83.4 | 29.4 | 118.1 | 83.4 | 39.3 |
| CR | 373.4 | 133.0 | 68.6 | 326.3 | 133.0 | 47.8 |
| WR | 82.5 | 86.3 | 20.3 | 139.3 | 86.3 | 29.5 |

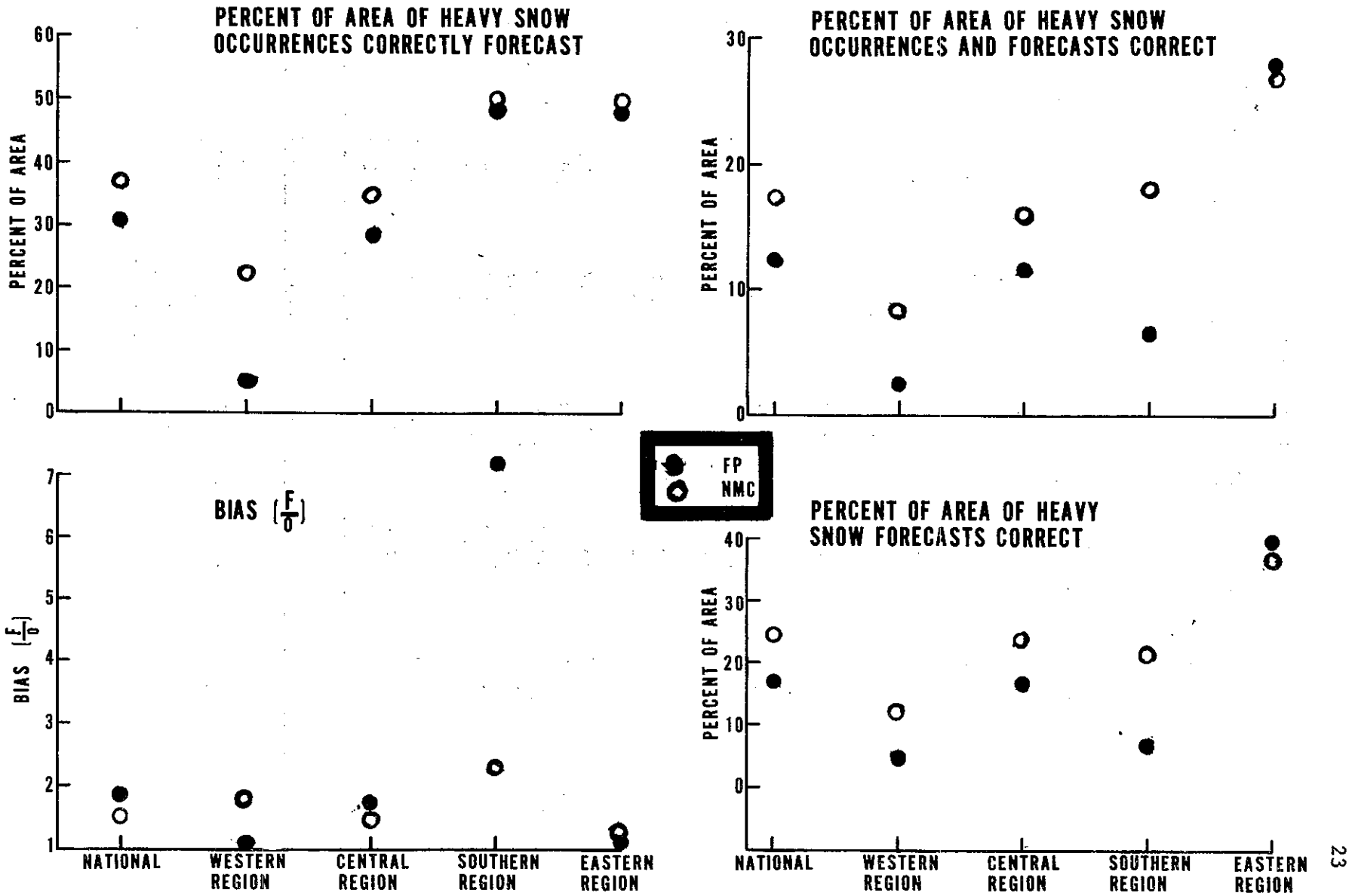
# HEAVY SNOW VERIFICATION 1968-69

| | | FP | | | NMC | | |
|---|---|---|---|---|---|---|---|
| 1968-69 | | Area Forecast | Area Observed | Area Correct | Area Forecast | Area Observed | Area Correct |
| Eastern | BOS | 140 | 146.5 | 74.1 | 193.0 | 146.5 | 81.4 |
| | CLE | 20 | .3 | 0 | 5.9 | .3 | 0 |
| | PIT | 0 | 7.9 | 0 | 13.6 | 7.9 | 1.7 |
| | NYC | 24.6 | 23.8 | 8.2 | 30.0 | 23.8 | 6.5 |
| | RDU | 9.2 | 8.5 | 2.3 | 4.7 | 8.5 | 3.5 |
| | CAE | -- | -- | -- | -- | -- | -- |
| | DCA | 64.0 | 25.2 | 17.9 | 38.4 | 25.2 | 13.3 |
| Southern | ABQ | 232.7 | 25.7 | 15.3 | 52.8 | 25.7 | 11.9 |
| | ATL | 0 | .2 | 0 | 2.6 | .2 | 0 |
| | GSW | 23.9 | 6.2 | .8 | 10.5 | 6.2 | 1.4 |
| | OKC | 20.5 | 2.2 | .3 | 19.9 | 2.2 | 3.5 |
| | MEM | 31.1 | 6.6 | 3.5 | 11.4 | 6.6 | 2.7 |
| | MIA | -- | -- | -- | -- | -- | -- |
| | MSY | -- | -- | -- | -- | -- | -- |
| | SAT | 16.9 | 4.1 | 1.8 | 3.2 | 4.1 | 2.7 |
| Central | CHI | 68.4 | 50.7 | 26.5 | 109.4 | 50.7 | 28.5 |
| | DTW | 34.7 | 33.7 | 5.1 | 65.3 | 33.7 | 20.2 |
| | DEN | 162.3 | 36.9 | 8.8 | 66.7 | 36.9 | 6.2 |
| | MKC | 183.9 | 81.3 | 21.0 | 121.9 | 81.3 | 28.1 |
| | MSP | 98.7 | 100.3 | 29.2 | 96.0 | 100.3 | 23.4 |
| | STL | 3.3 | 15.4 | .3 | 15.7 | 15.4 | 4.3 |
| Western | GTF | 103.0 | 41.7 | 3.0 | 88.8 | 41.7 | 6.0 |
| | SEA | 16.5 | 34.6 | 0 | 67.8 | 34.6 | 13.2 |
| | PDX | 36.5 | 14.1 | 2.2 | 21.7 | 14.1 | 2.3 |
| | SFO | - - - - | - - - - - - | - - -not verified- - - | - - - - - - - - - | | |
| | LAX | 0 | 4.7 | 0 | 8.3 | 4.7 | 2.3 |
| | SLC | 10.4 | 45.3 | 2.2 | 70.6 | 45.3 | 7.6 |
| National | | 1300.6 | 715.9 | 222.5 | 1118.2 | 715.9 | 270.7 |
| Eastern | | 257.8 | 212.2 | 102.5 | 285.6 | 212.2 | 106.4 |
| Southern | | 325.1 | 45.0 | 21.7 | 100.4 | 45.0 | 22.2 |
| Central | | 551.3 | 318.3 | 90.9 | 475.0 | 318.3 | 110.7 |
| Western | | 166.4 | 140.4 | 7.4 | 257.2 | 140.4 | 31.4 |

## HEAVY SNOW FORECAST VERIFICATION 1968-1969

For the country as a whole, and for all regions except the Eastern Region, the Quantitative Precipitation Forecast Branch of the National Meteorological Center (NMC) issued heavy snow forecasts in the winter season of 1968-1969 that were superior to those issued by the FP Centers. There was little difference in skill between the FP forecasts and the NMC forecasts for the Eastern Region. The Eastern Region did better than any of the other regions. Also, NMC guidance was better for the Eastern Region than for any of the other regions. The cumulative size of the areas in which the Eastern Region forecasters predicted heavy snow was about equal to the cumulative size of areas in which heavy snow was observed. This does not consider the accuracy of the forecast, but does indicate that there was no over- or under-forecasting bias.

# HEAVY SNOW WARNING VERIFICATION 1968-1969



## HEAVY SNOW VERIFICATION 1969-70

Forecast and observed areas of heavy snow (4 inches or more for the 12-hour periods 12Z-00Z and 00Z-12Z) measured by a planimeter and converted to square degrees of latitude.

| | | NMC | | | FP | | |
|---|---|---|---|---|---|---|---|
| 1969-70 | | Area Forecast | Area Observed | Area Correct | Area Forecast | Area Observed | Area Correct |
| Eastern | BOS | 78.0 | 65.8 | 32.8 | 76.3 | 65.8 | 37.4 |
| | CLE | 31.4 | 5.2 | 2.7 | 10.8 | 5.2 | 1.3 |
| | PIT | 40.3 | 27.0 | 11.0 | 21.7 | 27.0 | 7.4 |
| | NYC | 55.0 | 47.2 | 20.6 | 18.7 | 47.2 | 15.3 |
| | RDU | 5.3 | 0 | 0 | 5.2 | 0 | 0 |
| | CAE | 0.9 | 0 | 0 | 3.3 | 0 | 0 |
| | DCA | 49.8 | 26.4 | 12.5 | 53.5 | 26.4 | 14.7 |
| Southern | ABQ | 27.1 | 11.9 | 2.5 | 101.2 | 11.9 | 6.4 |
| | ATL | - | - | - | - | - | - |
| | GSW | 5.8 | 7.1 | 0 | 14.4 | 7.1 | 2.3 |
| | OKC | 18.7 | 10.0 | 3.3 | 10.6 | 10.0 | 4.1 |
| | MEM | 20.4 | 10.8 | 2.0 | 38.5 | 10.8 | 4.0 |
| | MIA | - | - | - | - | - | - |
| | MSY | - | - | - | - | - | - |
| | SAT | 0 | 0 | 0 | 3.6 | 0 | 0 |
| | BHM | - | - | - | - | - | - |
| Central | CHI | 60.6 | 56.1 | 30.1 | 17.2 | 56.1 | 6.4 |
| | DTW | 64.4 | 39.8 | 17.8 | 14.8 | 39.8 | 6.0 |
| | DEN | 170.3 | 62.0 | 17.6 | 214.9 | 62.0 | 15.1 |
| | MKC | 59.7 | 49.6 | 14.6 | 61.1 | 49.6 | 9.5 |
| | MSP | 98.7 | 76.4 | 22.6 | 107.2 | 76.4 | 33.3 |
| | STL | 13.9 | 14.9 | 2.6 | 10.8 | 14.9 | 1.7 |
| Western | GTF | 73.7 | 28.1 | 7.9 | 21.2 | 28.1 | 5.1 |
| | SEA | 12.7 | 5.4 | 0 | 0 | 5.4 | 0 |
| | PDX | 0 | 2.7 | 0 | 0 | 2.7 | 0 |
| | SFO | ----------not verified---------- | | | | | |
| | LAX | - | - | - | - | - | - |
| | SLC | 30.2 | 10.2 | 0.3 | 11.8 | 10.2 | 0 |
| Eastern | | 260.7 | 171.6 | 79.6 | 189.5 | 171.6 | 76.1 |
| Southern | | 72.0 | 39.8 | 7.8 | 168.3 | 39.8 | 16.8 |
| Central | | 467.6 | 298.8 | 105.3 | 364.9 | 298.8 | 60.8 |
| Western | | 116.6 | 46.4 | 8.2 | 33.0 | 46.4 | 5.1 |
| National | | 916.9 | 556.6 | 200.9 | 755.7 | 556.6 | 158.8 |

HEAVY SNOW VERIFICATION 1969-70 (continued)

| | Post Agreement | | Prefigurance | | Threat | | Bias | |
|---|---|---|---|---|---|---|---|---|
| | NMC | FP | NMC | FP | NMC | FP | NMC | FP |
| Eastern | .305 | .401 | .464 | .443 | .226 | .267 | 1.521 | 1.105 |
| Southern | .108 | .100 | .196 | .422 | .075 | .088 | 1.809 | 4.229 |
| Central | .225 | .167 | .352 | .204 | .159 | .101 | 1.565 | 1.221 |
| Western | .070 | .155 | .177 | .110 | .053 | .069 | 2.515 | .711 |
| National | .219 | .210 | .361 | .285 | .158 | .138 | 1.647 | 1.358 |

# HEAVY SNOW VERIFICATION 1970-71

| 1970-71 | | Area Observed | NMC Area Forecast | NMC Area Correct | FP Area Forecast | FP Area Correct |
|---|---|---|---|---|---|---|
| Eastern | BOS | 142.5 | 202.6 | 81.4 | 180.1 | 76.9 |
| | CLE | 13.0 | 26.3 | 5.5 | 8.8 | 1.4 |
| | CAE | 1.2 | .6 | 0 | 5.2 | 1.2 |
| | DCA | 35.1 | 47.1 | 18.0 | 55.9 | 17.9 |
| | NYC | 15.8 | 28.4 | 8.6 | 15.6 | 7.4 |
| | PHL | 14.3 | 25.1 | 9.8 | 13.3 | 7.6 |
| | PIT | 53.0 | 68.4 | 38.3 | 44.5 | 6.9 |
| | RDU | 1.5 | 10.9 | .9 | 22.0 | .9 |
| Southern | ABQ | 4.4 | 15.0 | 1.2 | 53.1 | 1.4 |
| | ATL | 0 | 0 | 0 | 0 | 0 |
| | FTW | 11.0 | 0 | 0 | 15.5 | 0 |
| | OKC | 8.5 | 1.5 | 1.2 | 9.1 | 0 |
| | MEM | 12.2 | 18.4 | 3.2 | 30.8 | 1.3 |
| | MIA | 0 | 0 | 0 | 0 | 0 |
| | MSY | .4 | .5 | .2 | 0 | 0 |
| | SAT | 0 | 0 | 0 | 0 | 0 |
| Central | DEN | 58.1 | 125.0 | 13.3 | 234.4 | 14.3 |
| | DTW | 54.3 | 72.3 | 30.2 | 86.8 | 17.2 |
| | CHI | 48.2 | 93.1 | 25.8 | 86.3 | 27.8 |
| | IND | 3.6 | 13.0 | 1.3 | 8.2 | 1.3 |
| | MKC | 108.3 | 139.3 | 49.3 | 153.2 | 54.4 |
| | MSP | 60.3 | 106.7 | 20.0 | 158.8 | 25.5 |
| | STL | 5.7 | 13.7 | 1.4 | 38.2 | 1.4 |
| Western | BOI | 5.4 | 2.0 | 0 | 4.7 | 0 |
| | GTF | 21.1 | 28.4 | 1.3 | 4.0 | 0 |
| | LAX | 0 | 0 | 0 | 0 | 0 |
| | PDX | 6.6 | 7.6 | 0 | 5.5 | 0 |
| | SLC | 39.3 | 38.6 | 6.6 | 52.5 | 3.7 |
| | SFO | ----------Not verified---------- | | | | |
| | SEA | 14.6 | 21.7 | 0 | 9.6 | 0 |
| Eastern | | 276.4 | 409.4 | 162.5 | 345.4 | 120.2 |
| Southern | | 36.5 | 35.4 | 5.8 | 108.5 | 2.7 |
| Central | | 338.5 | 563.1 | 141.3 | 765.9 | 141.9 |
| Western | | 87.0 | 98.3 | 7.9 | 76.3 | 3.7 |
| National | | 738.4 | 1106.2 | 317.5 | 1296.1 | 268.5 |

RESULTS OF HEAVY SNOW FORECAST VERIFICATION 1970-1971

| | NMC | | | | FP (WSFO) | | | |
|---|---|---|---|---|---|---|---|---|
| | Bias | PA% | PF% | TS% | BIAS | PA% | PF% | TS% |
| Eastern Region | 1.5 | 39.6 | 58.7 | 31.0 | 1.2 | 34.8 | 43.4 | 23.9 |
| Southern Region | 1.0 | 16.3 | 15.8 | 8.7 | 3.0 | 2.4 | 7.3 | 1.8 |
| Central Region | 1.7 | 25.0 | 41.7 | 18.5 | 2.3 | 18.5 | 41.9 | 14.7 |
| Western Region | 1.1 | 8.0 | 9.0 | 4.4 | 0.9 | 4.8 | 4.2 | 2.3 |
| National | 1.5 | 28.7 | 42.9 | 20.7 | 1.8 | 20.7 | 36.3 | 15.2 |

PF = Prefigurance (% of observed area correctly forecast)

PA = Post Agreement (% of forecast area correct)

TS = Threat Score

HEAVY SNOW VERIFICATION 1971-1972

| 1971-1972 | | | NMC | | FP | |
|---|---|---|---|---|---|---|
| | | Area Observed | Area Forecast | Area Correct | Area Forecast | Area Correct |
| Eastern | ALB | 43.9 | 41.2 | 15.6 | 10.8 | 7.5 |
| | BOS | 8.7 | 14.5 | 4.8 | 9.7 | 5.2 |
| | BUF | 21.4 | 15.0 | 4.6 | 42.0 | 4.2 |
| | CRW | 3.2 | 1.5 | 1.3 | 3.0 | 1.1 |
| | CLE | 0.5 | 0.5 | 0 | 1.5 | 0 |
| | CAE | 1.2 | 0.3 | 0.3 | 1.2 | 1.2 |
| | DCA | 7.4 | 6.1 | 2.5 | 7.3 | 2.8 |
| | NYC | 5.6 | 6.3 | 1.6 | 9.1 | 2.3 |
| | PHL | 12.3 | 15.8 | 7.6 | 5.9 | 1.9 |
| | PIT | 14.3 | 9.7 | 3.8 | 19.7 | 6.7 |
| | PWM | 85.7 | 105.0 | 53.1 | 80.6 | 39.4 |
| | RDU | 5.9 | 2.4 | 2.4 | 9.3 | 3.9 |
| Southern | ABQ | 8.9 | 27.1 | 1.3 | 133.3 | 3.5 |
| | ATL | 0.7 | 0.3 | 0.3 | 0 | 0 |
| | FTW | 5.1 | 5.0 | 2.3 | 16.9 | 2.3 |
| | LIT | 1.1 | 0.9 | 0 | 6.8 | 0 |
| | MEM | 2.1 | 1.1 | 0.1 | 2.7 | 1.5 |
| | MSY | 0 | 0 | 0 | 0 | 0 |
| | OKC | 4.9 | 10.5 | 1.2 | 10.0 | 1.5 |
| Central | CHI | 47.1 | 51.7 | 21.6 | 61.7 | 11.3 |
| | DEN | 66.9 | 152.0 | 22.4 | 432.5 | 33.9 |
| | DSM | 15.7 | 21.2 | 7.1 | 8.3 | 1.7 |
| | DTW | 21.0 | 47.5 | 8.3 | 50.4 | 2.8 |
| | IND | 1.5 | 2.7 | 0 | 0.3 | 0 |
| | STL | 3.3 | 7.2 | 1.6 | 8.7 | 1.0 |
| | MKC | 8.7 | 17.6 | 0.7 | 38.3 | 1.3 |
| | MSP | 25.2 | 73.8 | 10.2 | 120.3 | 10.0 |
| Western | BOI | 5.8 | 16.3 | 3.1 | 1.2 | 0.3 |
| | GTF | 48.0 | 68.9 | 8.9 | 34.7 | 2.8 |
| | PHX | 7.7 | 9.6 | 1.2 | 50.5 | 4.3 |
| | PDX | 2.3 | 9.6 | 0.2 | 3.6 | 0 |
| | SLC | 27.9 | 50.1 | 8.0 | 10.0 | 2.4 |
| | SEA | 16.4 | 33.0 | 7.9 | 3.2 | 0.5 |
| Eastern | | 210.1 | 218.3 | 97.6 | 200.1 | 76.2 |
| Southern | | 22.8 | 44.9 | 5.2 | 169.7 | 8.8 |
| Central | | 189.4 | 373.7 | 71.9 | 720.5 | 62.0 |
| Western | | 108.1 | 187.5 | 29.3 | 103.2 | 10.3 |
| National | | 530.4 | 824.4 | 204.0 | 1,193.5 | 157.3 |

HEAVY SNOW VERIFICATION 1971-1972 (continued)

| | Bias | | Post Agreement | | Prefigurance | | Threat | |
|---|---|---|---|---|---|---|---|---|
| | NMC | FP | NMC | FP | NMC | FP | NMC | FP |
| Eastern | 1.0 | 1.0 | 44.7 | 38.1 | 46.5 | 36.3 | 29.5 | 22.8 |
| Southern | 2.0 | 7.4 | 11.6 | 5.2 | 22.8 | 38.6 | 8.3 | 4.8 |
| Central | 2.0 | 3.8 | 19.2 | 8.6 | 38.0 | 32.7 | 14.6 | 7.3 |
| Western | 1.7 | 1.0 | 15.6 | 10.0 | 27.1 | 9.5 | 11.0 | 5.1 |
| National | 1.6 | 2.3 | 24.7 | 13.2 | 38.5 | 29.7 | 17.7 | 10.0 |

(Continued from inside front cover)

WBTM FCST 15 Weather Bureau Forecast Verification Scores 1968-69 and Some Performance Trends From 1966. Robert G. Derouin and Geraldine F. Cobb, May 1970. (PB-192-949)

NOAA Technical Memoranda

NWS FCST 16 Weather Bureau April 1969-March 1970 Verification Report With Special Emphasis on Performance Scores Within Echelons. Robert G. Derouin and Geraldine F. Cobb, April 1971. (COM-71-00555)

NWS FCST 17 National Weather Service May 1970-April 1971 Public Forecast Verification Summary. Robert G. Derouin and Geraldine F. Cobb, March 1972. (COM-72-10484)

NWS FCST 18 Long-Term Verification Trends of Forecasts by the National Weather Service. Duane S. Cooley and Robert G. Derouin, May 1972. (COM-72-11114)

NWS FCST 19 National Weather Service May 1971-April 1972 Public Forecast Verification Summary. Alexander F. Sadowski and Geraldine F. Cobb, July 1973. (COM-73-11-557-AS)