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VERIFICATION OF MOS HEAVY SNOW FORECASTS FOR THE  
1977-78 WINTER SEASON

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1. INTRODUCTION

A MOS heavy snow forecast system based on LFM model output became operational in October 1977. Heavy snow is defined as a fall of  $\geq 4$  inches (10 cm) during a 12-h period at a station. Development of the system is described in detail by Bocchieri (1977) and National Weather Service (1977a).

The MOS heavy snow forecast appears in the early FOUS12 bulletin which is available on request/reply at approximately 0400 GMT and 1600 GMT. Both the conditional and unconditional probability of heavy snow and a categorical forecast are provided for the 12- to 24-h period after the 0000 GMT and 1200 GMT cycle times. The conditional probability of heavy snow [PoSH(S)] is the probability of heavy snow at a station given that pure or mostly pure snow occurs during the 12-h valid period. The unconditional probability of heavy snow (PoSH) is approximated by

$$\text{PoSH} = \text{PoSH(S)} \times \text{PoP} \times \text{PoF(avg)},$$

where PoP is the 12-h probability of precipitation (National Weather Service, 1976a) and PoF is the conditional probability of frozen precipitation (National Weather Service, 1976b). Since the PoF forecasts are valid at specific times, an average of the 12-, 18-, and 24-h forecasts is computed to obtain a value for the 12-h period. In the averaging, the 18-h PoF is weighted twice as much as the 12- and 24-h forecasts. A categorical heavy snow forecast results if PoSH exceeds its threshold probability. I determined threshold probabilities for each region and cycle time so as to obtain a relatively high threat score and a reasonable bias (defined below) on the developmental data sample.

2. VERIFICATION

In this section, verification of the MOS categorical heavy snow forecasts is presented for the period October 1977 through February 1978. The scores for the 1976-77 winter season are also shown for comparison purposes. In addition, the performance of the MOS heavy snow forecasts is evaluated for two severe blizzards which occurred during January 25-27 and February 6-8, 1978 in the eastern United States.

The verification scores include the threat score, bias, post-agreement, and prefigurance<sup>1</sup>. Locally-caused heavy snows such as lake-effect events and isolated events in mountainous areas were included in the verification sample, even though the MOS system has difficulty in predicting such events. Table 1 shows the scores for the East, West, and all stations combined; data were combined from the 0000 GMT and 1200 GMT LFM cycle times. The 104° longitude line divides the West (50 stations) and the East (145 stations). The results in Table 1 indicate that for all stations combined all the scores improved in 1977-78 as compared to 1976-77; this was due to the much improved performance of the system in the East in 1977-78. In the West, all the scores except the bias showed considerable deterioration. MOS had much better scores in the East than in the West in 1977-78 except for the bias; in the previous season the scores for the two regions were closer. It's interesting that in the East the relative frequency of heavy snow in 1977-78 was about twice that in 1976-77; this was probably a factor in the improvement of the verification scores in 1977-78. Another possible cause for the significant change in the scores in the East and West from 1976-77 to 1977-78 is the fact that a finer-mesh version of the LFM model, called the LFM-II (National Weather Service, 1977b), became operational in September 1977.

Two record-breaking blizzards occurred in the eastern United States in the 1977-78 season. One storm affected the Ohio-Valley and Great Lakes region during January 25-27, and the other affected the Mid-Atlantic and New England region during February 6-7. Figs. 1 through 5 show MOS categorical heavy snow forecasts and observed heavy snow areas for these two storms. In these figures the solid line encloses stations for which MOS categorically forecasted heavy snow; the hatching shows the observed area of heavy snow. Only observed snow amounts at MOS stations were used; therefore, the observed areas are only approximate since the MOS station network is rather coarse.

Figs. 1 and 2 show the forecasted and observed heavy snow areas for 12-h periods ending at 1200 GMT January 26 and 0000 GMT January 27, 1978 respectively. For the first 12-h period (Fig. 1), MOS underforecasted the extent of the heavy snow. For the subsequent 12-h period (Fig. 2), MOS forecasted heavy snow too far to the east of the observed area.

Figs. 3, 4, and 5 show the MOS forecasts and observed heavy snow areas for the 12-h periods ending at 0000 GMT February 7, 1200 GMT February 7, and 0000 GMT February 8, 1978 respectively. The MOS forecasts for this storm were generally quite good except that initially (Fig. 3) the MOS forecast area was a little too far to the southwest of the observed area. Also, for the next 12-h period (Fig. 4) MOS underestimated the advance of the heavy snow into northern New England and ended the heavy snow too soon in eastern Pennsylvania, New Jersey, and southern New York. In Fig.

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<sup>1</sup> The threat score =  $A/(B+C-A)$ , the bias =  $B/C$ , the post-agreement =  $A/B$ , and the prefigurance =  $A/C$  where A, B, and C are the number of correct forecasts, the total number of forecasts, and the number of observations of the heavy snow event respectively.

5, MOS again ended the heavy snow too soon in southern New England. It should be noted that in each of the 12-h periods shown in Figs. 3-5, either Rochester, New York or Buffalo, New York or both reported heavy snow; much of this was attributed to the lake-effect since neither Syracuse, New York nor Bradford, Pennsylvania reported heavy snow in any of the three 12-h periods.

For this blizzard, the numerical model (LFM-II) and man-modified guidance from the National Meteorological Center were generally excellent (Brown and Olson, 1978).

#### REFERENCES

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Table 1. Verification of MOS categorical heavy snow forecasts for October 1977 through February 1978. The scores for the 1976-77 winter season are shown in parentheses. The 104° longitude line divides the West (50 stations) and East (145 stations). Data were combined from the 0000 GMT and 1200 GMT LFM cycle times. Heavy snow is defined as the occurrence of  $\geq 4$  inches (10 cm) during the 12-to 24-h period after 0000 GMT or 1200 GMT.

Region	Bias	Threat Score	Post-Agreement	Prefiguration	Rel. Freq. of Heavy Snow (%)
East	.88 (1.05)	.27 (.17)	.45 (.29)	.40 (.30)	.67 (.33)
West	.97 (1.46)	.07 (.18)	.14 (.26)	.14 (.38)	.28 (.23)
All Stations	.89 (1.13)	.24 (.18)	.41 (.28)	.37 (.32)	.58 (.30)

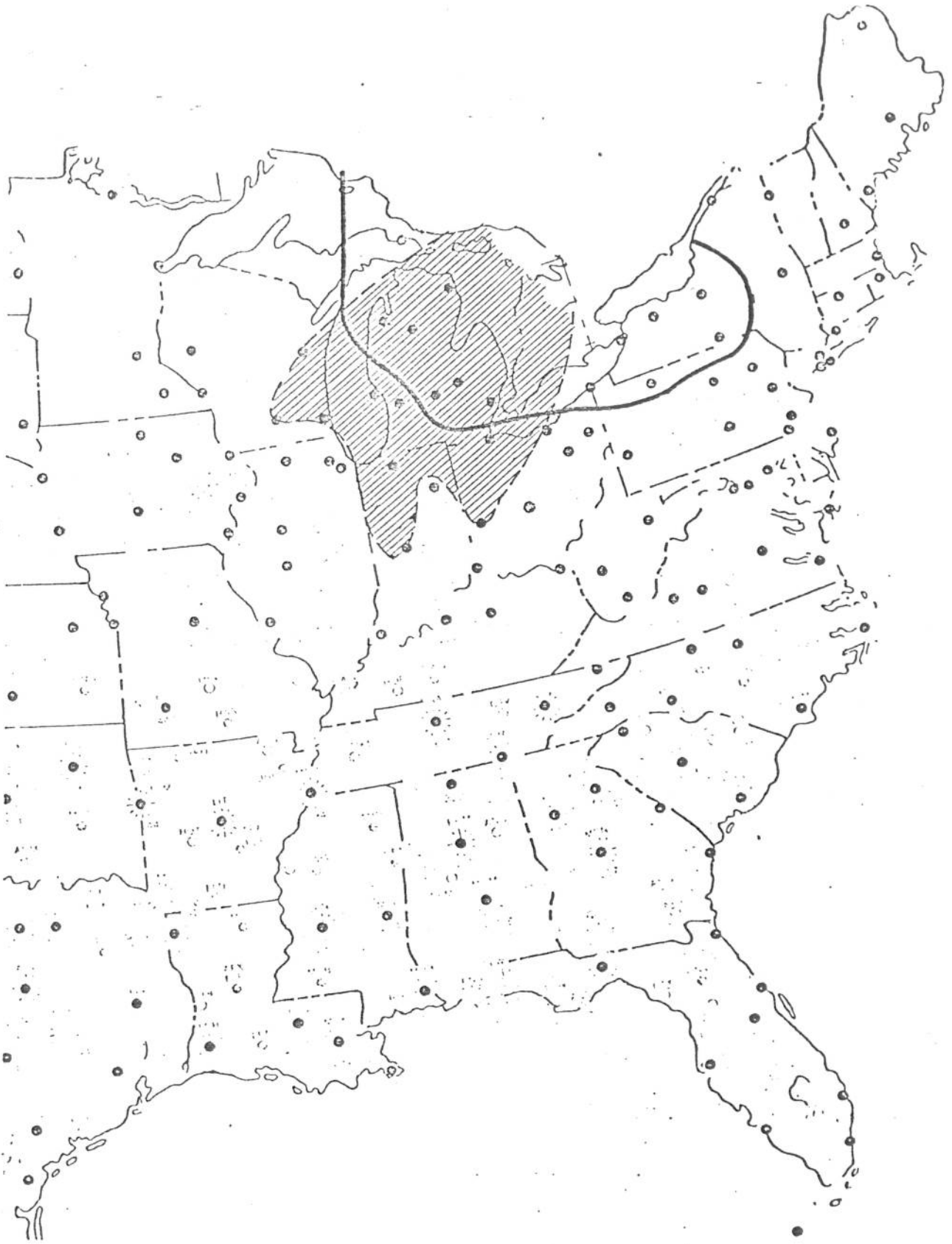


Figure 2. Same as Fig. 1 except for the 12-h period ending 0000 GMT January 27, 1978.

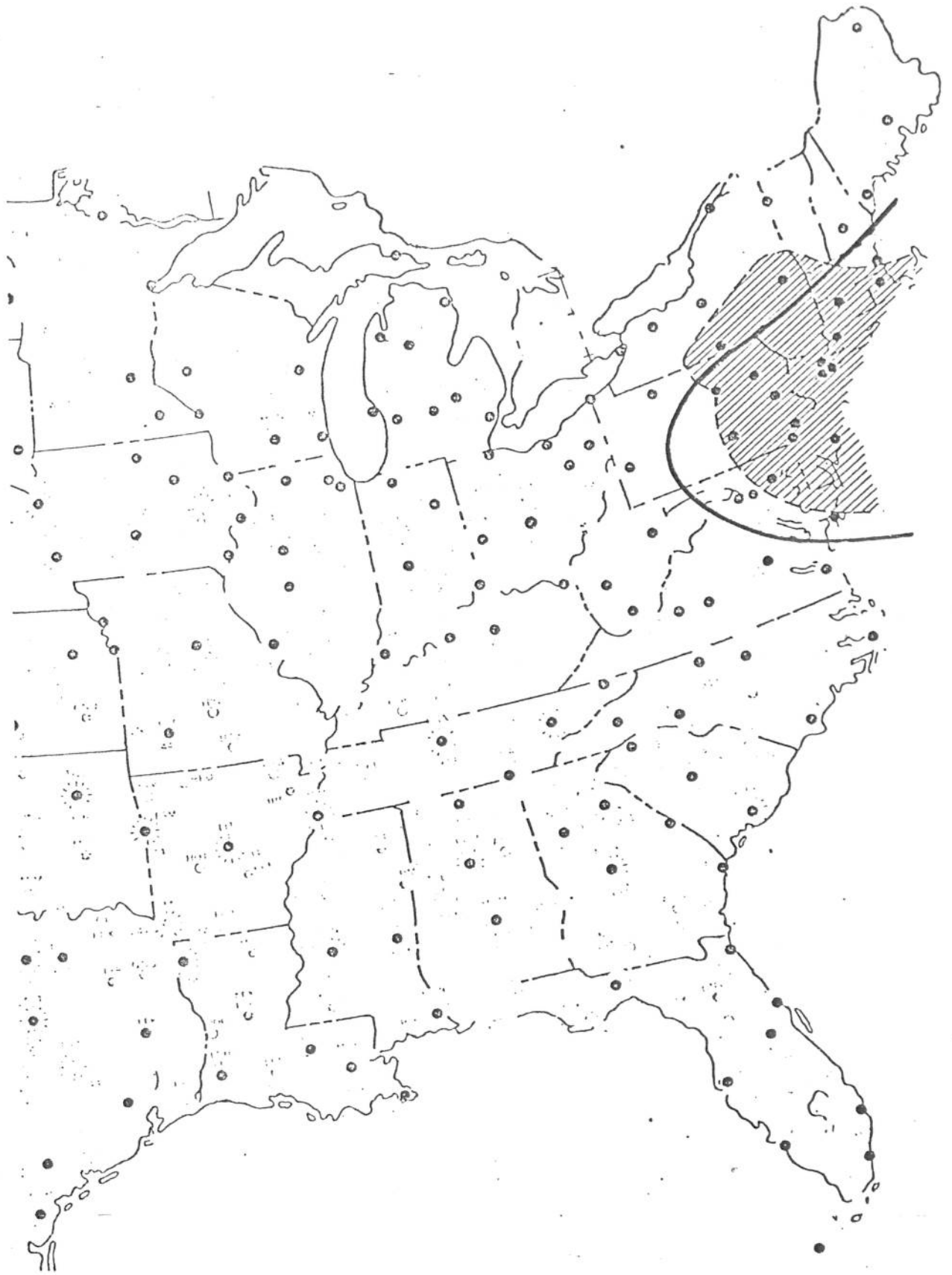


Figure 3. Same as Fig. 1 except for the 12-h period ending 0000 GMT February 7, 1978.



Figure 4. Same as Fig. 1 except for the 12-h period ending 1200 GMT February 7, 1978.





Figure 5. Same as Fig. 1 except for the 12-h period ending 0000 GMT February 8, 1978.