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VERIFICATION OF OBJECTIVE SNOW AMOUNT GUIDANCE (OCTOBER 1983-MARCH 1984)

(Revised)

George J. Maglaras

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1. INTRODUCTION

During September 1982, the Techniques Development Laboratory's new probability of snow amount (PoSA) forecast system described in Technical Procedures Bulletin No. 318 (National Weather Service, 1982a) and Bocchieri (1983) was put into operation at the National Meteorological Center. This system provides National Weather Service forecasters with both probabilistic and categorical guidance for 183 stations in the conterminous United States for three categories of snow amount ($\geq$2, $\geq$4, and $\geq$6 inches) for the 12-24 h periods after both 0000 and 1200 GMT. The PoSA system is based on equations developed through application of the Model Output Statistics (MOS) technique (Glahn and Lowry, 1972) and uses forecast output from the Limited-area Fine Mesh (LFM) model (National Weather Service, 1977; Newell and Deaven, 1981).

This report briefly describes the development of the PoSA system and presents verification statistics for the cool season months of October 1983 through March 1984. This was the second season for which the new PoSA system provided operational forecasts.

2. DEVELOPMENT

The Regression Estimation of Event Probability (REEP) screening technique (Miller, 1964) was used to develop the PoSA forecast equations. This technique objectively selects a subset of effective predictors from a larger set of potential predictors to use in multiple linear regression equations. The equations give estimates of the probabilities of occurrence of a given set of binary predictands. For the PoSA equations, snow amount was categorized into three, cumulative, binary predictands: $\geq$2, $\geq$4, and $\geq$6 inches. The predictand is called binary because in the developmental phase it was assigned a value of 1 or 0 for a given case depending, respectively, upon whether or not that particular snow amount category occurred. A good description of the screening procedure can be found in Glahn and Lowry (1972).

Conditional PoSA equations were derived for each of several geographic areas (see Fig. 1) by combining data from all stations within the region. The equations are conditional because only "pure snow" events were included in the developmental sample which consisted of nine cool seasons from 1972-73 through 1980-81. A pure snow event is defined as the occurrence at a station of $\geq$0.1 inches of snow and/or sleet, and no other type of precipitation, during a 12-h period.

To produce unconditional PoSA forecasts, PoSA(U), the conditional PoSA forecast, PoSA(C), for each snow amount category is multiplied by the probability of precipitation (PoP) (National Weather Service, 1980) for the corresponding 12-h period and the average conditional probability of frozen precipitation ($\overline{PoF}$) (National Weather Service, 1982b) for the same 12-h period. To obtain $\overline{PoF}$, the 12-, 18-, and 24-h PoF forecasts are averaged; in this scheme, the 18-h forecast is weighted twice as much as the 12- and 24-h forecasts. For instance, the unconditional probability of the $\geq$2 inch category is estimated by:

$$\text{PoSA(U)} (\geq 2 \text{ inches}) = \text{PoSA(C)} (\geq 2 \text{ inches}) \times \text{PoP} \times \overline{\text{PoF}}.$$

In order to make categorical snow amount forecasts from the unconditional probability forecasts, threshold values were developed for each snow amount category, for each region, and for both 0000 GMT and 1200 GMT. The thresholds were obtained in an iterative manner by computing verification scores for categorical snow amount forecasts based on differing sets of threshold probabilities. The threshold chosen was the one which produced the best verification scores on the developmental sample.

Operationally, conditional, unconditional, and categorical forecasts are all transmitted on the FOUS12 bulletin (National Weather Service, 1983). Further details regarding the development of the PoSA system may be found in Bocchieri (1982a, 1982b, and 1983).

3. VERIFICATION RESULTS

We verified the categorical forecasts by calculating the bias, threat score, and post-agreement for each category of snow amount for the 12-24 h forecast period from 0000 and 1200 GMT for October 1983 through March 1984.[1] Table 1 shows the scores for both cycles for 183 stations combined. Also included for the purpose of comparison are the verification results from the 1982-83 cool season (Maglaras, 1984).

The verification results indicate that, in general, the 1200 GMT forecasts were slightly better than those for the 0000 GMT cycle during the 1983-84 cool season. The bias scores show that the PoSA system greatly overforecast the $\geq$4 and $\geq$6 inch categories for both cycles. Compared to the 1982-83 cool season, the bias scores for the 1983-84 cool season were much worse for the $\geq$4 and $\geq$6 inch categories, but they were slightly better for the $\geq$2 inch category. A comparison of the 1983-84 cool season with the previous cool season in terms of threat score reveals the same pattern as for the bias scores. The post-agreement indicates that, when the PoSA system forecast a category to occur, it was correct approximately 43% of the time for the $\geq$2 inch category, about 25% of the time for the $\geq$4 inch category, and about 19% for the $\geq$6 inch category. The post-agreement scores for this cool season were much worse than those for the previous cool season for the $\geq$4 and $\geq$6 inch categories, but slightly better for the $\geq$2 inch category.

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[1]The bias = B/C, the threat score = A/(B+C-A), and the post agreement = A/B, where A, B, and C are the number of correct forecasts, the total number of forecasts, and the number of observations of the event, respectively.

4. SUMMARY

The new PoSA system was implemented during September 1982. It provides probability and categorical forecasts for 183 stations in the conterminous United States for three categories of snow amount for 12-24 h periods after both 0000 and 1200 GMT.

Verification results for the second cool season of operational use of the PoSA system (October 1983 through March 1984) indicate that the PoSA system performed much worse, overall, than during the previous cool season (1982-83). Slight improvements in bias and threat scores for the ≥2 inch category were more than offset by much worse scores for the ≥4 and ≥6 inch categories. We think this is related to the fact that the number of cases for the ≥4 and ≥6 inch categories were small and a relatively small change in the number of forecasts for these two categories from one season to the next can make a significant difference in the scores for the PoSA system.

5. ACKNOWLEDGMENTS

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Table 1. The bias, threat score, post-agreement, and number of cases for categorical snow amount forecasts for 183 stations combined. These scores were calculated for the forecasts made from October 1983 through March 1984 (83-84), and for forecasts made from October 1982 through March 1983 (82-83). The results are shown for both the 0000 and 1200 GMT forecast cycles.

Snow Amount Category (inches)	Bias		Threat Score		Post-Agreement (%)		Number of Cases	
	83-84	82-83	83-84	82-83	83-84	82-83	83-84	82-83
0000 GMT								
≥ 2	1.06	1.13	.29	.26	41.8	38.5	434	420
≥ 4	1.47	1.08	.17	.20	24.3	31.6	102	126
≥ 6	1.73	0.72	.12	.16	17.2	26.7	37	43
1200 GMT								
≥ 2	0.95	1.06	.29	.27	43.7	41.4	421	444
≥ 4	1.46	1.07	.18	.24	25.8	36.9	92	122
≥ 6	1.56	0.90	.14	.17	20.3	31.1	41	50

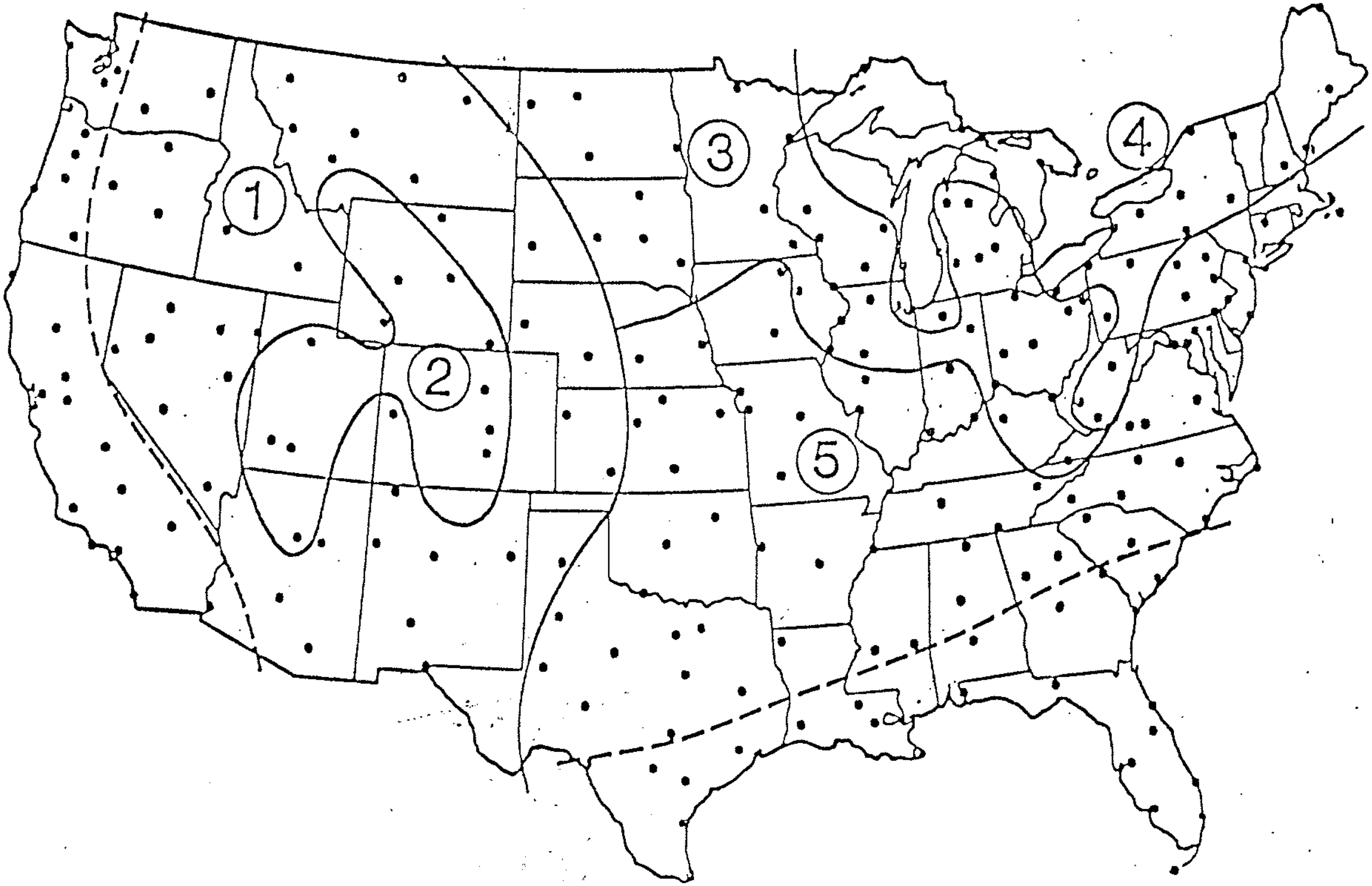

Figure 1. The five regions used in the development of the conditional probability of snow amount equations. Stations south and west of the dashed line were not included in the development.