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VERIFICATION OF WARM SEASON POPA CATEGORICAL FORECASTS OF PRECIPITATION AMOUNT

Robert J. Bermowitz and Edward A. Zurndorfer

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1. INTRODUCTION

Our probability of precipitation amount (PoPA) system for making both probabilistic and categorical forecasts of precipitation amount has been described in detail in a previous report (Bermowitz and Zurndorfer, 1975) The PoPA forecasts are supplied as guidance to the National Meteorological Center (NMC) twice per day. Until now, comparative verification of the PoPA system has been quite limited; consequently, the quality of the guidance received by NMC is relatively unknown.

To test the categorical forecasts made by our PoPA system, we established a comparative verification program with the assistance of NMC. This program and the results we have obtained so far are described in this paper.

2. VERIFICATION PROGRAM

We compared our PoPA categorical forecasts against those produced (1) subjectively at NMC, (2) by the limited area fine mesh (LFM) model (Howcroft and Desmarais, 1971) and (3) by the primitive equation (PE) model (Shuman and Hovermale, 1968). Threat scores[1] and biases[2] were computed for all forecast systems at 215 cities for the categories ≥ .25, ≥ .50, ≥ 1.0, and ≥ 2.0 inches for projections 12-36 and 36-60 hr after 0000 GMT and 24-48 hr after 1200 GMT. They were also computed for the categories ≥ .25, ≥ .50, and ≥ 1.0 inch for projections 18-24 hr after 0000 GMT and 12-18 hr after 1200 GMT. Subjectively prepared forecasts for these 6-hr projections were verified only for the category ≥ .25 inch, since NMC did not record categorical forecasts greater than that.

The period of verification consisted of about 100 days during the four months June-September 1976; missing forecasts caused some variation in sample size from projection to projection. Observations and subjectively prepared forecasts were recorded and supplied by NMC. LFM and PE precipitation amount forecasts were obtained from the Techniques Development Laboratory's (TDL's) collection of gridpoint fields of these models by interpolating to stations with use of a special interpolation algorithm (Gerrity and Newell, 1976). PoPA forecasts were retrieved from the operational computer runs.

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[1]Threat score = H/(F+O-H) where H is the number of correct forecasts of a category and F and O are the number of forecasts and observations of that category.

[2]Bias is the number of forecasts of a category divided by the number of observations of that category. A categorical bias equal to 1 means unbiased forecasts of that category.

We should point out that because of computer backlog and the necessity of meeting facsimile schedules, PoPA forecasts based on the PE and trajectory (TJ) (Reap, 1972) models were not always available in time for use by NMC in preparing their subjective forecasts. This problem was especially acute on the 1200 cycle. However, the 1200 GMT 12-18 hr early guidance PoPA forecasts based on the LFM (prepared about 2 hours earlier than the guidance based on the PE and TJ) should have been routinely available for use by the forecasters. Similarly, the 0000 GMT 18-24 hr early guidance PoPA also should have been routinely available.

3. RESULTS AND CONCLUSIONS

Results of the comparative verification are shown in Tables 1 and 2; Table 1 contains results for 24-hr projections and Table 2 has results for 6-hr projections. For the 6-hr projections, PoPA(L) means early guidance PoPA forecasts based on the LFM model. For all projections, PoPA forecasts based on the PE and TJ models are denoted by PoPA. Also, subjectively prepared forecasts are denoted by SUBJ.

A comparison of PoPA forecasts against those of the PE and LFM models shows that the PoPA forecasts had better threat scores with only one exception--the ≥ 2.0 inch category for the 12-36 hr projection, where the LFM had a higher threat score.

When the PoPA forecasts are compared to those prepared subjectively at NMC, considerable variation is evident. For example, PoPA had at least somewhat better threat scores than SUBJ for every category for both projections from 1200 GMT. However, for projections from 0000 GMT, PoPA was better only for the category ≥ .25 inch. SUBJ had better threat scores than PoPA for the category ≥ 2.0 inches, while PoPA and SUBJ were about the same for the ≥ .50 and ≥ 1.0 inch categories. The bias indicates that PoPA and SUBJ tended to overforecast precipitation amount. On the other hand, the LFM and PE tended to underforecast it, especially the higher amounts.

It is of interest to compare the PoPA forecasts (those based on the PE and TJ models) and PoPA(L) forecasts (those based on the LFM model) for the two 6-hr projections (Table 2). Although there was a tendency to overforecast precipitation amount by PoPA, especially for the 18-24 hr period after 0000 GMT, PoPA was better than PoPA(L) as indicated by the threat score. This superiority probably can be partially attributed to the larger sample size (nearly double) used in developing equations based on the PE and TJ models than that used to develop equations based on the LFM model. As a result, the PoPA equations and threshold probabilities that maximize the threat score are likely to be more stable than those of PoPA(L). (In order to improve the PoPA(L) forecasts, we have derived new equations and threshold probabilities for the 1977 warm season with an additional season of data.)

This verification program also makes it possible to compare forecasts of precipitation amount from the PE model to those of the LFM. The results indicate that the PE was better than the LFM in forecasting 24-hr amounts, except for the category ≥ 2.0 inches. For the 6-hr amounts, the LFM appeared to have a slight advantage, but the threat scores indicate little skill for categories ≥ .50 inch for both models. Indeed, the bias shows that the models forecasted very few occurrences of 6-hr amounts ≥ .50 inch at the 215 stations during the verification period.

To summarize, the results indicate that the PoPA forecasts were better than those of the PE and LFM models during the warm season at the 215 verification stations. Although there was considerable variation, the results also indicate that the PoPA forecasts were slightly better than those subjectively prepared at NMC. Therefore, we feel that the PoPA forecasts supplied to NMC should be useful guidance, at least for the summer season.

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Table 1. Comparative verification of 24-hr precipitation amount forecasts prepared (1) subjectively at NMC (SUBJ), (2) objectively with use of MOS and based on the PE and TJ models (PoPA), and (3) by the LFM and PE models. Sample consisted of forecasts for 215 stations for the period June-September 1976.

Forecast Projection (hrs)	Verification Score	Category (inch) ≥ .25				≥ .50				≥ 1.0				≥ 2.0			
		SUBJ	POPA	LFM	PE	SUBJ	POPA	LFM	PE	SUBJ	POPA	LFM	PE	SUBJ	POPA	LEM	PE
12-36 from 0000 GMT	Threat Score	.235	.244	.204	.225	.180	.180	.138	.173	.118	.113	.082	.092	.079	.025	.054	.019
	Bias	2.37	1.85	1.02	1.23	2.10	2.02	.92	1.20	2.02	2.19	.72	.87	1.35	.76	.47	.16
	Number of Precip. Cases	2064				1161				440				93			
36-60 from 0000 GMT	Threat Score	.195	.201	—	.171	.138	.136	--	.105	.073	.079	--	.059	.052	.025	—	.008
	Bias	2.20	2.00	—	1.12	1.88	2.15	--	.97	1.60	2.63	--	.68	.84	2.33	—	.20
	Number of Precip. Cases	2280				1279				478				99			
24-48 from 1200 GMT	Threat Score	.211	.219	.156	.186	.150	.162	.106	.131	.087	.108	.054	.071	.029	.049	.039	.012
	Bias	2.16	1.64	.92	1.07	1.75	1.82	.79	.91	1.57	2.09	.63	.54	1.06	2.25	.26	.02
	Number of Precip. Cases	2018				1126				422				85			

Table 2. Same as Table 1 for 6-hr periods. Objective forecasts based on the LFM model, PoPA(L), have been added.

Forecast Projection (hrs)	Verif-ication Score	Category (inch)														
		≥ .25					≥ .50					≥ 1.0				
		SUBJ	POPA	POPA(L)	LFM	PE	SUBJ	POPA	POPA(L)	LFM	PE	SUBJ	POPA	POPA(L)	LFM	PE
18-24 from 0000 GMT	Threat Score	.116	.137	.119	.079	.077	--	.076	.076	.027	.016	--	.035	.029	.007	0.0
	Bias	1.85	2.10	1.11	.66	.48	--	1.90	1.24	.29	.14	--	1.47	.88	.05	0.0
	Number of Precip. Cases			766					384					131		
12-18 from 1200 GMT	Threat Score	.103	.110	.105	.067	.056	--	.075	.042	.016	.008	--	.037	.020	0.0	0.0
	Bias	2.03	1.24	1.03	.45	.62	--	1.37	.83	.20	.16	--	.45	.97	0.0	0.0
	Number of Precip. Cases			491					218					78		