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PERFORMANCE OF OPERATIONAL OBJECTIVE 0-6 AND 3-9 H QUANTITATIVE PRECIPITATION FORECASTS RELATIVE TO MANUAL AND MODEL GENERATED FORECASTS

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An objective quantitative precipitation forecast (QPF) system developed at the Techniques Development Laboratory (TDL) has recently been implemented in the National Weather Service. The system produces 0-6 and 3-9 h probabilistic and categorical QPF's at the National Meteorological Center (NMC) twice daily (currently) for points over the conterminous United States. The forecasts are for the four precipitation amount intervals of $\geq$ 0.25, $\geq$ 0.50, $\geq$ 1.00, and $\geq$ 2.00 inches and for two 6-h forecast periods following 0000 and 1800 GMT. The forecasts are available on AFOS under the product identifiers NMCGPH01E and NMCGPH02E (see Technical Procedures Bulletin No. 370). Predictors used in the multiple regression equations on which the forecasts are based were derived from conventional surface observations, manually-digitized radar reports, localized precipitation amount and precipitable water climatologies, and forecast output from NMC's Limited-area Fine Mesh model (LFM). Separate regression equations are used during each of four seasons of the year and for seven climatologically-homogeneous regions.

The objective QPF's were evaluated by conducting daily verification during the summer and fall of 1986 and during the spring of 1987. The verification was performed on the objective QPF's in categorical form only since other operational QPF's with which this product was compared are expressed in this form. Also, the verification was performed only for the 0-6 h periods following 1800 and 0000 GMT, i.e., 1800-0000 and 0000-0600 GMT, since verification data are not presently available for the 2100-0300 and 0300-0900 GMT periods. For comparison, verification was also performed on three other short-range QPF products produced operationally at NMC and valid for the same periods as the objective forecasts. One was the 4-10 h QPF produced manually (MAN), and the two others are 6-12 and 12-18 h QPF's from NMC's LFM and Nested Grid Models (NGM). While the lead times for the various products differ, the NMC QPF's selected for comparison are the latest operationally-available issuances for the 1800-0000 and 0000-0600 GMT verification periods. The verifying precipitation (isohyetical) analysis was from an objective analysis of the 6-h precipitation amounts contained in 6-hourly conventional surface observations.

The verification for all four QPF products was performed by comparing the forecast and observed isohyetical maps over the United States. The scoring was performed both subjectively and objectively. In the subjective scheme (SUBJ), the author assigned a score to each forecast map by subtracting from 10.0 (a perfect forecast) a number between 0.5 and 2.0 for each precipitation feature incorrectly forecast and each observed feature not forecast. The amount subtracted for a particular incorrect forecast or non-forecast observed feature depended on its areal extent and the precipitation amounts. Smaller amounts were subtracted when individual forecast areas and amounts were close to those observed. All four forecast and observed isohyets were considered. In the objective scoring scheme, a rectangular grid with 40 n mi spacing was superimposed on the forecast and observed isohyetical maps. Grid points falling inside forecast or observed areas were tabulated to form 2 x 2 contingency tables. To reduce the manual workload, only the 0.5, 1.0, and 2.0 inch isohyets were considered. The standard Critical Success Index (CSI) and bias scores were then computed from the contingency tables.

Average values of the subjectively assigned scores for the four products are illustrated in Fig. 1. The scores are averaged over the 1800-0000 and 0000-0600 GMT forecast periods and for a sample from March 24-June 10, 1987. During the summer and fall of 1986, the relative scores for the various products were similar to those in Fig. 1. The averages for the objectively computed CSI and bias scores are shown in Fig. 2. The scores for this figure are for the same sample as that in Fig. 1, but recall the $\geq$ 0.25 inch precipitation interval is not considered, as it was for Fig. 1. In Fig. 2 the data are combined for the $\geq$ 0.50, $\geq$ 1.00, and $\geq$ 2.00 inch precipitation intervals. It should be noted the scores in Fig. 2 are heavily biased toward the $\geq$ 0.50 inch precipitation interval. For example, the sample consisted of 761 observations for this interval and 146 and 9 observations for the $\geq$ 1.00 and $\geq$ 2.00 inch intervals, respectively.

Figures 1 and 2a indicate the objective forecasts performed best, followed by the NGM, MAN, and the LFM. The top ranking of the objective QPF's is actually not surprising since this system was designed to update the MAN and LFM products (and eventually the NGM). Fig. 2b shows, however, the objective system in particular overforecast the observed precipitation, i.e., a bias of 1.0 denotes unbiased forecasts. This strong overforecasting is actually misleading, however, because it stems from an inconsistency between the observed precipitation field produced by the objective analysis and the forecasted precipitation from the objective QPF system. The objective system actually forecasts the maximum (or near maximum) point precipitation within a 40 x 40 n mi grid box, with the maximum based on the high density climatic hourly precipitation network, as noted in Technical Procedures Bulletin No. 370. The precipitation analysis used here for verification, on the other hand, represents a local area-average based on the lower density conventional surface network. Thus, the area-average precipitation strongly under-represents the maximum point amounts forecast by the objective system. The bias with proper verifying data for this system should be about 1.2 to 1.5 and the CSI should improve also. As for the NMC QPF products, the verifying precipitation analysis is believed consistent with amounts forecast, as suggested by the bias' for these products in Fig. 2b. Thus, the present verification for the objective system, in particular, is considered preliminary and final results await availability of the climatic hourly precipitation data. However, it seems certain the relative performance of the objective QPF's will improve with the better precipitation data.

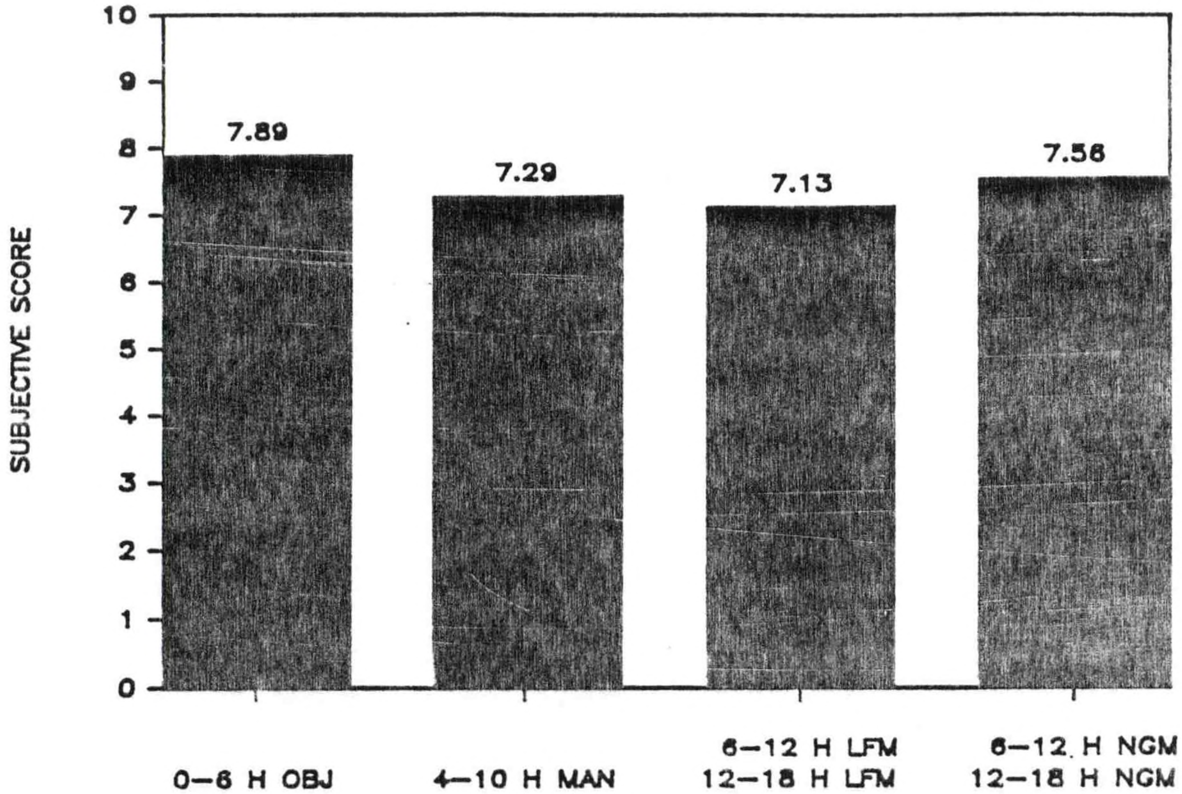

Figure 1. Subjective scores for four QPF products valid 1800-0000 GMT and 0000-0600 GMT over the period March 24-June 10, 1987. OBJ stands for the TDL objective QPF's and MAN denotes the NMC manual forecasts. The 6-12 h LFM and NGM forecasts are valid 1800-0000 GMT and the corresponding 12-18 h forecasts are valid 0000-0600 GMT. The sample sizes for all products were 58 days and 48 days for the 1800-0000 and 0000-0600 GMT periods, respectively.

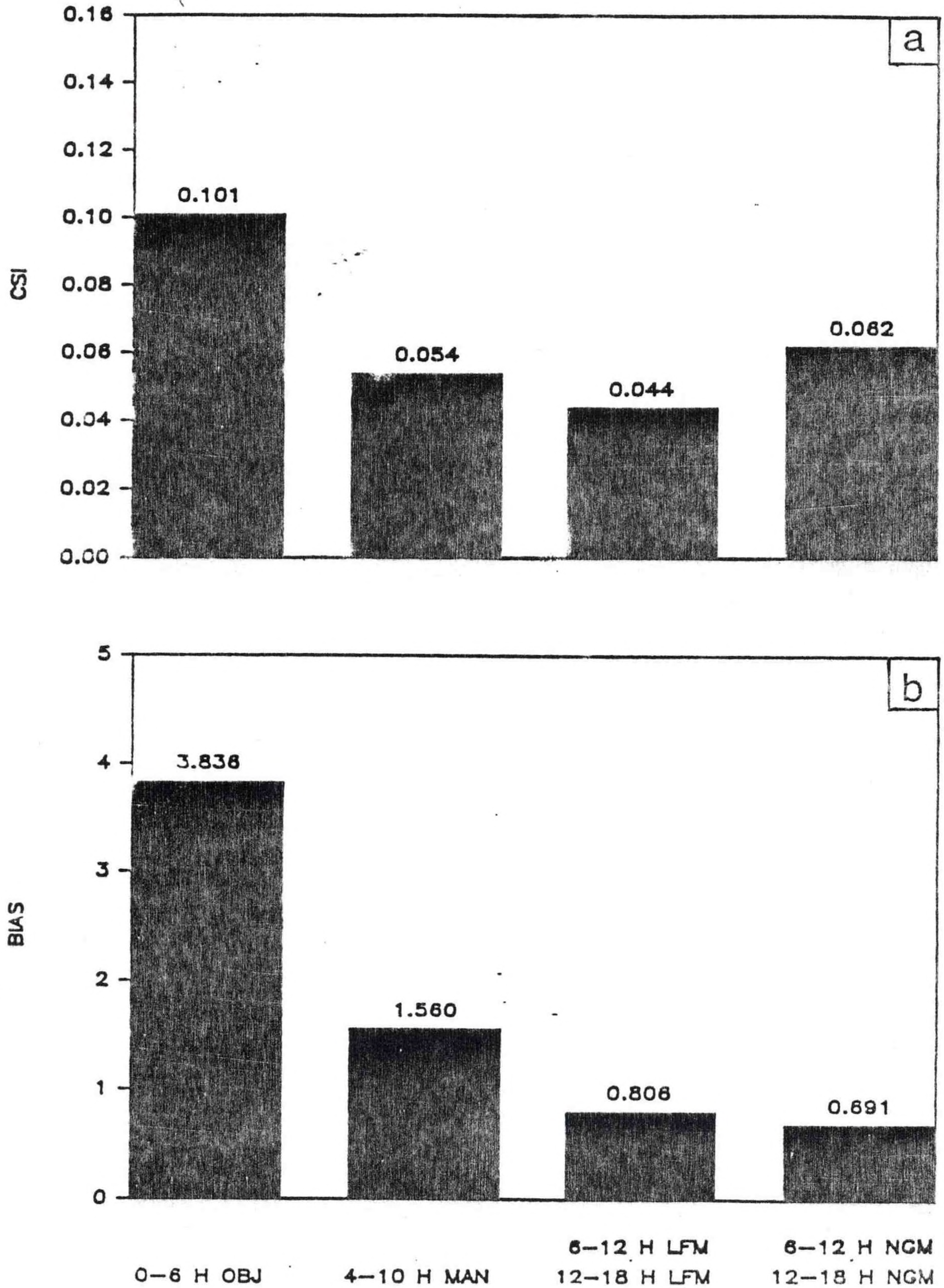

Figure 2. Critical Success Index (CSI) (a) and bias (b) computed objectively for four QPF products. The CSI was computed for combined verification data for the ≥ 0.50, ≥ 1.00, and ≥ 2.00 inch precipitation intervals. Otherwise, the same as Fig. 1.