



**Western Region Technical Attachment  
No. 90-28  
August 7, 1990**

**MODEL OUTPUT STATISTICS  
WHICH IS BETTER, LFM OR NGM?**

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*[Editor's Note: New NGM MOS guidance replaced the NGM perfect prog guidance in July 1989. The cool-season (October-March) NGM equations are based on three years of data. This new guidance became available to forecasters for the first time this past cool season. Note that the LFM MOS system consists of separate equations for four seasons while the NGM MOS has separate equations for only two seasons. Both systems have single-station equations for temperature but regionalized equations for POPs. Please refer to Technical Procedures Bulletin 387 (June 1990) for additional details on the NGM-based MOS guidance.]*

Now that NGM-based MOS forecasts of temperature and POPs are available, it seems only natural to compare this product with our old standby, the LFM MOS. And in the process, determine not only which is best, but also look at the biases of each.

With this in mind, a comparison of the output from the MOS systems was done from October 6, 1989 through March 31, 1990, in general, the cool half of the year. Five sites in the southwest U.S. were examined.

**Observations:**

1. As illustrated in tables 2 through 6, overall the NGM MOS temperature guidance was slightly superior to the LFM guidance for the five stations.
2. The NGM showed a warm bias to both maximum and minimum temperatures; the LFM a cool bias. This was especially true when observed temperatures were somewhat above normal.
3. Frequently, when temperatures were below normal by five degrees or more, the LFM was as good, or better, than the NGM.
4. At Flagstaff, the observed maximum/minimum temperature most often fell between the NGM and LFM values. Note Flagstaff was the only location where, overall, the LFM was superior to the NGM.

The primary reason for the LFM superiority was the strong warm bias of the NGM at this location; in particular, when the air mass was cold, due to a temperature inversion. This is reflected in table 5.

5. In general, the NGM was at it's best at the lower desert stations of Phoenix and Tucson.

Note also that, in general, both models did better at lower elevation locations.

I was unable to find biases in the NGM and LFM POPs. As indicated in table 7, the Brier Scores for the two were almost identical.

*[Editor's Note: Output from the National Verification Program for this past cool season shows that overall, for the Western Region, the Mean Absolute Error (MAE) temperature scores for the LFM and NGM were very similar, with the NGM slightly better. The LFM did score better on forecasts of maximum temperatures when the 24-hour change was ten degrees or more. The NGM had a better MAE for cases where the minimum temperature changed by 10 degrees or more. The percent of the time that temperature forecasts were within five degrees of the observed was slightly higher for the NGM. Brier Scores for the region as a whole were almost identical. Thus, the NGM MOS guidance is very competitive with the LFM MOS. As illustrated by the author, the challenge to forecasters now is to determine which system provides the better guidance under various situations.]*

Table 1

## Total Number of Cases

Phoenix	1360
Tucson	1352
Flagstaff	1360
Las Vegas	1295
Cedar City	1344

Table 2

Mean Absolute Temperature Error  
(00Z and 12Z Cycles Combined)

	LFM	NGM	% Improvement
Phoenix	2.84	2.51	12
Tucson	3.31	2.85	14
Flagstaff	3.60	3.71	-3
Las Vegas	2.66	2.63	1
Cedar City	3.69	3.44	7
Totals	3.22	3.03	6

Table 3

## MAE 00Z Cycle

	LFM	NGM	% Improvement
Phoenix	2.92	2.70	8
Tucson	3.53	3.01	15
Flagstaff	3.71	3.79	-3
Las Vegas	2.76	2.77	0
Cedar City	3.76	3.51	7
Totals	3.34	3.16	6

Table 4

## MAE 12Z Cycle

	LFM	NGM	% Improvement
Phoenix	2.74	2.33	16
Tucson	3.06	2.68	14
Flagstaff	3.49	2.63	-4
Las Vegas	2.56	2.49	3
Cedar City	3.62	3.36	7
Totals	3.10	2.90	7

Table 5

## MAE Minimum Temperatures

	LFM	NGM	% Improvement
Phoenix	3.16	2.63	17
Tucson	3.30	3.07	7
Flagstaff	4.29	4.45	-6
Las Vegas	2.96	2.88	3
Cedar City	4.01	3.73	7
Totals	3.55	3.38	5

Table 6

## MAE Maximum Temperatures

	LFM	NGM	% Improvement
Phoenix	2.51	2.40	5
Tucson	3.31	2.62	21
Flagstaff	2.91	2.86	2
Las Vegas	2.35	2.38	-1
Cedar City	3.37	3.14	7
Totals	2.89	2.68	8

Table 7

## Brier Scores (Combined 5-station)

	LFM	NGM	% Improvement
00Z Cycle	.046	.048	-6
12Z Cycle	.048	.047	2
Totals	.047	.048	-2