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NGM WINTER PRECIPITATION BIAS AT SALT LAKE CITY AND CEDAR CITY UTAH

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The quantitative precipitation forecast (QPF) output of the NGM is examined during the 1986-87 winter months. The purpose of this paper is two-fold: 1) to determine the quantitative precipitation bias of the NGM for Salt Lake City (SLC) in northwest Utah and Cedar City (CDC) in southwest Utah during the winter, and 2) to determine the accuracy of the NGM to forecast measurable precipitation at both stations. This paper is similar to Carle's paper on the LFM winter precipitation bias [1]. Comparisons are made between the results from the LFM study and this NGM study.

Almost five months of NGM QPF forecasts (from AFOS product FRHT73) were examined for both SLC and CDC during the period November 18, 1986 through March 31, 1987. Close to 4,300 forecasts from the FRHT73 bulletins were evaluated.

The QPF bias is examined first. This was accomplished by comparing the amount of precipitation forecast for each 6-hour period against that which actually occurred. Table 1 illustrates these comparisons.

The first 6-hour period of the NGM is extremely dry. These NGM results were similar to the LFM, in spite of the fact that the initialization procedures are very different between the NGM and the LFM. After the 0-6 hour period, the percent gradually increases until the 18-24 hour period. This is consistent with results of other NGM studies (i.e., NMC Quarterly Performance Summary, July-September 1987) and is related to the model's initialization process. A change implemented in August 1987 should alleviate the NGM's dry bias in the 1st 12 hours of the cycle (see Editor's Note at end of paper). After 24 hours, there does not appear to be a significant trend. Unlike the LFM, which shows a wet bias (Table 2), Table 1 clearly shows the NGM does not have a significant bias after 12 hours. Overall, the NGM dry bias is less pronounced than the wet bias of the LFM. The statistical correction made to the NGM in October 1987 to compensate for the model's pronounced cold bias may make the NGM dry bias more pronounced. This is because a reduction in the cold bias will result in lower RH values.

The accuracy or number of correct NGM forecasts of measurable precipitation is next examined. In this case, an NGM QPF forecast was defined to be correct if the NGM predicted measurable precipitation during a 6-hour period, and it occurred. Cases where no precipitation was forecast and none occurred were not considered. This is because both SLC and CDC are generally dry, and the majority of cases would have consisted of correct forecasts of no precipitation forecast and none occurring. For the most part, these forecasts provide little worthwhile guidance. Tables 3 and 4 indicate the percent of correct NGM forecasts.

The accuracy of the FRHT73 forecasts are generally between 25-35% correct. The poorest performances are generally for the 0-6 hour period and the 42-48 hour period. The former are due to the excessively dry initial period, and the latter are due to the difficulty in forecasting further out in time. When comparing the NGM results with Carle's LFM results [1] (see Tables 5 and 6), it appears that both models have a similar percentage of correct forecasts, but the LFM does slightly better at SLC and the NGM slightly better at CDC.

In conclusion, it is obvious that the NGM possesses a dry bias during the first 6-12 hours. From 12-48 hours, the NGM QPF looks reasonable, whereas the LFM has a strong wet bias. Both models are similar in their inability to correctly predict measurable precipitation. Quantitative knowledge of this QPF bias provides the forecaster a basis for adjusting LFM and NGM guidance to obtain more realistic QPF forecasts. This study should also provide the forecaster a better feel for how much confidence to place on the ability of the NGM and LFM to predict measurable precipitation at SLC and CDC.

Reference:

[1] LFM Winter Precipitation Bias at Salt Lake City and Cedar City, Utah, Western Region Technical Attachment No. 86-02, January 1986.

[Editor's Note - On August 12, 1987, the NGM normal mode initialization (NMI) procedure was reduced from 8 to 2 vertical modes. The purpose of NMI is to reduce the high frequency/amplitude non-meteorological oscillations present at the outset of the forecast. Each additional vertical mode acts as an accumulative filter, removing more and more of these oscillations. However, in doing this, some of the real ageostrophic (divergent wind field) motions are also removed. These ageostrophic motions are responsible for moisture convergence and resulting vertical motion fields. Using the rather heavy-handed approach of 8 vertical modes yields an initial wind field near geostrophic balance and removes most of the horizontal convergence/divergence and vertical motion couplets. As a result, the model usually takes the first 6-12 hours of the forecast cycle to regenerate this ageostrophic motion. Consequently, the precipitation forecasts from the model tend to have a dry bias in the first 12 hours of the cycle. In the 12-24 hour time frame, the model will catch up, and in some cases, overcompensate for precipitation during this period.

Results of parallel testing last year showed that a reduction from 8 to 2 vertical modes of the normal initialization process filtered out most of the excessive non-meteorological noise but preserved much of the initial ageostrophic field; hence, 0-12-hour predicted precipitation amounts for the NGM should increase and be more realistic. For more information, the reader should check Technical Procedures Bulletin No. 372].

TABLE 1

Forecast Periods (Hours)	Amount of Precipitation Forecast by the NGM Divided by Amount of Precipitation that Occurred (Percent)	
	Salt Lake City	Cedar City
0-6	14	18
6-12	30	75
12-18	73	95
18-24	98	131
24-30	94	119
30-36	85	95
36-42	126	86
42-48	102	127
0-48	78	91

TABLE 2

Forecast Periods (Hours)	Amount of Precipitation Forecast by the LFM Divided by Amount of Precipitation that Occurred (Percent)	
	Salt Lake City	Cedar City
0-6	16	15
6-12	114	148
12-18	134	132
18-24	168	173
24-30	168	173
30-36	180	257
36-42	210	221
42-48	210	343
0-48	151	175

Table 3

SLC	Only Cases When Pcpn Fcst or Occurred	
Forecast Periods	Number of NGM Forecasts Correct Divided by Number of Forecasts	Percent Correct
0-6	6 / 25	24
6-12	11 / 35	31
12-18	12 / 44	27
18-24	21 / 58	36
24-30	15 / 55	27
30-36	14 / 68	20
36-42	16 / 62	26
42-48	17 / 75	23
0-48	112 /422	27

Table 4

CDC Forecast Periods	Only Cases When Pcpn Fcst or Occurred Number of NGM Forecasts Correct Divided by Number of Forecasts	Percent Correct
0-6	10 / 42	24
6-12	13 / 34	38
12-18	13 / 51	26
18-24	17 / 45	38
24-30	19 / 57	33
30-36	13 / 42	31
36-42	17 / 56	30
42-48	10 / 48	21
0-48	112 /375	30

Table 5

SLC Fcst Periods	Only Cases When Pcpn Fcst or Occurred Number of LFM Fcsts Correct Divided by Number of Fcsts	Percent Correct
0-6	22 / 108	20
6-12	68 / 145	47
12-18	65 / 165	39
18-24	76 / 195	39
24-30	58 / 192	30
30-36	73 / 222	33
36-42	63 / 214	31
42-48	67 / 226	30
0-48	496 /1467	34

Table 6

CDC Fcst Periods	Only Cases When Pcpn Fcst or Occurred Number of LFM Fcsts Correct Divided by Number of Fcsts	Percent Correct
0-6	13 / 46	28
6-12	26 / 66	39
12-18	30 / 84	36
18-24	30 / 96	31
24-30	27 /106	26
30-36	27 /112	24
36-42	23 /115	20
42-48	23 /116	20
0-48	199 /741	27