Western Region Technical Attachment
NO. 88-29
October 25, 1988

NMC MODEL PERFORMANCE MARCH-MAY 1988

A copy of the NMC Seasonal Performance Summary for the period March to May 1988 was recently sent to each WSFO. There is a lot of good information in this summary, and we encourage each forecaster to look through this bulletin. A few of the more salient points are highlighted below.

As reported in previous Western Region Technical Attachments (WRTA) 86-29 and 87-44, the NGM developed a significant cold bias after the radiation physics package was introduced in July 1986. An example of the cold bias for the month of September 1986, is shown in Figures 1a and 1b (from WRTA 86-29). The bias was fairly uniform in height and increased with time. This, of course, translated into a strong negative height bias with time. In October 1987, a statistical correction was introduced into the NGM to negate this cold bias. Once each hour, the average potential temperature is computed over the entire hemisphere at each level. This average is compared with the initial (time zero) average, and the value at each grid point is then adjusted by this difference. The adjustment has the effect of restoring the average potential temperature back to the value it had at the start of the forecast for each model layer, every hour. Last year, *experimental* runs indicated this would make a positive impact on the model run. Did this correction make a difference?

Figures 2a and 2b, from the Performance Summary, show the NGM mean height and temperature error for the period March-May 1988. The mean temperature error is now only slightly negative below 500 mb (less than 0.4 deg C) and even less than that above that level, and showing no significant tendencies with projection time. This change is reflected in the mean height error (Figure 2b), which shows the mean height error now is positive below 400 mb, but generally less than 4 m. Above 400 mb, the positive bias becomes larger, though there are no strong tendencies with projection time. The correction implemented in October 1987 has contributed to improved model performance in these areas. It should be pointed out, however, that this correction was applied hemispherically, and there still exist regional anomalies. In the West, there is still a slight negative height and temperature bias in the latter projection periods of the NGM.

For comparison, the same data is shown from the LFM in Figures 3a and 3b. Note the strong negative height and temperature biases, especially in the later projection times, above 300 mb.

Although the bias scores seem to favor the NGM, these scores do not show the amount of variance of forecast error. In this case, the models are closer although the NGM holds a slight edge. Figures 4a and 4b show the standard deviation of height error for the LFM and NGM, respectively. Both show the standard deviation of height errors increasing with time.

Table 1 presents the precipitation statistics for the LFM and NGM. Note that this verification is only for points east of the Rockies. NMC is planning to make a change within the next year to include the western U.S. as well. The lack of verifying observations in the West has been a problem. For amounts $\leq$ 0.5 inch, the NGM does not exhibit a strong bias (does not under- or over-forecast significantly), and is generally better than the LFM. This is a change from previous seasons. For amounts $\geq$ 0.75 inch, the NGM significantly underforecasts for all periods while the LFM strongly overforecasts, especially from 24-48 hours.

The NGM historically underforecast precipitation in the 0-24 hour range and then generated too much from 24-48 hours. This problem was related to model spin-up. Until last year, a heavy handed initialization procedure removed most of the divergent wind fields, which are important in developing the vertical motion fields. Therefore, the model started out slow, and after it "caught up", it overforecast precipitation from 24-48 hours. A change in the initialization procedure was implemented last August and apparently has corrected this tendency. The LFM, however, still exhibits a strong tendency to underforecast early in the model run and then overforecast considerably from 24-48 hours. It should be noted that this tendency is not reflected in MOS. This is one of the primary differences between MOS and the Perfect Prog approach. Once a model's weakness or tendency is recognized, MOS compensates for it; the Perfect Prog approach always assumes the model output is correct. Therefore, as long as the Perfect Prog approach is used, it is more important that the NGM reduce its biases. NGM MOS is still several months away.

The global spectral model, used to produce the aviation and medium-range forecasts, has also undergone a few changes over the past few years, including increased horizontal and vertical resolution, the GFDL physics package, a diurnal cycle, silhouette mountains and gravity wave parameterization. Figure 5 shows the monthly 500 mb S1 scores for the 12 and 36 hour forecasts from this model, as taken from the cover of the Performance Summary. The S1 score evaluates how well the model has forecast gradients at each hemispheric grid point and is particularly sensitive to phase errors in the forecasts. A perfect S1 score is zero. A steady improvement in the S1 score over the past several years is evident. Still, verification of the 120 hour 250 mb forecasts reveals a negative height bias (previously reported in WRTA 85-36) in most Northern Hemisphere locations for the March-May 1988 period (Figure 6).

<u>References</u>

NOAA, 1988: NMC Seasonal Performance Summary March - May 1988, Vol 1, No. 2, National Meteorological Center, Washington D.C., 74 pp.

NOAA, 1987: Statistical Correction for the NGM Cold Bias, Western Region Technical Attachment WRTA 87-44, NWS Western Region, Salt Lake City, UT, October.

NOAA, 1986: Temperature Bias of the NGM, Western Region Technical Attachment WRTA 88-29, NWS Western Region, Salt Lake City, UT, October.

NOAA, 1985: Summertime Biases in the MRF Model, Western Region Technical Attachment WRTA 85-36, NWS Western Region, Salt Lake City, UT, August.

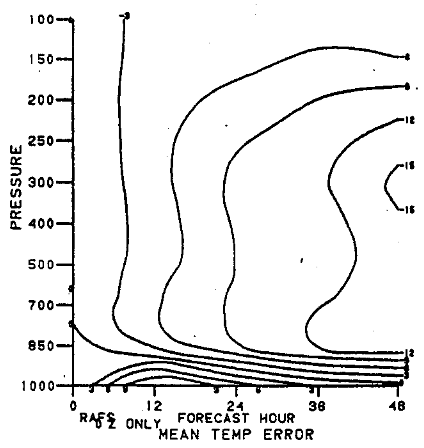

Fig. 1a. 1986 September average NGM forecast error (x 10^{-1} ^{o}C) over North America for 00Z model runs. Values below 850 mb are meaningless.

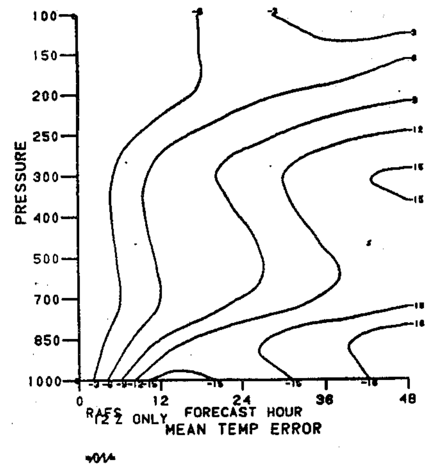

Fig. 1b. As in Fig. 1a, except for 12Z model runs.

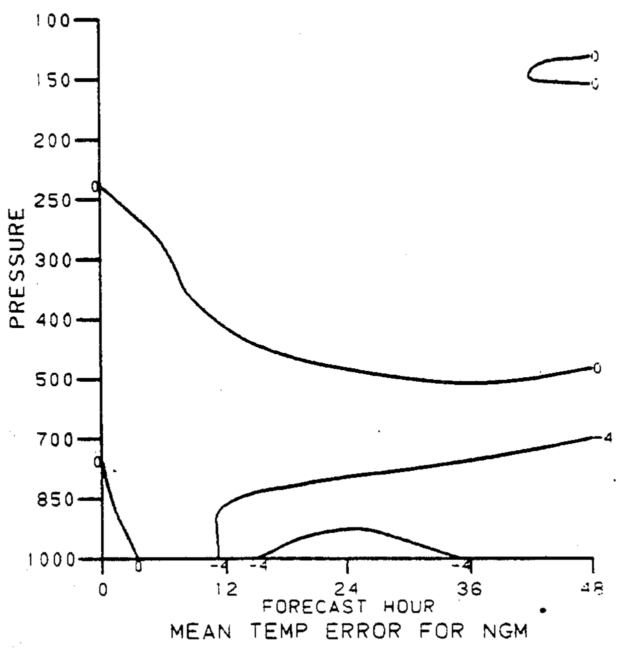

Fig. 2a. Mean NGM temperature error (x 10^{-1} ^{o}C) over North America, March-May 1988.

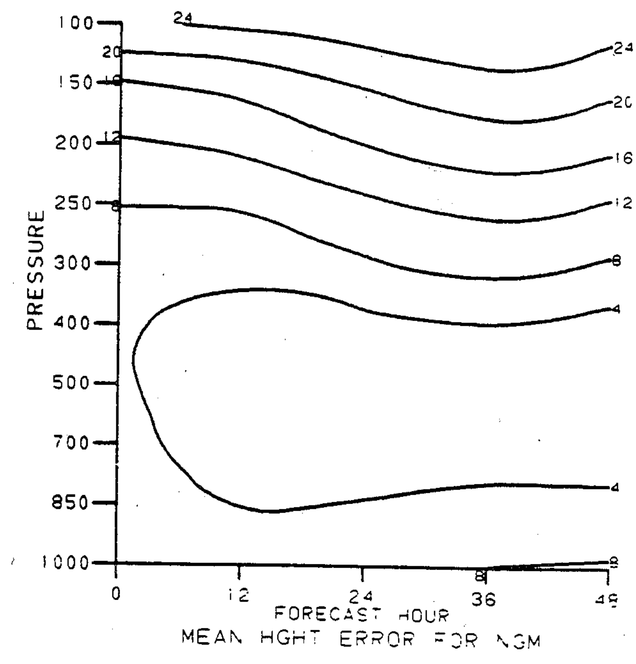

Fig. 2b. Mean NGM height error(m) over North America, March-May 1988.

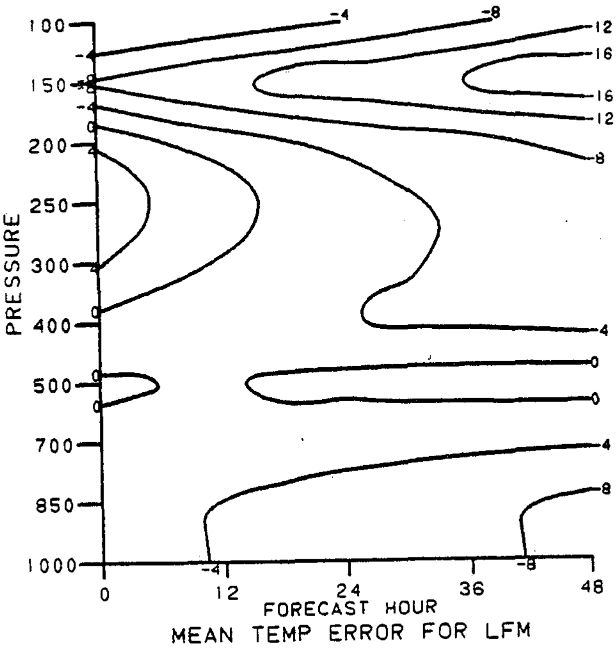

Fig. 3a. Mean LFM temperature error ($\times 10^{-1}$ °C) over North America, March-May 1988.

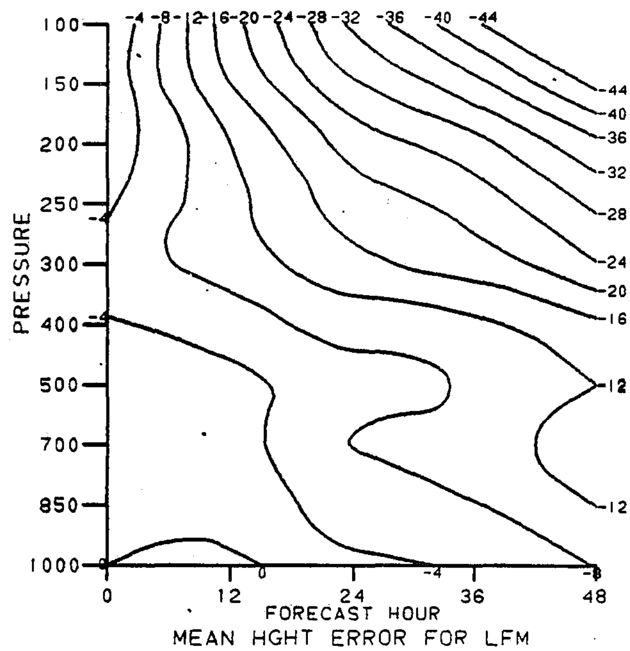

Fig. 3b. Mean LFM height error (m) over North America, March-May 1988.

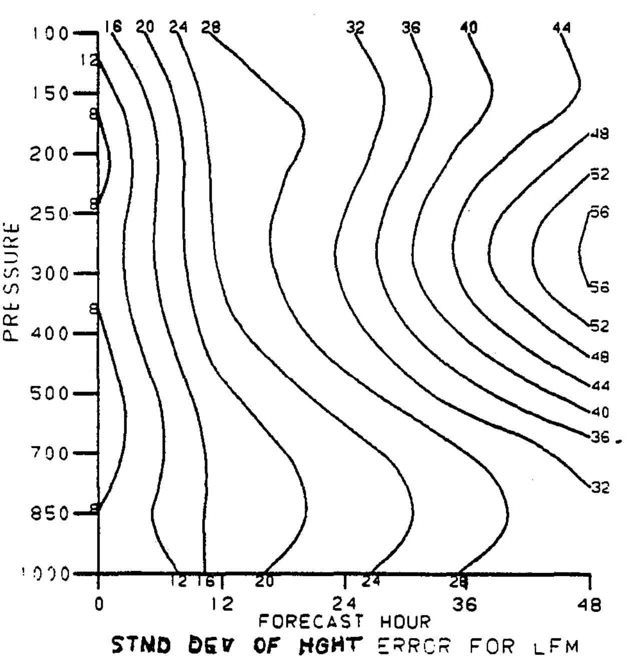

Fig. 4a. Standard deviation of LFM height error (m) over North America, March-May 1988.

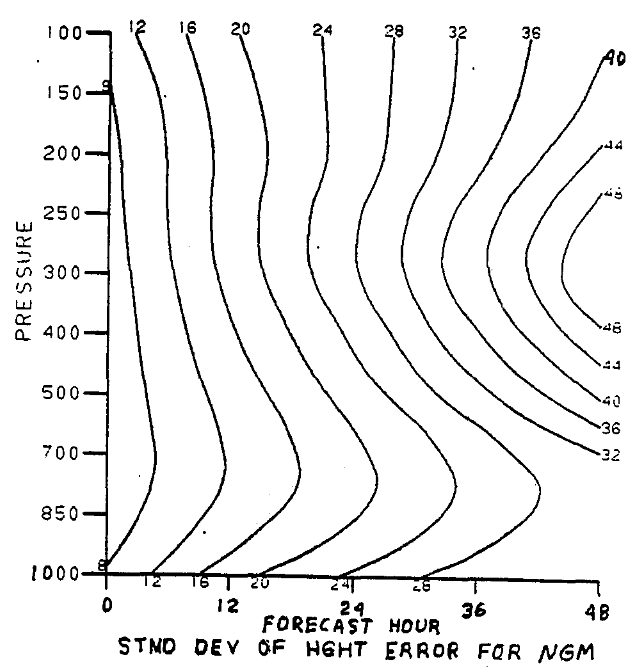

Fig. 4b. Standard deviation of NGM height error (m) over North America, March-May 1988.

Table 1. Mean verification statistics (threat score and bias) for LFM and NGM forecasts derived from daily precipitation scores for the spring season. LFM grid is used for verification, with NGM forecast amounts interpolated from the NGM C grid and observed amounts interpolated from the 32 km NMC 24-hr precipitation analysis grid by a method that conserves total areal precipitation. 'PTS' indicates the average number of verifying grid points over the 3 24-hr forecast intervals. Only land points east of the Rocky Mountains are considered. (Bold face type indicates the winner.)

MARCH - MAY 1988 -- SPRING SEASON

THRESH-OLD (IN.)	0-24 HOUR FORECAST THREAT LFM	THREAT NGM	BIAS LFM	BIAS NGM	12-36 HOUR FORECAST THREAT LFM	THREAT NGM	BIAS LFM	BIAS NGM	24-48 HOUR FORECAST THREAT LFM	THREAT NGM	BIAS LFM	BIAS NGM	PTS.
0.01	0.45	**0.51**	0.78	**1.04**	0.47	**0.51**	**0.99**	1.09	0.45	**0.49**	**0.96**	1.23	10001
0.25	0.28	**0.34**	0.77	**1.26**	0.31	**0.32**	1.29	**1.24**	0.25	0.25	**1.09**	1.50	2085
0.50	**0.26**	0.25	0.75	**1.05**	0.25	0.25	1.47	**1.04**	**0.18**	0.17	1.22	**1.17**	973
0.75	**0.24**	0.19	0.82	**0.83**	0.20	0.20	1.78	**0.91**	**0.12**	0.08	1.50	**0.94**	473
1.00	**0.21**	0.17	**0.85**	0.59	**0.14**	0.13	2.10	**0.81**	**0.09**	0.06	1.64	**0.72**	263
1.50	**0.12**	0.08	**0.99**	0.28	**0.08**	0.05	3.08	**0.61**	**0.04**	0.03	1.77	0.56	90
2.00	**0.02**	0.00	**1.60**	0.24	0.02	**0.06**	6.00	**0.46**	0.00	0.00	2.88	**0.42**	24
2.50	0.00	0.00	**2.00**	0.11	0.00	0.00	9.78	**0.11**	0.00	0.00	**3.56**	0.00	9
3.00	0.00	0.00	4.00	**0.50**	0.00	0.00	28.5	**0.50**	0.00	0.00	**10.0**	0.00	2
3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0

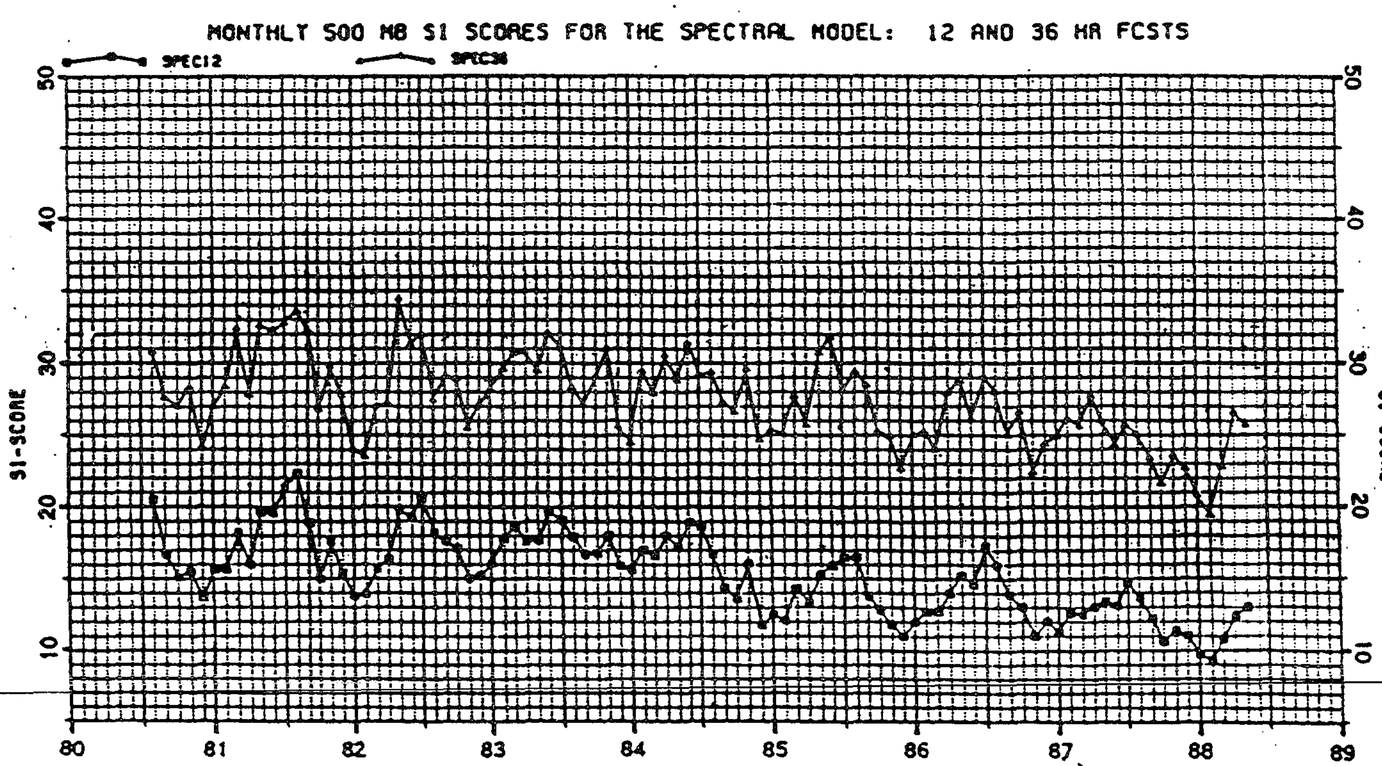

Fig. 5. 500 mb S1 scores for NMC Medium Range (spectral) Forecast Model since 1980 for 36-hr (top) and 12-hr (bottom) projections.

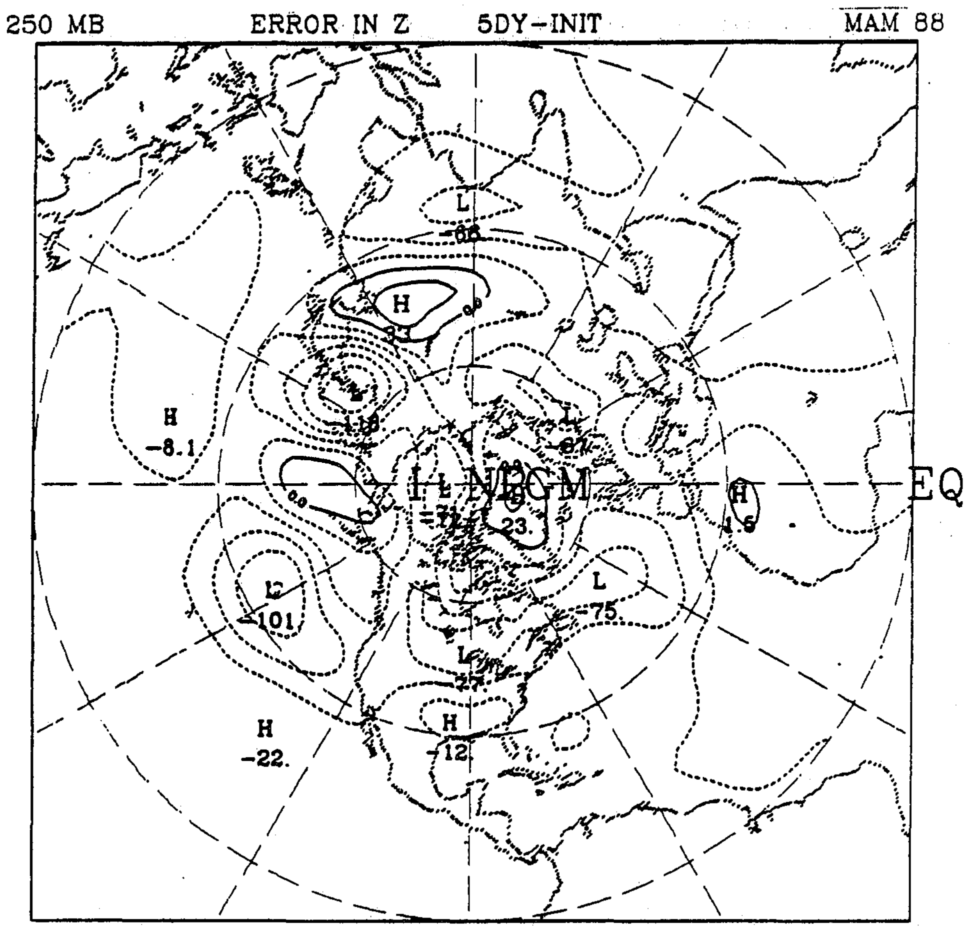

Fig. 6. Mean 120-hr height error (m) at 250 mb, March-May 1988. Contour interval 20 m. Negative contours dashed.