WESTERN REGION TECHNICAL ATTACHMENT
NO. 88-14
April 5, 1988

REVIEW OF THE NMC NUMERICAL GUIDANCE SUITE IN 1987 AND A PREVIEW OF CHANGES IN 1988
PART I

Ronald D. McPherson, Editor
Meteorological Operations Division

Contributors
James E. Hoke
Masao Kanamitsu
Development Division

Robert E. Bell
Frank D. Hughes
David A. Olson
Meteorological Operations Division

National Meteorological Center

Meteorological Operations Division Technical Note 88-1

March 15, 1988

NMC/MOD Technical Notes are unreviewed manuscripts intended for informal exchange of information among NMC personnel and NWS field forecasters.

[SSD Editor's Note: This weeks's technical attachment is Part I in a seven part series on NMC model changes and performance characteristics. We think forecasters will find the information quite useful; it should serve to update forecasters on recent model changes and let them know what near term future changes they can anticipate. One part will be published each week over the next seven weeks.]

1. Introduction

On December 10/11, 1987, a year-end review of the NMC numerical guidance suite was held at the World Weather Building. The review was jointly organized by Development and Meteorological Operations Divisions. It was aimed at keeping MOD forecasters abreast of the latest changes in the guidance, and imminent ones, and of providing feedback to developers on model performance. The speakers were James Hoke, and Masao Kanamitsu of Development Division, and Robert Bell, Frank Hughes, and David Olson of MOD. Ronald McPherson of MOD served as the moderator.

The following sections are summaries of each speaker's remarks. Attached as appendices are copies of each speakers's viewgraphs in the order they were presented.

2. Changes to the Regional Analysis and Forecast System (RAFS) in 1987: James Hoke

Significant modifications of the RAFS were introduced on six occasions during the year.

<u>February 18:</u>

The first guess for the analysis component (Regional Optimum Interpolation - ROI) comes from the Global Data Assimilation System. On this date, the resolution of the spectral prediction model used in the GDAS was increased from R30 to R40* in the horizontal, and from 12 to 18 layers in the vertical. This had the effect of improving the quality of the guess, and is especially important in data-sparse regions, where the first guess in essence supplies the initial conditions for the prediction model. The most noticeable effect was the improvement of the bottom layer temperatures in the first guess.

Also, on this date, changes were introduced in the ROI to treat temperature soundings from polar-orbiting satellites (TOVS) in a more discriminating fashion. Figure A-1 shows the difference in 500 mb height at initial time and in the subse-

---

* The nomenclature rhomboidal (R) and triangular (T) is used to describe horizontal resolution in spectral models and is derived from the way the spectral series representations are truncated. (See Figure B-1 for the illustration.) Basically, rhomboidal truncation allows more terms in the series (more variability latitudinally) for each longitudinal wave number, given the same numerical truncation. R40 (40-wave truncation) means that the minimum resolvable wave has a wavelength of 9 degrees in the east-west direction.

quent 48 h forecast for runs with this change (indicated by RAFX) and without this change (RAFS). Note the large difference off the west coast at the initial time, and the spread of those changes with time. The differences were such that the 48 h RAFX prediction was much superior to the operational run.

February 25:

In response to performance problems noted when storms originated in the low resolution domain of the NGM and moved into the high-resolution grid C domain, or vice versa, the NGM B- and C- grid domains were expanded on this date. This moved the coarse resolution domain farther from the area of forecast interest. Figure A-2 shows the new configuration. Improved performance resulted along both Pacific and Atlantic coasts. Figures A-3 and A-4 are included to illustrate the former. Note the operational forecast (A-3) of the cyclone which verified at 956 mb near 50N, 148W was too far south and not deep enough by 40 mb. With the expanded domain, both position and intensity were much improved, although the latter was still in error by 23 mb.

August 12:

Another change in the GDAS affected the RAFS performance. This time the MRF87, with T80 horizontal resolution and a diurnal cycle, was introduced, as will be discussed in the next section. This again had the effect of improving the RAFS analysis.

Also, at this time the nonlinear normal mode initialization procedure was modified. This change was based on the work of Professor F. Carr of the University of Oklahoma, who was a UCAR* Visiting Scientist at NMC during the latter half of 1986, and by NMC modelers Richard Wobus and Ralph Petersen. They showed that including the lowest eight vertical modes in the initialization destroys the divergent circulations that are crucial ingredients for short-term precipitation forecasting. Figure A-5 shows the difference between the analysis and the 8-mode initialization in one case. The sense of the difference is such that the initialization removed the large-scale upper level divergence centered over Louisiana and the corresponding low-level convergence. The 2-mode initialization largely corrected this.

The third change at this time was the introduction of an improved long-wave radiation formulation near the ground in the prediction model. This change reduced the excessive long-wave cooling in the bottom layer of the model at night.

* University Corporation for Atmospheric Research, sponsored by the National Science Foundation.

August 26:

The postprocessor of the NGM was modified to generate hourly profile data at a number of points in the computational domain. Figure A-6 is an example of the graphics that can be generated from hourly model information. Thus far, these products are used only internally at NMC as operational forecasting and diagnostic aids because communication limitations prevent their external dissemination. Work is underway, however, to make this excellent data base available to users outside of NMC.

October 21:

The long-standing hemispheric cold bias in NGM predictions was corrected on this date. Introduced with the advanced physics package in the summer of 1986, this cold bias has resisted all efforts to understand its origin to enable the formulation of a physically based correction. Accordingly, an empirical correction was introduced, in which the hemispheric average potential temperature in each layer of the model is reset every hour to its initial value. Pre-implementation tests showed this indeed corrected the hemispheric problem, as illustrated in Figure A-7. An additional side-effect is the area of precipitation forecasts was slightly reduced, thus reducing the NGM's characteristic of overforecasting measurable precipitation. Figure A-8 is another interesting illustration of the cold-bias correction, taken from a Western Region Technical Attachment. Displayed are the 48 h 500 mb height forecast from the last run before the correction, and the 36 h forecast from the first run after the correction. Both verified at the same time and the isolines are almost exactly 60 m different. Although the correction eliminated the hemispheric cold bias problem in the NGM, there is still a significant regional temperature bias problem. The model is still too cold over the Rocky Mountains, for instance, and is now too warm in the eastern U.S.

December 9:

The last changes of 1987 were basically computational in character, affecting the running time but not the meteorological performance of the RAFS. Indirectly, however, there will eventually be an impact on the performance, because the efficiencies will permit some additional changes in 1988 that would otherwise have to wait for the next-generation computer.

In the ROI, a new, more efficient code was introduced that reduced the running time of the analysis from 30 to 24 minutes. This is part of a unification effort that in 1988 will result in the same basic computer codes being used for both regional and global applications.

Tests with the NGM demonstrated that certain physical processes--for example, radiation and convection--do not require calculation every 75 seconds on grid C. Instead, calculation of these processes every 15 minutes provides essentially the same forecast, and saves 15 minutes computer time per run. The performance of the model after this change is still under review, however, and further adjustments may be necessary in 1988.

The combined savings of 21 minutes will be used to accomplish some of the 1988 upgrades discussed in Section 7.

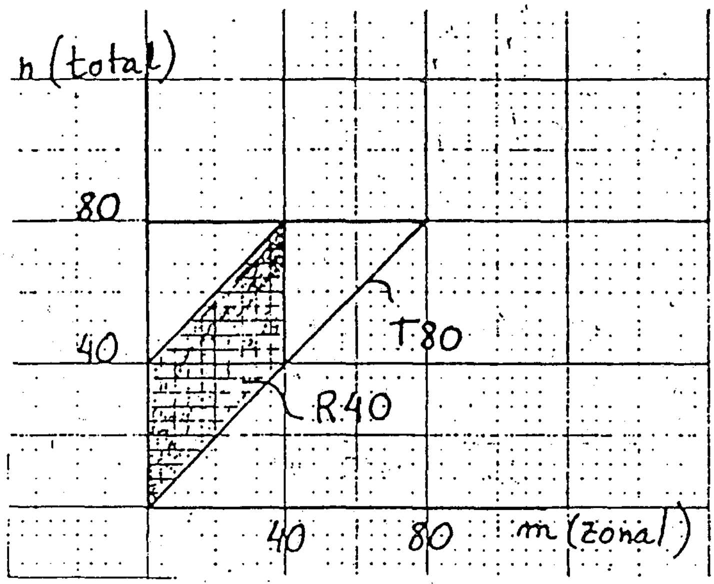


Fig. 1. Schematic of horizontal truncation in wavenumber space.

FIGURE B-1

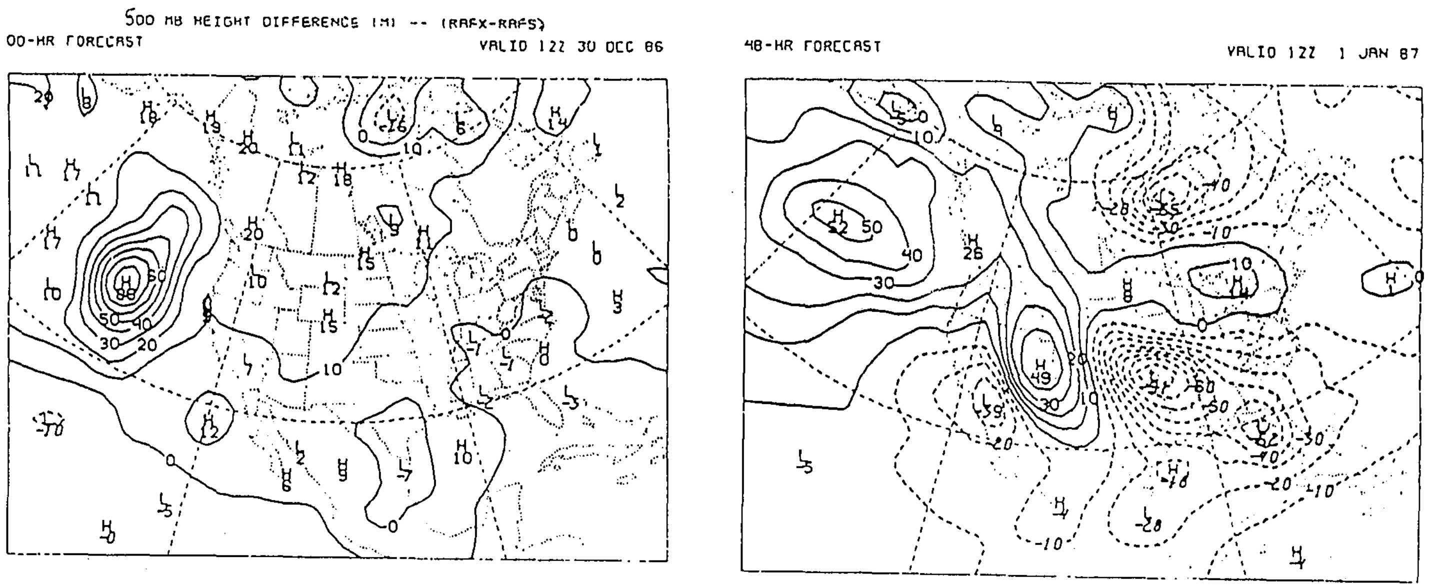
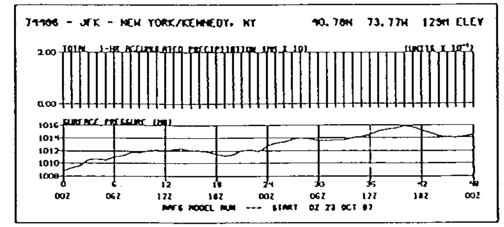


FIGURE A-1



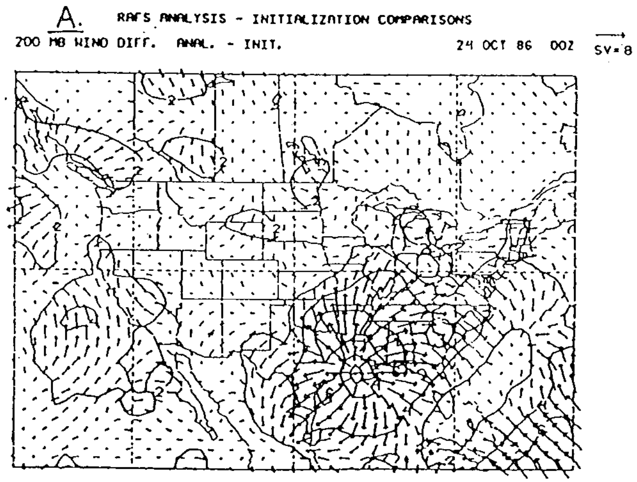


FIGURE A-5

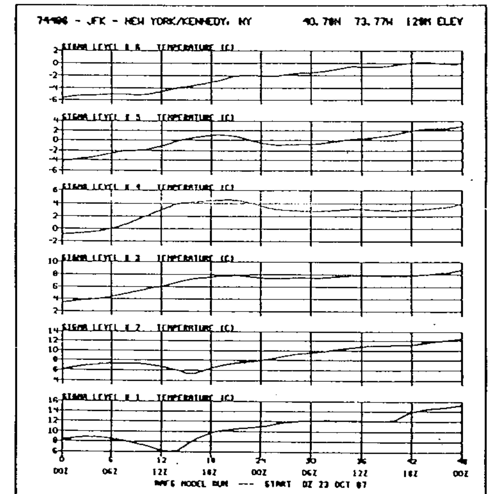


FIGURE A-6

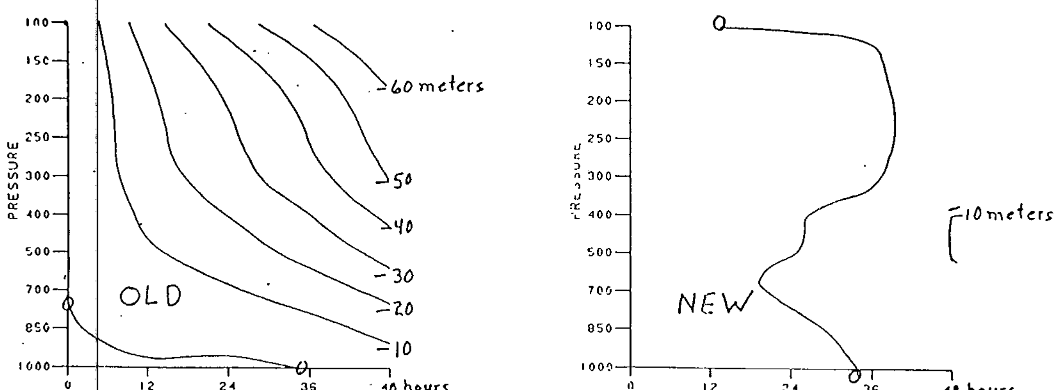


FIGURE A-7

Figure 1. Development with forecast time of isobaric height error averaged over North America and averaged over 25 forecasts for the period 7/30/12Z - 8/12/00Z 1987. The top diagram is for operational forecasts, the bottom diagram for experimental forecasts using the temperature adjustment described in the text.

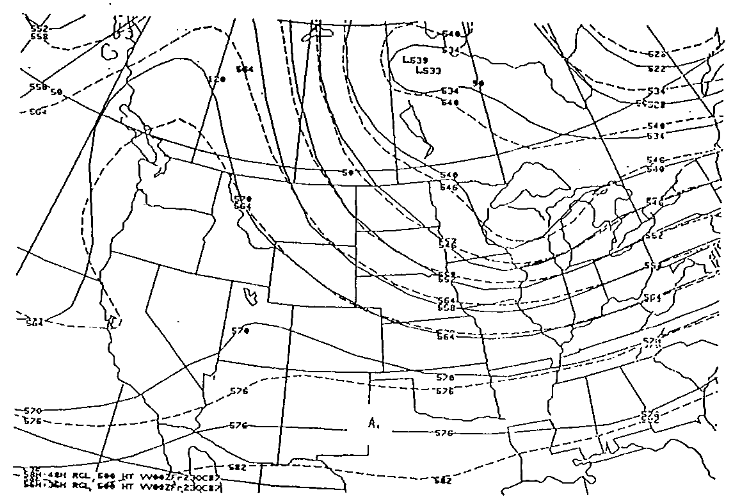


FIGURE A-8

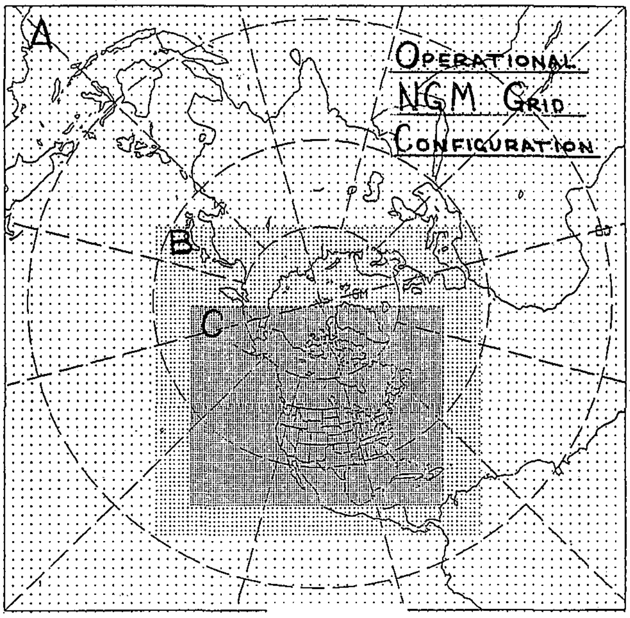


FIGURE A-2

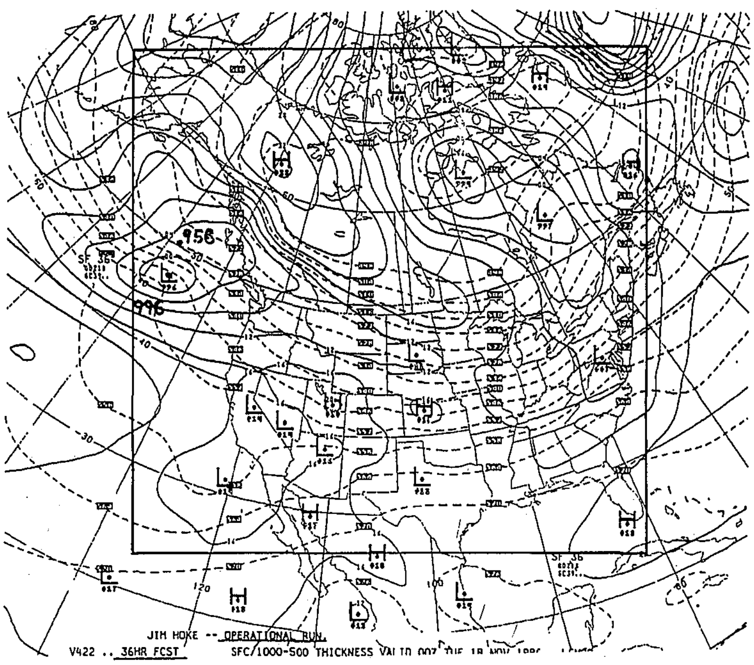


FIGURE A-3

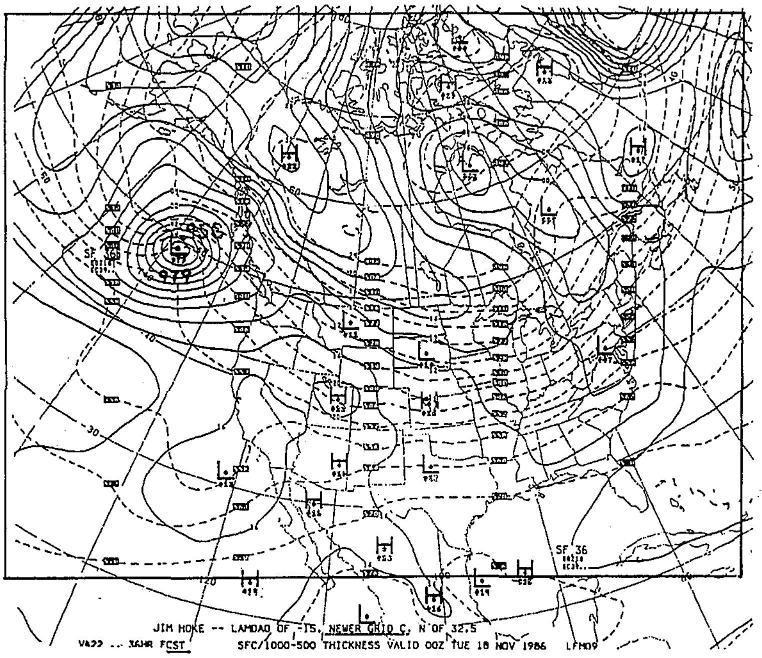


FIGURE A-4