NMC NOTES

Recent Changes to NMC's Analysis and Forecast Systems

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1. Introduction

This is the first of what we expect will be a regular series of National Meteorological Center (NMC) contributions to *Weather and Forecasting*. These "NMC Notes" will provide a mechanism for presenting information on NMC forecast systems and changes in these systems to the wide community of weather forecasters—both public and private—who depend upon our products. We have long felt the need for a way to do this and are delighted at the opportunity that *Weather and Forecasting* affords.

We will focus these notes on matters of interest to operational forecasters and welcome comments through the Co-Chief Editors on the topics we select and the clarity of our presentations. We will try, through these notes, to respond to your questions that we consider of general interest. Two-way communication is important. We will certainly want to know if these notes are meeting the need for which they are intended and we encourage suggestions for change.

NMC notes will cover not only the activities of NMC Washington but those of our component centers: The Climate Analysis Center, the National Hurricane Center, and the National Severe Storms Forecast Center. Focal points have been established in each of these centers and in each NMC division, who will identify and encourage contributions.

This first NMC note includes a brief summary of some recent changes to NMC numerical analysis and forecast systems. Readers who wish more detail are referred to National Weather Service *Technical Procedures Bulletins* or other reports or publications that document these changes. *Technical Procedures Bulletins* or *NMC Office Notes* referred to in the Notes will be made available upon request to the authors or the Co-Chief Editors of *Weather and Forecasting*.

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2. Changes in the start time for the Aviation Forecast Run

On 14 December 1988, the start times for the NMC Aviation Global Forecasts (AVN) were advanced by 45 min to 0245 and 1445 UTC. The earlier start times permit earlier product delivery. The trade-off, however, is a reduced time allowance for collection of 0000 and 1200 UTC data. Studies show that the earlier start time has only a small effect on the collection of rawinsonde reports; the primary data loss is in the satellite-based wind observations from the western Pacific. Parallel forecasts run for two periods of approximately 1 month each showed no significant loss of accuracy in forecasts to 72 h. Verifications were conducted in Northern and Southern hemispheres separately and involved both rawinsonde reports and global analyses.

3. Global model changes

The same global forecast model is used in the AVN, the Medium Range Forecast System (MRFS) and the Global Data Assimilation System (GDAS). On 30 November 1988, a series of changes were introduced in this model. Changes are interrelated and were introduced primarily to reduce the cold-bias of the model in the mid- and lower tropospheres, to reduce the systematic loss of eddy kinetic energy during the course of a 10-day forecast, and to make the model run faster. Changes involved the replacement of zonal mean climatological clouds by more realistic model-humidity-derived clouds in the radiative flux calculations, reduction of the horizontal diffusion coefficients for divergence, vorticity, humidity and heat, and lengthening of the time step for calculation of vorticity and specific humidity through calculation of the horizontal advection by a semi-implicit technique. Parallel tests prior to the implementation of these changes showed a reduction by as much as 50% in the bias of 5-day forecasts of temperature and geopotential height. Running time required for a 10-day forecast, even with the more complex cloud/radiation calculations was reduced by

30 min (about 15%). Changes are described in an NMC *Technical Procedures Bulletin* (Campana et al. 1988).

4. Changes to the global analysis system

A number of small changes were introduced in the global analysis system on 30 November 1988.

The most significant of these changes dealt with the use of satellite temperature soundings along coasts. Satellite temperatures over the oceans are used at all levels. Over the continents they are currently used only above 100 mb where the errors of the satellite temperatures become comparable to or less than the errors of radiosonde observations. Erroneous temperature gradients introduced along coastlines by the previous system were reduced by correcting errors in the codes that calculated the satellite thicknesses and "anchored" these data to the 100-mb analyses.

Other changes involved the assignment of errors to observed and forecast data. These preassigned errors determine the relative weights given to various types of observations in correcting the 6-h forecasts that provide first-guess fields for each global analysis. Forecast errors were reduced to reflect improvements in the global forecast model. New estimates of observational error were introduced that brought the NMC estimates into closer agreement with those used by the European Centre for Medium-Range Weather Forecasts (ECMWF).

Minor changes were made in the quality control procedures for dealing with isolated observations.

Changes are described in an NMC Technical Procedures Bulletin (Deaven et al. 1989).

5. Changes in the initialization procedures in the Regional Analysis and Forecast System

In the Regional Analysis and Forecast System (RAFS), fields analyzed on the σ levels of the model are passed through an initialization procedure before the forecast begins. The purpose of this initialization is to remove the meteorologically insignificant gravity waves to suppress forecast "noise". The method used initially (Hoke 1984) used the normal modes of an 80-wave (rhomboidal) spectral model with the same vertical structure as the Nested Grid Model (NGM) of the RAFS. This procedure was modified in 1987 (Carr et al. 1989) to improve the ability of the system to retain meteorologically significant divergence. A new procedure was implemented on 14 December 1988. This procedure, based upon a method developed by Temperton (1988), performs the initialization only upon the corrections derived from observations rather than the full analysis fields. It retains a major share of the divergence associated with moutains and ageostrophic flow and permits more rapid "spin up" of precipitation in the first 12 h of the forecast. Improvements over the modified initialization procedures described by Carr et al. (1989) are small; use of the new method is an important first step, however, in the development of a new regional system for assimilation of profiler, aircraft, and NEXRAD observations over the United States. The new procedure is discussed in an NMC Office Note (Parrish 1989).

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