U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL WEATHER SERVICE
NATIONAL METEOROLOGICAL CENTER

OFFICE NOTE 336

1987 SUMMARY OF CHANGES TO NMC OPERATIONAL GLOBAL ANALYSES

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JANUARY 1988

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I. INTRODUCTION

This is the third in a series of reports prepared to keep researchers throughout the meteorological community abreast of changes made to the National Meteorological Center (NMC) operational global analysis procedures. The first two such reports -- Dey, et.al., 1985 and Dey, Ballish, and Phoebus, 1987 -- covered the years 1984 and 1985-86, respectively. This one is devoted to 1987. The major change made to the global system during 1987 was the replacement of the 40-wave (rhomboidal truncation), 18-layer global prediction model with a 80-wave (triangular) version. We hope the description of this and other changes made during 1987 will prove useful to users of the NMC global analyses.

Section II describes briefly the various global analyses run operationally at NMC. Section III reviews the changes we made to our operational analysis procedures during 1987. Problems are described in the final section.

II. Overview of NMC Operational Global Analyses

Three distinct global analyses are run at NMC every 12 hours: the ERL -- Early -- analysis (1+05 data cutoff), the AVN -- Aviation System -- analysis (3+45 data cutoff), and the GDAS -- Global Data Assimilation System -- analyses (6+00 cutoff for data centered on 0000 GMT, 8+30 cutoff for data centered on 12 GMT, and 9+30 cutoff for data centered on 0600 GMT and 1800 GMT). The ERL is a Hough Function analysis, while the AVN and GDAS analyses are based on the optimum interpolation procedure described in Dey and Morone (1985) The ERL analysis provides initial conditions for a 48-hour barotropic forecast. The AVN analysis is used to initiate a 72-hour global forecast designed to provide guidance for the aviation community. The GDAS analyses provide initial conditions for the 6-hour global forecasts that represent the forecast part of the GDAS. The 6-hour global forecasts are used as the first guess for all NMC operational analyses, both global and regional. In addition, the 0000 GMT GDAS analysis provides initial conditions for a 10-day medium-range forecast (MRF) model integration.

III. Changes Made During 1987

A. Change of 1200 GMT, January 12, 1987 (AVN, GDAS)

NOAA-10 data were admitted to the analyses. Retrieval path A (clear) and B (partly cloudy) data were admitted at all latitudes, while retrieval path C (cloudy) data were used only poleward of 20° latitude.

B. Change of 1200 GMT, January 13, 1987 (AVN, GDAS)

The NOAA-10, retrieval path C data admitted just the previous day were found to be bad and were therefore removed from the analyses.

C. Implementation of 1200 GMT, February 25, 1987 (AVN, GDAS)

NOAA-10, retrieval path C data were readmitted to the analyses. At the same time, the observational error standard deviation values assigned to retrieval path C data were revised. The old and new values are given in Table 1.

D. Change of 1200 GMT, March 11, 1987 (AVN, GDAS)

The NOAA-9 data were deteriorating and were therefore removed from the analyses.

E. Implementation of 1200 GMT, August 12, 1987 (AVN, GDAS)

This was the major alteration of the global system made during 1987. In this alteration, the global spectral model resolution was increased from 40 to 80 waves and the truncation changed from rhomboidal to triangular. In addition, a diurnal cycle was added to the short-wave radiation parameterization. Numerous other changes were necessary in order to interface the optimum interpolation (OI) analysis with the revised prediction model. Only two of the changes were meteorologically significant, however.

In the OI analysis, the first guess is interpolated from sigma to pressure and the pressure-level spectral coefficient fields are evaluated on a latitude/longitude grid. The gridded values are then bilinearly interpolated to the observation locations in order to form the observed corrections, or residuals. The first of the two (somewhat) significant changes to the OI analysis was to increase the resolution of the intermediate latitude/longitude grid from 2.5°x2.5° to 1.0°x1.0°. Note that the analysis grid itself was not changed.

During preimplementation testing of the "triangular 80" GDAS, a satellite report in the tropics was accepted that had an erroneously warm 1000 mb-850 mb thickness. The resulting analysis caused the new global model to fail due to excessive convection. In order to prevent reoccurences of such situations, a test was installed to compare the satellite 1000 mb-850 mb thickness temperature with the first guess 1000 mb temperature in the tropics. When the former exceeds the latter by more than 1.5°C, the satellite thickness is considered to be too warm (which takes into account a lapse rate assumption). Such warm tropical retrievals are not used in the analysis.

F. Change of 1200 GMT, September 2, 1987 (AVN, GDAS)

An error was corrected in the tropopause wind shear field, a diagnostic field prepared after the analysis is completed. Also, a large set of statistics on the fit of the GDAS first guess, analysis, and initialization to individual data types was prepared, sent from the CYBER 205 back to the front end NAS computers, and archived on the internal NMC history tapes. Finally, a gravity wave drag parameterization was added to the global spectral model. Table 2 describes the attributes of the global spectral model after this implementation. The new features added or changed during 1987 are underlined.

G. Change of 1200 GMT, December 2, 1987 (AVN, GDAS)

The statistics from the GDAS on the fits to the data were changed. The dropsondes were removed as an individual category and replaced by the ASAP ships.

H. Change of 1200 GMT, December 22, 1987 (AVN, GDAS)

An error was corrected in the code that updates the first guess. The error had caused two operational failures discussed in Section IV. B.

IV. Problems Encountered During 1987

In any system as complex as the AVN and GDAS, it is difficult to avoid some problems. There were relatively few problems during 1987, but three are worth mentioning. This list is not exhaustive, but it covers those most likely to affect users of the NMC global analyses.

A. Satellite Data Problems (AVN, GDAS)

As noted in Section III. D., a deterioration in the quality of NOAA-9 soundings led to its removal on March 11. However, poor quality soundings could have been accepted by the analysis prior to that time. Some caution would be wise for the week preceding March 11.

B. Failures of 0000 GMT, November 25, 1987 and 1800 GMT on December 14, 1987 (GDAS)

A test in the code that updates the first guess checks for any analyzed residuals that exactly equals 999 on the analysis grid, a preset value, to insure all analysis grid points have been treated. If it occurs, the updating process terminates, causing the subsequent forecast to fail. This test was inadvertently changed to compare to 9.99. On these two occasions, an analysed residual was calculated that was exactly 9.99. The change of December 22 corrected the error.

C. Failure of 1800 GMT, December 24, 1987 (GDAS)

This failure was due to an ill-conditioned analysis resulting from satellite retrievals that were very close together spatially. This problem should be corrected in an implementation planned for January 1988.

References

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Table 1. NOAA-9 and NOAA-10 Retrieval Path C (cloudy) Observational Error Standard Deviations (m)

Pressure	Old	New
50	40.0	55.0
70	40.0	53.0
100	40.0	50.9
150	40.0	46.5
200	40.0	43.2
250	36.5	42.6
300	33.0	42.0
400	26.0	44.8
500	26.0	45.3
700	22.0	38.3
850	14.0	21.0
1000	13.0	20.0

Table 2. Characteristics of the New GDAS Global Prediction Model

Resolution:	Global spectral triangular-80 truncation. Eighteen (18) unequally spaced layers.
Orography:	Silhouette mountains (enhanced, without smoothing) (Mesinger/Mintz).
Cumulus Convection:	Deep convection (Kuo/Anthes) Shallow convection (Tiedike).
Large Scale Condensation and Evaporation of Rain:	100% saturation criterion. Modified Kessler formulation.
Air Surface Interaction:	Analysis of SST (fixed during forecast). Predicted land temperature and moisture.
Diffusion:	Horizontal -- quasi-isobaric, biharmonic, for u, v, t, and q, but not pstar. Vertical -- stability dependent for temperature, momentum, and humidity.
Gravity Wave Drag:	After Pierrhumbert, Helfand et.al., and Palmer et.al.
Radiation:	Short-wave -- Lacis and Hansen, with simplified diurnal variation. Long-wave -- Fels and Schwartzkopf. 12 hourly update, three layers of clouds zonally averaged climatological.
Surface Parameters:	
Roughness:	Vegetation dependent over land. Stress dependent over oceans.
Albedo:	Monthly mean modified by snow cover.
Soil Moisture:	Monthly climate interactive with forecast precipitation and evaporation.
Snow Depth/Cover:	Monthly climate interactive with forecast snow evaporation.
Sea Ice:	Monthly climate, fixed during integration.