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

OFFICE NOTE 320

ELIMINATION OF 1000 MB TEMPERATURE ANALYSIS IRREGULARITIES

William J. Bostelman and Clifford H. Dey
Medium-Range Modeling Branch

MARCH 1986

I. INTRODUCTION

During the past year, the Ocean Products Branch has pointed out that the NMC Global Analysis of 1000 mb temperature contains extensive areas of small-scale noise. Geographically, their location is confined to oceanic regions and they are detectable only under unusually tight (1°-2°C) contour intervals. One typical example of such an analysis is shown in Fig. 1. Naturally, the cause of this problem had to be determined and corrective measures taken. The following report documents the results of the susequent investigation which was undertaken by the Medium-Range Modeling Branch.

II. DISCUSSION

Two possible sources of error were considered for investigation. These included:

1) the initial observational data file and all first guess files used by the Analysis, and

2) the Analysis program code itself (1000 mb height analysis sections only).

A. Initial Data and First Guess

First, the 1000-850 mb thickness of radiosonde, TIROS, and first guess data for 00Z, July 18, 1985, were plotted on several maps by the Versatec. Next, intercomparisons were made between each set. The intercomparisons can be summarized as follows:

1. For the most part, TIROS and radiosonde observations were in agreement.

2. Radiosonde observations and the first guess were also in close agreement.

3. In areas not covered by radiosondes, TIROS observations differed significantly from the first guess.

Based upon result no. 3, a review of the Analysis program's handling of TIROS data seemed appropriate.

B. Review of Analysis Program

During the analysis procedure, TIROS sounding data is modified several times by various anchoring techniques. The first is applied prior to the 1000 mb height analysis by using the 1000 mb first guess height field as the anchor so that a gross error check can be performed. Then, following the 1000 mb height analysis (in which TIROS data are not used), the TIROS data are re-anchored before they are used in the height and wind analyses at atmospheric levels above 1000 mb. Thus, the first anchoring does not affect the 1000-850 mb thickness analysis, while the second anchoring does. For the 1000 mb temperature analysis, the second anchoring has the most relevance, since the temperature calculation depends to a large degree on the 1000-850 mb thickness analysis (the "analyzed" temperature fields are, in fact, calculated from the analyzed height fields). Consequently, this anchoring section of the Analysis program, contained in subroutine FIXTIROS, was chosen to be examined thoroughly for errors.

Briefly stated, the re-anchoring process performed in FIXTIROS is accomplished by adding the previously calculated analyzed 1000 mb height residuals to the TIROS soundings at all analysis levels at and above 850 mb. To obtain the residuals at the geographical locations of the TIROS report, a rather involved procedure is invoked. First, the analyzed residuals are transformed from a

gridded field to spectral coefficients which are then evaluated spectrally at each satellite report location.

An initial review of the internal workings of this subroutine revealed no obvious coding errors. As a result, it was necessary to test, individually, each step of the procedure for accuracy in order to verify that it was working correctly. The results of the testing are discussed below.

C. Test Results From FIXTIROS

A representative data plot of individual height residual values at the satellite locations as evaluated by FIXTIROS is shown in Fig. 2. Note the definite lack of consistency and continuity of this set of data. This result suggested that the re-anchoring procedure was somehow flawed.

Further testing, which involved examination of the latitude and longitude specifications of the satellite report locations, finally revealed the source of the error. Subroutine FIXTIROS assumes latitude and longitude positions between +90° to -90° for latitude and 0° to 360° East for longitude. However, the report latitudes and longitudes are extracted from the large data array BUFFS. In BUFFS, the latitude-longitude positions are stored as between 0° to 1800° for latitude and between 0° and 3600° East for longitude. To remedy this error, the following modifications were made to the procedure in FIXTIROS:

$$lat = lat/10. - 90$$

$$lon = lon/10.$$

Where:

lat is the latitude of sounding

lon is the longitude of sounding

The effect of the coding mistake was to add a quasi-random error to the TIROS observations at and above 850 mb, and leave them anchored to the first guess 1000 mb height field. It is interesting to note that we have thus run for 18 months without ever anchoring the satellite sounding observations to an analysis.

When the analysis was rerun, the values of the new height residuals at the satellite sounding locations were plotted and contoured in Fig. 3. The corresponding region from the analyzed height residual map was extracted and inserted in Fig. 4. Allowing for some graphical limitation of the objective analysis and the subjective nature of the TIROS sounding analysis, Figures 3 and 4 agree reasonably well.

III. RESULTS

In order to determine the overall impact of these corrections, three sets of analysis maps were prepared. These included 1000 mb temperature and 1000-850 mb thickness fields from the old and new Analysis and difference maps between the respective temperature, thickness, and 850 mb vector wind fields. See Figs. 5-7.

The comparison between the two analysis runs (Figs. 5 and 6) shows that the new version removes much of the noisiness which characterized the original run. Differences, as seen in Fig. 7, show changes of +5 to -10°C for temperature, +15 to -15 m for 1000-850 mb thickness, and up to 10 knots for 850 winds. These difference fields point out that, although the main impact at the correction is at 1000 mb, other quantities, such as winds and heights at higher levels also are affected, although to a much lesser degree.

Another confirming bit of evidence can be seen in Fig. 8. In comparing Fig. 8a to Fig. 8b, it was noted that a high correlation exists between the

large temperature differences in Fig. 8a and the centers of large height residuals in Fig. 8b. This, in effect, suggests that the new Analysis is responding appropriately to the initial 1000 mb height field.

On 00Z March 9, 1986, the correction was implemented into the operational Analysis. Fig. 9a and 9b, provided by the Ocean Products Branch, show the dramatic effect that this change had on the 1000 mb temperature field. Most of the characteristic noisiness of previous 1000 mb analyses has now been eliminated.

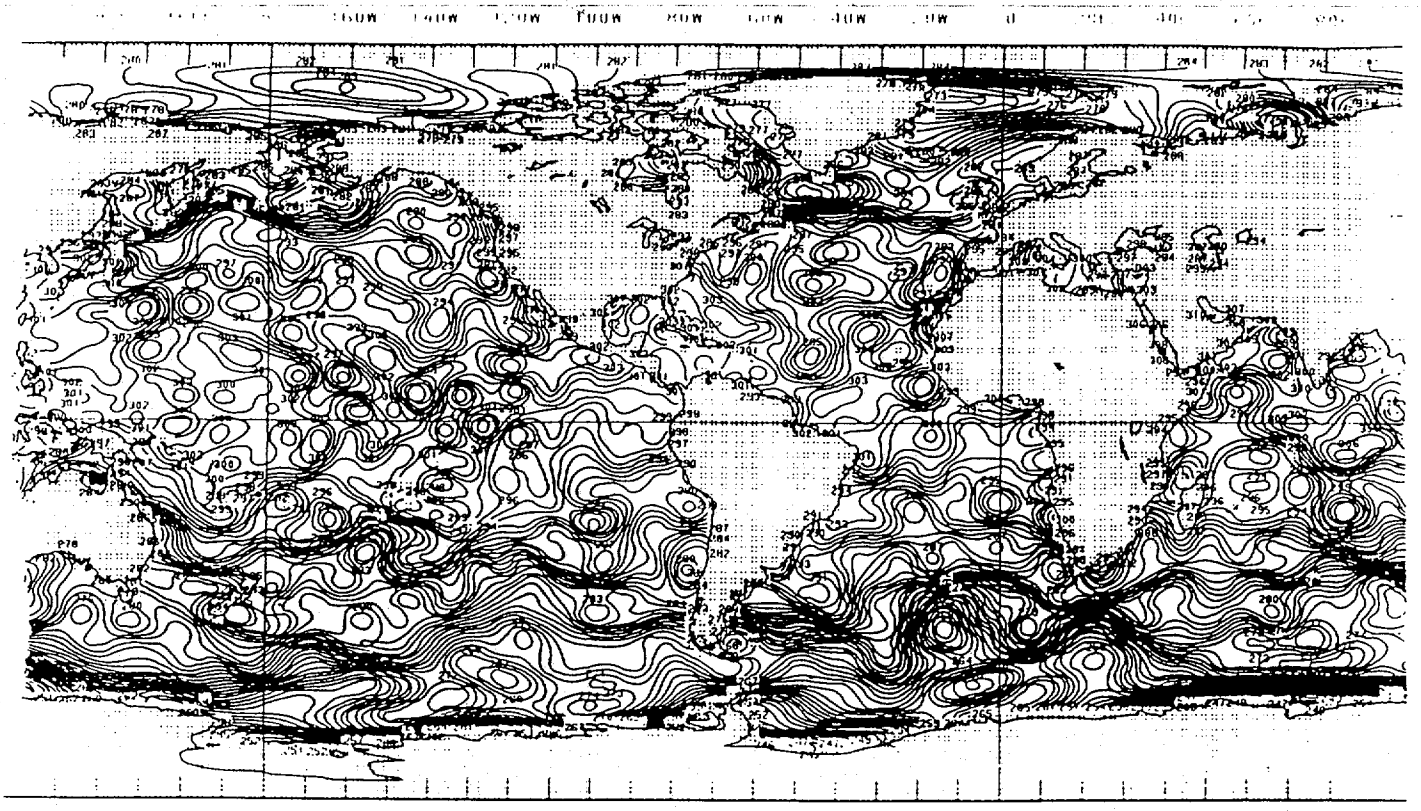

Fig. 1 Original 1000 mb Temperature Analysis - 00Z July 18, 1986

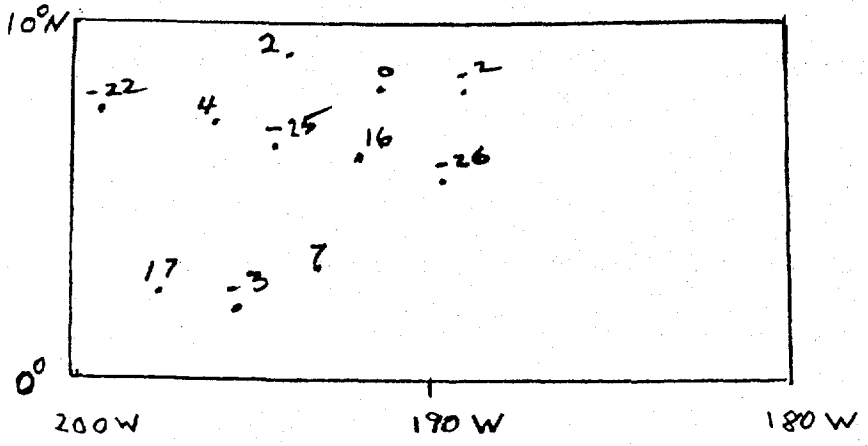

Fig. 2 1000 mb height residuals evaluated at TIROS locations.

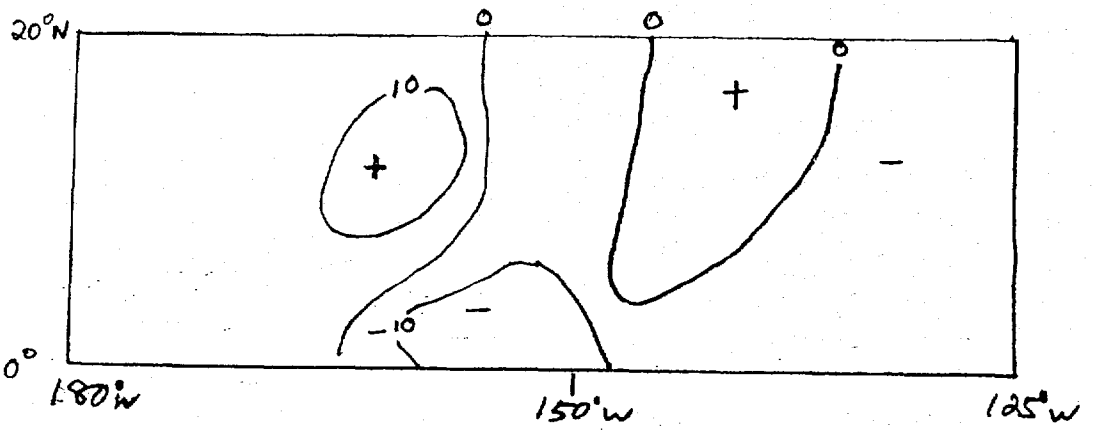

Fig. 3 Subjective analysis of 1000 mb height residuals evaluated at TIROS locations (corrected FIXTIROS).

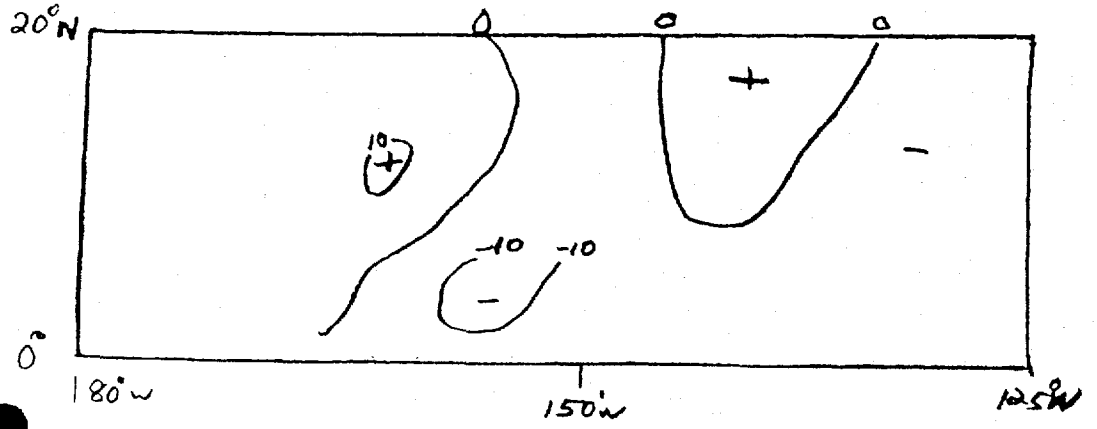

Fig. 4 Objective analysis of 1000 mb height residuals.

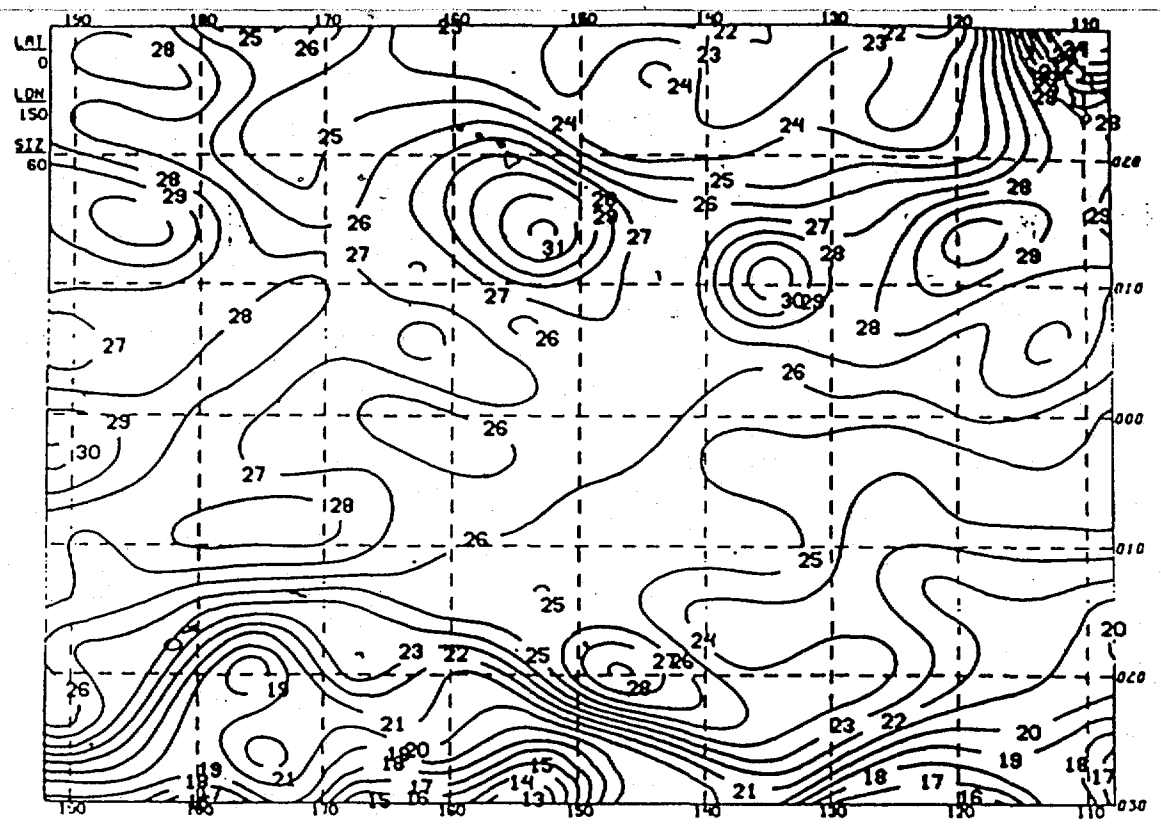

Fig. 5a Rerun of Analysis

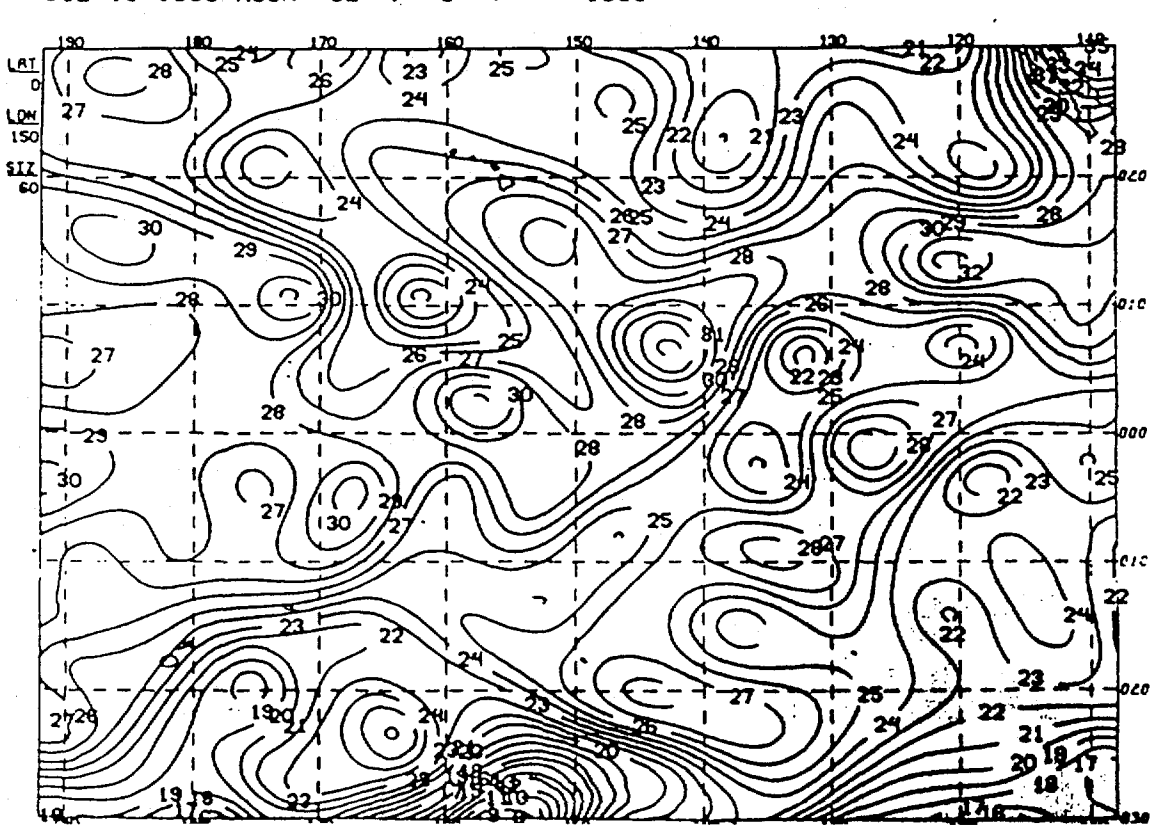

Fig. 5b Original Analysis

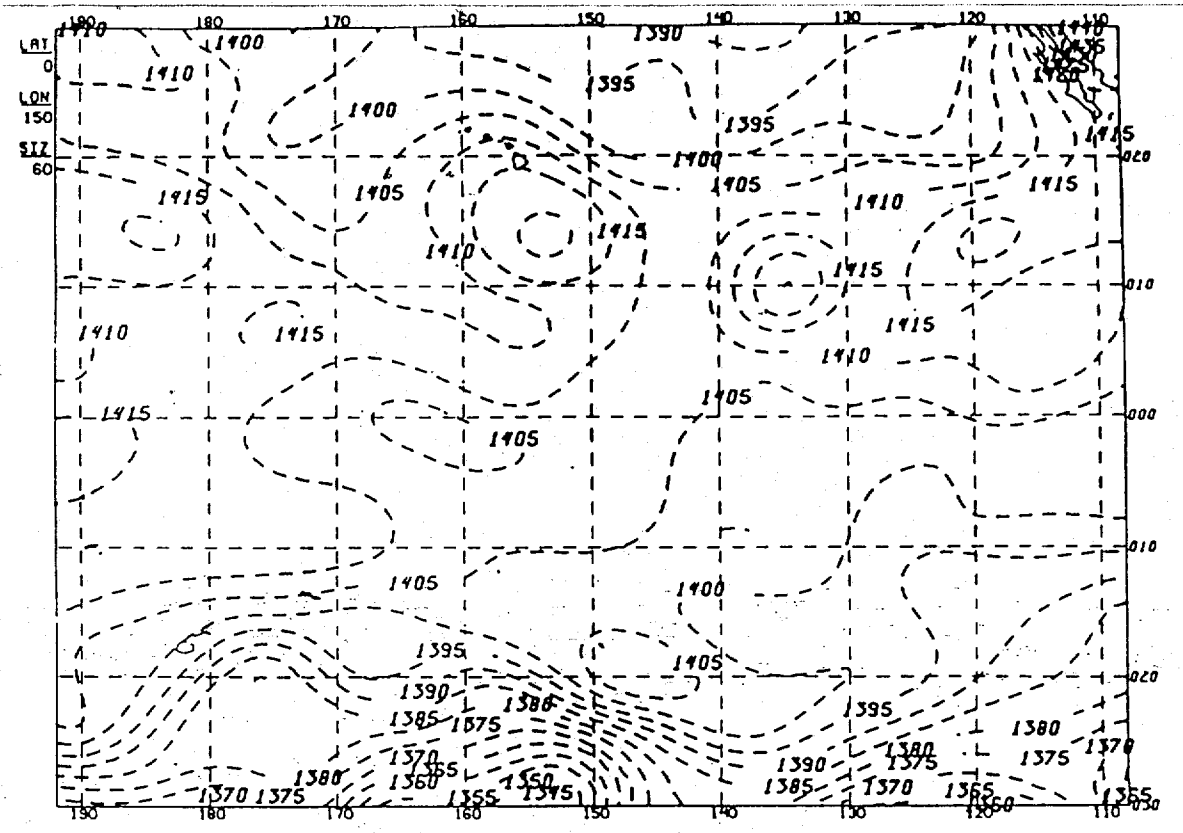

Fig. 6a Rerun of Analysis

JUL 18 1985 HOUR= 0Z +/- 3 THKN 1000-850

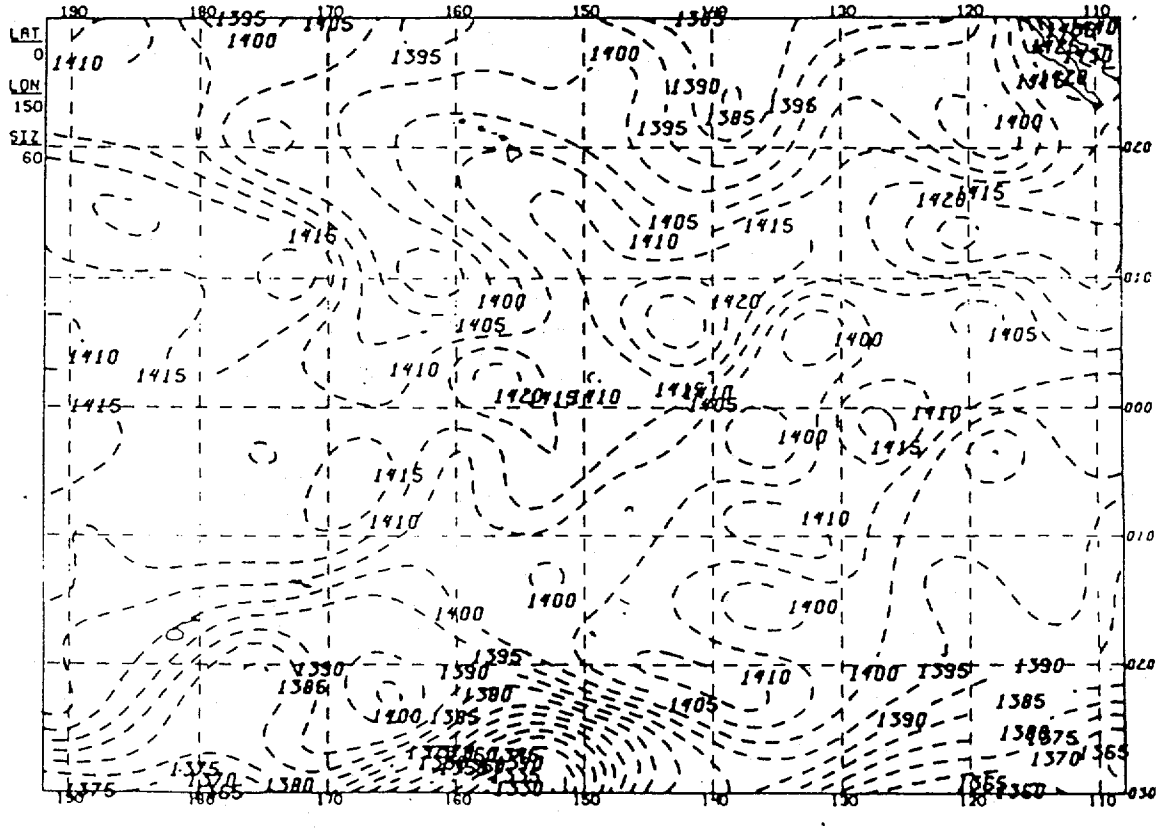

Fig. 6b Original Analysis

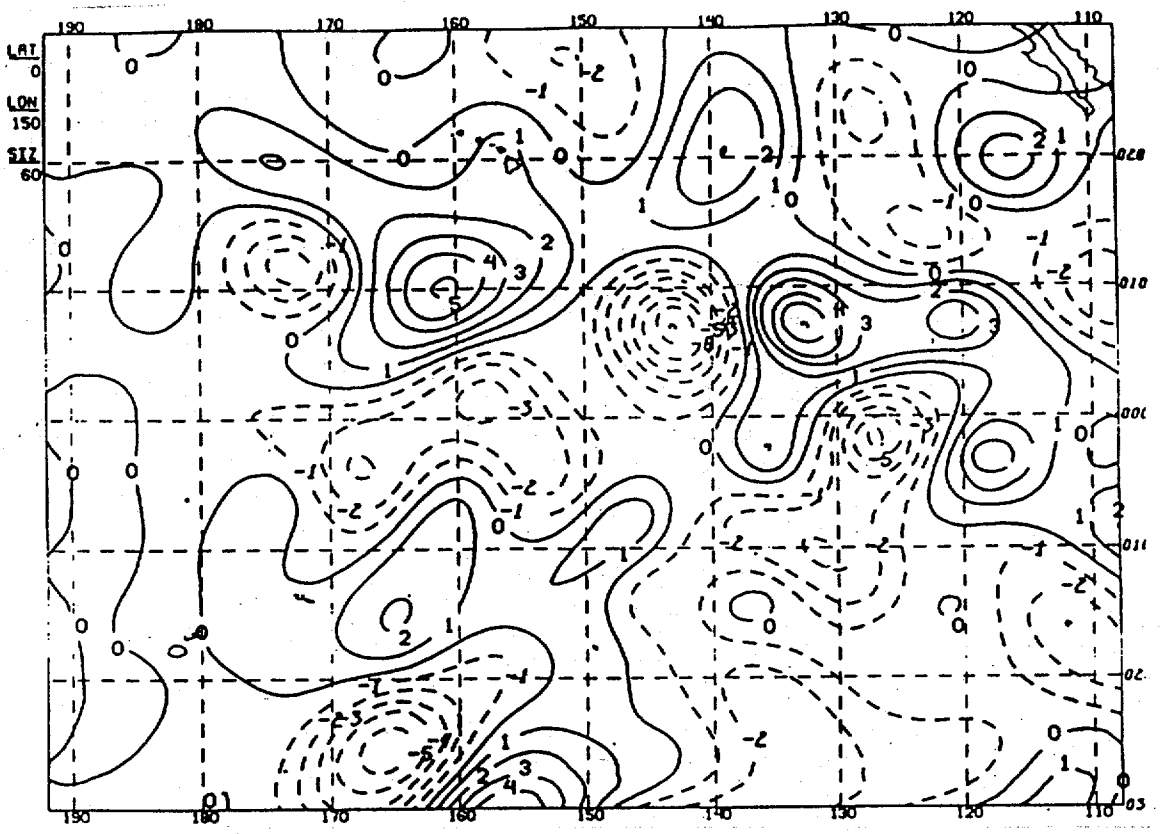

Fig. 7a Difference between Analyses (new-old) of Temperature

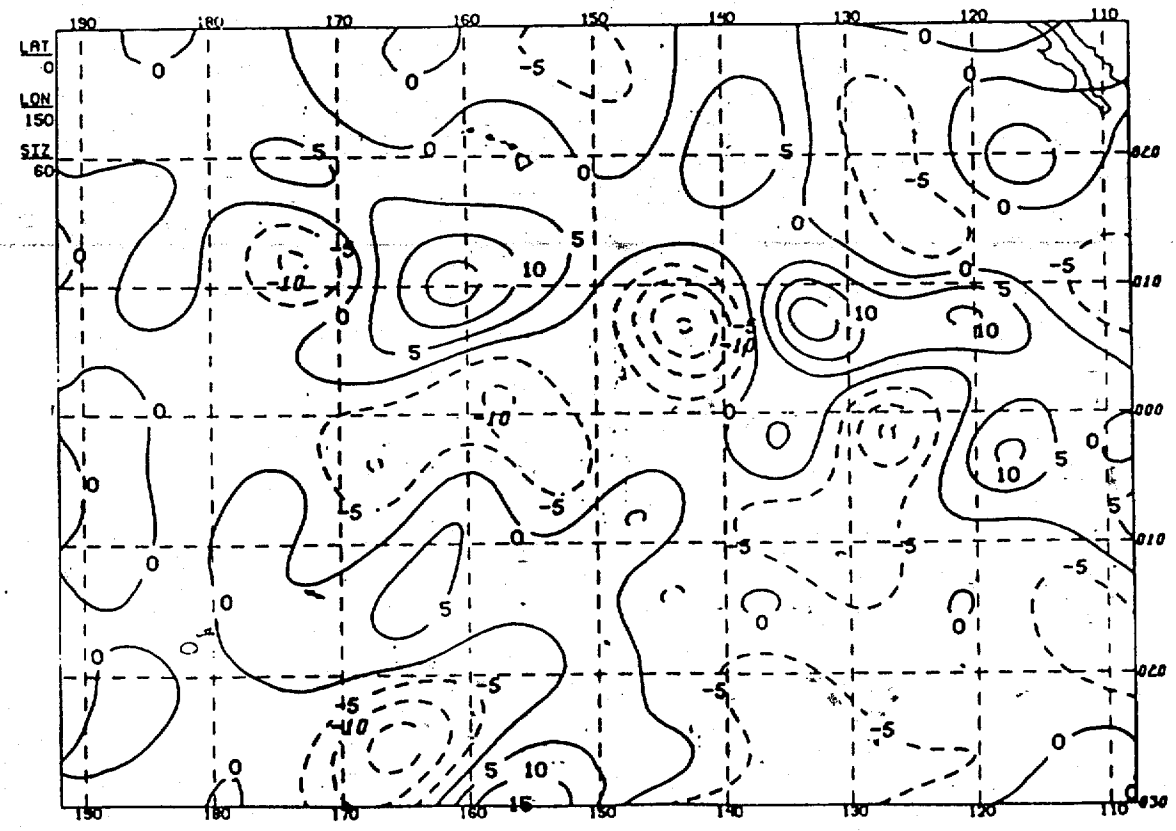

Fig. 7b Difference between Analyses (new-old) of 1000-850 mb Thickness.

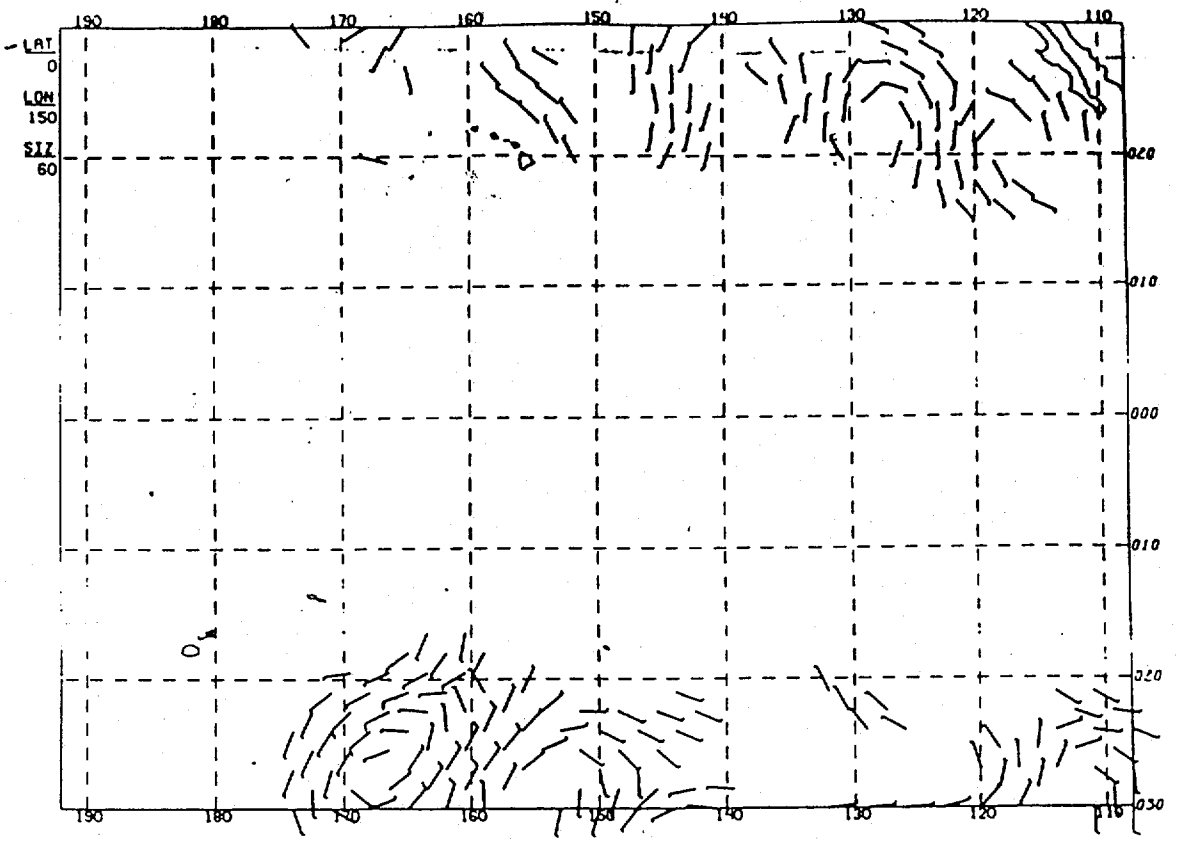

Fig. 7c. Difference between Analyses (new-old) 850 mb Wind.

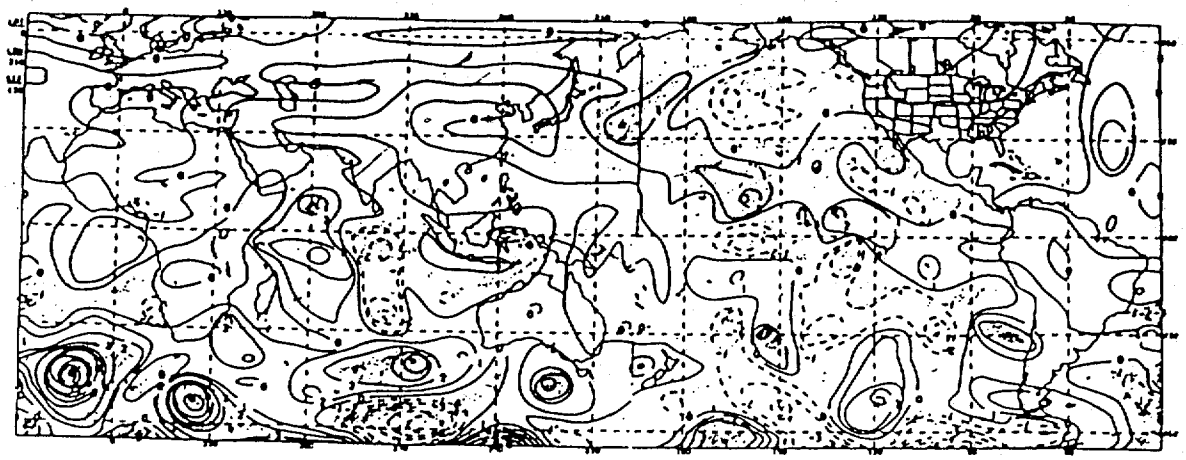

Fig. 8a Difference between Analyses (new-old) for 1000 mb temperature.

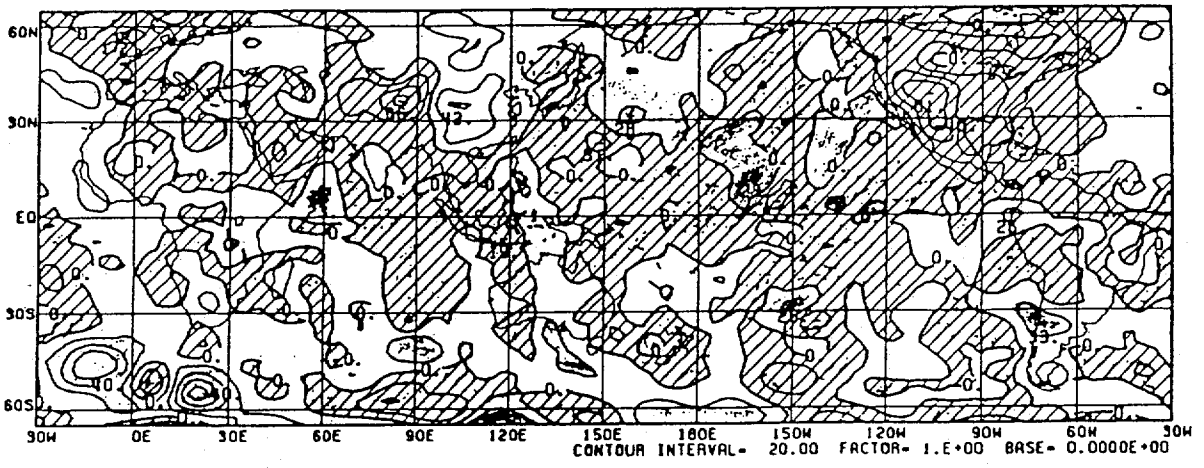

Fig. 8b Analyzed 1000 mb height residuals.

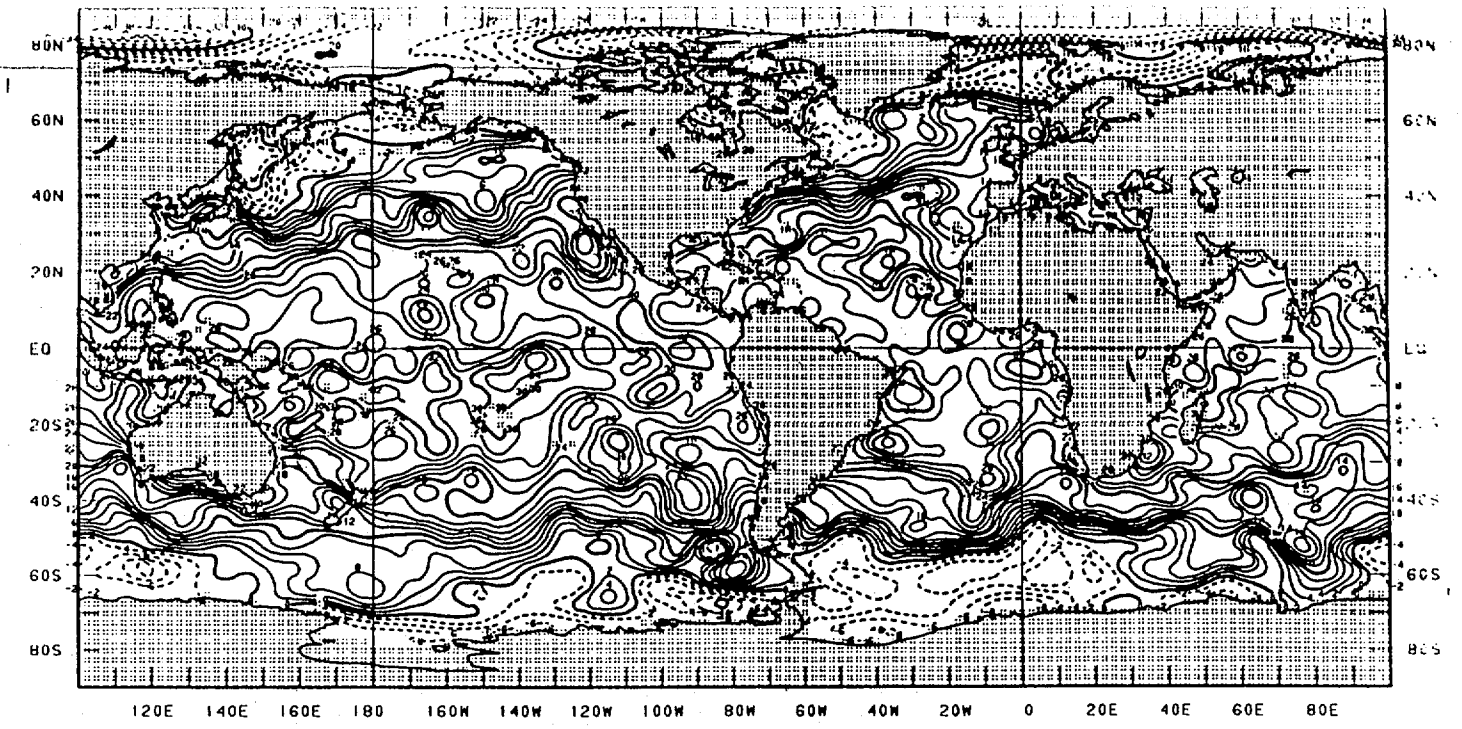

Fig. 9a 1000 mb Air Temp 0Z MAR 5, 1986

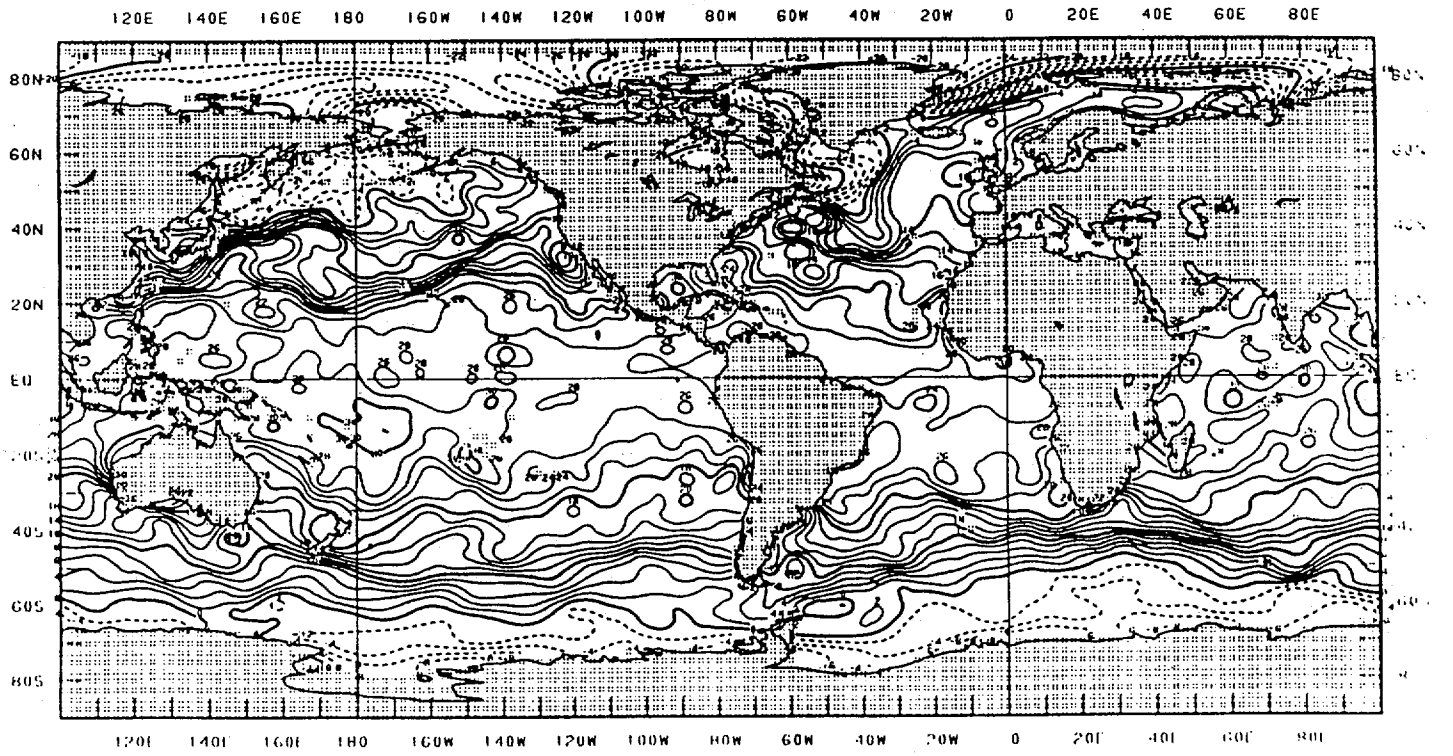

Fig. 9b 1000 mb Air Temp 0Z MAR 12, 1986