THE ASSIMILATION OF ATOVS AT JMA

Kozo Okamoto

Japan Meteorological Agency/Numerical Prediction Division
Tokyo, Japan

Summary

The Japan Meteorological Agency (JMA) has been operationally using NOAA/NESDIS (National Oceanic and Atmospheric Administration/National Environmental Satellite and Data Information System) retrieved TOVS data in the JMA Optimum Interpolation (OI) analysis system. As for ATOVS, we are preparing to assimilate NESDIS retrievals. Results of forecast experiments with ATOVS BUFR data are encouraging, although a few problems are remained in quality control.

JMA has also been developing a TOVS one-dimensional variational (1DVAR) method and made a preliminary research for assimilating ATOVS radiance. Brightness temperatures (TBBs) of AMSU window channels indicate a large variability comparing with background TBBs. This result indicates the necessity of improving surface emissivity estimation by using more accurate input parameter and emissivity model. The other channels show negative biases. More sophisticated quality control and bias correction are needed for assimilating ATOVS radiance.

1. INTRODUCTION

The Japan Meteorological Agency (JMA) has been using TOVS data retrieved by NOAA/NESDIS (National Oceanic and Atmospheric Administration/National Environmental Satellite and Data Information System). We operationally assimilate both TOVS BUFR data and SATEM data. TOVS BUFR data are thinned into every sixth point because of limitation of our computational costs. NESDIS distributes layer mean thickness and virtual temperature data. We convert them into temperature and geopotential height on pressure levels to assimilate in the Optimum Interpolation (OI) analysis where analysis variables are temperature, height, relative humidity and wind vector. TOVS humidity has not been used operationally because layer precipitable water which NESIDS distributes is difficult to handle in the OI analysis.

We have operationally used ATOVS SATEM data retrieved by NESDIS since July 1999. The parallel experiments show clear improvements in the Southern Hemisphere and in the Tropics, but no difference in the Northern Hemisphere with ATOVS SATEM. ATOVS BUFR data have been transmitted stably since the latter half of August of 1999.

In order to make better use of TOVS data, a one-dimensional variational (1DVAR) method has been developed. The development of TOVS 1DVAR for RTOVS is nearly completed. The latest parallel experiment with TOVS 1DVAR shows positive impacts. As for ATOVS, we are investigating error characteristics and an appropriate screening method.

This note describes a part of these results. Section 2 describes impacts of ATOVS BUFR data on the analysis system. We investigated an accuracy of ATOVS BUFR data and their impacts on analysis and forecast. They have small heating and drying effects on the analysis in the lower troposphere. They demonstrate positive impacts in the Southern Hemisphere and the Tropics and neutral or slightly negative impacts in the Northern Hemisphere. After investigating the feature of TBB bias and developing a more sophisticated quality control procedure, we will assimilate them operationally as soon as possible.

We also studied difference of NESDIS preprocessed TBB from TBB calculated with RTTOV-5 for a preliminary research of ATOVS 1DVAR. A large variance is found for window channels and water vapor channels. A large scan dependent bias is found in AMSU-4 and 5. They are primarily due to wrong estimates of surface wind, skin temperature or surface emissivity. As atmospheric channels show negative biases, we need to develop adequate bias correction and quality control schemes.

JMA is going to implement TOVS 1DVAR operationally at the beginning of 2000. 3DVAR will be introduced operationally into our global analysis in March 2000. Direct assimilation of TOVS and ATOVS radiance will be started in 2001 and 1DVAR will remain as a preprocessor for a quality control procedure.

References

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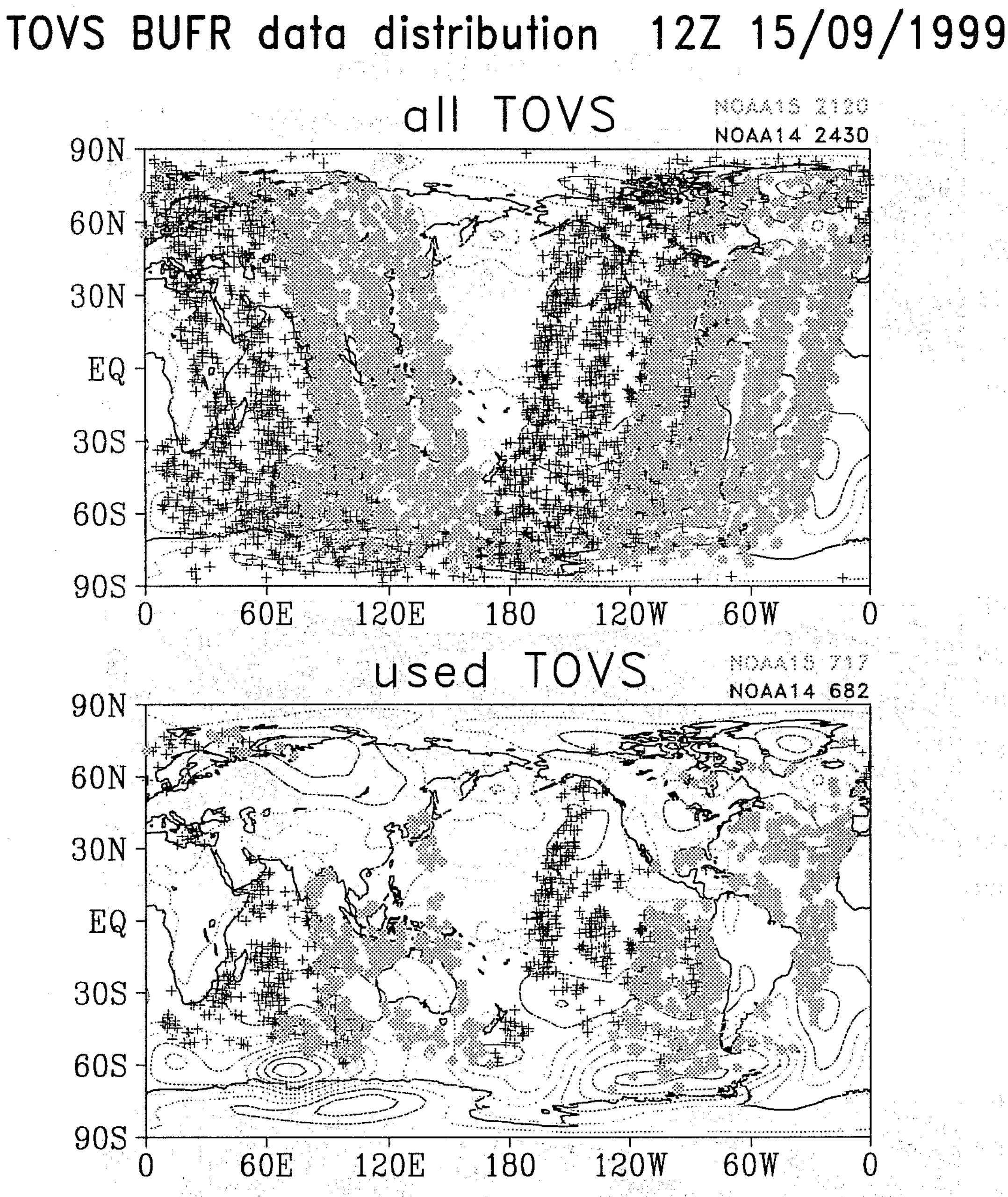

Fig. 1: TOVS data distributions over a 6 hour period centered on assimilation time at 12UTC 15 September 1999. The upper panel shows the distribution for all data after thinning and the lower panel the distribution of data which passed into analysis after quality control. A circle denotes NOAA15 ATOVS and a cross denotes NOAA14 RTOVS. Contours show analysis of Psea at 12UTC 15 September.

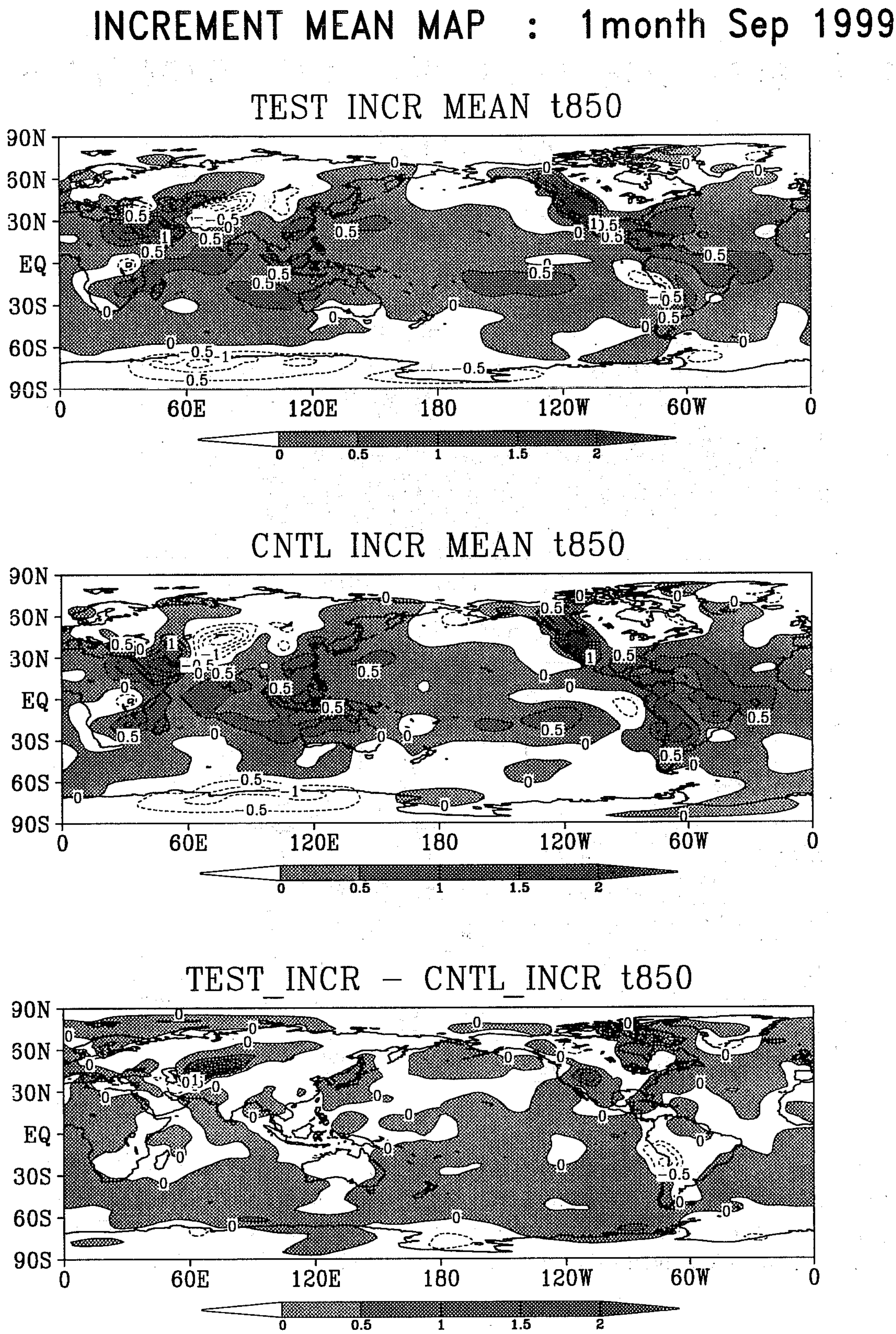

Fig. 2: Analysis increments for 850hPa temperature in Test (top panel), Control (middle) and difference between Test and Control (bottom). Shading in the upper two panels denotes positive increment, which means analysis temperature is higher than guess. Shading in the bottom panel indicates positive difference. Contour interval is 0.5K.

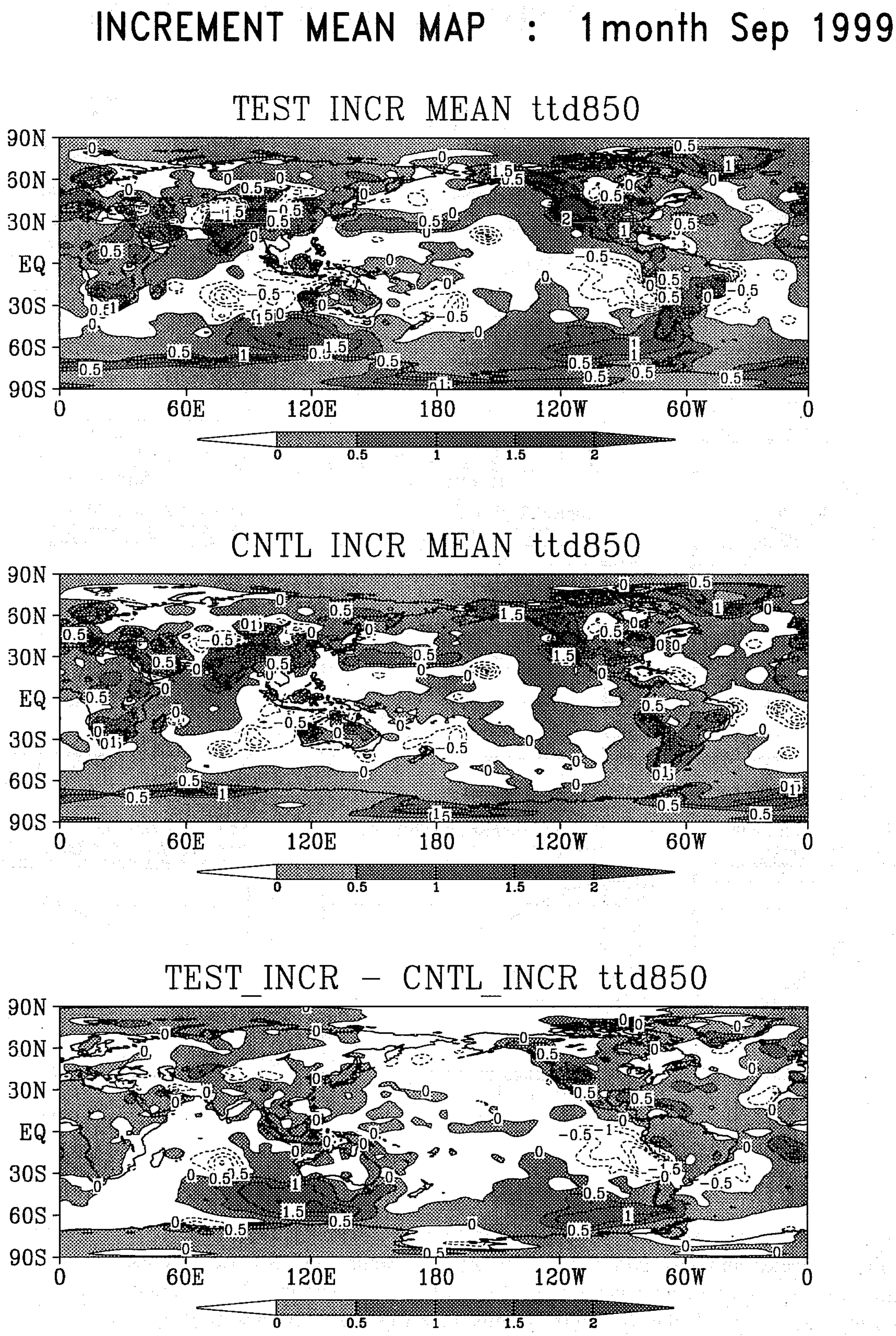

Fig. 3: The same as Fig. 2, except for 850hPa dew point depression. Contour interval is 0.5K.

Forecast Scores Against Initialized Analysis (1999.9.8-1999.9.23)

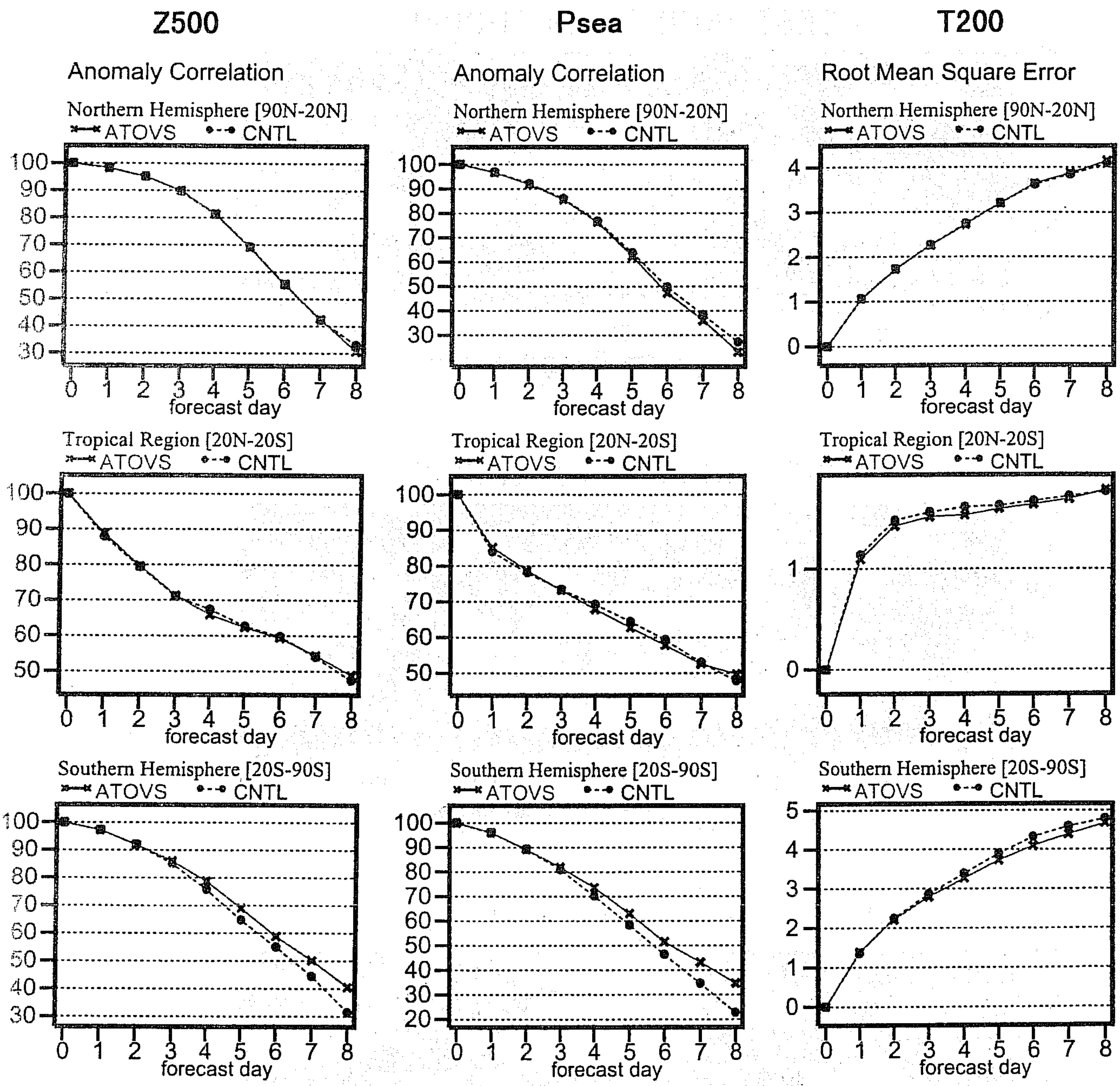

Fig. 4: The average forecast score of 16 cases over 12UTC 8-23 September 1999. A left column and a middle column indicates anomaly correlations for 500hPa Height and Sea Level Pressure respectively. Right column indicates root mean square error for 200hPa Temperature. Each column consists of the figures showing the score of the Northern Hemisphere(top), the Tropics(middle) and the Southern Hemisphere(bottom). Solid line denotes Test with ATOVS BUFR and dashed line denotes Control without ATOVS BUFR.

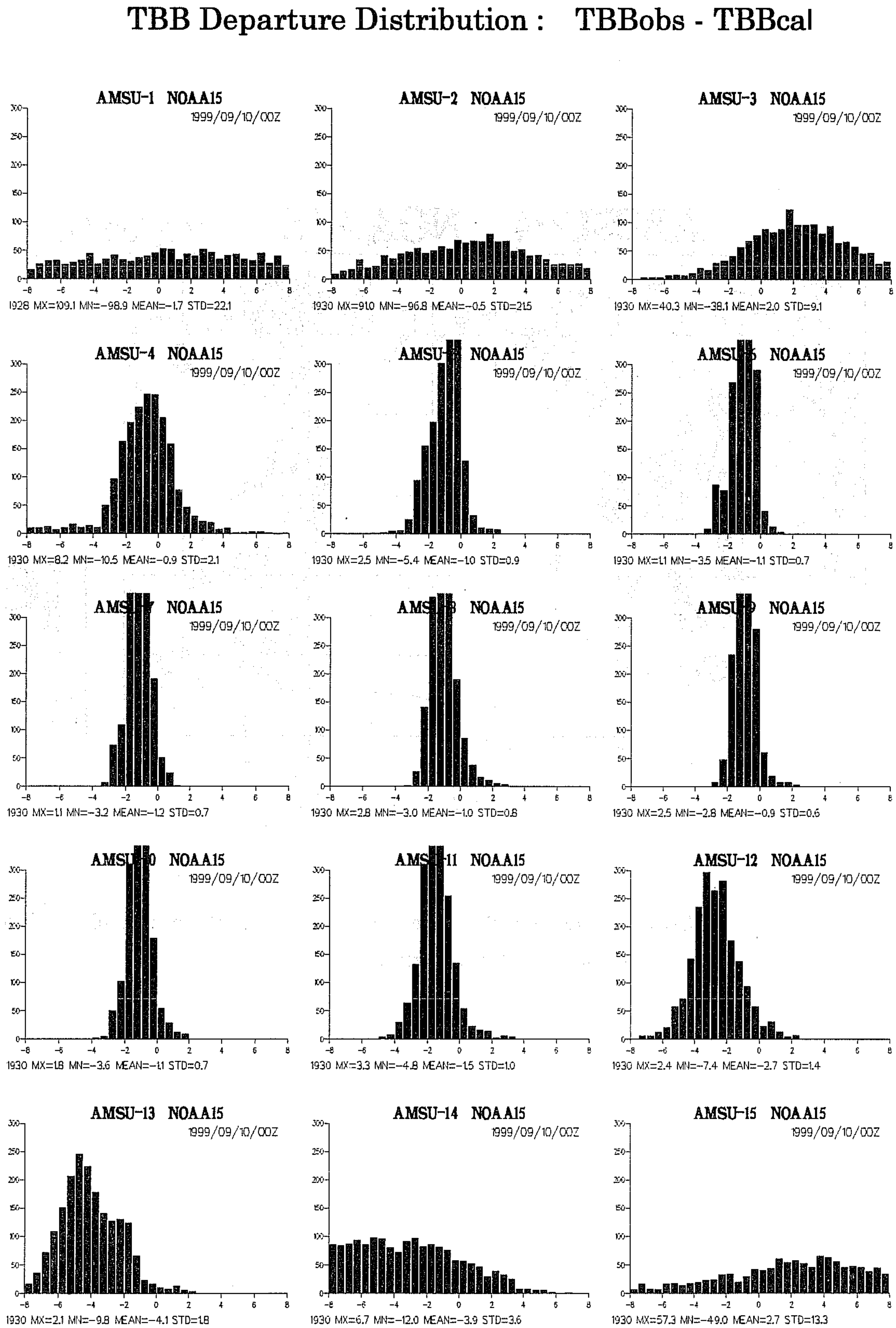

Fig. 5 : Frequency of TBB departure (NESDIS preprocessed TBB minus background TBB using RTTOV-5) for all AMSU-A channels during 6 hours at 00UTC 10 September 1999. TBB difference is along the x-axis raging –8K to +8K and the number of each case is along y-axis with 300 of maximum. Number of data, max departure, minimum departure, mean departure and standard deviation of departure are plotted under each graph.

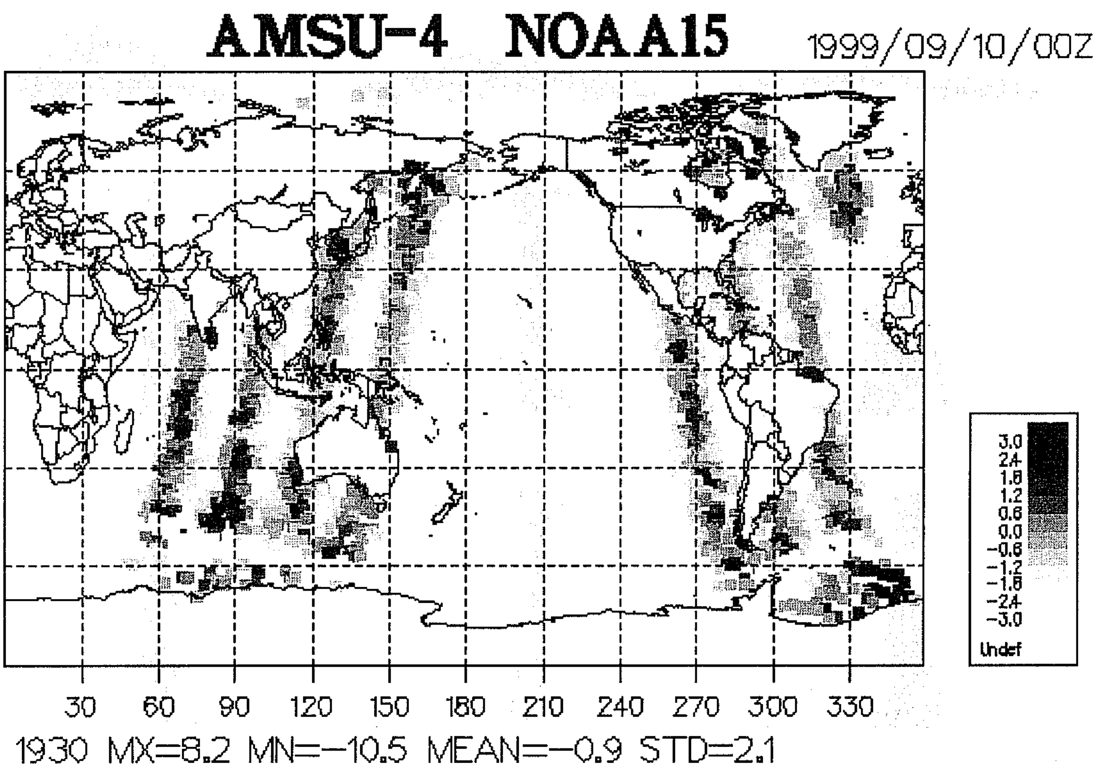

Fig. 6 : Distribution of TBB departure from the same data as Fig. 5 Dark shading plot indicates large positive departure and light shading large negative departure.