CURRENT USE OF TOVS AND MONITORING OF ATOVS DATA AT METEO-FRANCE

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1. INTRODUCTION

Since 1997, the operational analysis system at Météo-France has been a three-dimensional variational analysis, which is a convenient framework for the assimilation of radiance data. The assimilation of NESDIS SATEM retrievals has thus been replaced by a direct assimilation of NESDIS TOVS pre-processed radiances in March 1999. Section 2 describes the characteristics of the new system and the results. To prepare for the assimilation of ATOVS pre-processed radiances from NOAA15, the comparison of cloud flags from ATOVS-120 and the MAIA algorithm (Lavanant et al., 1999) over Western Europe was studied. Results are presented in section 3. Section 4 discusses results on the monitoring of both ATOVS-120 from NESDIS and ATOVS-AAPP (ATOVS and AVHRR Processing Package, Klaes, 1997) over Western Europe, with various tests to eliminate cloudy pixels.

2. DIRECT ASSIMILATION OF TOVS RADIANCES

Since 8th March 1999, the assimilation of SATEM-500 retrievals has been replaced by the direct assimilation of pre-processed radiances, thinned at 250 kms (Caille et al., 1999). This new system is very similar to the one which was operational at ECMWF from 1996 to 1999 (Saunders et al., 1997). The bias correction scheme developed at ECMWF (Bret Harris, pers. comm.) removes the bias between observed and modelled radiances due to problems in the data and in the radiative transfer model. Then, 1D-Var is run to provide temperatures above the top of the model (5hPa) up to 0.1hPa, and to retrieve the surface temperature. It also performs a useful quality control check before assimilation of the radiances in 3D-Var. Forecast scores have been computed for the test suite comparing the two systems. Scores with respect to its own analysis are shown in Figure 1. Over our area of interest (Europe and the Northern Hemisphere) these forecast scores show a small improvement in the short range which increases with time. These improvements are less marked in the Tropics, but much larger in the Southern Hemisphere.
The monitoring of TOVS/ATOVS SATEM retrievals is still performed at Météo-France. The inclusion of ATOVS data in the monitoring statistics in July 1999 lead to an improvement of the bias between the observations and the background (short-range forecast), especially in the Southern Hemisphere.

3. COMPARISON OF CLOUD FLAGS FROM ATOVS-120 AND ATOVS-AAPP OVER WESTERN EUROPE

In Lannion, Météo-France/SCEM uses local HRPT (High Resolution Picture Transmission) data and the AAPP software (ATOVS and AVHRR Processing Package, Klaes, 1997) to process raw radiances. Within the AAPP software, a cloud-detection algorithm (MAIA) based on AVHRR data provides information about clouds in the HIRS ellipse. In particular, the percentage of cloudy AVHRR pixels within the HIRS ellipse is documented. One usually considers as clear an ellipse with less than 10% of the pixels being cloudy, whereas one might consider as cloudy an ellipse with more than 70% of the pixels being cloudy (Lavanant et al., 1999). Comparing NESDIS and AAPP cloud flags described above over a couple of weeks over Lannion's data reception area (Western Europe), one finds that NESDIS sees a smaller amount of cloudy data than AAPP. An example is given in Figure 2, for 25th September 1999. It seems that the processing used at NESDIS lets more clouds through, especially over sea. Collocation statistics have been produced over the Western European area for NOAA15 data. NESDIS pre-processed ATOVS HIRS radiances, AAPP-1D HIRS radiances and analysis, are collocated within areas less than 50km wide and within a 3-hour time window. Statistics are accumulated between 4th October 1999 and 18th October 1999 (for only the evening orbits around 18Z). Results show that, among 632 situations seen clear by NESDIS , 54% have 0 to 10% clouds in AAPP, 21% have 10 to 50% clouds in AAPP and 25% have 50 to 90% clouds in AAPP. The question is then: are these clouds, not seen by the NESDIS processing, detrimental to the data quality? The table below gives some indications that this is indeed the case.

Data **Flag**	**HIRS-120** **AAPP flag**	**HIRS-120** **NES. flag**	**HIRS-1D** **AAPP flag**	**HIRS-1D** **NES. flag**
ch 8 clear / sea	**1.36** 1.37 (94)	**2.33** -0.09 (280)	**1.07** 1.46 (94)	**3.90** -0.88 (280)
ch 8 clear / land	**2.21** -0.71 (380)	**2.38** -0.85 (443)	**1.32** -0.77 (380)	**3.01** -1.55 (443)
ch 4 clear / sea	**0.23** -0.92 (94)	**0.27** -0.81 (280)	**0.24** -0.97 (94)	**0.31** -0.89 (280)
ch 4 clear / land	**0.35** -0.84 (380)	**0.35** -0.82 (443)	**0.32** -0.89 (380)	**0.41** -0.91 (443)
ch 6 clear / sea	**0.56** -0.50 (94)	**0.66** -0.78 (280)	**0.44** -0.52 (94)	**1.26** -1.08 (280)
ch 6 clear / land	**0.74** -0.68 (380)	**0.64** -0.75 (443)	**0.42** -0.67 (380)	**1.24** -0.99 (443)

Table 1: Statistics of the differences between observed and analysed HIRS brightness temperatures over Western Europe from collocations obtained during the period from 19991004 to 19991018 (18Z). For each combination of data and flag: **std**, bias, (Nb obs) are shown.

The best results are obtained with HIRS-1D data for which only clear data for the AAPP flag are averaged (3rd column), then the second best result is seen for HIRS-120 data for which only clear data for the AAPP flag are averaged (1st column). Flags agree quite well over land, with only a slightly smaller amount of clear data for the AAPP processing (380 versus 443), whereas over sea AAPP is much stricter than NESDIS (94 clear data versus 280).

Over sea, for data seen clear by NESDIS, statistics of departures would be improved by adding some simple tests such as T(HIRS-Ch8)/Tsurf> 0.99 or T(HIRS-Ch8)- T(Analysis)> -1K.

4. RADIANCE MONITORING FROM ATOVS-120 AND ATOVS-AAPP OVER WESTERN EUROPE

Statistics of the quality of the Obs-Forecast were computed for both AMSU-A and HIRS instruments onboard NOAA-15. Due to some interference problems, AMSU-B data were not monitored. This has enabled us to point out some interference problems in the release of level-1B data from the satellite above Lannion receiving station (shift sometimes in the data with respect to their location for one ascending orbit, visible on AMSU-A channels 1,2 and 15). On October 7th 1999, the way the data were transmitted has changed and such shifts were no more observed any more. We focussed here on a 17-days period of time (Sept. 19th until October 6th) over the Lannion data acquisition area, on the descending orbits (around 18Z) not affected by the interference problem. Subsection 4.1 presents the statistics concerning AMSU-A, and subsection 4.2 those relative to HIRS.

4.1 AMSU-A Statistics

Results, by channel and field-of-view, are presented in Figure 4. Channels 1,2,3 and 15, sensitive to surface, show a higher standard deviation and bias than the other channels, which are quite well simulated by the model. Due to a quite low model top (5hPa), the quality of the simulated brightness temperatures might be responsible for a larger error (as compared to the observations) when the corresponding weighting functions peak higher. These considerations might lead us to reject channels 11, 12, 13, 14 for future assimilation experiments. Differences Land/Ocean are the largest for channels 1,2,3 and 15. Preprocessed (ATOVS-120) and level-1B data agree quite well, with a higher bias for low-peaking channels over ocean than over land. The reasons of this may come from an imperfect surface emissivity model. However, we must note that there was no test to remove cloud-liquid water (CLW) contaminated observations from the statistics, so that these may be improved by adding a quality control. For channels 4 to 14, results are comparable for both types of data, with only slightly better results for level-1B data.

4.2 HIRS Statistics

HIRS data are generally less sensitive to the type of surface (indeed, the emissivity of the hirs channels is very close to unity). However, the influence of clouds has been studied here. Results, by channel and field-of-view, are presented in Figure 5 for statistics over sea. Comparing the number of selected observations by either AAPP clear flags or the various tests (not shown), one can state that the first test (T(8)/TSFC>0.99) seems to be quite comparable with AAPP cloud detection, but still needs some improvement because it eliminates too many pixels on the edges of the scan lines. The test should take into account the limb viewing effect through the satellite zenith angle before any operational application. The second test ((T-TB)(8)>-1K) removes much less pixels. It keeps about twice the number of data. An important result is that whatever the test is, statistics look about the same for AAPP clear only or the two tests only. For the preprocessed data, adding the second test does not remove much more data than the Nesdis flag does. It helps reducing the standard deviation, but the cost of this is to slightly increase the bias. The statistics of channel 12, sensitive to cirrus, seem to show that the clear/cloudy flags (both AAPP and Nesdis) are not quite efficient to remove the cirrus-contaminated pixels. Actually,a more stringent threshold on AAPP "clear" flags (rejecting all pixels with more than 1% clouds) did show better results. Yet, the repartition of Obs-Forecast errors for channel 12 reminds us that temperature is not the only concern for simulating the corresponding brightness temperature.

5. PERSPECTIVES

We are currently planning the assimilation of NESDIS pre-processed radiances, using 1D-Var as pre-processor for profiles above the top of the model and surface temperature analysis. We will then investigate the assimilation of NESDIS pre-processed radiances or raw radiances without using 1D-Var as pre-processor, based on the successful experience at NCEP and ECMWF.

6. REFERENCES

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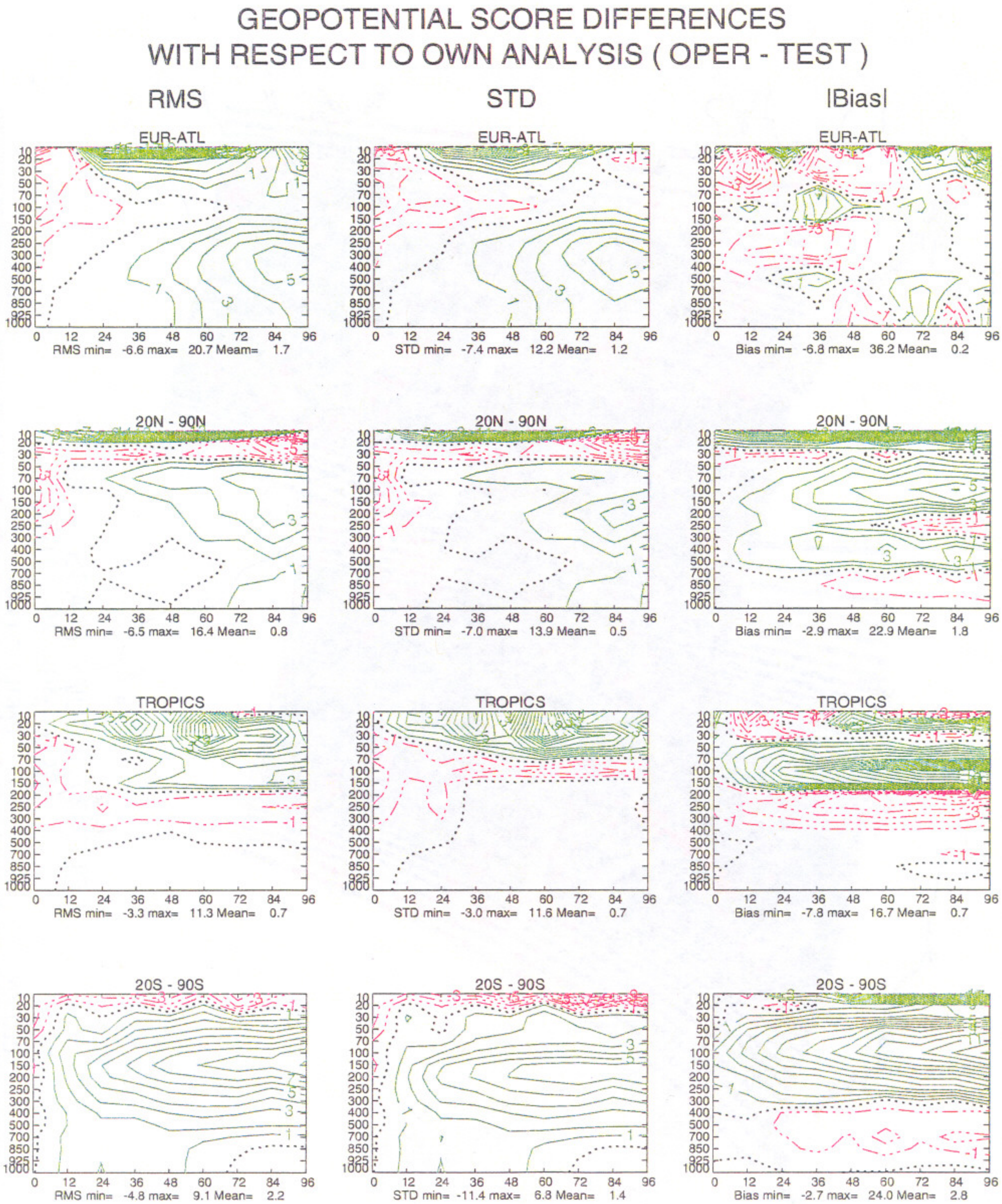

Figure 1: Vertical profiles of geopotential score differences as a function of forecast range in hours. Scores are computed with respect to radiosondes over twenty-six cases. The score differences are computed as operational errors minus test-suite errors. Positive values (solid lines) indicate smaller errors for the test-suite using the radiances. The first column represents the root-mean-square errors, the second the standard deviation and the third the absolute value of the bias. These scores are shown for different areas: Europe, Northern Hemisphere, Tropics and Southern Hemisphere. The contour interval is 1m. Negative values are dashed.

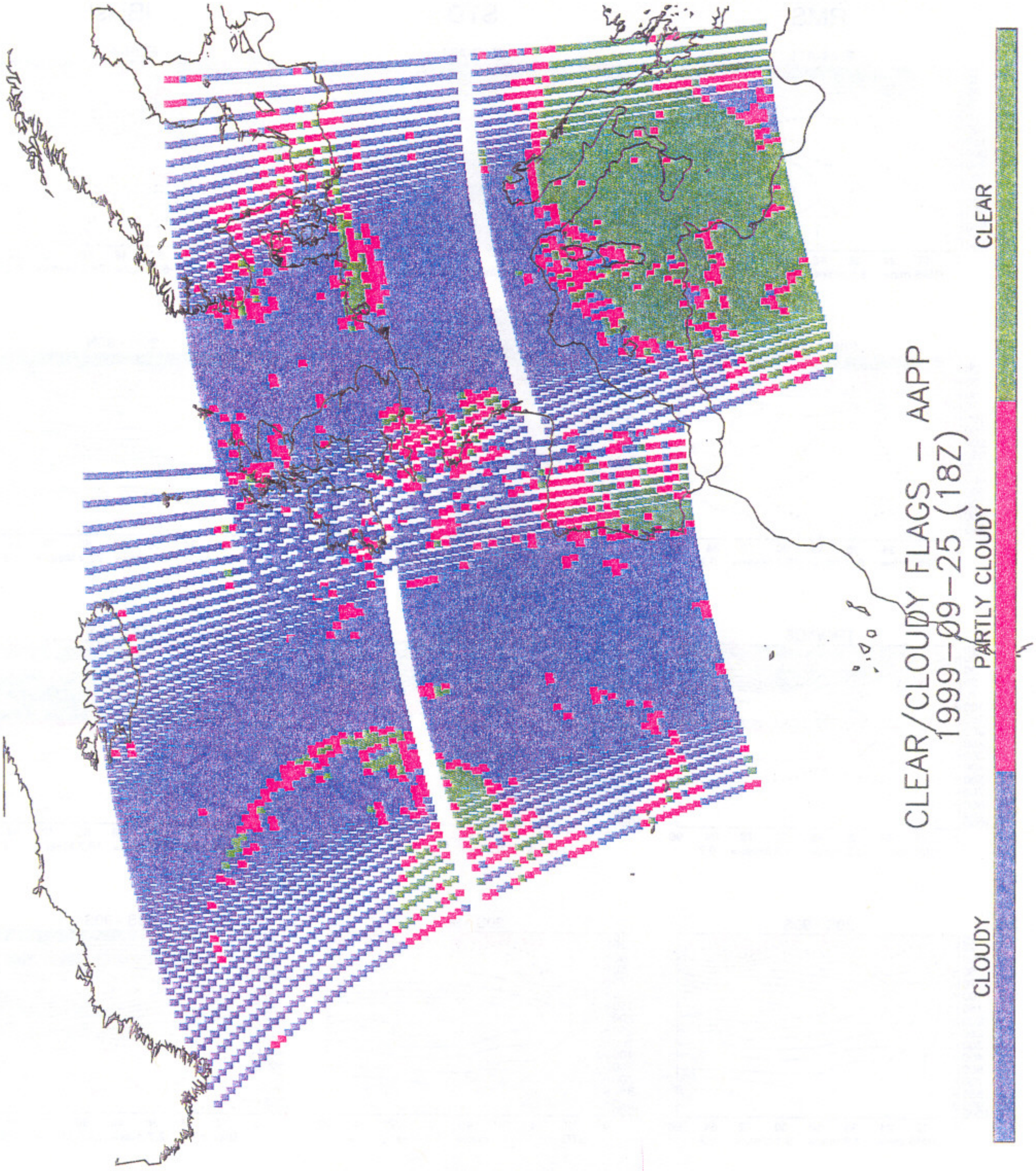

Figure 2: Cloud flags on HIRS-1D pixels produced by the MAIA algorithm (part of AAPP) for 25/09/99 over a Western European area. Clear pixels (less than 10% cloudy AVHRR pixels in the HIRS ellipse) are shown by green squares, partly cloudy pixels 10% to 70% cloudy AVHRR pixels in the HIRS ellipse) by magenta squares and cloudy ones (more than 70% cloudy AVHRR pixels in the HIRS ellipse) by blue squares.

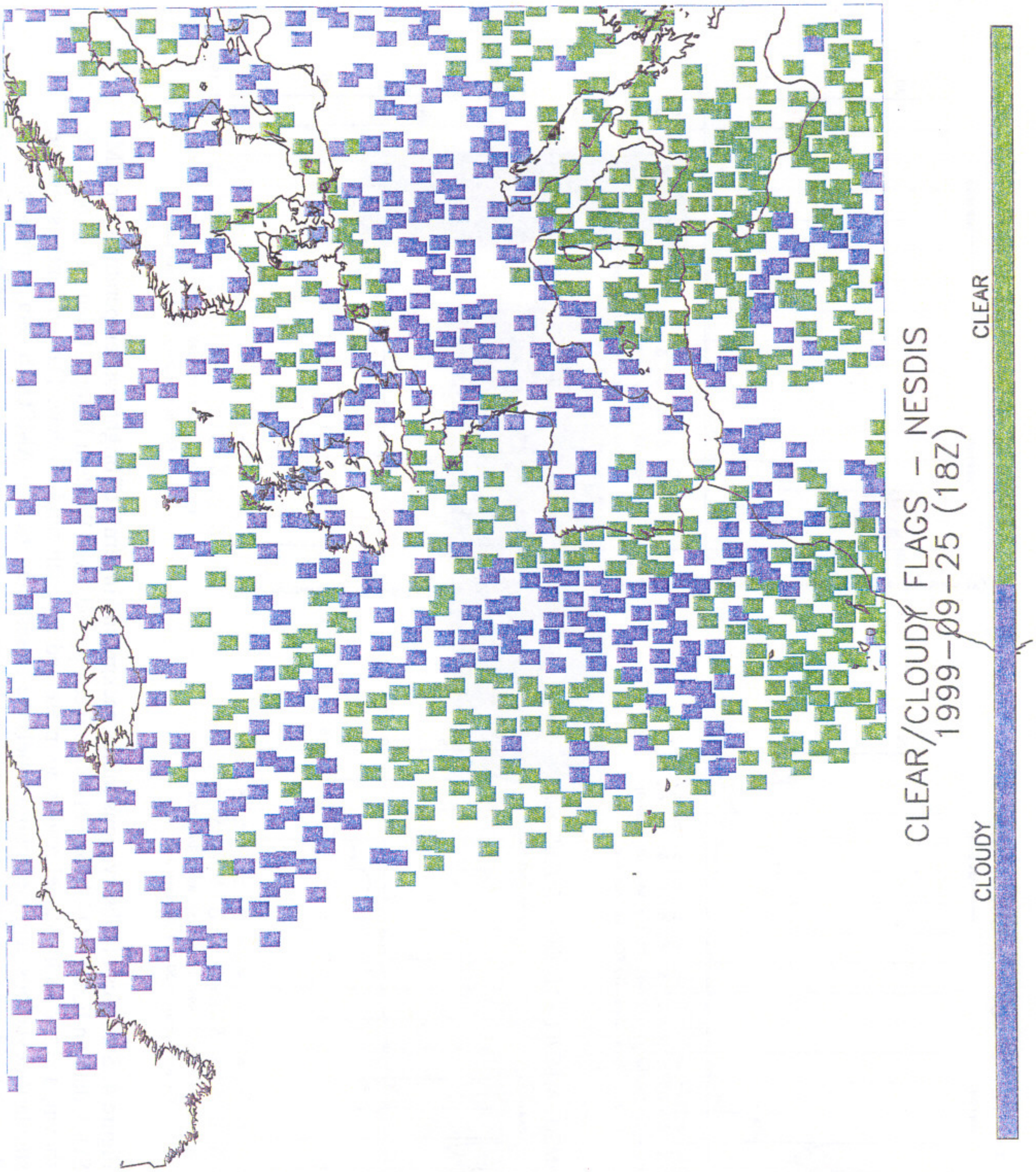

Figure 3: Cloud flags on HIRS-120 pixels produced by NESDIS for 25/09/99 over a Western European area. Clear pixels are shown by green squares and cloudy ones by blue squares.

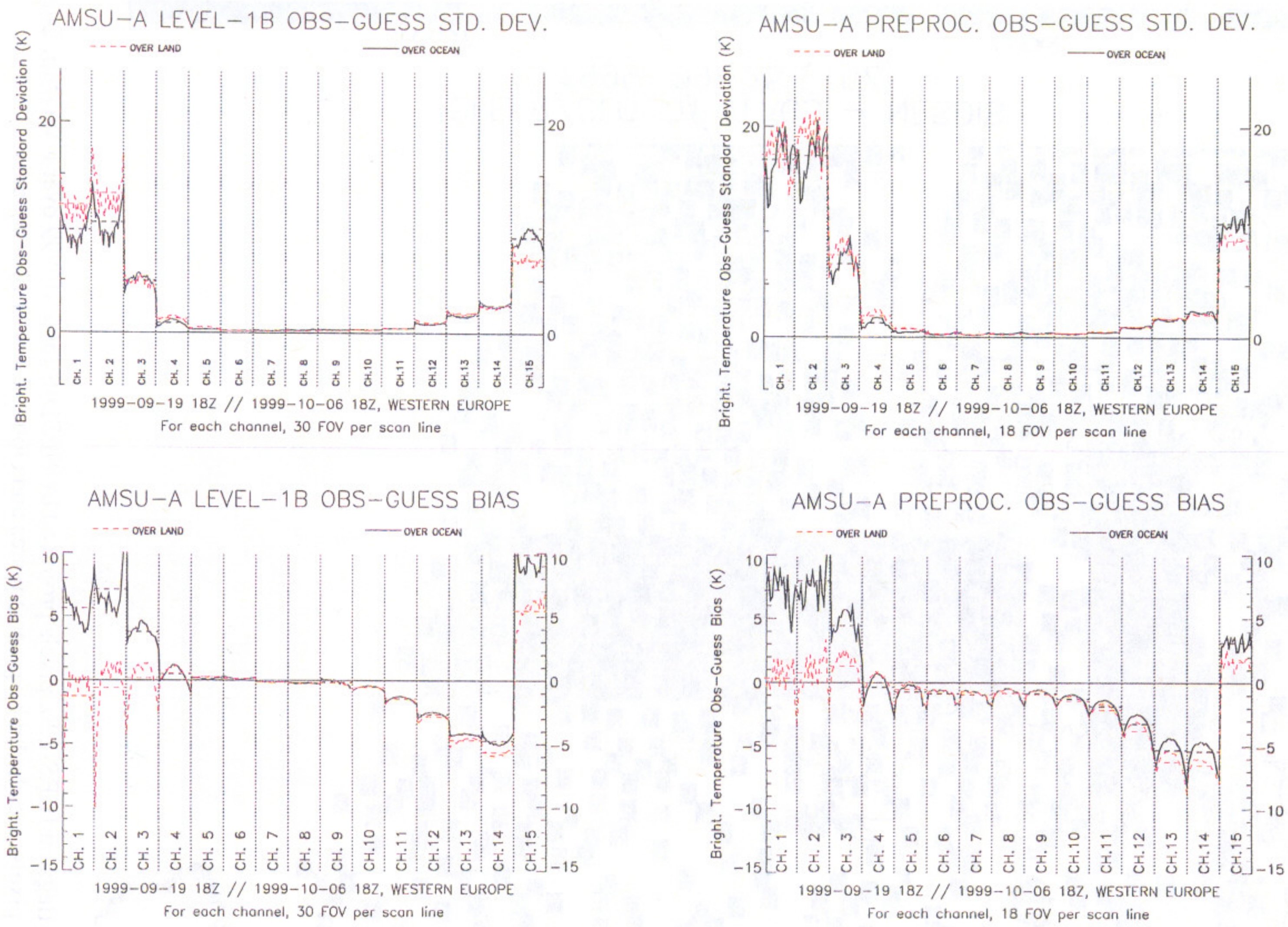

Figure 4: Statistics of Observations minus background in terms of brightness temperatures for AMSU-A data on board NOAA15 over a two-week period, over Western Europe. Channels 1 to 15 are shown, and for each channel results are presented for each field-of-view. The top panels show the standard-deviations, and the bottom panels the biases. Statistics for AMSU-1B data are presented in the left-hand panels, and those for AMSU-120 in the right-hand panels. Statistics over land are shown in red, and over sea in black.

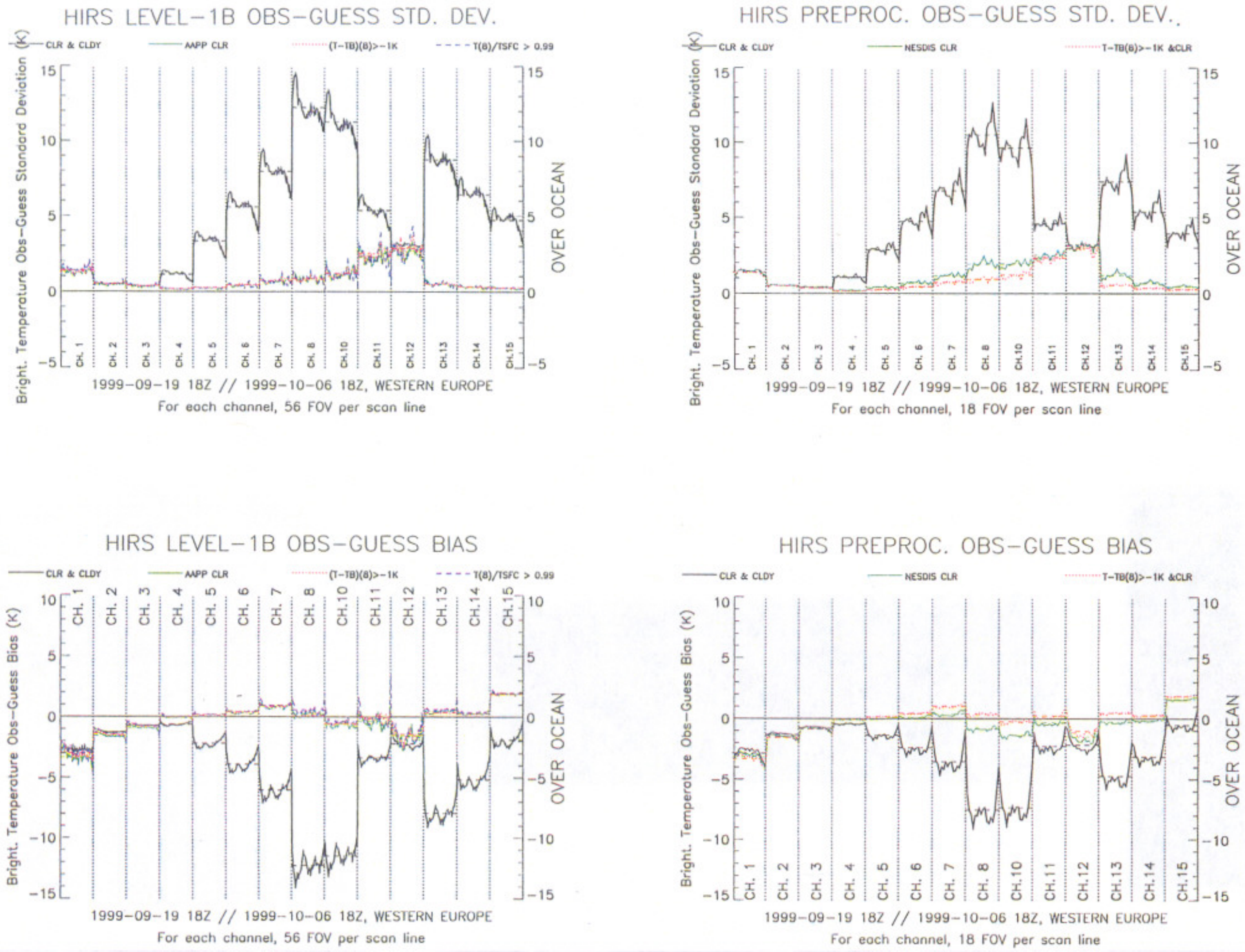

Figure 5: Statistics of Observations minus background in terms of brightness temperatures for HIRS data on board NOAA15 over a two-week period, over Western Europe over sea. For each channel results are presented for each field-of-view. The top panels show the standard-deviations, and the bottom panels the biases. Statistics for HIRS-1B data are presented in the left-hand panels, and those for HIRS-120 in the right-hand panels. Statistics for all clear and cloudy data are shown as a black line in all panels. In the left-hand panels relative to HIRS-1D, pixels seen clear by AAPP flags are represented by the green lines, those seen clear by the (T-TB)(8)> -1K test by a red dotted line, and those seen clear by the T(8)/TSFC> 0.99 test by a blue dashed line. In the right-hand panels relative to HIRS-120 data, pixels seen clear by NESDIS are represented by the green lines, those seen clear by NESDIS on which the (T-TB)(8)> -1K test is successful by a red dotted line,