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Nomenclature : -

ENVISAT/MWR : 36.5 GHz Channel Drift Status

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APPLICABLE DOCUMENTS / REFERENCE DOCUMENTS

RD 1 : MWR Instrument Performance, Alenia presentation, Envisat Calibration Review, 10 December 2002.

RD 2 : Intercomparison of TMR and ERS/MWR calibrations and drifts, Eymard et al, SWT TOPEX-JASON, New Orleans, Oct. 2002.

CONTENTS

1. INTRODUCTION

The aim of this document is to give a status of the 36.5 GHz channel drift of the Envisat MWR.

In chapter 2 we present the evolution of the main instrumental parameters since the beginning of the mission.

The impact of these instrumental drifts in terms of brightness temperatures has been estimated using different methods. Results are presented in chapter 3.

Chapter 4 contains a rough estimation of the impact in terms of wet tropospheric correction.

Finally Chapter 5 contains the conclusions.

2. INSTRUMENTAL PARAMETERS SURVEY

In this chapter we present the variation of hot and cold counts, of the gains, and of the residual temperature for the 2 channels and since the Envisat launch.

2.1. SKY HORN COUNTS

Figure 1 shows the evolution of the sky horn counts since launch. The counts for the first channel appear quite stable around 3300, despite a very weak increasing. For the second channel, a strong drift appeared clearly about 2/3 months after launch : values falling from 3600 to 3500.

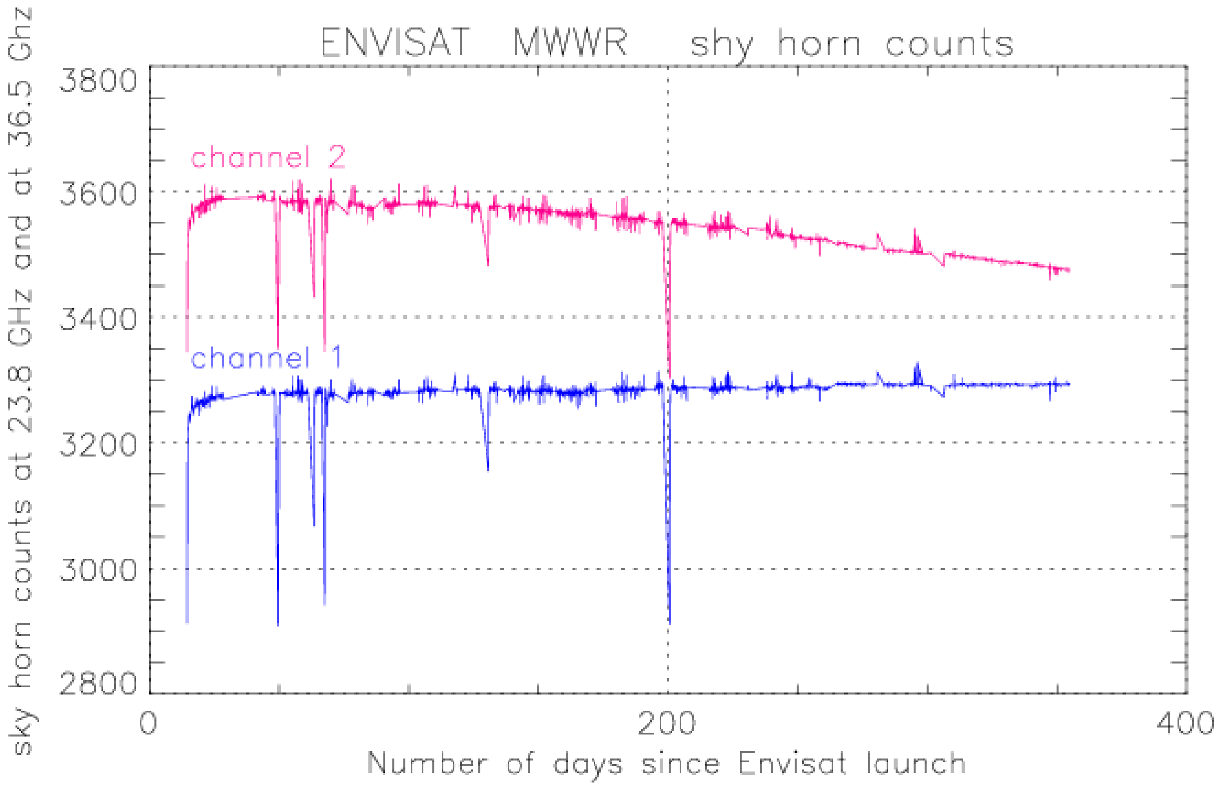


Figure 1 : Survey of the sky horn counts in both channels since Envisat launch.

2.2. HOT LOAD COUNTS

The survey of the hot load counts is presented on Figure 2. As for the cold counts, the hot counts are stable for the first channel (around 550) but decrease a lot for the second channel (660 at launch time, 640 now).

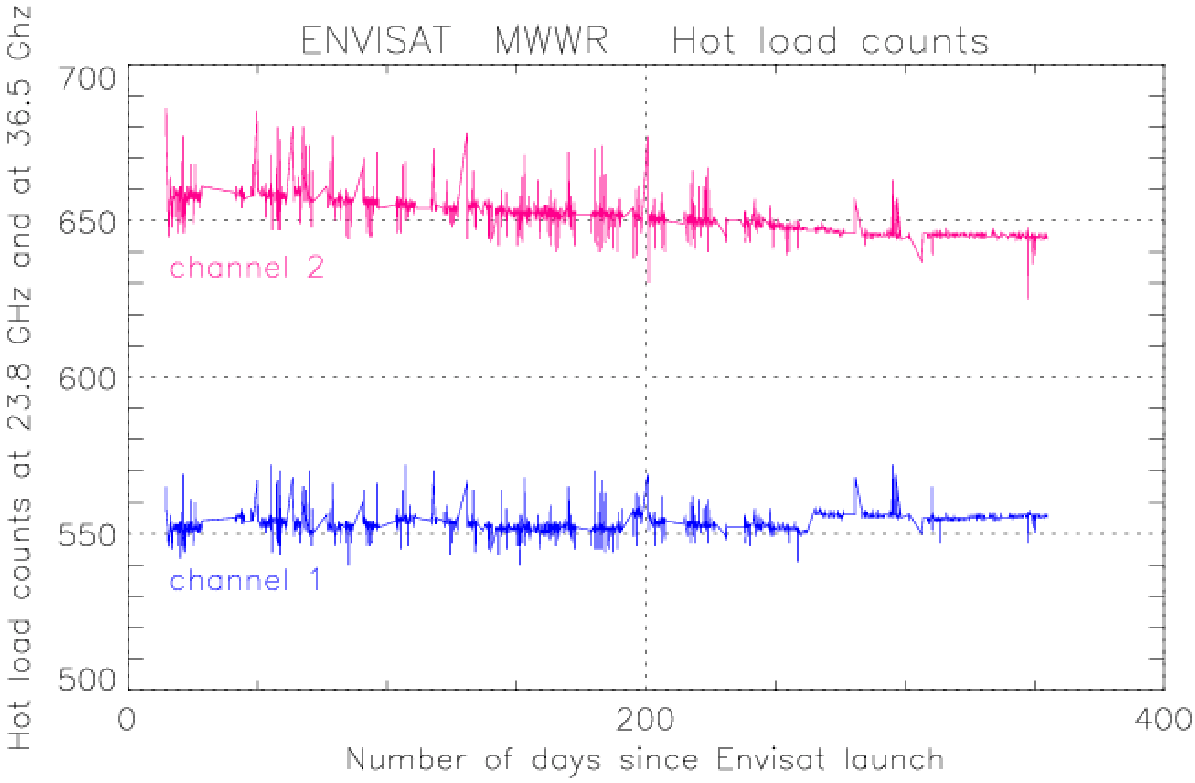


Figure 2 : Survey of the hot load counts in both channels since Envisat launch.

2.3. GAINS

The survey of both gains since launch is presented on Figure 3. The gain in the 23.8 GHz channel seems to increase very slightly since the beginning of the mission but remains very stable (around 9.6). For the second channel, the evolution of the gain is characterized by a decrease of about 4 % (values 0.4 lower now).

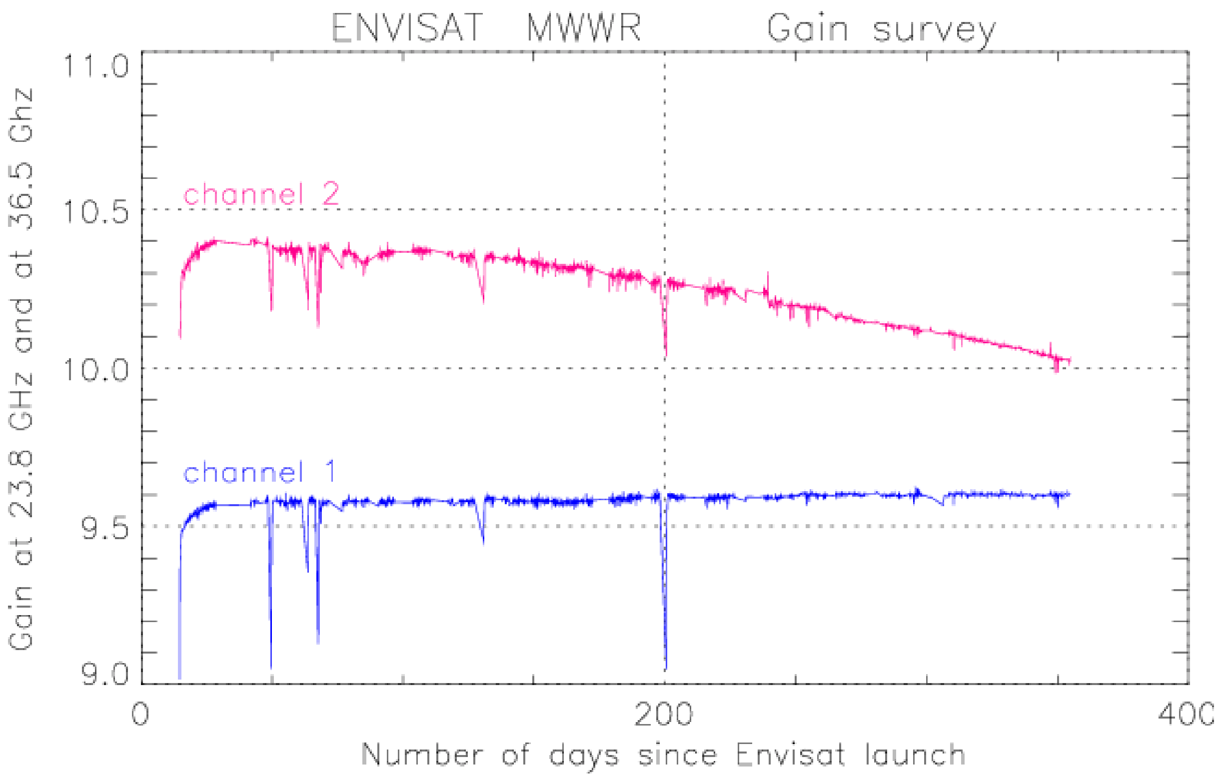


Figure 3 : Survey of the gains in both channels since Envisat launch.

2.4. RESIDUAL TEMPERATURES

Finally, the last parameter to survey is the residual temperature, which corresponds to the accuracy of the calibration model used to compute the antenna temperature. The results are presented on Figure 4.

Since launch these values are higher than expected from on ground test : the residual temperature was expected to be around 0.5 K for the first channel and a bit higher, 0.5-0.7 K for the second one, i.e. close to the ERS ones (cf. RD 1). No explanation for these high values (> 1K) has been given at this stage. Furthermore, there are 2 particular behaviors of these parameters to be analyzed :

- an important drift of the residual temperature at 36.5 GHz : the value is now higher than 2.2 K with a regular linear drift since 2 or 3 months after launch.
- a step in the residual temperature at 23.8 GHz around day 260 with an increase of 0.5 K.

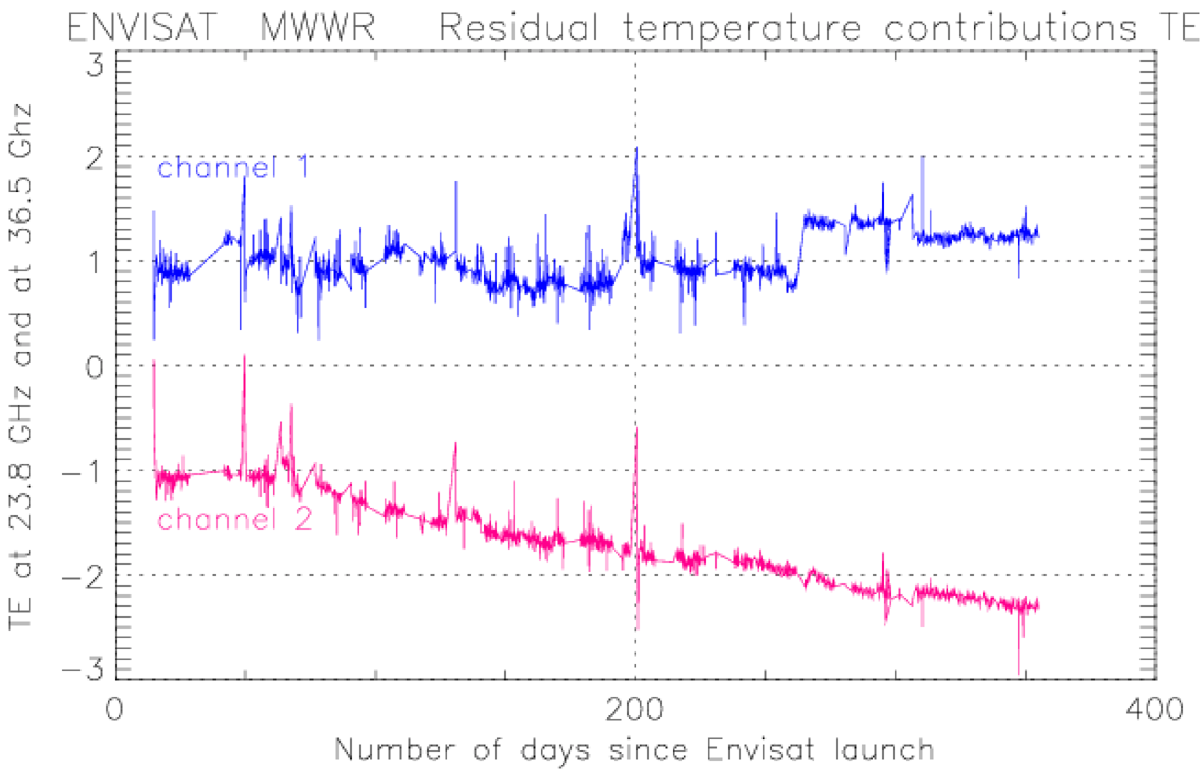


Figure 4 : Survey of the gains in both channels since Envisat launch.

3. DRIFT OF THE 36.5 GHZ BRIGHTNESS TEMPERATURES

In this part, we tried to point out and to assess the effect of the previous drift over the 36.5 GHz brightness temperatures. Different methods have been used, some using ERS2 36.5 GHz brightness temperatures as reference, since different studies have shown the very stable behavior of this channel (see RD 2).

3.1. SURVEY OVER CONTINENTAL AREAS USING COLLOCATED ERS2 AND ENVISAT MEASUREMENTS

For this first study, we extracted ERS2 and ENVISAT brightness temperatures over continental areas (Antarctic and Sahara). Figure 5 shows the evolution of the difference between ERS2 and ENVISAT daily averages of the 36.5 GHz brightness temperatures over these two areas. A fit performed over these points pointed out a drift of the difference between 1 and 2 K/year. Assuming a mean bias of 2.4K between ERS2 and ENVISAT brightness temperatures ($TB_{ENVISAT}$-TB_{ERS2}=2.4K), this is equivalent to a decrease of the ENVISAT brightness temperatures of 1 to 2K/year.

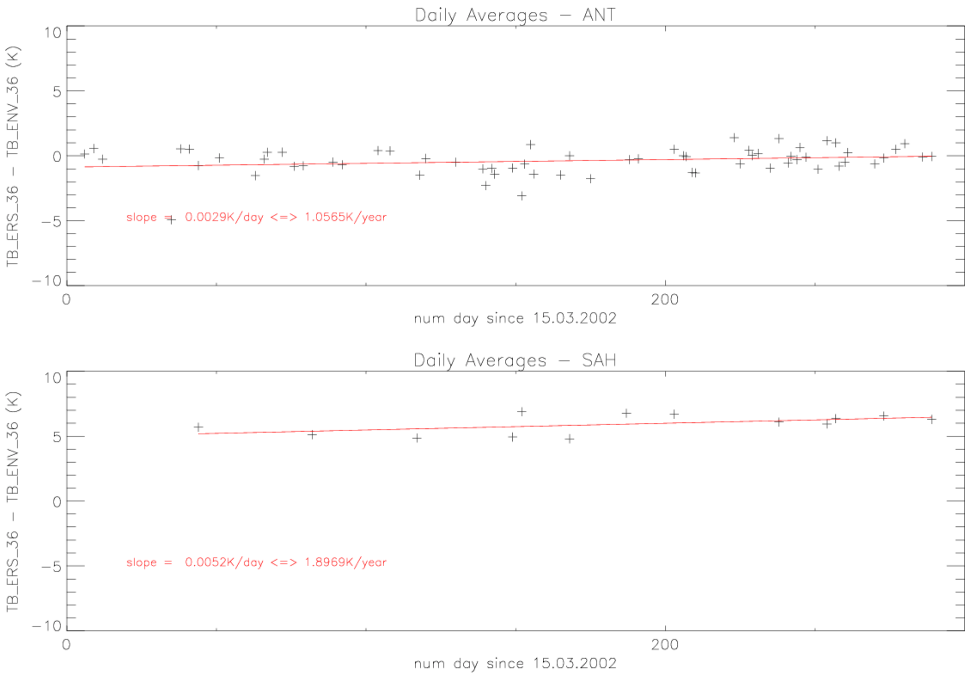


Figure 5 : Daily averages of the differences between ERS2 and ENVISAT 36 brightness temperatures. Top : over Antarctica ; bottom : over Sahara Desert.

3.2. SURVEY USING ALL ERS2 AND ENVISAT COLLOCATED MEASUREMENTS

For this study, we used all available and collocated ERS2 and ENVISAT measurements (both over land and ocean) between the 1st April 2002 and the 31 December 2002. We use the ERS2 TB36.5 as reference to classify the brightness temperatures and to estimate the drift for different values of the 36.5 GHz brightness temperatures. Figure 6 shows for all collocated points, the difference between ERS2 and ENVISAT brightness temperatures as a function of time for different classes of the ERS2 TB36.5. Slope values obtained for brightness temperatures lower than 150K or higher than 300K are very high and maybe not representative (not enough points, continental particular situations, ice...). Slopes obtained for classical ocean situations (between 150 and 300K) are between 0.7K and 2.8 K per year. These values are in agreement with the ones obtained in the previous section.

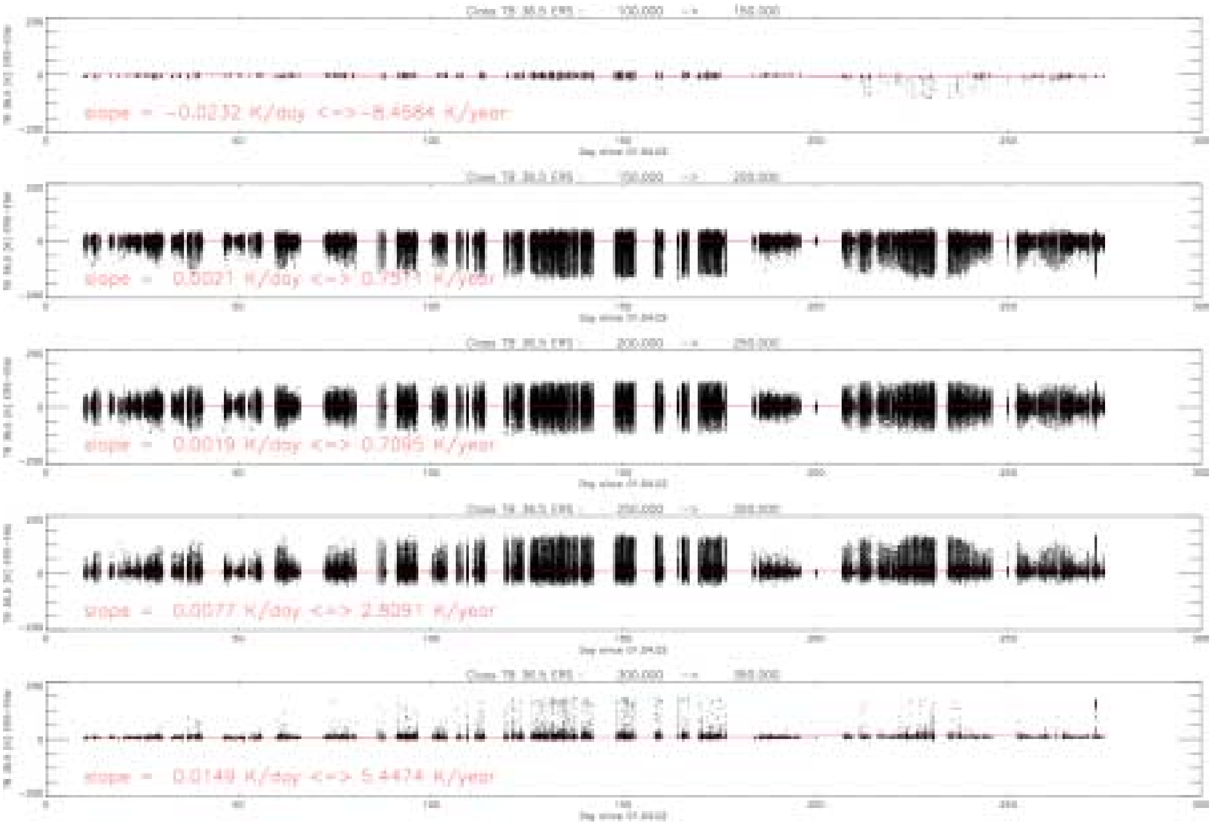
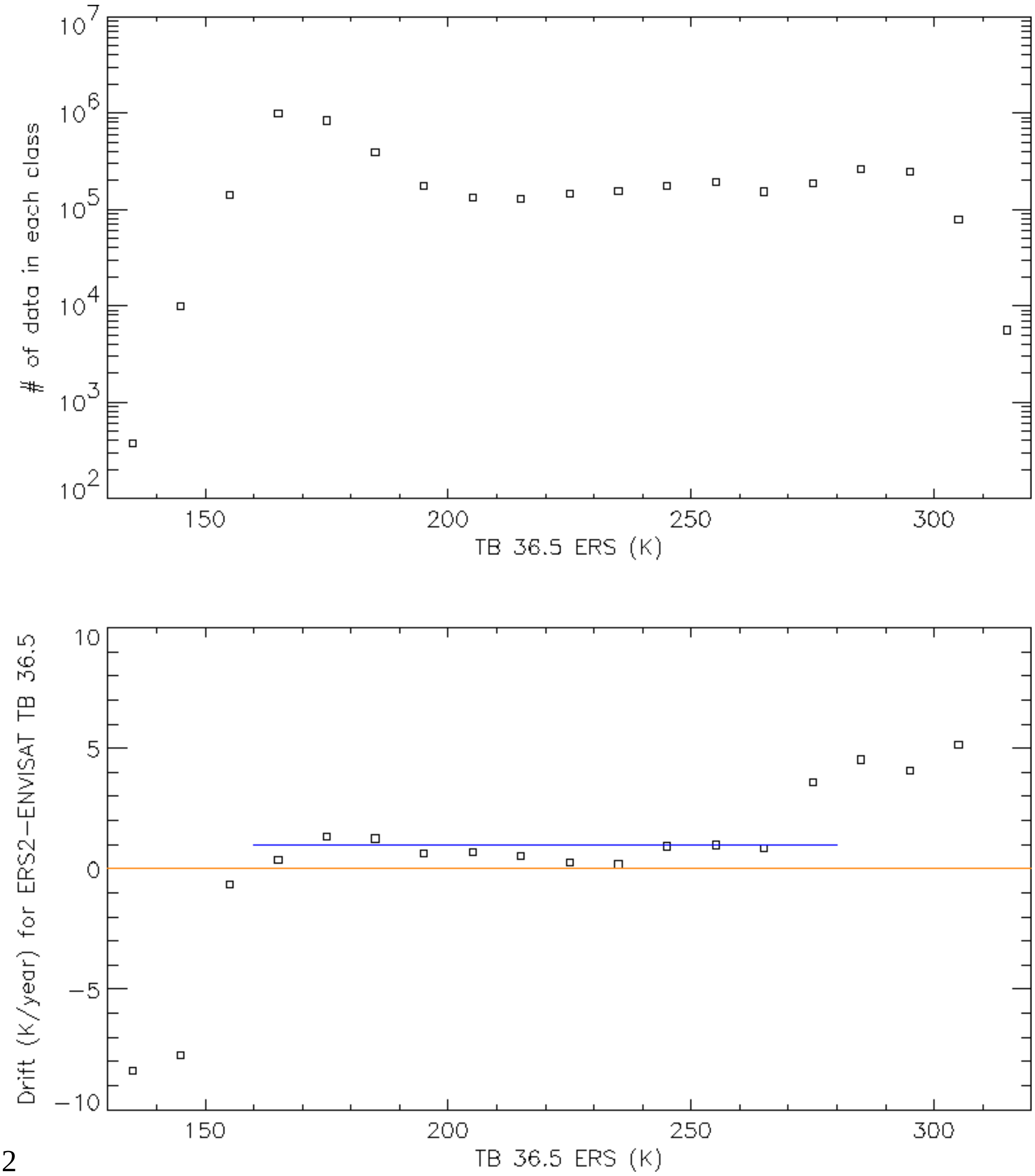


Figure 6 : TB_{ERS2}-$TB_{ENVISAT}$ for collocated points and for 5 different classes of ERS2 36.5 GHz brightness temperatures.

Figure 7 presents the results obtained with a classification of 10 K (number of points per class and value for the drift in this class). The values of the drift are between 0.2 and 2K per year for brightness temperatures between 160 and 270 K (corresponding to ocean values). For this range of brightness temperatures, we obtain a mean value for the drift of 1K/year.



ERS2

Figure 7 : For each class of ERS2 TB36.5, number of points and values obtained for the drift of the difference between ERS2 and ENVISAT brightness temperatures.

3.3. SURVEY OVER OCEAN

This study is similar to the one performed in section 3.2 but selecting only ocean points (selection over 7 particular ocean regions in moderate latitudes to avoid ice contamination represented on Figure 8). The ERS2 TB36.5 are classified in classes of 2 K, and the drift is estimated for each class. On Figure 9 we present the drift obtained for the differences between ERS2 and ENVISAT 36.5 GHz TBs. Figure 10 is the same but estimating just the drift of the ENVISAT TBs in a given class of ERS2 TBs. Results are very consistent and confirm the very good stability of the ERS2 TBs with time. In both cases, the drift obtained with enough accuracy (between 160 and 185K) is between 1 and 2 K/year.

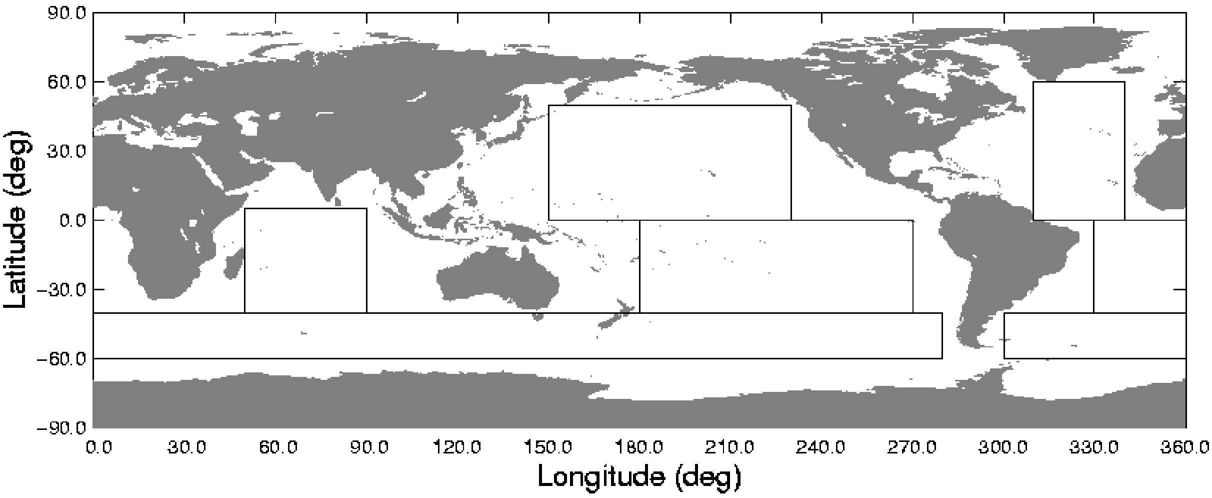


Figure 8 : map of the 7 selected areas for the brightness temperatures extraction.

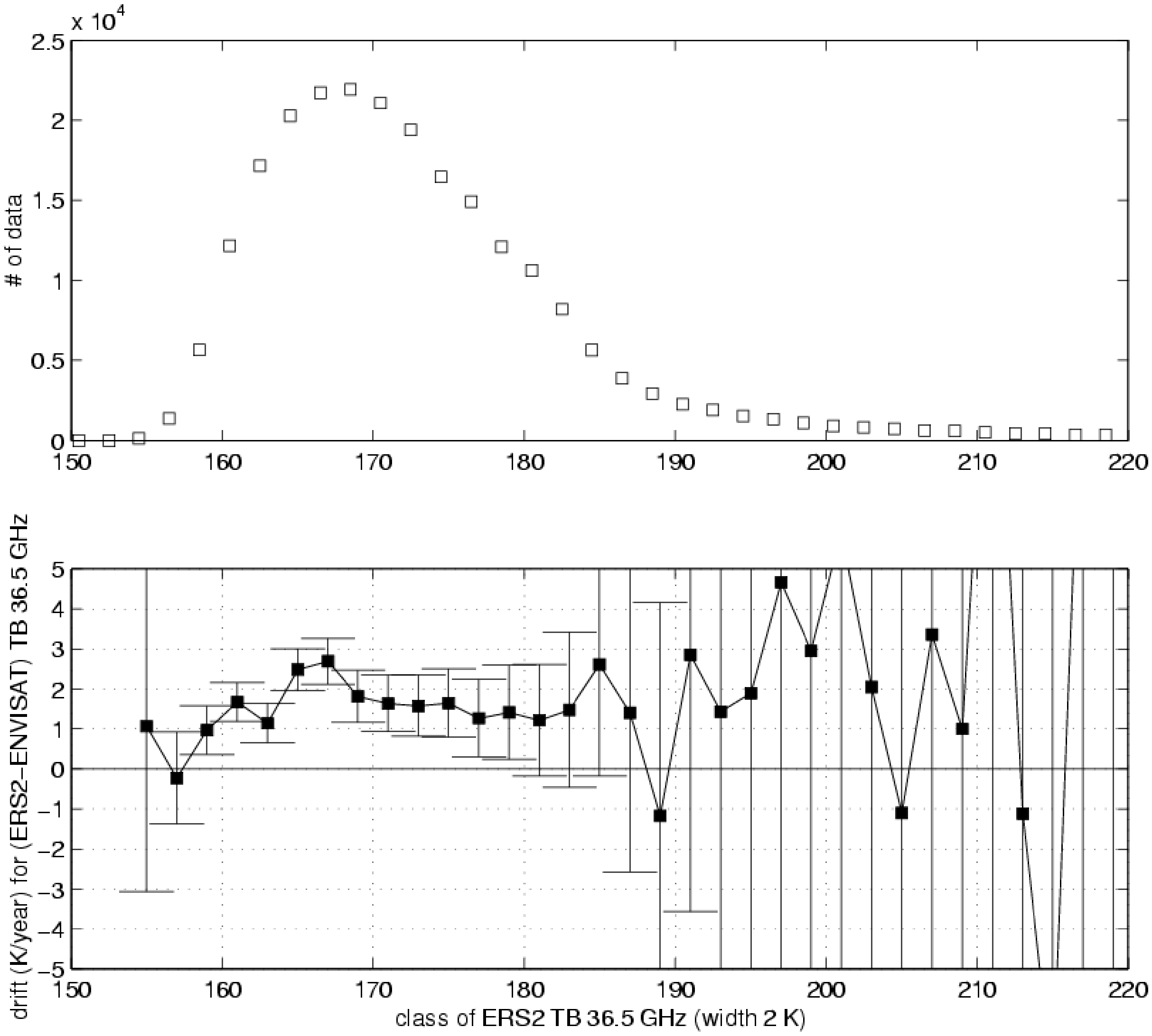


Figure 9 : For each class of ERS2 TB36.5, number of points and values obtained for the drift of the difference between ERS2 and ENVISAT brightness temperatures over ocean.

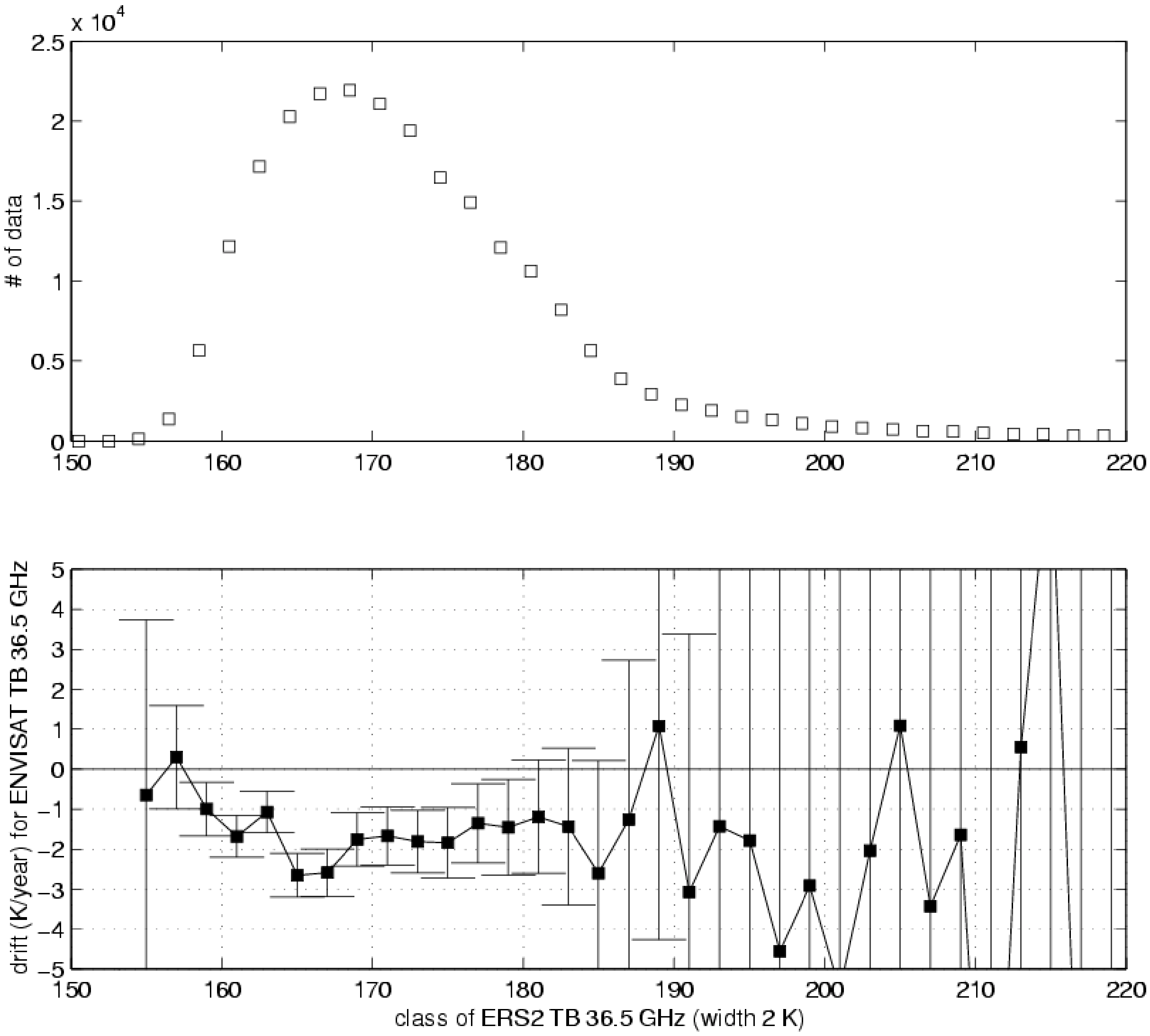


Figure 10 : For each class of ERS2 TB36.5, number of points and values obtained for the drift of ENVISAT brightness temperatures over ocean.

3.4. SURVEY OF THE COLDEST POINTS OVER OCEAN

Following the method developed for the long term survey of ERS2, we selected the coldest points over ocean :

- a first test consisted of filtering out points of temperature higher than a fixed threshold (150 and 170K for the 23.8 and the 36.5 GHz channels, respectively) and of latitude greater than 70° (N and S), to remove possible values over ice.

- a second test was to calculate the average brightness temperature over about 15 days (100 orbits), as well as the standard deviation, then to filter out points warmer than the average minus 1.5 times the standard deviation.

The resulting time series is plotted in Figure 11. The 2K trend relative to ERS2 is not observed here, but a slight decrease of –0.6K over the first year is clearly depicted.

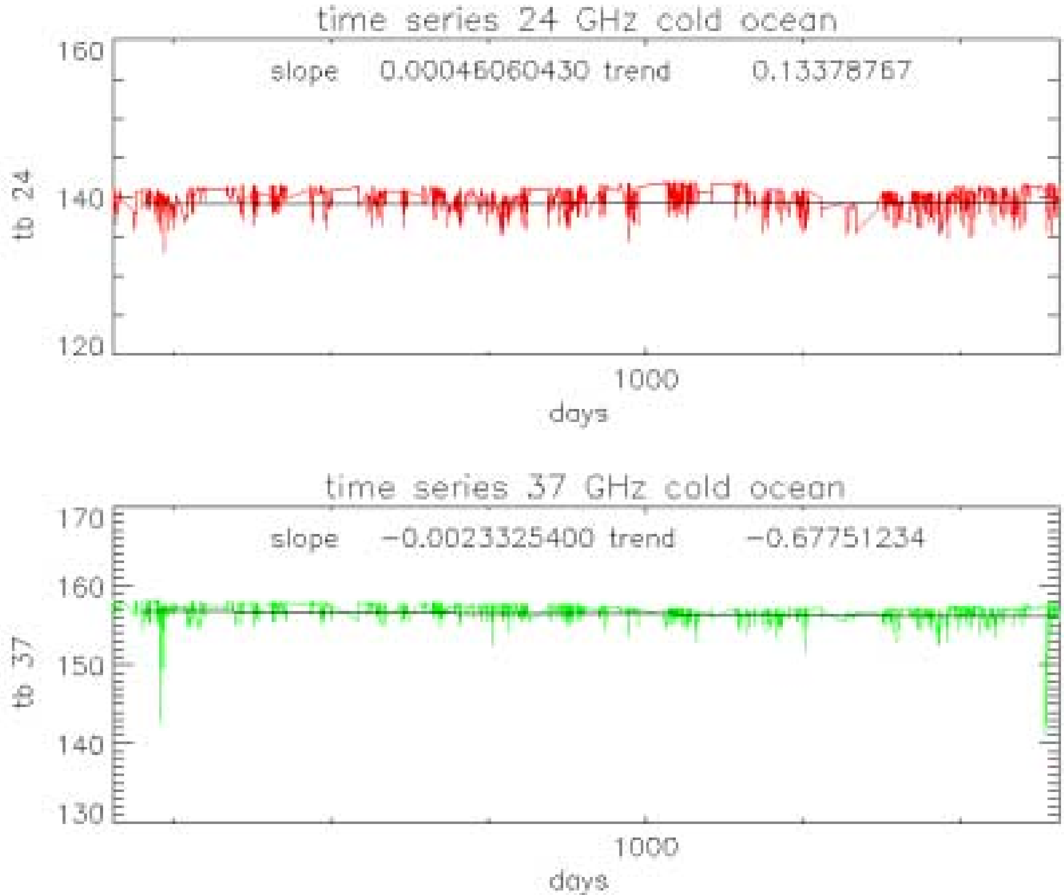
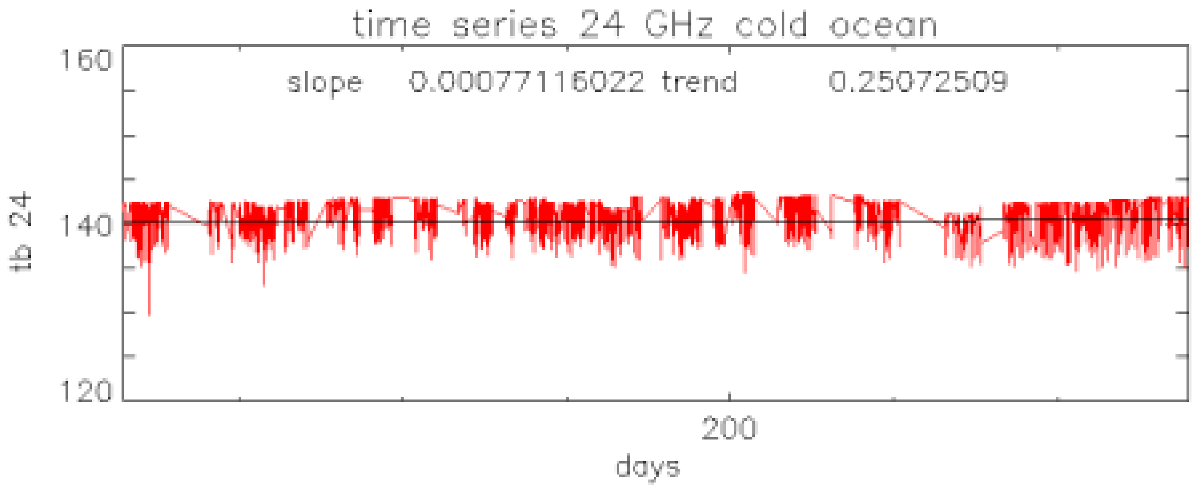


Figure 11 : time series of cold ocean data for the two channels over the first year (March 2002 to February 2003). The reference date is the 01.01.2000. A slight trend is observed on the 36.5 GHz channel (-0.6K over one year).

Using a threshold equal to the average-the standard deviation, the result slightly changes, as shows Figure 12.



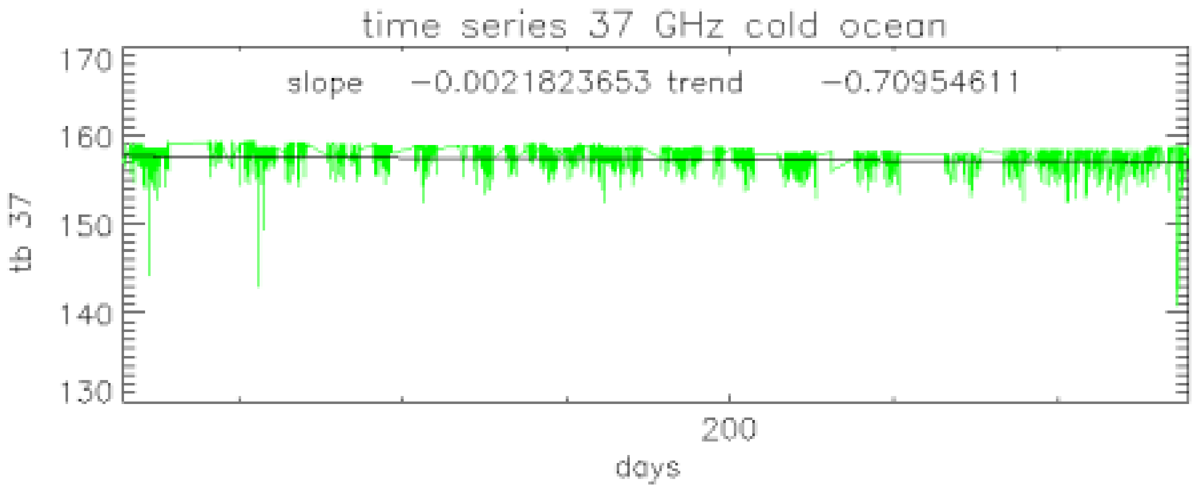


Figure 12 : same as Figure 11, but with a threshold less stringent for each 100 orbit series and a time scale using the ENVISAT launch as reference.

Finally, we investigated the impact of the abrupt changes of the gain and TE on the brightness temperatures, by calculating the regression line for particular intervals :

- for the 23.8 GHz, we distinguished the time series before day 265 and after, this date corresponding to a sudden jump of TE
- for the 36.5 GHz, the regression line was calculated for data after day 75, corresponding to the beginning of decrease both on the gain and TE.

Results are shown in Figure 13. For channel 1, there is a sudden decrease of the brightness temperatures, and there is possibly a rapid trend in this last portion of data. However, the data set is too short to permit a definite conclusion. For channel 2, results are consistent with the previous figures, showing a clear trend correlated with the gain decrease (0.9K over 10 months, equivalent to 1.2 K for one year).

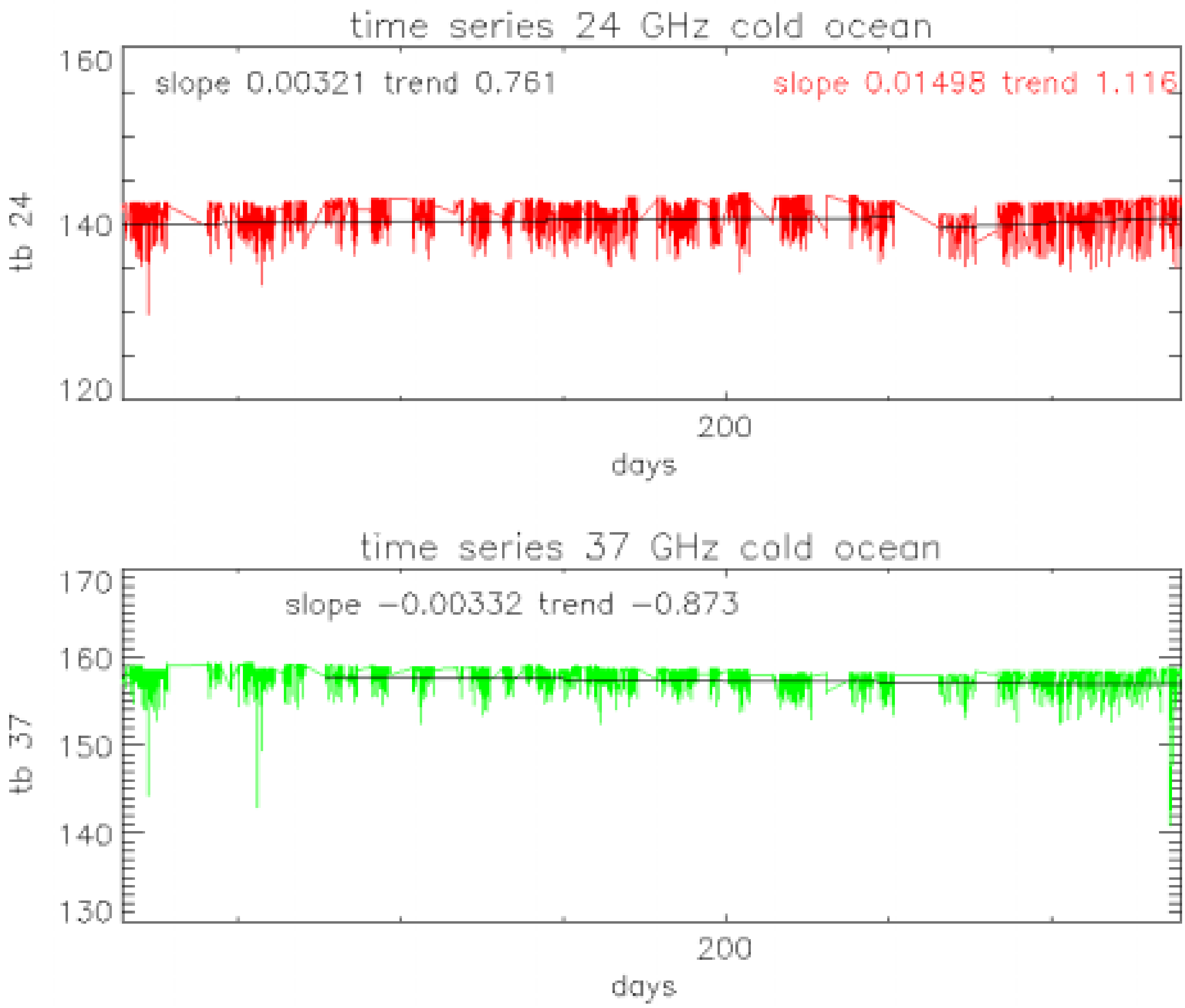


Figure 13 : same as Figure 12, by calculating the regression line for particular date intervals.

3.5. CONCLUSION FOR THIS PART

The 4 methods provide a similar estimation for the drift of the brightness temperatures. Differences between ERS and ENVISAT TBs present a drift, which is between +1 and +2 K/year. Knowing that the mean bias between ERS2 and ENVISAT brightness temperatures at 36.5 GHz is 2.4 K (TBERS-TBENV=2.4 K), it means that ENVISAT brightness temperatures have decreased with a drift of 1 to 2K per year. This is in agreement with the results obtained over cold Ocean and presented over figure 12 (-1.2K/year).

4. IMPACT OF THE DRIFT ON THE WET TROPOSPHERIC CORRECTION

The algorithm used to retrieve the wet tropospheric correction from the brightness temperatures is the following :

$dh=170.268-53.6767*Log_e(280-TB23)+20.9889*Log_e(280-TB36)-450.383*(1/sigma0\_Ku)^2$,
with TB23 and TB36 are in K, and dh is the wet tropospheric correction in cm>0.
A drift of 1 to 2K/year corresponds therefore to a drift between 0.7mm and 3 mm per year depending on the brightness temperature.

5. CONCLUSIONS

In this study, we made an evaluation of the drift of the main instrumental parameters of the radiometer at 36.5 GHz. It appears that the sky horn counts, the hot load counts, the gain have decreased by about 4% since launch. Furthermore, the residual temperature is now 2 times higher in absolute value than the one estimated at the beginning of the mission and 4 times higher than the one expected from on ground tests. The brightness temperature also exhibits a drift of 1 – 2 K/year at temperatures usually observed over ocean. The above analysis did not allow to establish the drift at very high temperatures, due to the higher noise and the small number of data, but such an increase is suspected. At very low temperatures, the drift is estimated to be around –1.2K.

At this stage it seems to us that the following investigations have to be performed :

- to explain the too high value for both residual temperature as well as the drift at 36.5 GHz
- to quantify the effect of this high residual term on the antenna temperature
- to explain the drift of the 3 other parameters (sky horn counts, hot load counts and gain). The fact that the calibration counts, the gain, and the residual temperature are drifting with time could be due to a receptor problem. It does not seem to be a drift of a switch or of microwave components, as in the ERS2 radiometer.