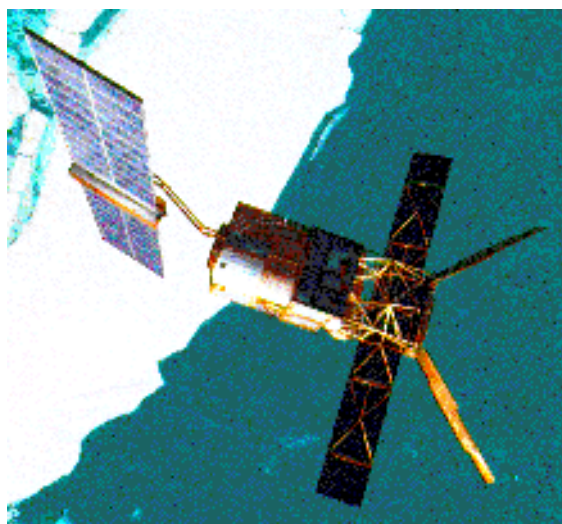


ERS-2 Radar Altimeter Cyclic Report

from 25th September to 4th December 2000
Cycles 57 and 58



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1.0 Introduction and summary

This document reports on the performances of the ERS-2 RA during nominal operations and on the quality of the RA fast delivery products (URA) in the period between 25th September to 4th December 2000, corresponding to cycles 57 and 58.

The results reported in each section concern, apart from a summary of the daily quality control made within the PCS, an explanation of the major events that have impacted the performance during the last cycles.

After the increasing pattern at the beginning which corresponds to the commissioning phase; in the last period the AGC Openloop Calibration values are following a decreasing pattern which can be related to instrumental ageing. During cycle 57 a small increase of the AGC values is noticeable just in correspondence of the anomaly occurred on the 7th of October (ref. par. 3.2.2). The AGC values just after the recovery from the anomaly were about 0.05 dBs higher than the previous trend while this difference was reduced to 0.02 dBs at the end of cycle 58. Because of these small values, the AGC variation occurred should not have had a very big impact in the backscattering quantity measured by the Radar Altimeter. Anyway the problem is under investigation in order to determine, under a quantitative point of view, the rebound, if any, on the measured sigma₀.

For the HTL Openloop Calibration the overall increasing pattern is easy to notice, being the first part related to the commissioning phase. It is superimposed to sudden variations (jumps) of the values in concomitance to instrument anomalies. For the period covering cycles 57 and 58 one anomaly occurred, in relation to this, a jump in the HTL trend is easy to notice at the end of the time series.

Over the last period the Ultra Stable Oscillator drift measurements slope tend to be lower than it was before (smaller negative value). Since the beginning of the year 1999 the values of the USO frequency are likely to follow a different trend respect to what they did before that date. Starting from cycle 46 the amount of values following that different trend was big enough to cause the overall drift passing from a negative value of 8.9 mm/year to a negative value of 8.7 mm/year. After specific investigations it has been found that since November the 21st 1998 the slope had assumed a value of 7.1 mm/year until cycle 53 and has been continuing to increase until reaching a value of 6.9 mm/year at the end of cycle 58. This fact cannot be correlated to a particular event regarding the instrument itself; the explanation could be a high amount of magnetic or X rays in the space outside the spacecraft which often cause a frequency change in this kind of devices. Anyway this does not introduce further errors in the Radar Altimeter measurements, being the USO frequency regularly measured and the appropriated correction evaluated.

The Scanning Point Target Response correction values history clearly shows the jumps occurring in correspondence to the instrument anomalies. It is worthwhile to notice that the jumps in the SPTR correction value are much less frequent after the summer 1997. This is related to a patch in the on-board software performed on July the 14th 1997, aimed to reduce the frequency of occurrence of the most common anomaly for the Radar Altimeter. That anomaly is denominated "Memory Checksum Violation" and consists in the change of a bit's value in the internal memory due to casual electric discharge. During cycle 57 and 58 the instrument suffered of one anomaly, therefore one jump is visible during this period of time.

The Percentage of products in Acquisition Mode for cycles 57 and 58 was around 1.5%. This parameter represents a figure which helps in assessing the instrument tracking performance. The present value is nominal since cycle 40 when the Ice/Ocean Mask was changed and consequently the Radar Altimeter tracking performance definitely improved. Before that date the percentage of products in Acquisition Mode was stable around a value of 1.8%. Worthwhile to notice that for the 8th and the 9th of October no information is available due to the instrument anomaly (ref. par. 3.2.2)

Considering the whole mission time extent, the trend of most of the internal instrument parameters appears to be quite stable. The only cases showing variations are the HPA Transmitted Power and the Helix Current being anyway those variations so slow to be detectable in one or two cycles time scale. On the other hand, an anomalous event occurred at the beginning of July 2000 caused a small but abrupt change in some of the parameters figures (e.g. High Power Amplifier transmitted power, Instrument Control Unit temperature, Signal Processor Sub Assembly panel temperature). During cycle 57 and 58 the parameters kept the trends they had assumed during the three previous cycles despite the anomaly occurred on the 7th of October 2000 (ref. par. 3.2.2).

The IF Filter Shape was monitored during cycles 57 and 58. The anomaly occurred on the 7th of October did not have a noticeable impact on the IF Filter behaviour. The average difference over the whole filter bank in comparison to the beginning of the mission remains at about 0.035 dBs also after the recovery of the instrument on the 10th of October. Of course due to the anomaly, no data were available for the IF Filter Shape computation on October the 7th, the 8th and the 9th. More generally, the IF Filter shape is affecting the received echo shape within the filter bank. For this reason it has an influence on all the RA retrieved parameters (e.g. Range, Sigma_0 and Significant Wave Height) being their evaluation based on the received waveform profile. Investigations are on going in order to assess the impact of the IF Filter shape variations on the RA retrieved geophysical parameters.

During cycles 57 and 58 the Radar Altimeter off-nadir pointing continued to be monitored resulting in an overall mispointing average value of 0.085°. A very small increasing trend is evident after middle February 2000 (change of the piloting system) and another after the 7th of October 2000 when the Gyro 5 failed and the Gyro 1 was chosen to pilot the platform in nominal operations (after a very short period during which Gyro 6 was used). The total increment, being in average lower than 0.01°, can be anyway considered irrelevant bearing in mind the uncertainties affecting the retrieved figures.

The fast delivery data performance during cycle 57 was reasonably satisfying. The value close to 10 percent for the missing products was due to the occurrence of an instrument anomaly in the period 7-10 October 2000 (ref. par. 3.3.2) and to acquisition problems occurred between 10:10 and 10:50 on the 26th of September. The value of about 1.5 percent, characterising the Wet Tropospheric Correction Default Values during this cycle, is not negligible. It was mostly due to some acquisition problems occurred on the 26th of September and to the fact that the Gyro 5 failure related anomaly lasted almost one day longer for the MWR than for the RA (ref. par. 3.3.2).

The fast delivery data performance during cycle 58 was very good.

2.0 Calibration Performances

The calibration measurements performed operationally for the Radar Altimeter are executed with the internal calibration technique. It is not an end-to-end absolute calibration because some elements like some ferrite circulators, waveguides and the antenna are outside the calibration path, but makes a relative calibration of time dependent variations in the instrument measurements caused by thermal variation around the orbit as well as ageing effects. There are three types of calibration measurements: The Openloop Calibration, the Scanning Point Target Response (SPTR) Calibration and the Ultra Stable Oscillator (USO) Calibration. The Openloop Calibration, is related to two parameters: the altimetric range and the received power which is then related to the normalized backscattering coefficient (σ_0). The Openloop Calibration is dedicated in particular to correct for the thermal orbital variation. It does anyway take into account variabilities due to instrument ageing. The SPTR and USO Calibration are performed to keep under control time-related effects on some reference parameters used in the evaluation of the altimetric range.

2.1 Openloop Calibration

2.1.1 Automatic Gain Control (AGC)

The received power in the Radar Altimeter, during nominal tracking operations, is automatically attenuated or amplified by the instrument aiming to have the best detection of the signal. In order to calibrate the value of that attenuation, a measurement is performed every minute using a special transmitted impulse called Point Target Response. In this case the impulse is not sent to the ground but, after transmission, is redirected to the receive along the calibration path. The calibration mode measures the variations of the Point Target Response power due to the internal electronics of the instrument. The attenuation or amplification of the signal is performed respect to a Reference Power defined at the beginning of the mission as described by the following formula:

$$A^F = \frac{\sum_{i=1}^{64} MWA(i)}{K_4}$$

Where:

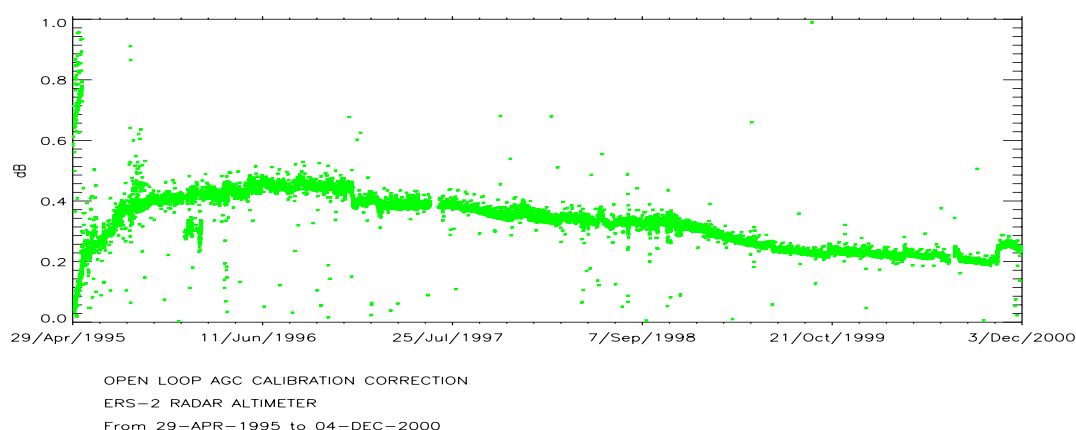
A^F : Calibration σ_0 correction value

$MWA(i)$: Waveform Samples

K_4 : Power reference value for Openloop Calibration

The values measured with this technique, after smoothing, are added to the σ_0 measurements during the on-ground processing. The AGC Openloop Calibration trend since the beginning of the mission is plotted in the following picture. Every value represents the average over one orbit; this hides the orbital variations in the AGC values, which otherwise would be clear. The in-

creasing pattern at the beginning corresponds to the commissioning phase. The decreasing pattern covering the last few years can be related to instrumental ageing. During cycle 57 a small increase of the AGC values is noticeable just in correspondence of the anomaly occurred on the 7th of October (ref. par. 3.2.2). The AGC values just after the recovery from the anomaly were about 0.05 dBs higher than the previous trend while this difference was reduced to 0.02 dBs at the end of cycle 58. Because of these small values, the AGC variation occurred should not have had a very big impact in the backscattering quantity measured by the Radar Altimeter. Anyway the problem is under investigation in order to determine, under a quantitative point of view, the rebound, if any, on the measured sigma_0.



2.1.2 Height Tracking Loop (HTL)

The Radar Altimeter, during nominal tracking operations, measures the time delay the transmitted impulse takes to travel to the ground and back, including the internal path. In order to calibrate the equivalent length of the internal path, a measurement is performed every minute using a special transmitted impulse called Point Target Response (PTR). In this case the impulse is not sent to the ground but, after transmission, is redirected to the receive along the calibration path. The calibration measures the variations in the delay time the Point Target Response signal takes to travel through the entire length of the calibration path; or, in other words, the variation of the calibration path equivalent length. The measurements are performed with reference to the centre of the tracking window. The overall calibration correction value is given by the following formula:

$$T^F = (N_f - 32)k_f + K_1$$

where:

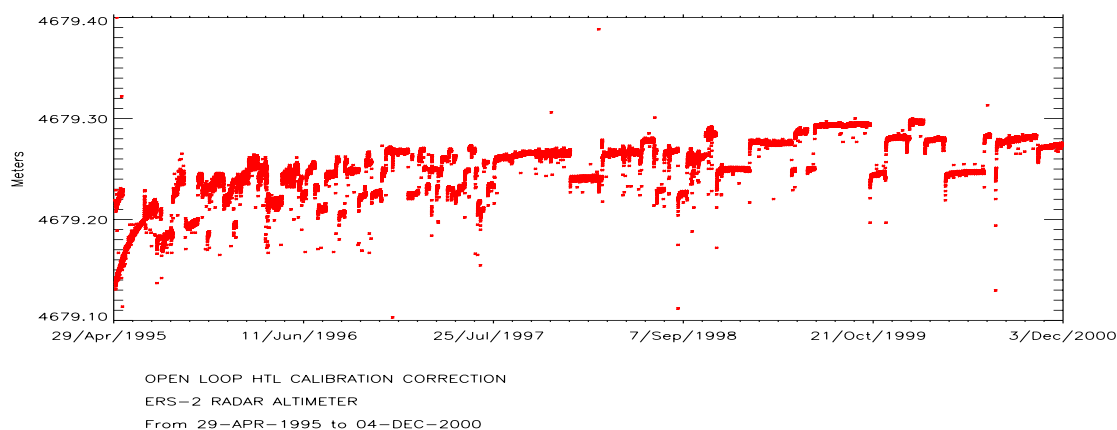
T^F : Calibration height correction value

N_f : derived centre of the Point Target response

k_f : conversion factor from filter units to time

K_I : delay time to the range window position

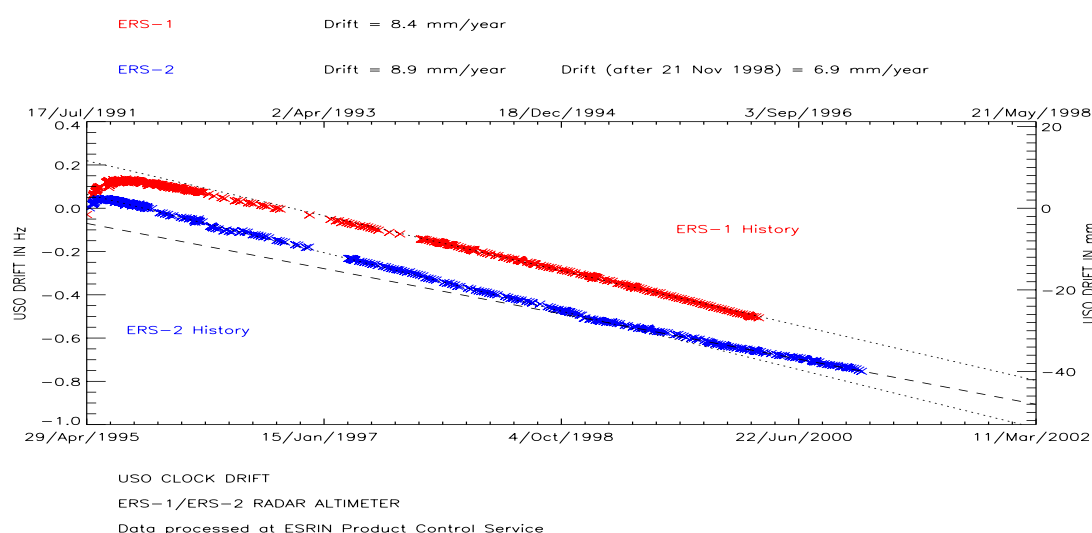
First the position of the PTR in the tracking window is determined (where the centre of the tracking window is identified by filter number 32) and then the position of the tracking window is established and added. During the openloop calibration only the position of the PTR within the tracking window is observable and the window position is assumed as know. Anyway for the calibration to be accurate, also this last parameter has to be kept under control and its stability to be assessed. This can be done via the SPTR Calibration described in par. 2.3. The values measured with this technique, after smoothing, are added to the altimeter measurements during the on-ground processing. As for all the time delay measurements in the Radar Altimeter, the measurement unit for the Openloop HTL calibration is a frequency derived from the USO one. In case of instrument anomaly, the HTL measurements can show very sudden variations in their values; they are probably due to an asymmetry of the reference clock and to a variation of the equivalent length of an internal subsystem. The HTL Openloop Calibration trend since the beginning of the mission is plotted in the following picture. Every value represents the average over one orbit; this hides the orbital variations in the HTL values, which otherwise would be clear. The overall increasing pattern is easy to notice, being the first part related to the commissioning phase. It is superimposed to sudden variations (jumps) of the values in correspondence to instrument anomalies. For the period covering cycles 57 and 58 one anomaly occurred, in relation to this a jump in the HTL trend is easy to notice at the end of the time series.



2.2 Ultra Stable Oscillator (USO)

Every time delay measurement performed by the Radar Altimeter, both in tracking and calibration modes, uses, as measurement unit, a clock frequency derived from the Ultra Stable Oscillator one. Any variation in that reference clock could cause an error the time delay measurements and consequently on the altimetric range estimation. For this reason the USO is kept under control by mean of a weekly measurement of a derived frequency, which nominal value is 15 MHz. The output of this campaign is used by ESRIN/PCS to calculate, every week, a correction value to be add-

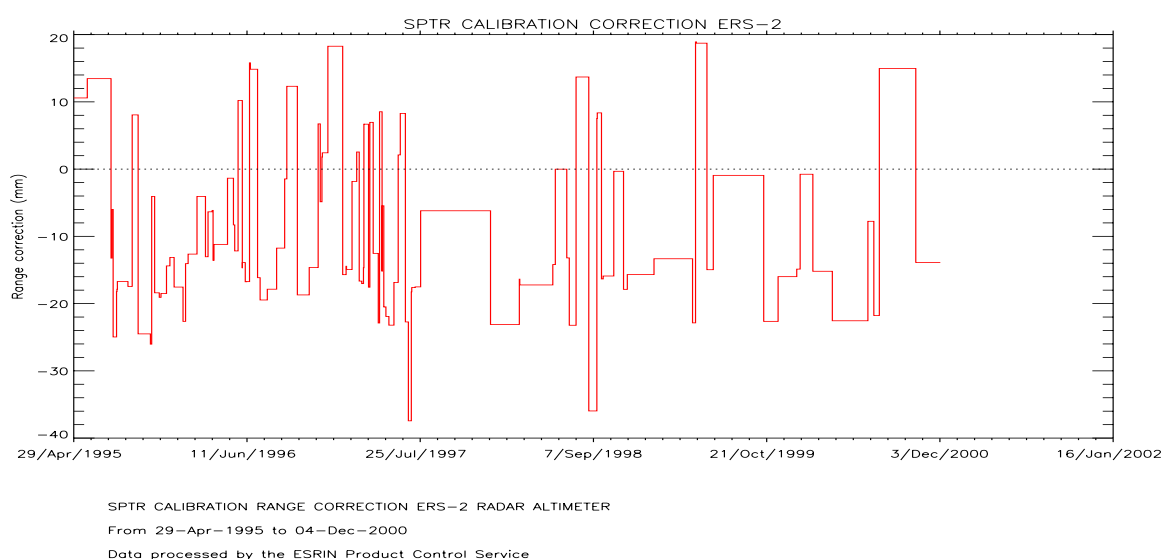
ed to the range measurements in order account for any variation of the internal clock and so to enhance the quality of the data. The following picture shows the USO measurements trend since the beginning of the mission. It has to be noticed that during the last period, the Ultra Stable Oscillator drift measurements slope tend to be lower than it was before (smaller negative value). Since the beginning of the year 1999 the values of the USO frequency are likely to follow a different trend respect to whet they did before that date. Since cycle 46 we had noticed that the amount of values following that different trend was big enough to cause the overall drift passing from a negative value of 8.9 mm/year to a negative value of 8.7 mm/year. After specific investigations it has been found that since November the 21st 1998 the slope had assumed a value of 7.1 mm/year until cycle 53 and has been continuing to increase until a value of 6.9 mm/year at the end of cycle 58. This fact cannot be correlated to a particular event regarding the instrument itself; the explanation could be a high amount of magnetic or X rays in the space outside the spacecraft which often cause a frequency change in this kind of devices. Anyway this does not introduce further errors in the Radar Altimeter measurements, being the USO frequency regularly measured and the appropriated correction evaluated.



2.3 Scanning Point Target Response (SPTR)

During the Radar Altimeter operations all the time delay measurements are performed calculating the position of the received echo within the tracking window with reference to its centre. The range value equivalent to the tracking window centre has been evaluated prior to launch and was considered to be stable. After launch it has been noticed that value was not stable, on the contrary, it was affected by abrupt changes in correspondence to instrument anomalies. The original value is anyway still used as reference for the time delay measurements both in tracking and calibration modes. The cause of those jumps has been identified in an internal clock asymmetry; in order to determine the position of the tracking window centre, correcting for the clock asymmetry effects, a dedicated Scanning Point Target Response campaign is performed every day. The basic concept for the measurement campaign is the study of the positions, within the tracking window, of different PTR related to different trigger positions. Every day, the output of this campaign is used by ESRIN/PCS to calculate a range correction value which takes into account the discrepancies between the operationally used tracking window position values and the measured one. Those cor-

rection values have to be added to the range measurements in order to improve the quality of the data. The campaign was previously performed every three days and it could happen that two subsequent anomalies occur without that an SPTR campaign was performed. Knowing that the position of the tracking window is affected by abrupt changes related to instrument anomalies, in the period between the two anomalies it would not have been possible to determine the exact position. The SPTR correction values history is reported in the following picture showing clearly the jumps in correspondence to the instrument anomalies. It is worthwhile to notice in the plot that the jumps in the SPTR correction value are much less frequent after the summer 1997. This is related to a patch in the on-board software performed on July the 14th 1997, aimed to reduce the frequency of occurrence of the most common anomaly for the Radar Altimeter. That anomaly is denominated “Memory Checksum Violation” and consists in the change of a bit’s value in the internal memory due to casual electric discharge. During cycle 57 and 58 the instrument suffered of one anomaly, therefore one jump is visible during this period of time.

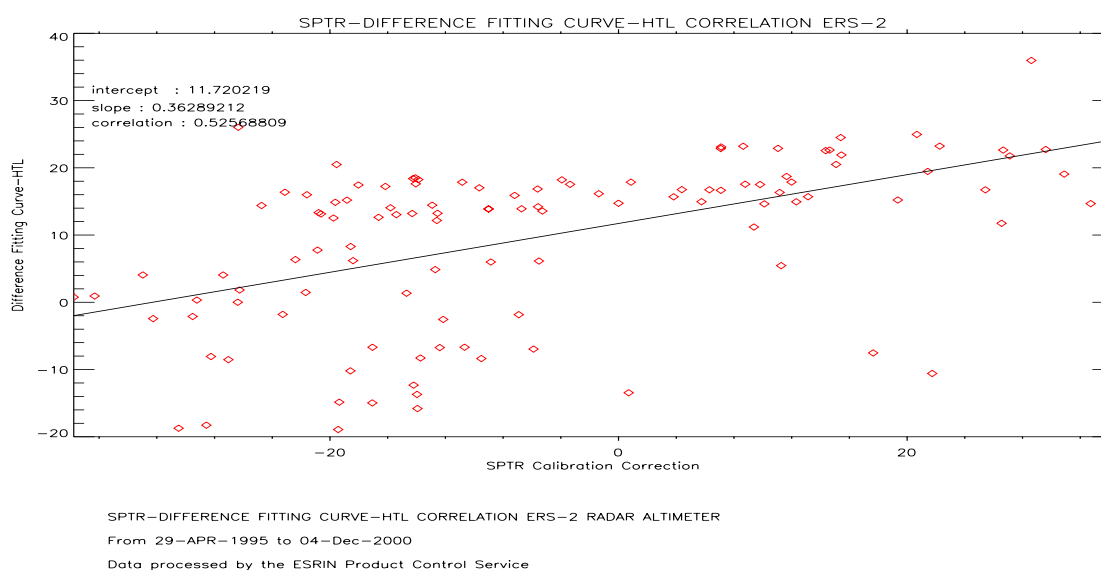
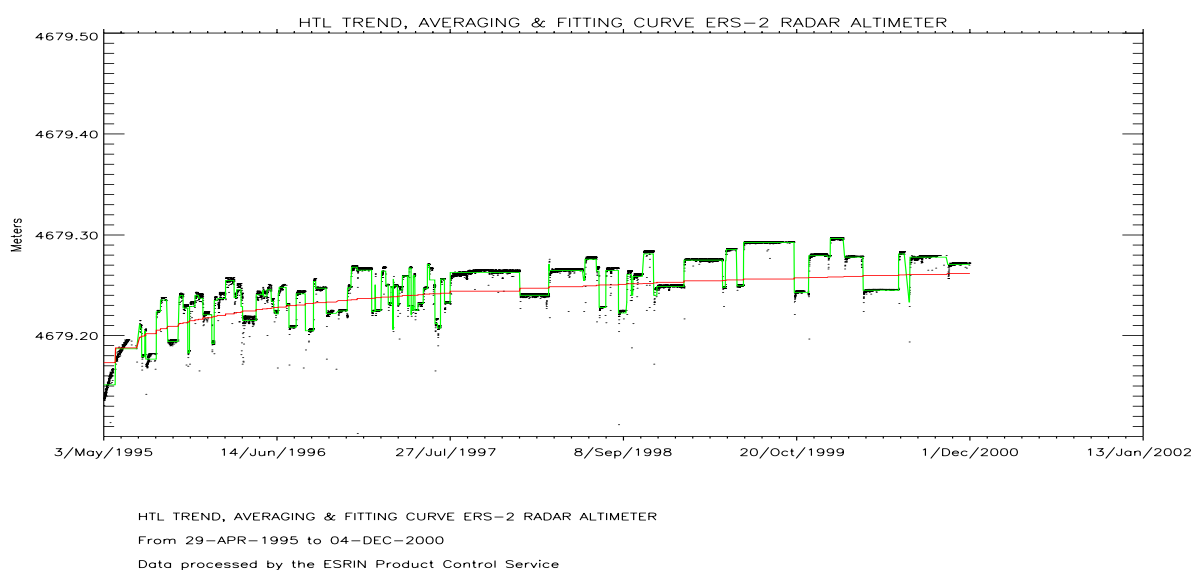


2.3.1 SPTR and HTL Openloop Calibration Corrections Correlation

Observing the plots related to the SPTR and the HTL Openloop Calibration corrections trends, both affected by jumps in their values in correspondence to instrument anomalies; it would be reasonable to think that the values of the two corrections could be in some way correlated. This idea could be furthermore supported by the fact that the techniques the two calibrations are implemented with are very similar, both basing on the measurement of the Point Target Response internal delay.

Considering that the SPTR calibration is aimed to correct for the abrupt changes in the tracking window centre position which is the reference for the HTL Openloop calibration and supposing that the HTL Openloop calibration would follow a logarithmic trend when not affected by jumps; the following algorithm was implemented. For each interval between two instrument anomalies (inter-anomaly period), a differential value was calculated between the theoretical HTL logarithmic trend and the average over that period of the real HTL Openloop calibration series. That value was then correlated with the corresponding SPTR correction one.

Hereafter, in the first plot, the HTL Openloop calibration trend, its average over every inter-anomaly period and the theoretical logarithmic behaviour are plotted. Only HTL Openloop calibration values lower than the median over every inter-anomaly period have been considered in order to eliminate the influence of the high HTL variability. The scatter plot between the just described differential values and the corresponding SPTR correction values is reported in the second figure. The low correlation coefficient value and the scatter plot itself reveal that the expected correlation is not in practice realised. The knowledge of the instrument and the calibrations techniques can explain the evidence as follows. Even if both the SPTR and HTL Openloop calibrations are effected by the clock asymmetry which causes a certain similarity in the their behaviours, the HTL Openloop calibration is affected by a secondary effect, also happening in correspondence to instrument anomalies, which causes the numerical uncorrelation. The secondary effect just mentioned can be identified in the delay line equivalent length variation due to the internal temperature change often associated with instrument anomalies.



3.0 Instrument performance

The instrument performances are assessed monitoring the following parameters:

- Acquisition Percentage: the percentage of products in Acquisition Mode both for cycle 57 and cycle 58 since the beginning of the mission. It is useful to determine the capability of the instrument in performing meaningful measurements.
- Internal Instrument Parameters for the period covering cycle 57 and 58. They are important to keep track of the status of every subsystem internal to the instrument, and try to establish correlation with eventual variations in the measured quantities (e.g. Range, Sigma_0 and Significant Wave Height) and with instrument malfunctions.
- IF Filter Shape for cycle 57 and cycle 58 and trend of the difference respect to the shape the IF Filter had at the beginning of the mission (e.g. on the 5th of May 1995). This is important in order to monitor if and how the waveforms are distorted by this component inside the instrument and if how distortions have been changing during the mission lifetime.
- Off-nadir pointing trend since the beginning of the mission. This is important in order to assess if the RA antenna really points at nadir being this one the of the main requirements for all the RA data processing.

3.1 Acquisition Percentage

During nominal operations the Radar Altimeter works alternatively in Acquisition and Tracking Modes. In Acquisition Mode the instruments adjust cyclically its internal parameters in order to reach the best reception of the backscattered echo. In this mode the instrument cannot perform any meaningful measurement. When the internal parameters are set to their optimum values for the best reception of the echo in those particular conditions, the instrument switches automatically to Tracking Mode. In Tracking Mode the instrument can perform meaningful measurements. A change in the environment the instrument is flying over (in particular the slope of the terrain) cause the instrument to adjust again its internal parameters to obtain the best reception. If it is able to perform the adjustment without switching again to Acquisition Mode, we can affirm that the instrument “maintains the lock” with the backscattered signal; the most the instrument stays in Tracking Mode, the better its performances can be considered. Considered the working concept just described, it is easy to understand that zones characterised by high terrain slope variations (like mountainous and coastal zones) cause the instrument to lose the lock and consequently force him to work in Acquisition Mode for an high percentage of time. The amount of ocean products in Acquisition and Tracking Modes for cycle 57 and 58 are reported in the second and third plots hereafter together with the percentage of products in Acquisition Mode respect to the total. Worthwhile to notice that for the 8th and the 9th of October no information is available due to the instrument anomaly (ref. par. 3.2.2)

The percentage of products in Acquisition Mode is, in general, lower than the one reported for any other cycle previous cycle 41. The values of that parameter during, for example, cycle 40, were, in average, lying around 1.95% (in previous reports the value 1.8% had been reported but a more accurate observation allows us to affirm that a higher value is more appropriate); in this case the values lie around 1.5%. This is due to the change of the Ice/Ocean mask used for the Radar Altimeter operations, mentioned more in detail in the chapter dedicated to the Instrument Mode, avoiding the instrument to often switch to Acquisition Mode when flying over coastal zones. The decrease of Acquisition Mode percentage can be noticed also in the Tracking Performance Trend

since the beginning of the mission plotted just behind. Here the two burst of higher values close to the beginning are relative to periods when the internal parameters have been manually changed for tests.

DAY	ACQUISITION Number	TRACKING Number	ACQUISITION Percentage(%)
25-SEP-2000	852	54949	1.526
26-SEP-2000	895	62463	1.412
27-SEP-2000	1065	60831	1.720
28-SEP-2000	848	59044	1.415
29-SEP-2000	1018	64036	1.564
30-SEP-2000	1066	57818	1.810
01-OCT-2000	894	60259	1.461
02-OCT-2000	843	57713	1.439
03-OCT-2000	1502	71748	2.050
04-OCT-2000	845	59146	1.408
05-OCT-2000	30	4278	0.696
06-OCT-2000	1027	62633	1.613
07-OCT-2000	614	44984	1.346
08-OCT-2000	0	0	No data
09-OCT-2000	0	0	No data
10-OCT-2000	324	16098	1.972
11-OCT-2000	890	58968	1.486
12-OCT-2000	916	63425	1.423
13-OCT-2000	1102	60466	1.789
14-OCT-2000	884	58938	1.477
15-OCT-2000	982	63958	1.512
16-OCT-2000	1058	57995	1.791
17-OCT-2000	918	59828	1.511
18-OCT-2000	881	59231	1.465
19-OCT-2000	1077	62355	1.697
20-OCT-2000	977	60431	1.591
21-OCT-2000	952	59107	1.585
22-OCT-2000	1085	62645	1.702
23-OCT-2000	947	60904	1.531
24-OCT-2000	946	59072	1.576
25-OCT-2000	969	62912	1.516
26-OCT-2000	1028	60957	1.658
27-OCT-2000	989	59421	1.637
28-OCT-2000	939	67220	1.377
29-OCT-2000	947	56352	1.652

TRACKER PERFORMANCE

ERS-2 RADAR ALTIMETER/CYCLE 57

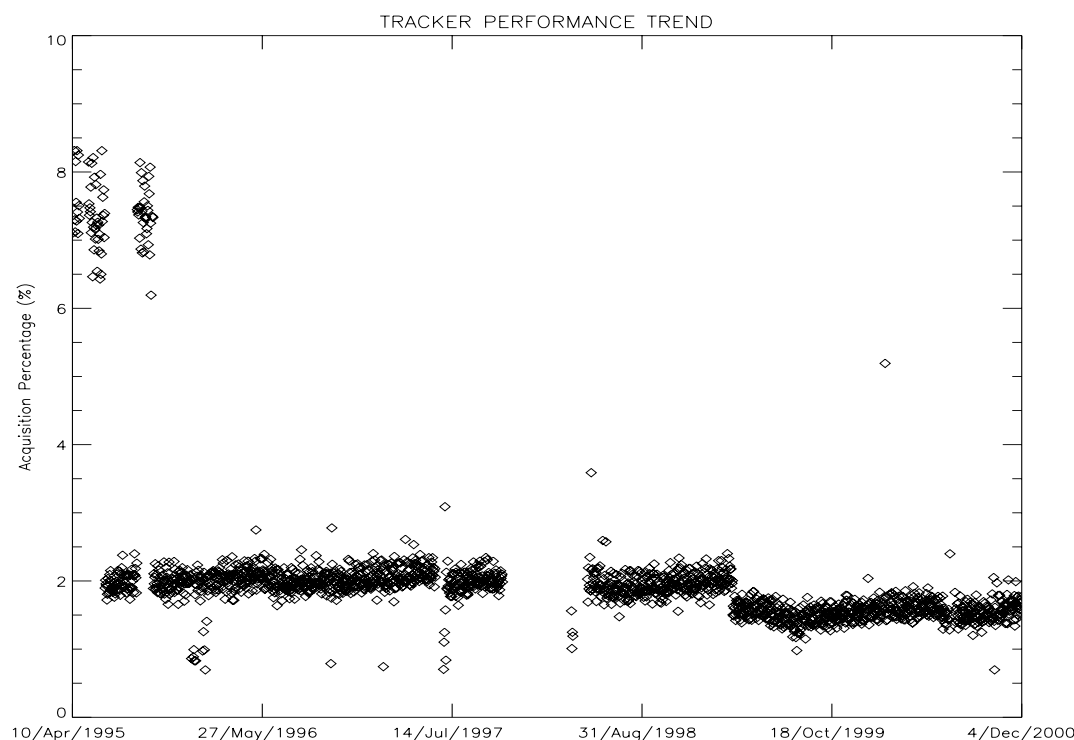
From 25-Sep-2000 to 30-Oct-2000

DAY	ACQUISITION Number	TRACKING Number	ACQUISITION Percentage(%)
30-OCT-2000	873	54587	1.574
31-OCT-2000	955	67982	1.385
01-NOV-2000	1432	77976	1.803
02-NOV-2000	992	71173	1.374
03-NOV-2000	1401	82886	1.662
04-NOV-2000	1473	71606	2.015
05-NOV-2000	1180	76755	1.514
06-NOV-2000	1145	72386	1.557
07-NOV-2000	1397	81231	1.690
08-NOV-2000	1296	79217	1.609
09-NOV-2000	1168	73367	1.567
10-NOV-2000	1423	81093	1.724
11-NOV-2000	1378	79638	1.700
12-NOV-2000	1195	72515	1.621
13-NOV-2000	1228	76856	1.572
14-NOV-2000	1375	79203	1.706
15-NOV-2000	1192	71229	1.645
16-NOV-2000	1158	79859	1.429
17-NOV-2000	1504	82697	1.786
18-NOV-2000	1015	74818	1.338
19-NOV-2000	1761	103041	1.680
20-NOV-2000	1462	71984	1.990
21-NOV-2000	1130	77430	1.438
22-NOV-2000	1280	77053	1.634
23-NOV-2000	1525	84788	1.766
24-NOV-2000	1269	83274	1.501
25-NOV-2000	1255	77244	1.598
26-NOV-2000	1539	84960	1.779
27-NOV-2000	1328	79747	1.637
28-NOV-2000	1011	62916	1.581
29-NOV-2000	1416	81132	1.715
30-NOV-2000	1323	77919	1.669
01-DEC-2000	1225	71634	1.681
02-DEC-2000	1318	85271	1.522
03-DEC-2000	1503	83117	1.776

TRACKER PERFORMANCE

ERS-2 RADAR ALTIMETER/CYCLE 58

From 30-Oct-2000 to 04-Dec-2000



3.2 Internal Instrument Parameters

During nominal operations several engineering parameters characterizing many of the instrument subsystems are constantly measured and transmitted to the ground. The parameters are measured with a frequency of one sample every 16 seconds and mainly consist of power, current, voltage and temperature at different points inside the instrument. They are useful in order to have a better insight of the behaviour of the instrument and can be used to identify eventual malfunctions or anomalous functioning.

3.2.1 Internal Instrument Parameters Trends

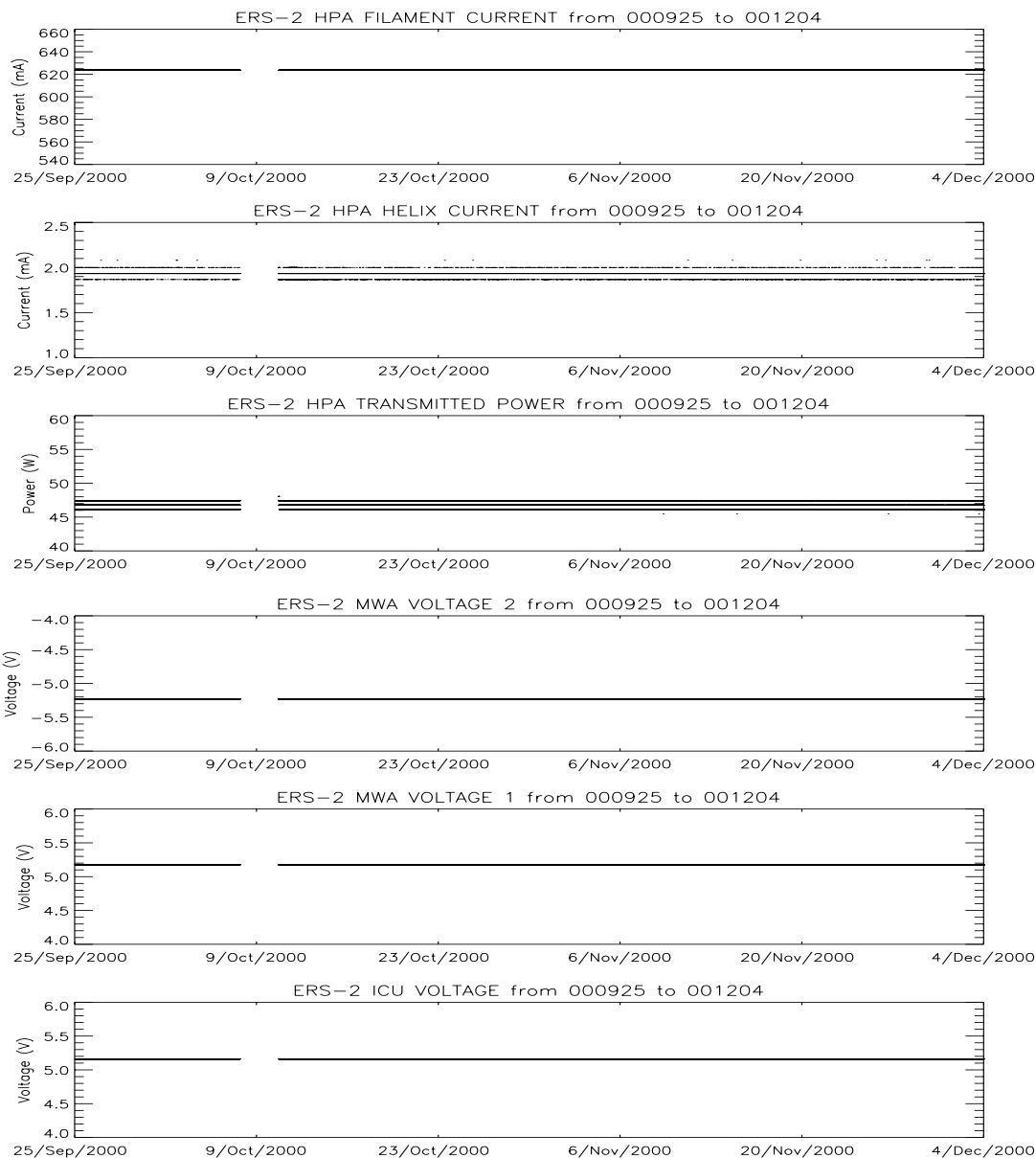
For detailed information on the internal instrument parameters long term trends: <http://ersmon-rp.esoc.esa.de/>

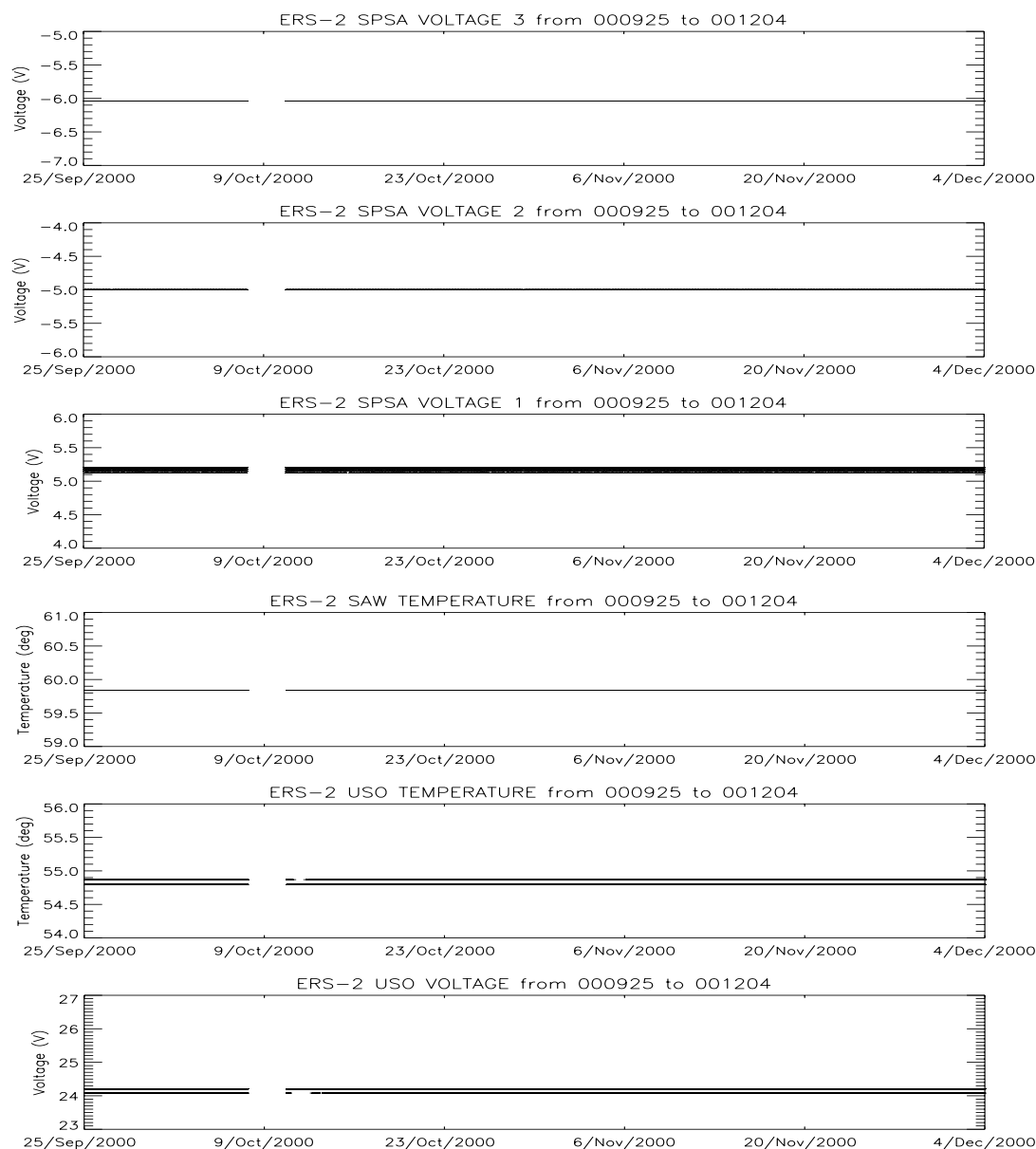
The internal instrument parameters can be subdivided into two categories:

- Parameters not influenced by the temperature outside the instrument thus not presenting variations synchronous with the orbit. They are plotted in the following pictures where all the values (one every 16 seconds) are displayed and the discrimination due to the quantization is easy to notice.

Considering the whole mission time extent, the trend of most of the parameters appears to be quite stable. The only parameters showing variations are the HPA Transmitted Power and the Helix Current. The two parameters had been following a very slow decreasing trend since the beginning of the mission until cycle 37 (November 1998) when the decreasing became slightly more important. Since cycle 45 (August 1999) the Helix Current trend started slowly to increase while the decreasing of the HPA Transmitted Power became again less noticeable. Those variations are so slow that they are not detectable in one or two cycles time scale.

On the other hand, an anomalous event occurred at the beginning of July 2000 caused a small but abrupt change on several of the parameters hereafter reported. Among them the HPA Transmitted Power, for example, has recorded a decreased of about 0.5 W. During cycle 57 and 58 the parameters kept the trends they had assumed during the three previous cycles despite the anomaly occurred on the 7th of October 2000 (ref. par. 3.2.2).



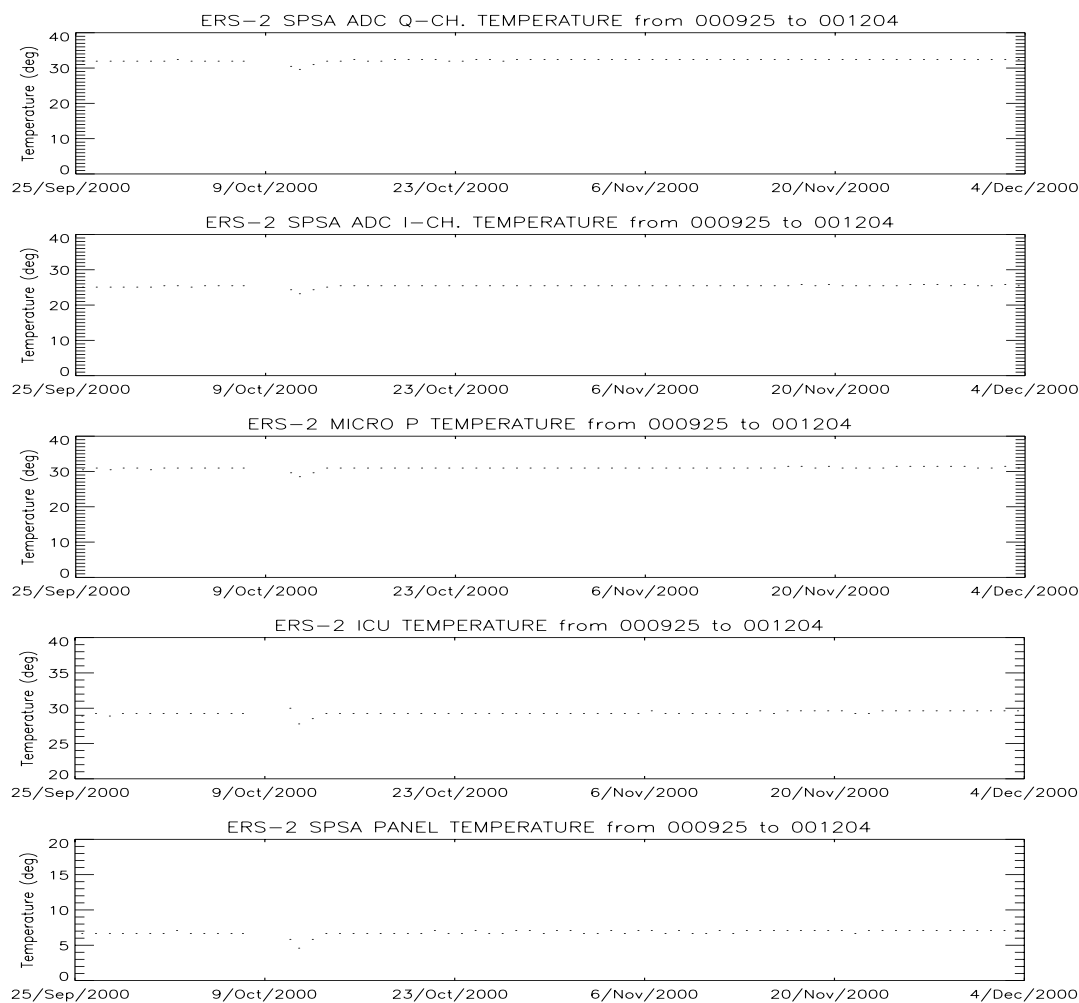


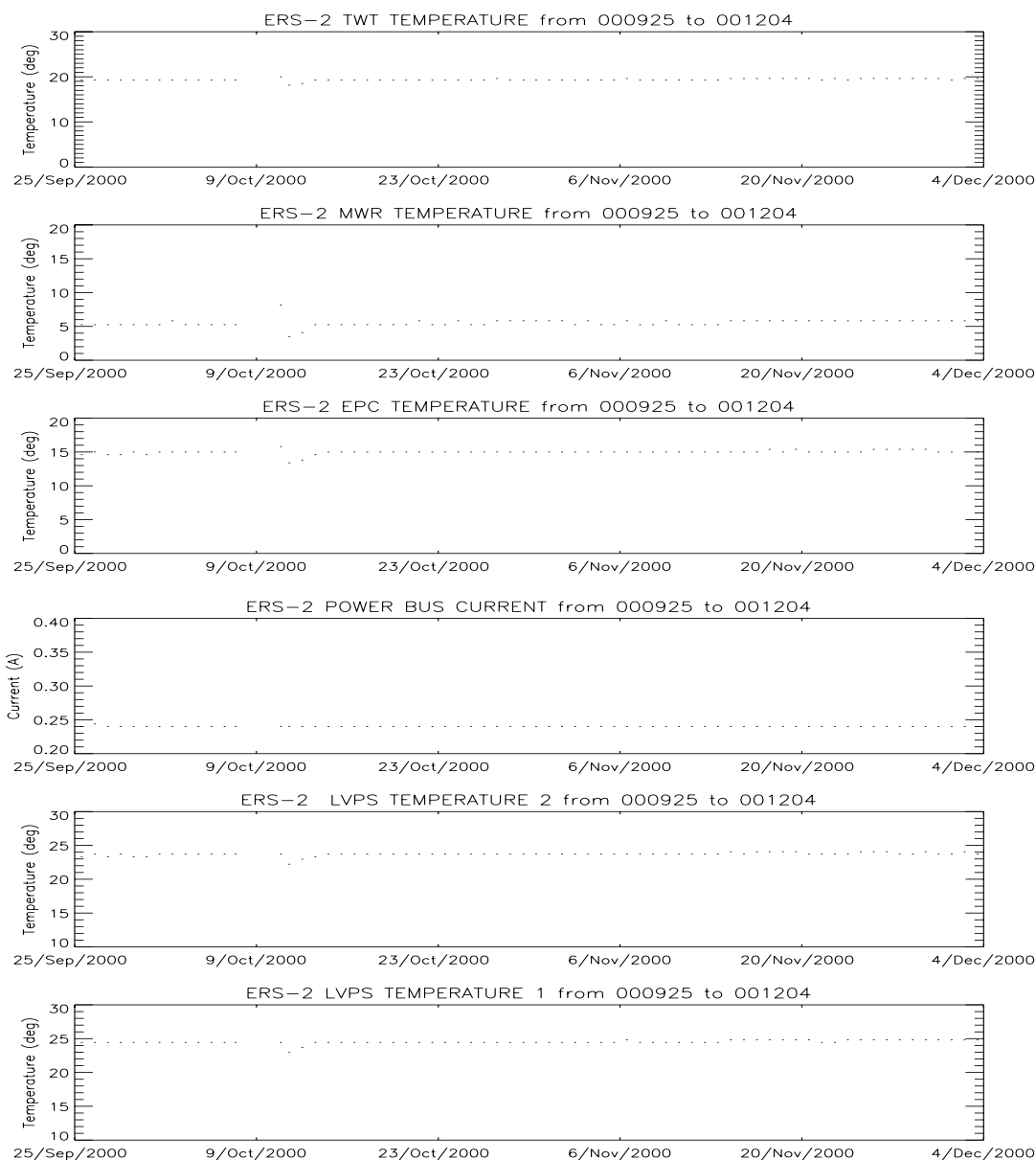
- Parameters influenced by the temperature outside the instrument thus presenting variations synchronous with the orbit. They are displayed in the following pictures after the daily mean has been calculated.

In general, within few cycles time extent, the trends for all the parameters are quite stable; the most of them even maintain the same value during the whole period. An exception to this is given by the ICU temperature which shows, in the daily average, variations up to one degree. Most probably the actual variation inside the instrument is not so significant. The more substantial one degree variation noticeable in the plot is, possibly, due to the quantization of the telemetry measurements and the way they are transformed from binary into engineering values.

The Instrument Control Unit (ICU) temperature is the parameter which suffered the most of an instrument anomaly occurred at the beginning of July 2000; this is easy to understand considering that a malfunction of this component caused a failure of the whole payload. After the anomaly the ICU temperature was more than 7° lower than before and actually it is stable at

around 29° . Furthermore, the July anomaly caused a SPSA Panel temperature decrease of 1° while the LVPS temperatures experienced a 1° increase. During cycle 57 and 58 the parameters trends remained stable at the values they had assumed in the three previous cycles despite the anomaly occurred on the 7th of October 2000 (ref. par. 3.2.2).





3.2.2 Internal Instrument Parameters and Instrument Anomalies

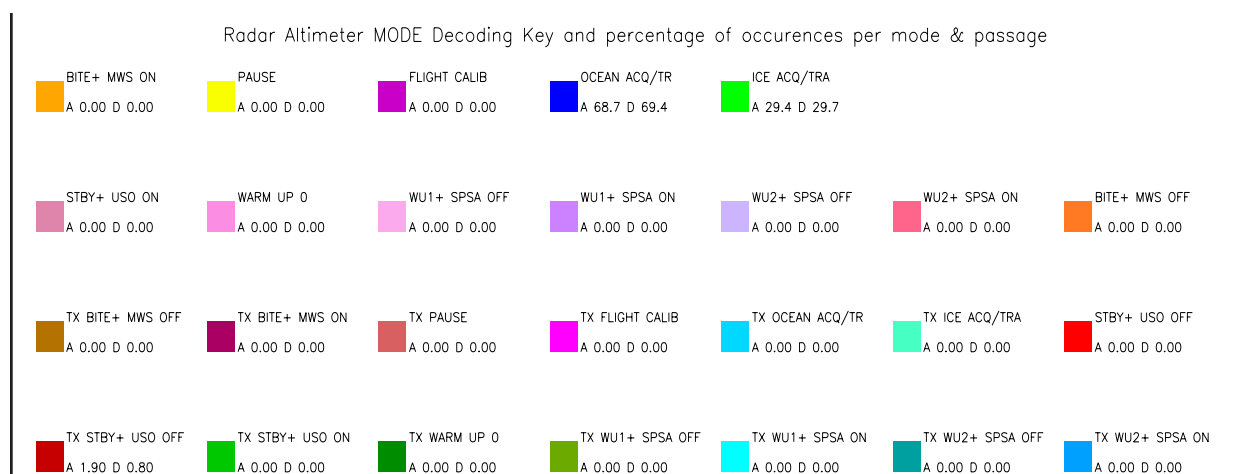
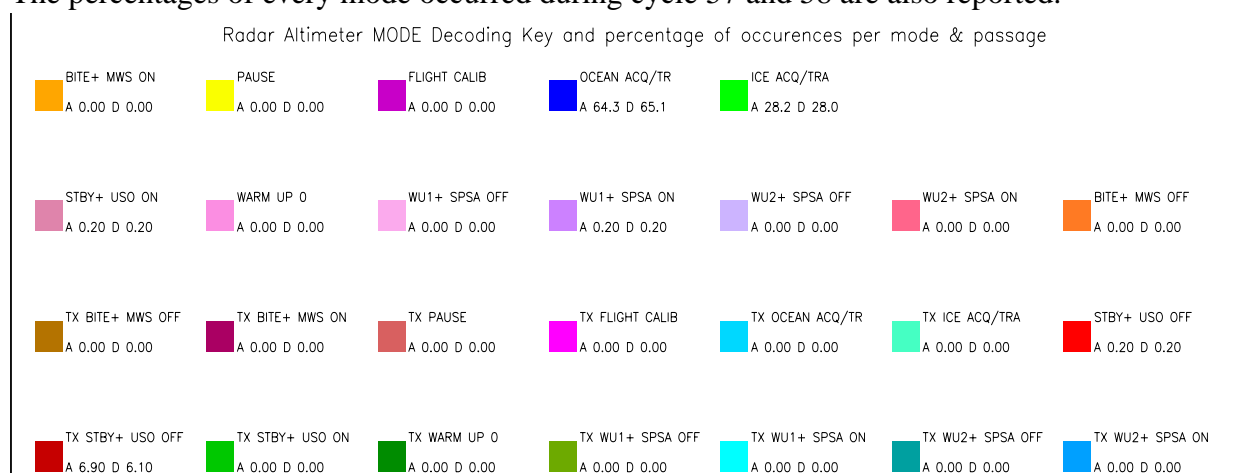
The internal instrument parameters are very useful in controlling the status of the instrument especially in case of instrument anomalies. They allow a better understanding of its behaviour during the different phases of the operational status recovery and help to identify the different types of anomalies occurred.

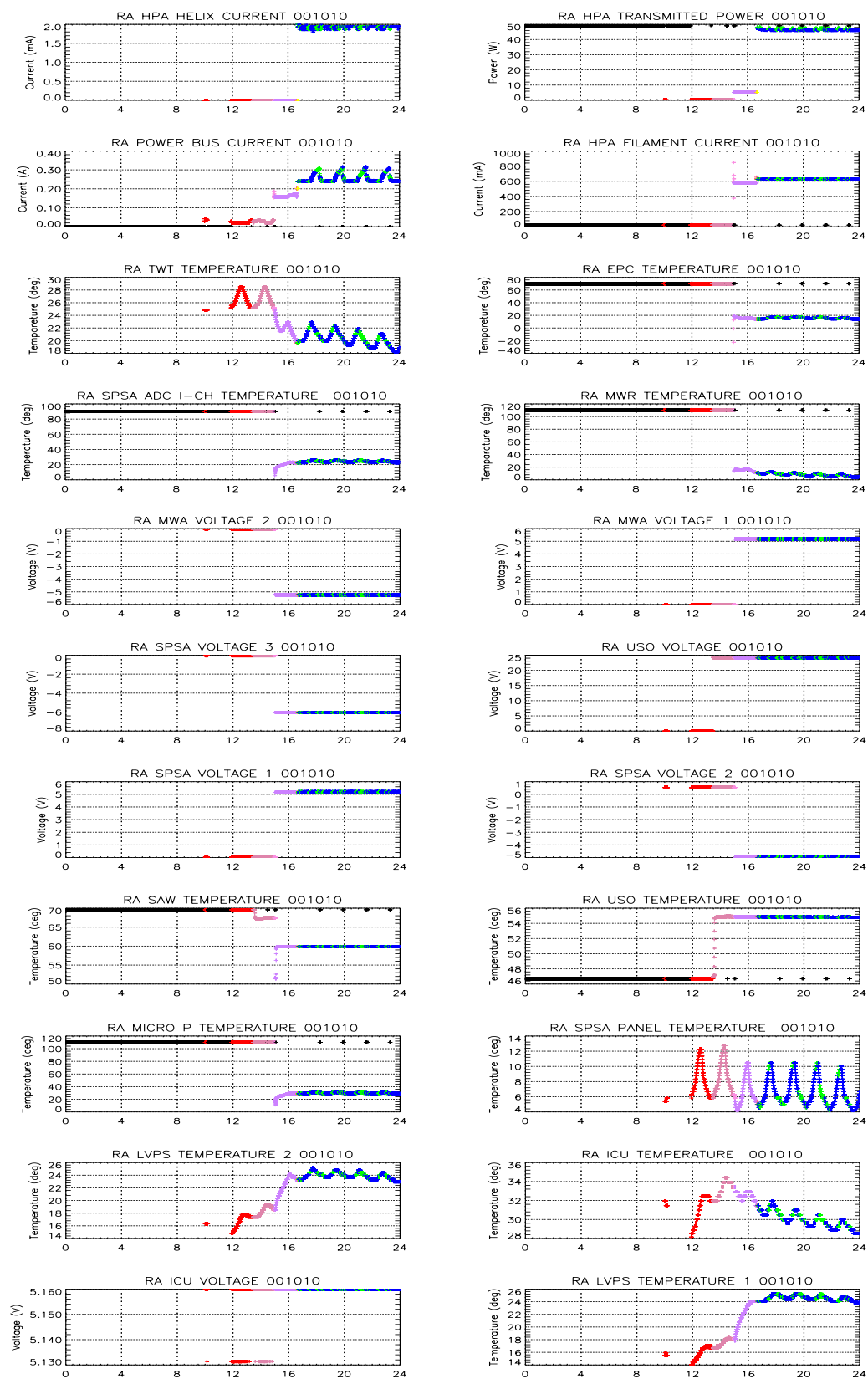
During cycles 57 and 58 one instrument anomalies occurred. The table hereafter reports the date and a short explanation for every of them (in case they are present), if known at the time of the report. The information is made available at ESRIN/PCS by the ERS Mission Control Centre at ES-OC.

Table 1: Anomalies occurred during cycle 57 and 58

Anomaly	Reason
07-Oct-2000 17:30:49 - 10-Oct-2000 16:40:33	Failure of Gyro 5 Platform in CAM

In the following pictures all the internal instrument parameters are plotted for day October 10th. For every plot all the values of the parameters (one every 16 seconds) are displayed together with the relative instrument mode (represented by the colours). In some cases the parameters values were not available while the instrument mode information was. In those cases the parameter value has been chosen to be a value out of the nominal range; so the displayed points much higher or much lower than the overall trend do not represent real values of the parameters but they have been used just to show the instrument mode. During nominal operations the instrument works alternatively in Ocean and Ice mode. Depending on the type of anomaly, when an anomaly occurs, sometimes the instrumental parameters are not recorded sometimes they are. Anyway during the anomaly, or just after it, the instrument switches to one of the not nominal modes like Stand By USO Off/On, Stand By SPSA Off/On recovering to the operational working modes via some of the following ones: Warm Up 0, Warm Up 1, Warm Up 2. Hereafter the legend relative to the following pictures is reported showing all the possible instrument modes for the Radar Altimeter. The percentages of every mode occurred during cycle 57 and 58 are also reported.



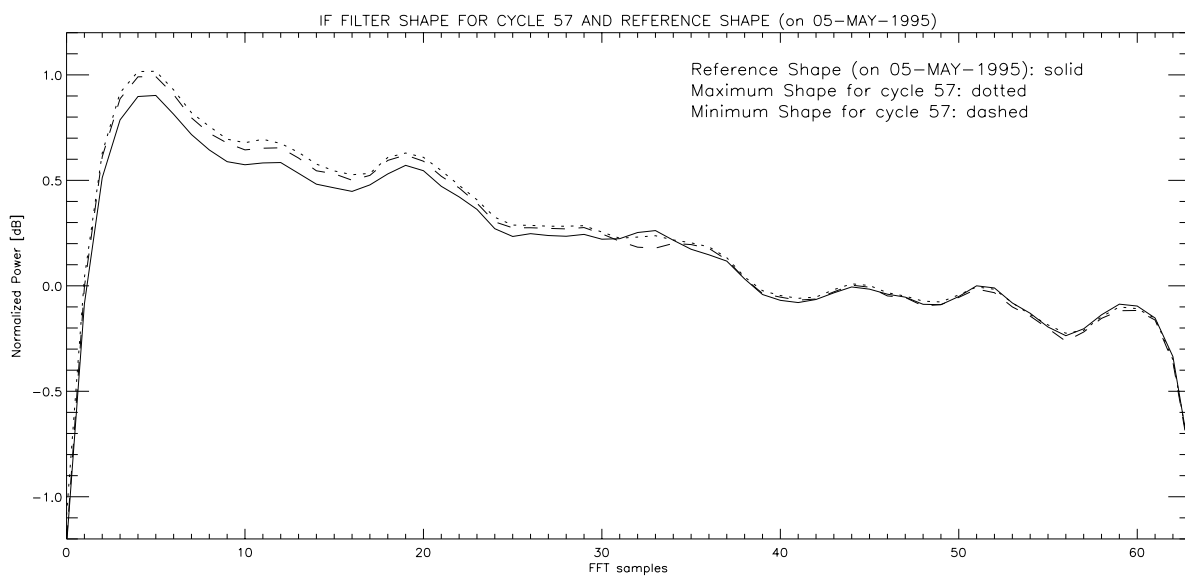
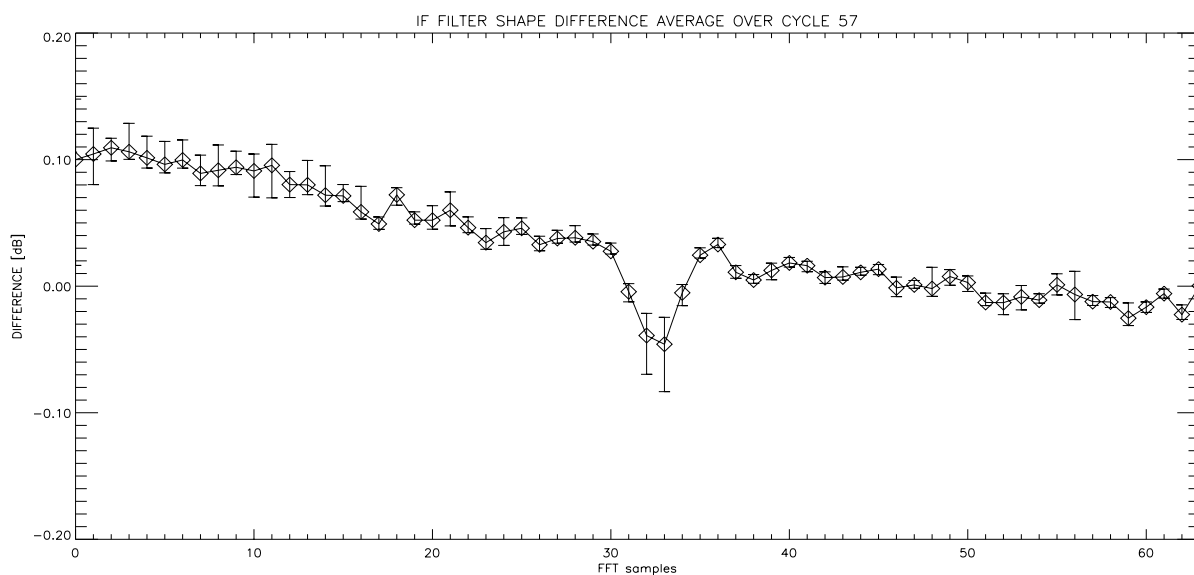
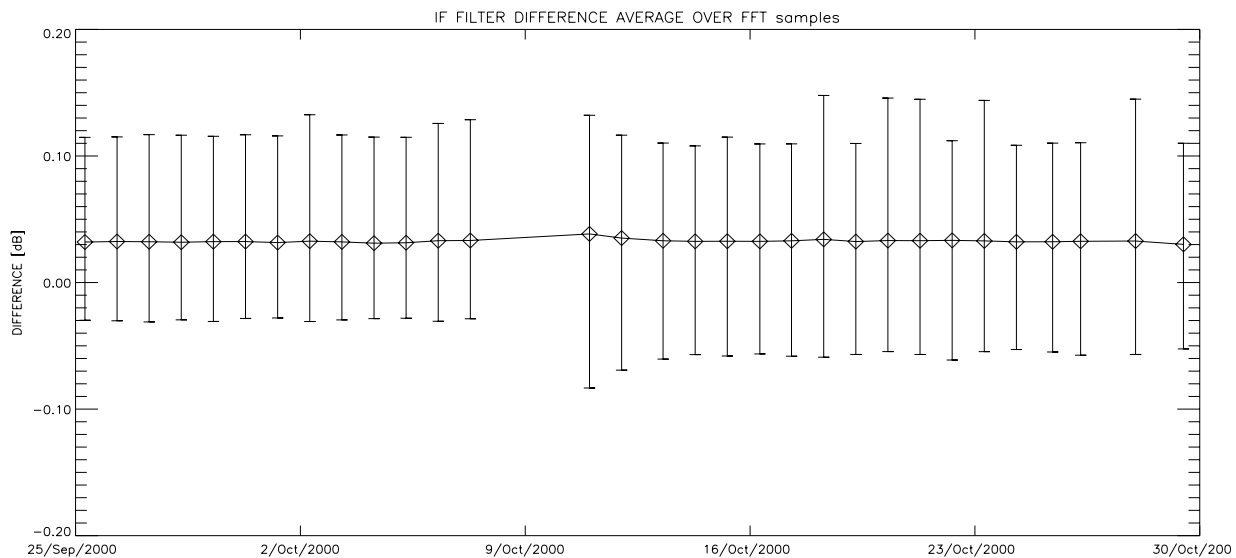


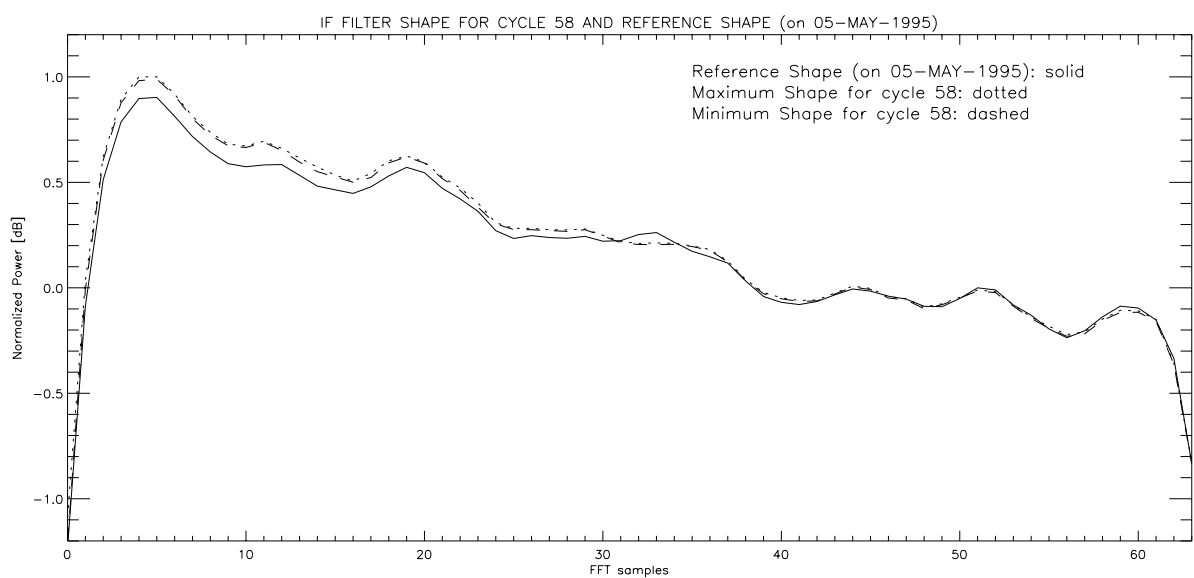
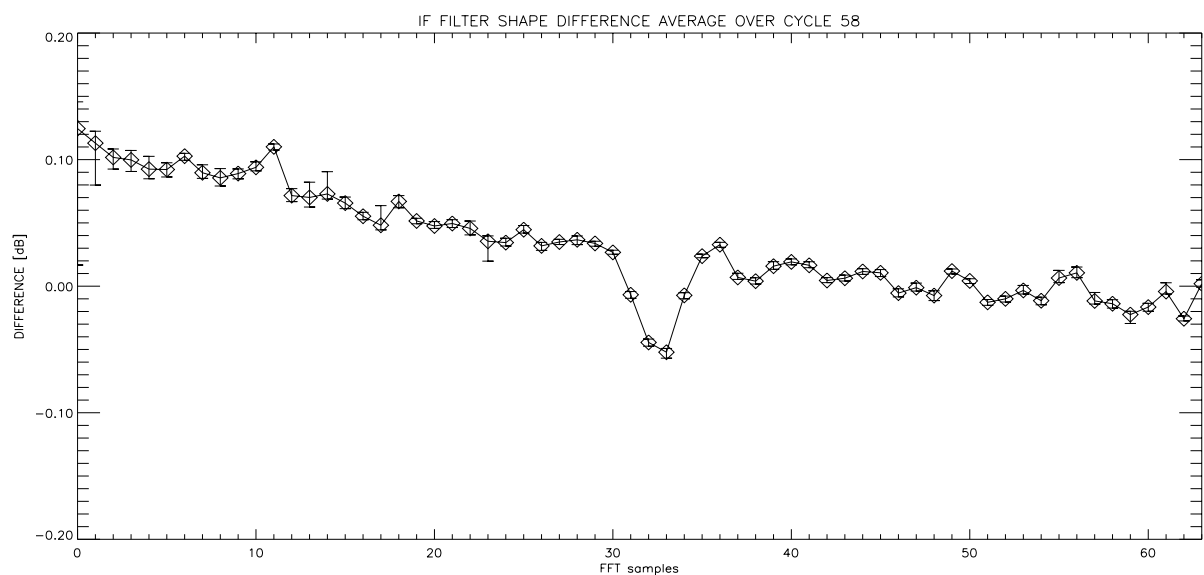
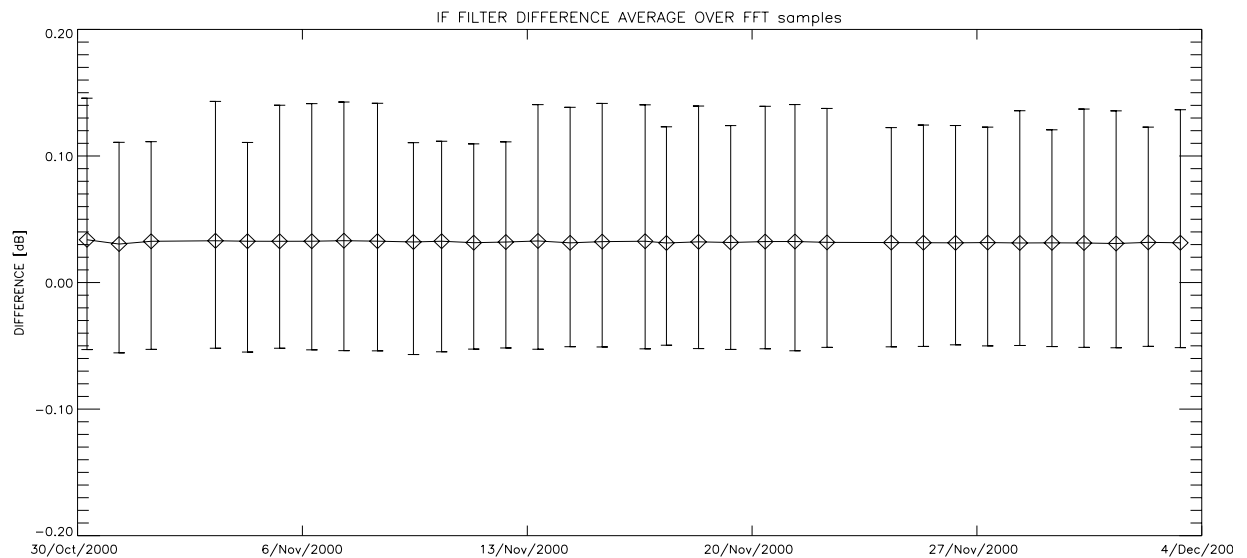
3.3 IF Filter Shape

Within the microwave section of the receiver, the Intermediate Frequency filter plays a very important role. After being deramped and downconverted to intermediate frequency, the return signal is filtered in order to remove spurious components. The IF filter is made using a SAW device and has a bandwidth of 3.2 MHz. The characteristics of this filter have a very critical role since they can introduce distortions in the signal, which affect the waveform shape as it is seen within the filter bank. It is easy to understand that, since the retrieval of the geophysical parameters is based on the waveform shape, especially in case of application of retracking algorithms; the waveform should not be distorted by instrumental effects. In any case, the distortions on the signal, due to instrumental effects such as the IF filtering, have to be known and corrected. The impulse response of the filter has been retrieved making use of the Scanning Point Target Response calibration data in ice mode. This operation mode allows to perform a sort of sampling of the IF filter shape in the frequency domain. Using a spline function a more smoothed shape can be reconstructed in order to evaluate the filter attenuation on the signal for any position within the filter bank.

The first picture reported hereafter give a vision of the IF Filter Shape behaviour respectively for cycle 57 and 58.

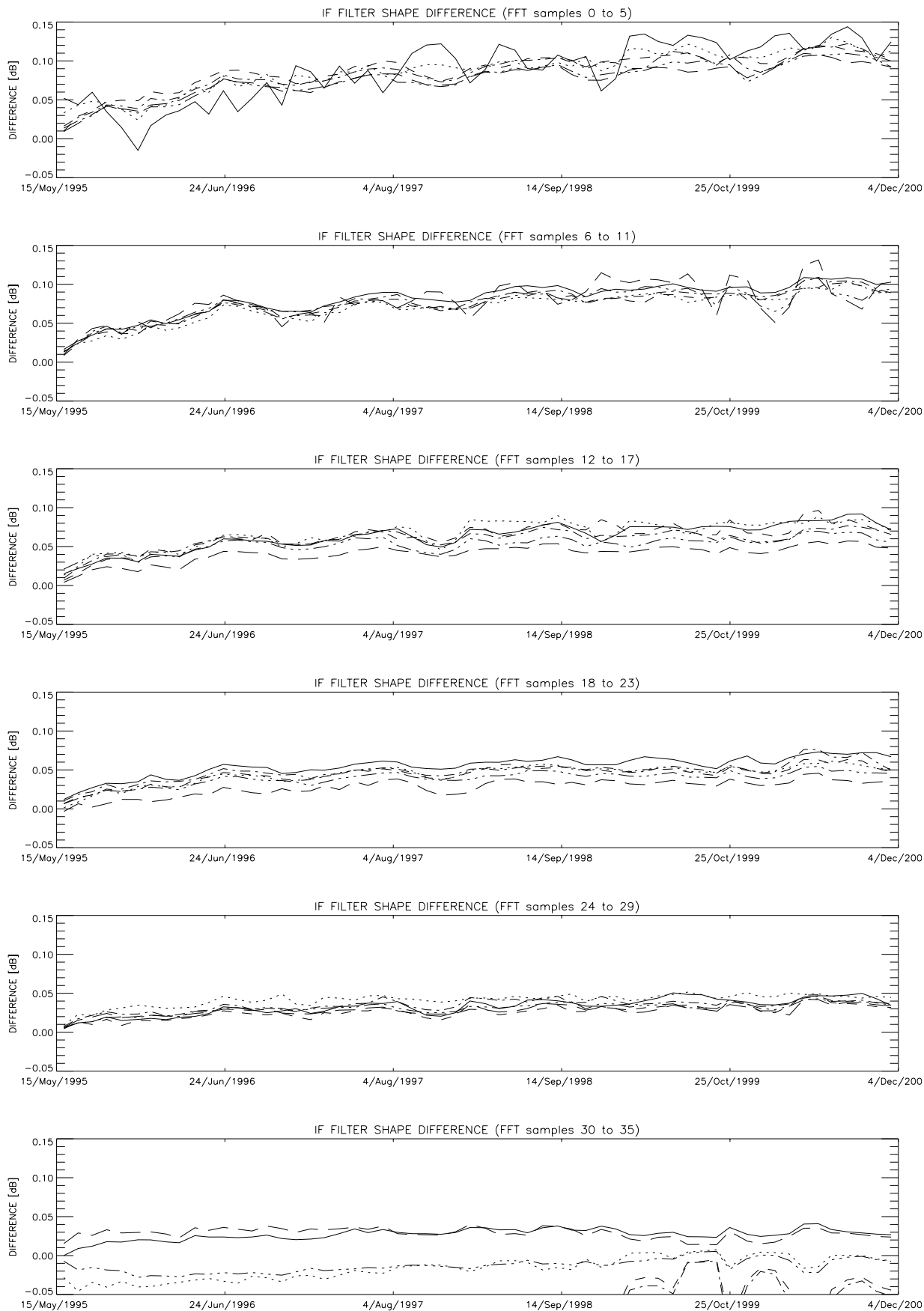
- The IF Filter Shape reported in the lowest panel of either picture is the filter impulse response power spectrum normalised to the average integrated power in the filters range 30 to 59. The middle panel represents the difference between the IF Filter Shape of the current cycle respect that evaluated on the 5th of May 1995 (reference shape); the diamond represents the mean difference over the cycle for each of the 64 FFT samples while the bar is ranging from the minimum to the maximum in the cycle. The highest panel shows the IF Filter Shape difference with the reference shape averaged over all the 64 FFT samples (also here the each bar is ranging from the minimum to the maximum over each filter) in function of time.
- In the lowest panel it is easy to notice that the normalised power values for FFT samples 30 to 33 have a big variations over the cycles and on the middle panel those samples show the biggest differences respect to the reference. What is estimated over those samples is not the real IF filter behaviour but it is caused by another instrumental effect (probably A/D conversion and DC offset) acting over the PTR pulses used in the retrieving process.
- What is evident is that the changes of the IF Filter Shape with reference to the beginning of the mission are, in average, limited to ca. 0.035 dBs being the biggest variations relative to the first part of the filter bank (low filter numbers). This fact should insures that those shape variations have a low impact on the Radar Altimeter performances since the waveform samples related to the low number filters assume usually values close to zero. Anyway the different behaviour of the low and high filter numbers, which causes a variation of the filter shape slope, has been demonstrated to affect the instrument performance.
- The anomaly occurred on the 7th of October did not have a noticeable impact on the IF Filter behaviour. The average difference over the whole filter bank in comparison to the beginning of the mission remains at about 0.035 dBs also after the recovery of the instrument on the 10th of October. Of course due to the anomaly, no data were available for the IF Filter Shape computation on October the 7th, the 8th and the 9th.

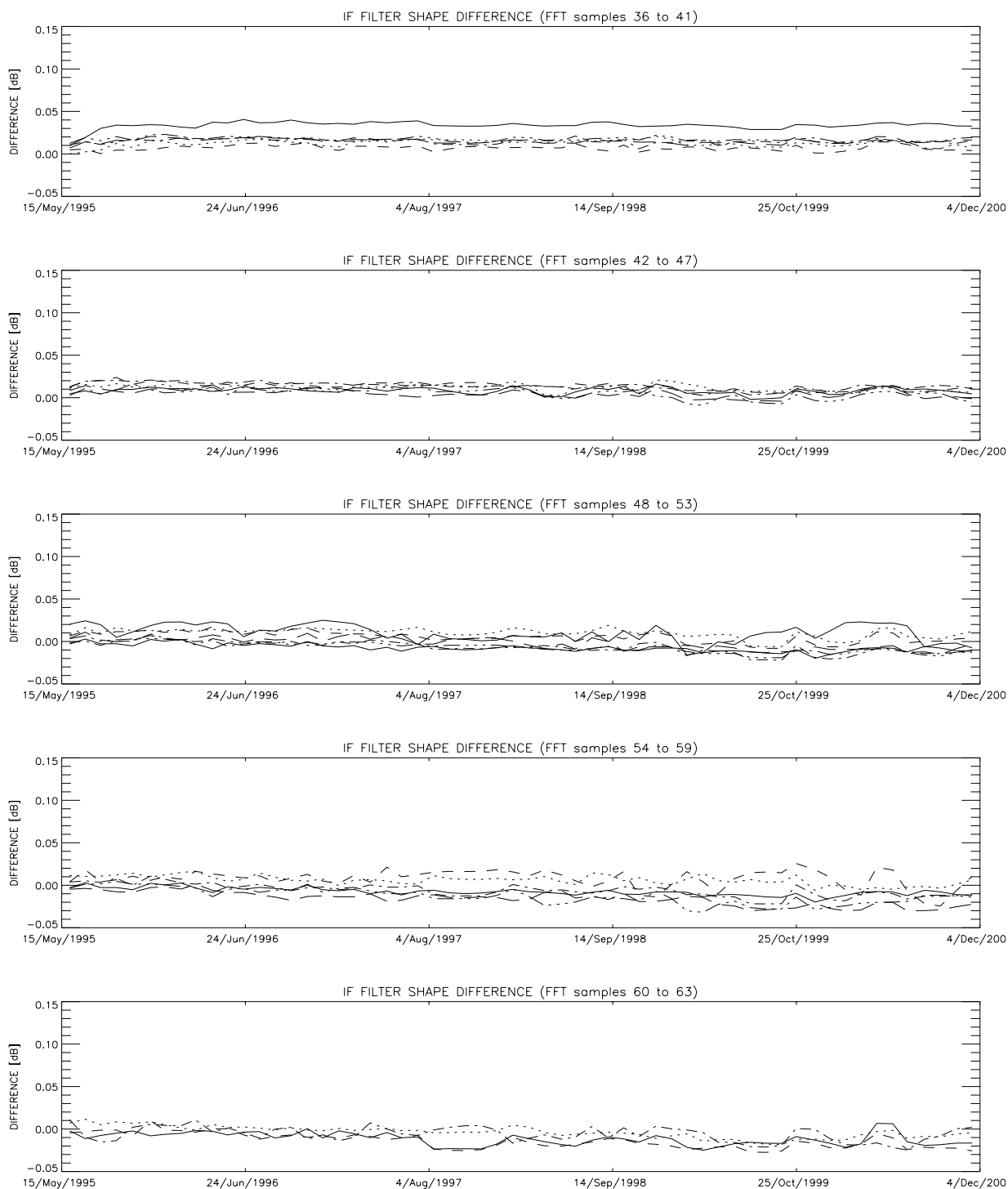




The two pages reported afterwards document trends of the IF filter characteristics difference respect to the reference, for each of the 64 FFT samples averages over cycles have been calculated.

- The same observations can be made as for the cycle results: differences over samples 30 to 33 have been always quite big (being the values related to filters 31 and 32 even outside our plotted range for a significant time span). The low filter number samples show the biggest differences which increase with time while the smaller differences related to the high filter number samples tend to slightly diminish with time. This effect causes the variation of the IF Filter shape slope which has been shown to have an impact on the off-nadir pointing value (ref. par. 3.4). More generally, the IF Filter shape is affecting the received echo shape within the filter bank. For this reason it has an influence on all the RA retrieved parameters (e.g. Range, Sigma_0 and Significant Wave Height) being their evaluation based on the received waveform profile. Investigations are on going in order to assess the impact of the IF Filter shape variations on the RA retrieved geophysical parameters.





LEGEND

—————	FFT samples 0, 6, 12, 18, 24, 30, 36, 42, 48, 54, 60
.....	FFT samples 1, 7, 13, 19, 25, 31, 37, 43, 49, 55, 61
- - - - -	FFT samples 2, 8, 14, 20, 26, 32, 38, 44, 50, 56, 62
- . - . - .	FFT samples 3, 9, 15, 21, 27, 33, 39, 45, 51, 57, 63
—	FFT samples 4, 10, 16, 22, 28, 34, 40, 46, 52, 58
— — — .	FFT samples 5, 11, 17, 23, 29, 35, 41, 47, 53, 59

3.4 Off-Nadir Pointing

The Radar Altimeter is a nadir looking instrument. This means that the bore-sight of its antenna pattern has to be perpendicular to the scene the Radar Altimeter looks at. Any variation of the pointing angle (mispointing) degrades the measurements introducing errors on the three most important geophysical parameters derived from the raw data. For this reason the mispointing angle has to be monitored in order to characterize its behaviour and eventually to evaluate a correction to be applied to the Radar Altimeter measurements.

Furthermore during cycles 50 a special event occurred referring to the scheme with which the ERS-2 satellite attitude is maintained. On the 7th of February 2000 a new software has been uploaded in order to pilote the satellite with only one gyroscope while before the piloting has always been performed with three of them. After a commissioning period of two weeks, the attitude of the ERS-2 platform is operationally maintained with one gyro. Since the change in attitude control could have affected the pointing performances of the Radar Altimeter, a tool was developed which allows to keep under control the mispointing behaviour.

3.4.1 Method Description

The off-nadir pointing of the radar Altimeter has an impact on the shape of the averaged returned waveform in the filter bank. Hereafter the method will be described which has been used to retrieve the mispointing information from those echo waveforms and then to evaluate the mispointing trend from the Radar Altimeter raw data.

The theoretical shape of the return waveform can be described, for small pointing error ξ respect to the nadir direction, by the following formula. This when the echo has already been corrected for the antenna effects and when some approximations, valid for small ξ , have been performed. for $t < 0$

$$P(t) = L \left(1 + \operatorname{erf} \left(\frac{t}{\sigma_c \sqrt{2}} \right) \right)$$

for $t > 0$

$$P(t) = L \left(1 + \operatorname{erf} \left(\frac{t}{\sigma_c \sqrt{2}} \right) \right) \left[1 + \left(\frac{2}{\gamma} \sqrt{\frac{c \epsilon t}{H}} 2 \xi \right)^2 \right]$$

In order to put this in relation with the waveform representation in the filter bank (frequency domain) the time variable t has to be related to the FFT filter numbers. A FFT sample n represents a time instant t_n as: $t_n = (n - 32)t_c$; where t_c is the time delay corresponding to one FFT unit: 3.012 ns for ERS-2 depending on the chirp slope. The factor L is regulated by the Automatic Gain Control in order to have a predetermined average power value P_{ref} . The factor ϵ takes into account the non spherical earth; γ depends on the 3dBs antenna aperture and σ_c is a composite parameter taking into account the point target response -3dBs width and the rms height of the backscattering points.

Considering the two equations previously reported it is possible to notice that: the mispointing value ξ has influence on the echo waveforms only for positive values of the time variable t and it

has effect on the slope of the trailing edge of the echo shape which is proportional to ξ^2 . This allows the mispointing squared to be calculated using the following formula:

$$\xi^2 = \frac{\frac{slope}{L} \gamma^2 H}{16c\epsilon t}$$

3.4.2 Data Processing Description

The Radar Altimeter raw data contain information over the echo waveforms in the frequency domain with a frequency of 1/20 Hz. They have been processed and corrected in such a way that the waveforms obtained from them could be assimilated to the theoretical ones described in the previous paragraph. Only data over ocean have been selected. For every data file containing several minutes of data the processing algorithm used to assess the average mispointing value can be summarised as hereafter reported:

- The waveform information have been extracted from the raw data; 20 waveforms per seconds are available which have been then normalised in order to prevent errors related to the Automatic Gain Control loop behaviour.
- The waveforms have been corrected for the IF Filter Shape (ref. par. 3.3). This compensate for an instrumental effect affecting the echo waveform in reality but which is not considered in the theoretical model used.
- The waveforms have been averaged over one second and corrected for antenna pattern effects.
- One mispointing squared value per second has been evaluated using the formula reported in the previous paragraph. From the corrected echo shapes, the slope has been identified as the one of the line which best fitted the samples related to FFT numbers 37 to 60.
- A sliding average with one minute window duration has been performed over the mispointing squared ξ^2 time series. The mispointing ξ time series has been obtained from it by mean of a square root operation (eventual ξ^2 negative values have been considered equal to zero).
- Assuming the mispointing squared ξ^2 distribution being gaussian (central limit theorem) and considering that the mispointing can be defined as: $\xi = \sqrt{\xi^2}$ for $\xi^2 \geq 0$ and $\xi = 0$ for $\xi^2 < 0$; the probability density function describing the mispointing statistics behaviour can be represented with the following formula:

for $\xi \geq 0$

$$P(\xi) = \frac{1}{\sqrt{2\pi}\sigma_{\xi^2}} 2\xi \exp \left[-\left(\frac{\xi^2 - m_{\xi^2}}{\sqrt{2}\sigma_{\xi^2}} \right)^2 \right]$$

for $\xi < 0$

$$P(\xi) = 0$$

from which its mean value m_{ξ} can be derived as:

$$m_{\xi} = \sqrt{m_{\xi^2}} \left[0.5 + \frac{1}{2\sqrt{2\pi}m_{\xi^2}} \frac{\sigma_{\xi^2}}{m_{\xi^2}} \right]$$

where m_{ξ^2} and σ_{ξ^2} are respectively the mispointing squared mean and standard deviation.

- The histogram of the mispointing time series has been evaluated and fitted to the theoretical probability density function just described. From this procedure the two values m_{ξ^2} and σ_{ξ^2} have been retrieved with which the mispointing average value m_{ξ} has been determined.

3.4.3 Results

The off-nadir pointing analysis work has been performed on the Radar Altimeter raw data products disseminated in fast delivery since the beginning of the ERS-2 mission. Every three days, ten minutes of raw data are available three hour after sensing. They are measured over the Pacific Ocean within 0° and 35° latitude north. Those data have been analysed with the method described in par. 3.4.1 and 3.4.2 giving, as output, one mispointing value every three days for the main part of the mission.

On the other hand, during the period between 11th February and 11th March 2000, a larger number of data has been processed in order to keep the off-nadir pointing behaviour under control in occasion of the new mono-gyro piloting software commissioning phase (ref. Cyclic Report for cycles 50 and 51, APP-ADQ/PCS/RA00-003, par. 4.6).

Two important considerations have to be made at this point:

- The Radar Altimeter waveforms undergo several corrections during the processing. They are the antenna and the IF Filter correction which do influence a lot the outcome of the exercise. In particular, during this study, the processing to retrieve the mispointing squared figures from the echo shape has been found to be very sensitive to the IF Filter Shape used for the correction. The analysis has been anyway performed using the proper IF Filter Shape, the most updated for each measurement, in order to minimize the IF Filter Shape impact on the off-nadir pointing results (ref. par. 3.3).
- The algorithm itself is affected by an error, which is exponentially growing as the absolute mispointing value decreases.

Table 2: Average and Median off-nadir pointing angle values in different configurations

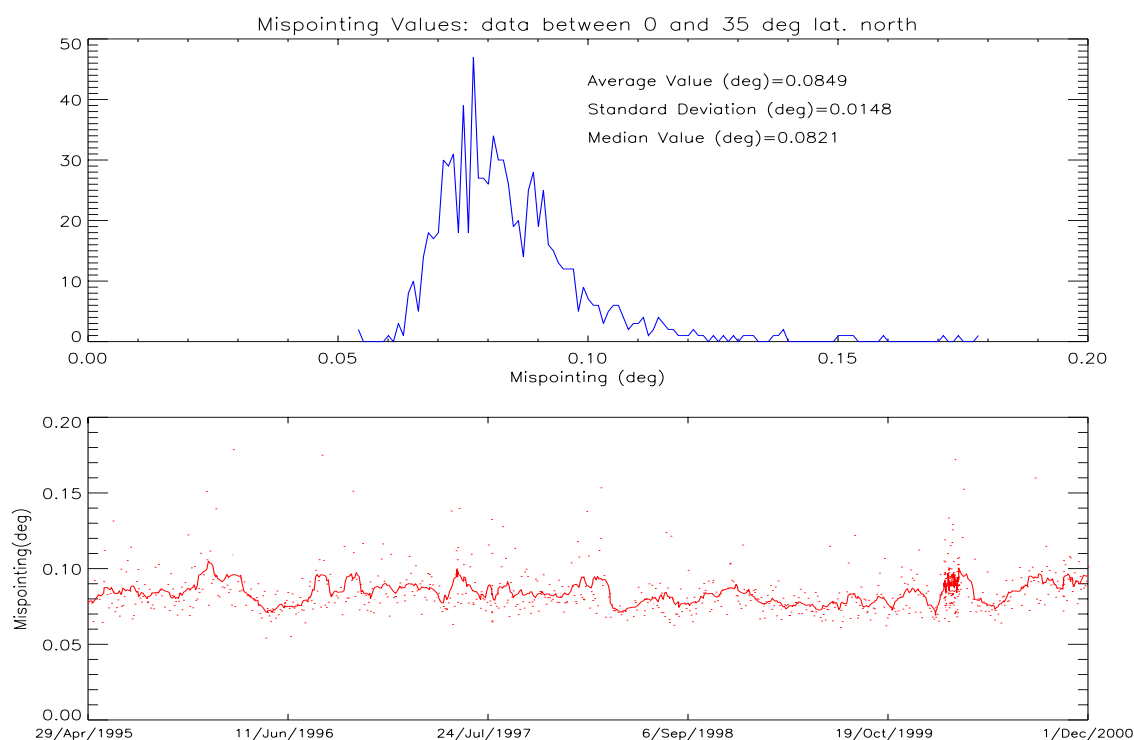
Configuration	Average (°)	Median (°)
Three Gyros piloting (29-Apr-1995 to 3-Feb-2000)	0.0831	0.0800
Mono Gyro piloting - Gyro 5 (18-Feb-2000 to 7-Oct-2000)	0.0892	0.0887
Mono Gyro piloting - Gyro 6 (10-Oct-2000 to 24-Oct-2000)	0.0897	0.0919

Table 2: Average and Median off-nadir pointing angle values in different configurations

Configuration	Average (°)	Median (°)
Mono Gyro piloting - Gyro 1 (25-Oct-2000 to present)	0.0916	0.0913

Table 2 reports the average and median mispointing values for the different piloting configurations used until present. Next to the increase of the mispointing values due to the change from the Three Gyros scheme to the Mono-Gyro one; a very tiny further increase is noticeable when passing from Mono-Gyro piloting with Gyro 5 to mono-Gyro piloting with Gyro 1 (scheme actually in use). The absolute number are anyway so small that the difference can be considered negligible.

From the following figure we can notice that the overall mispointing time series lies around a value of 0.085°. A very small increasing trend is evident after middle February 20000 (change of the piloting system) and another after the 7th of October 2000 when the Gyro 5 failed and the Gyro 1 was chosen to pilot the platform in nominal operations (after a very short period during which Gyro 6 was used). The total increment, being in average lower than 0.01°, can be anyway considered irrelevant bearing in mind the uncertainties affecting the retrieved figures. On the other hand, because of those uncertainties, the mispointing figures during the whole mission could be considered assuming values from 0° to 0.15°. Please note that none of the values hereafter reported are suffering from the sun blinding effect, being evaluated from data sensed over the latitude range [0, 35] deg.



4.0 Products performance

The four ESA ground stations (Gatineau, Kiruna, Mas Palomas and Prince Albert) process ERS-RA raw data to produce URA products and distribute them within three hours after sensing. Before the beginning of cycle 44, the raw data received by the fourth ground station (Prince Albert) were processed a week later at Gatineau; since the 28th June 1999 a network connection has been established between Prince Albert and Gatineau which allows also the data received in Prince Albert to be processed and distributed in near real time. The quality of these URA products is checked by PCS at ESA/ESRIN. (For more information on the ground stations; http://earth1.esrin.esa.it/f/eeo3.324/0xc1cce41c_0x00006d3b).

The performance of the fast delivery products is determined by mean of the following criteria:

- Availability of Data and Quality Assessment: a summary of the percentages of available/not available products and of all the features affecting their quality during cycles 57 and 58.
- Fast Delivery Data Summary
- Instrument Mode: an overall picture of the modes the instrument worked in during cycle 57 and 58.
- Look Up Tables (LUT) Status
- Data Comparison with Forecasts: the comparison of the fast delivery data with the forecasts performed by ECMWF is useful to validate the URA products

4.1 URA Fast Delivery Products Short Description

Each product of the RA fast delivery data consists of:

- **1 MPH (Main Product Header):** general information of the product such as sensing and generation time, the satellite position at sensing time, the ground station which acquired the product, the software used to process the data and some quality flags.
- **1 SPH (Specific Product Header):** information on the auxiliary parameters used in the processing of the product and some quality flags.
- **77 DSRs (Data Set Record)** include information as wind speed and significant wave height, instrument mode, geophysical corrections and some quality flags are part of it.

Note that only the data in ocean tracking mode are processed within the on-ground processing chain and reported in the fast delivery products.

For more information on the URA products: <http://earth1.esrin.esa.it/f/eeo2.267/pgersaltura>

4.2 Availability of Data and Quality Assessment

The fast delivery data (URA) are checked every day by ESRIN/PCS for quality assurance. The summary of all the most important features affecting the quality of the data during cycle 57 is hereafter reported.

Percentage of not available products (relative to the nominal number for a cycle): 9.32%

Percentage of blank DSRs (relative to the nominal number for a cycle): 0.230%, of which 0.146% due to whole blank products and 0.084% due to products not totally blank.

Table 3: Percentage of products having one of the following flags set

Flag name	Percentage(%)
HDDT	2.55
FS to Processor	0.0
Checksum Analysis	0.0
Formats/Sources	0.0
Auxiliary Data	0.0
Arithmetic Fault	0.0
Processor Status	0.0
Enough Measurement	1.38

Table 4: Percentage of products having one of the following parameters outside the respective range

Parameter	Percentage(%)
Peakiness out of [1.2, 1.7]	0.26
Sigma_0 out of [0., 24.] (dB)	0.03
Wind Speed out of [0., 25.] (m/s)	less than 0.01
Significant Wave Height ot of [0., 12.] (m)	0.0

Note that the numbers here above (Table 4) are only relative to ocean products.

Percentage of flagged products relative to the Wet Tropospheric Correction: 1.43%

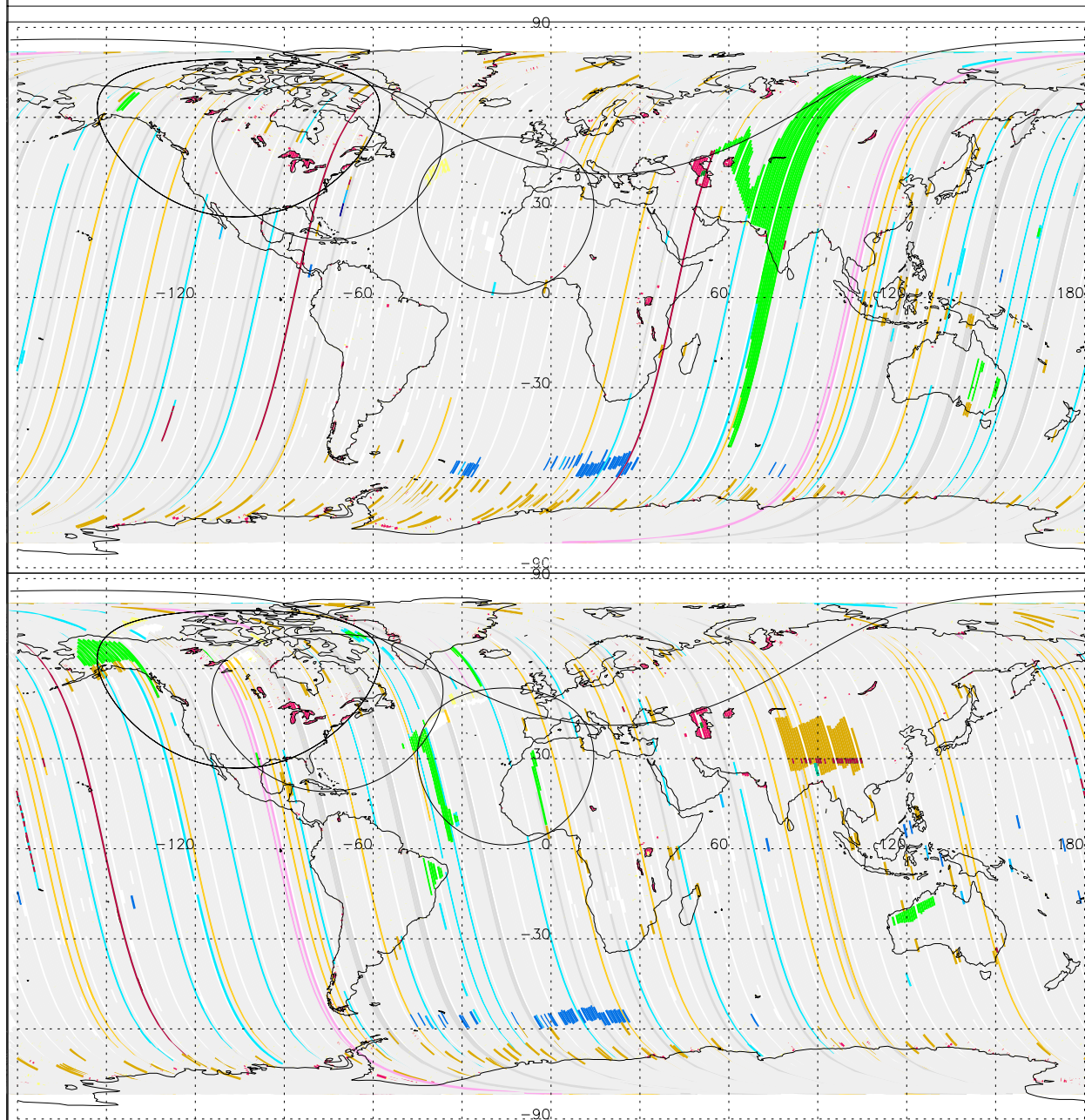
(a product is flagged if it contains more than 10 DSRs which all have the default value for the Wet Tropospheric correction instead of a value derived from the MWR measurements).

The fast delivery data performance during cycle 57 was reasonably satisfying. The value close to 10 percent for the missing products was due to the occurrence of an instrument anomaly in the period 7-10 October 2000 (ref. par. 3.3.2) and to acquisition problems occurred between 10:10 and 10:50 on the 26th of September.

The value of about 1.5 percent, characterising the Wet Tropospheric Correction Default Values during this cycle, is not negligible. It was mostly due to some acquisition problems occurred on the 26th of September and to the fact that the Gyro 5 failure related anomaly lasted almost one day longer for the MWR than for the RA (ref. par. 3.3.2).

The following figure reports the global distribution of flagged parameters detected in the URA products for cycle 57.

ERS-2 URA Products Summary, Cycle 57



URA Summary Decoding Key

IF Gap	Gap	Groundtrack		
A18 Wet Tr.	A18 Version	A19 Meteo	Blank	Blink DSR
A13 Mode	A14 WSpeed	A15 WHeight	A16 Peak	A17 Sigma0
A8 Blank	A9 Blink DSR	A10 MPH	A11 SPH	A12 DSR
A3 File	A4 Missprd	A5 Acq	A6 Overlap	A7 Duplic.

The fast delivery data (URA) are checked every day by ESRIN/PCS for quality assurance. The summary of all the most important features affecting the quality of the data during cycle 58 is hereafter reported.

Percentage of not available products (relative to the nominal number for a cycle): 0.24%

Percentage of blank DSRs (relative to the nominal number for a cycle): 0.089%, of which 0.035% due to whole blank products and 0.054% due to products not totally blank.

Table 5: Percentage of products having one of the following flags set

Flag name	Percentage(%)
HDDT	0.69
FS to Processor	0.0
Checksum Analysis	0.0
Formats/Sources	0.0
Auxiliary Data	0.0
Arithmetic Fault	0.0
Processor Status	0.0
Enough Measurement	1.56

Table 6: Percentage of products having one of the following parameters outside the respective range

Parameter	Percentage(%)
Peakiness out of [1.2, 1.7]	0.17
Sigma_0 out of [0., 24.] (dB)	0.06
Wind Speed out of [0., 25.] (m/s)	0.0
Significant Wave Height ot of [0., 12.] (m)	0.01

Note that the numbers here above (Table 6) are only relative to ocean products.

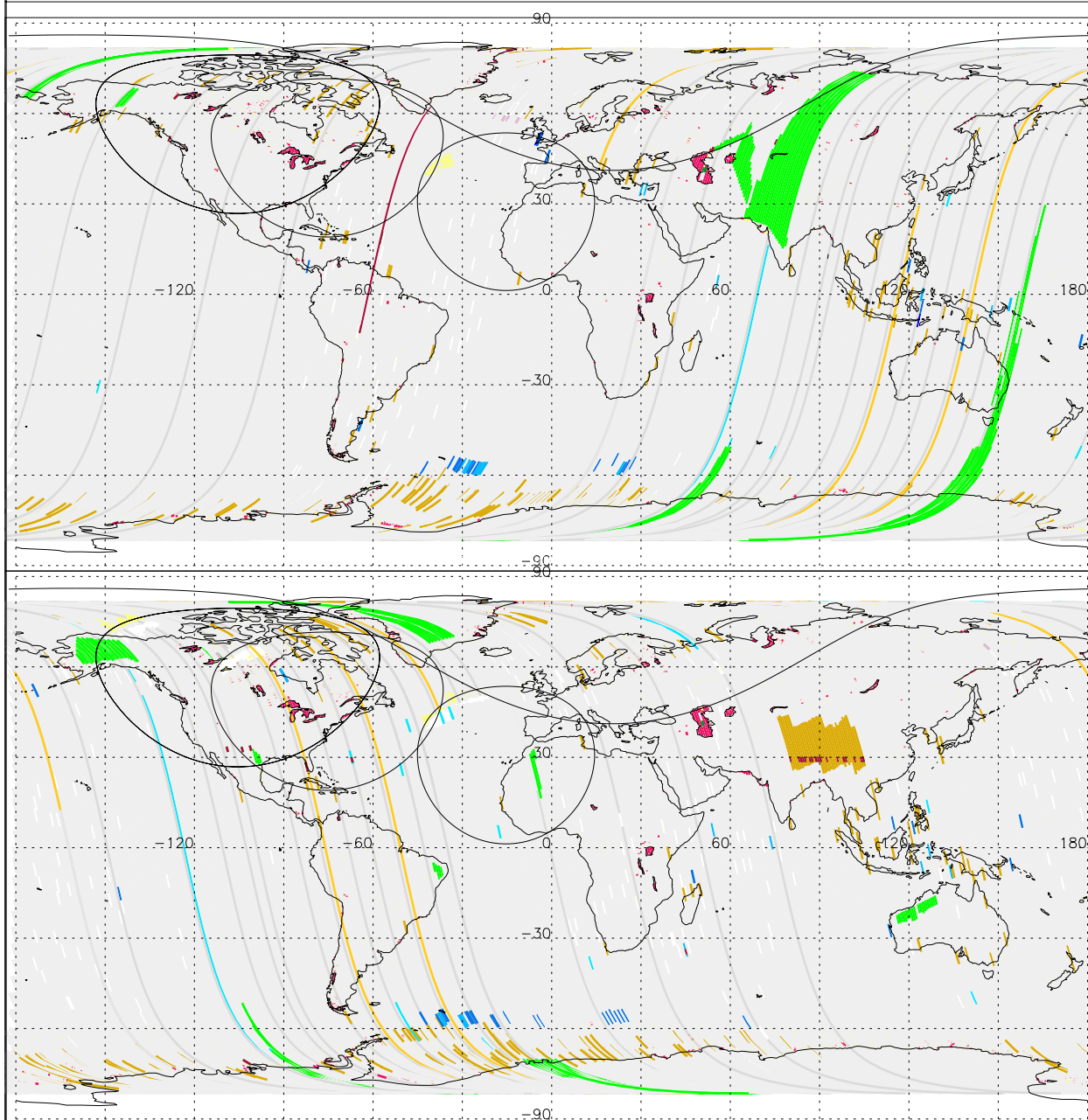
Percentage of flagged products relative to the Wet Tropospheric Correction: 0.055%

(a product is flagged if it contains more than 10 DSRs which all have the default value for the Wet Tropospheric correction instead of a value derived from the MWR measurements).

The fast delivery data performance during cycle 58 was very good.

The following figure reports the global distribution of flagged parameters detected in the URA products for cycle 58.

ERS-2 URA Products Summary, Cycle 58



URA Summary Decoding Key

IF Gap	Gap	Groundtrack		
A18 Wet Tr.	A18 Version	A19 Meteo	Blank	Blink DSR
A13 Mode	A14 WSpeed	A15 WHeight	A16 Peak	A17 Sigma0
A8 Blank	A9 Blink DSR	A10 MPH	A11 SPH	A12 DSR
A3 File	A4 Missprd	A5 Acq	A6 Overlap	A7 Duplic.

In relation to the previous URA Products Summary pictures for cycle 57 and 58, here the description of flags meaning:

IF Gap: not nominal gap, between two files (Inter-file Gap)

Gap: nominal gap (due to descoping)

Groundtrack: no flagged products, everything is nominal

Wet Tr.: problem with the Wet Tropospheric correction

Version: problem with the Meteo Table version (auxiliary parameter used for the processing, giving the meteorological forecast)

Meteo: problem with the Meteo Table number (auxiliary parameter used for the processing, giving the meteorological forecast)

Blank: blank product, nominal (due to descoping)

Blank DSR: product with more than 5 blank DSRs over ocean, nominal (due to descoping)

Mode: not nominal instrument mode

Wspeed: problem with the Wind Speed (value out of [0., 25.] (m/s))

WHeight: problem with the Significant Wave Height (value out of [0., 12.] (m))

Peaki: problem with the Significant Wave Height (value out of [1.2, 1.7])

Sigma0: problem with the Significant Wave Height (value out of [0., 24.] (dB))

Blank: blank product

Blank DSR: product with more than 5 blank DSRs over ocean

MPH: Main Product Header flag set

SPH: Specific Product Header flag set

DSR: Data Set Record flag set

File: Missing File

Missprd: Missing Product, product counter not consecutive

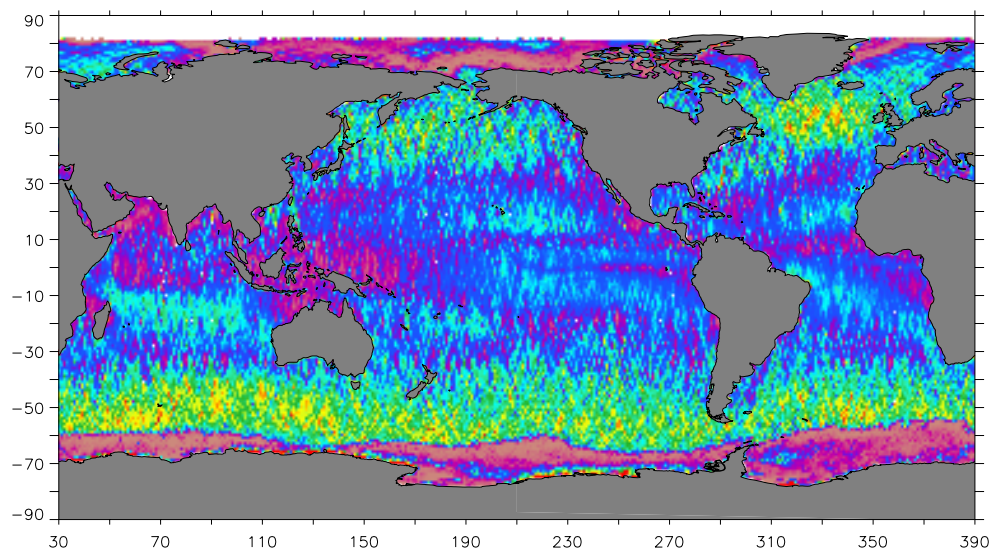
Acq: problem with acquisition, gap within one file

Overlap: product overlapping with another one

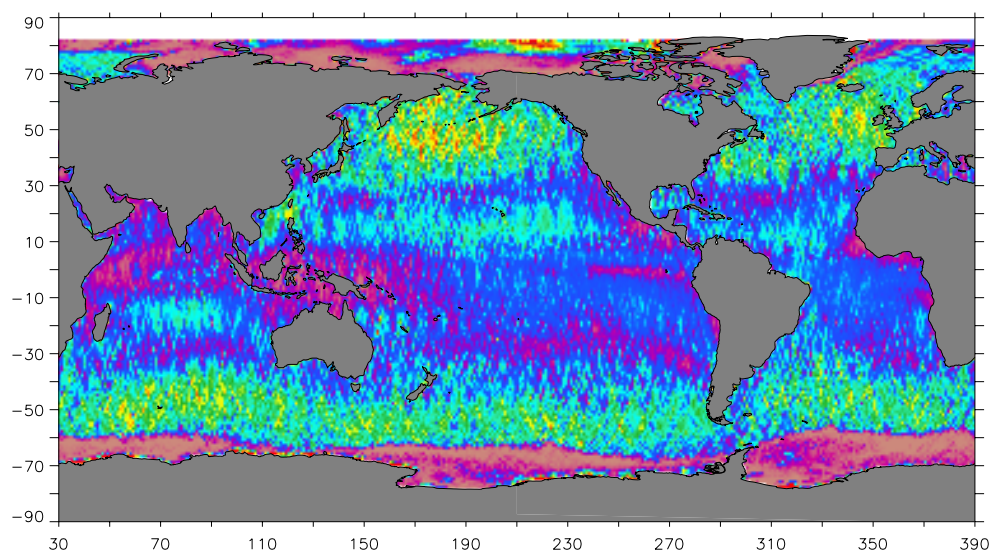
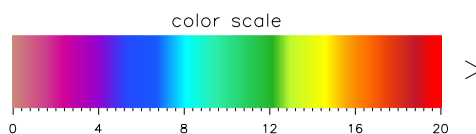
Duplic: duplicated product

4.3 Fast Delivery Data Summary

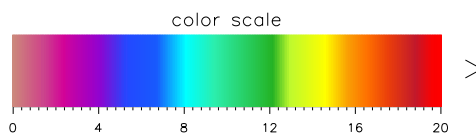
From the fast delivery data arriving every day at ESRIN/PCS, the relevant parameters are extracted on a daily basis. For every parameter all the information relative to every cycle have been averaged on a geographical basis over pixels of 1 deg latitude per 1 deg longitude. They are reported in the following pictures, giving a global overview of the Radar Altimeter data for cycles 57 and 58.



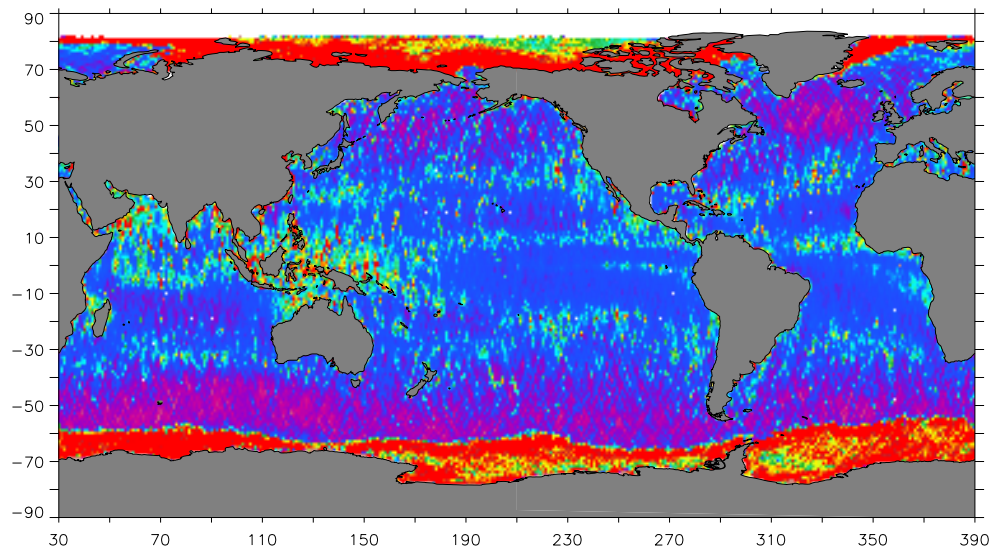
URA Average Wind Speed (m/s)
ERS-2 RADAR ALTIMETER/CYCLE 57
From 25-SEP-2000 to 30-OCT-2000
Absolute orbit: 28412 to 28912



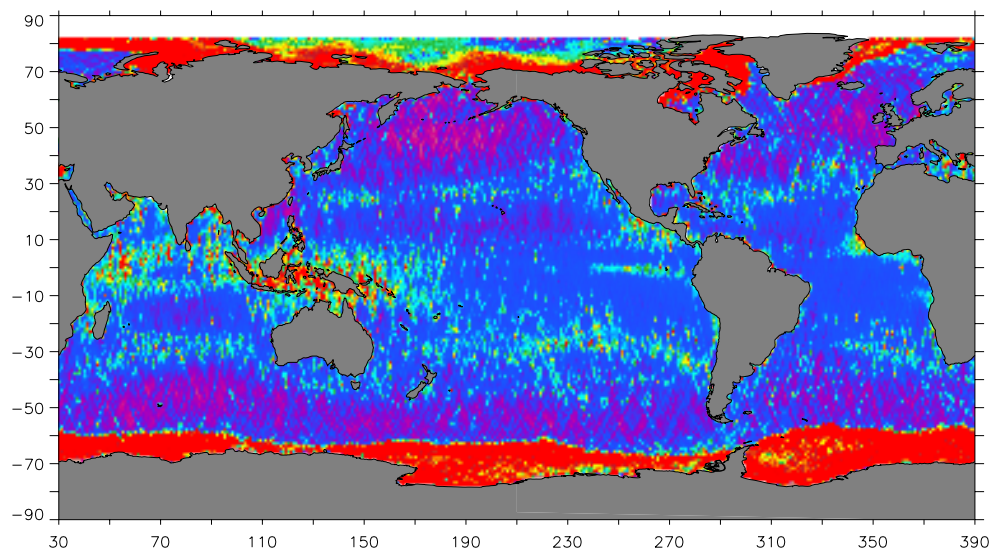
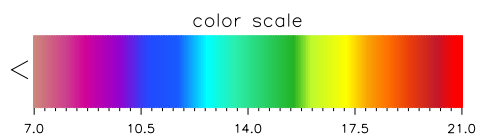
URA Average Wind Speed (m/s)
ERS-2 RADAR ALTIMETER/CYCLE 58
From 30-OCT-2000 to 04-DEC-2000
Absolute orbit: 28913 to 29413



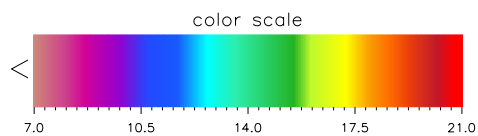
Worthwhile to notice in the first plot the Wind Speed values over the polar regions. Those value, both for cycle 57 and 58, are quite often identically equal to zero; they correspond to sigma_0 values higher than 20 dBs for which the wind speed retrieval algorithm used for the fast delivery URA data gets saturated.

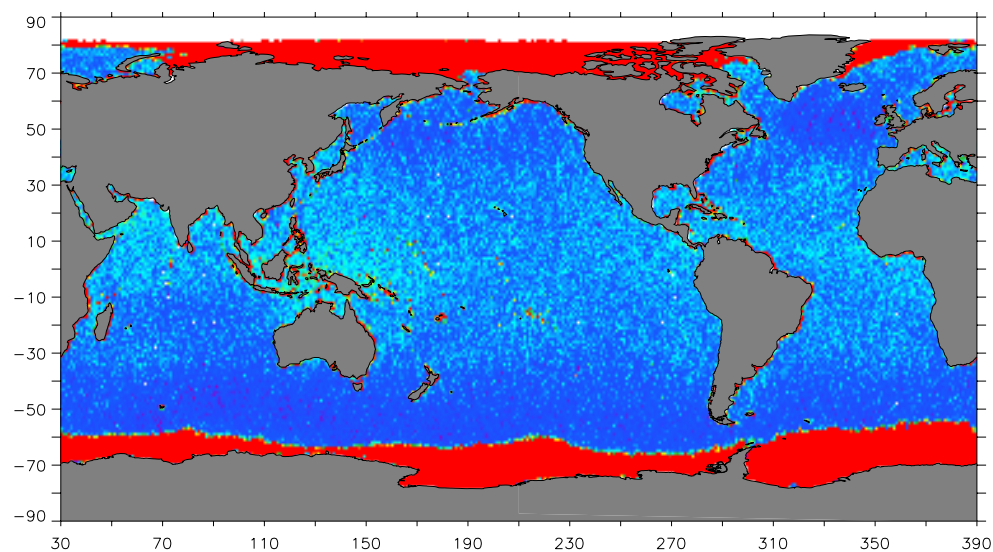


URA Average Sigma 0 (dB)
ERS-2 RADAR ALTIMETER/CYCLE 57
From 25-SEP-2000 to 30-OCT-2000
Absolute orbit: 28412 to 28912

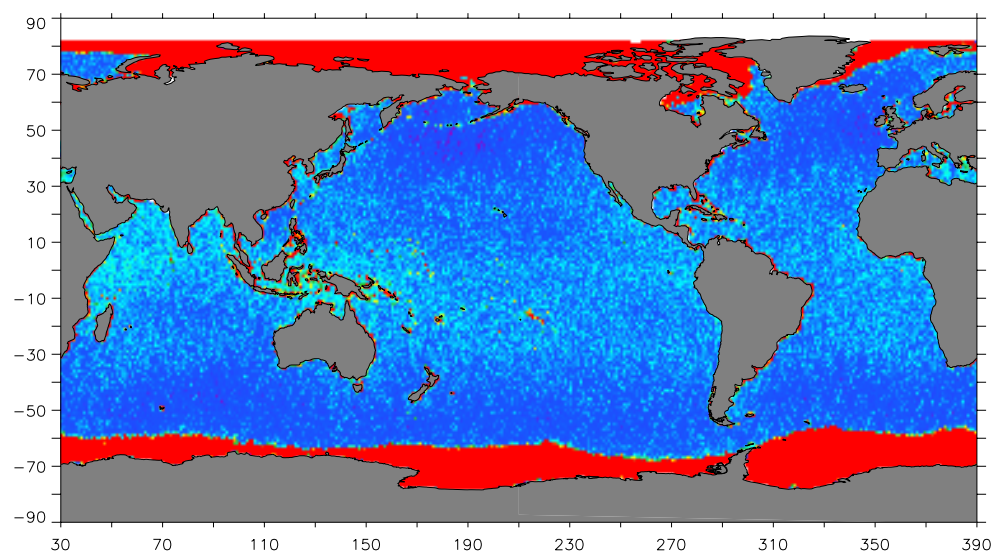
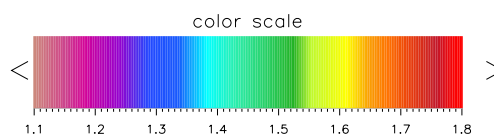


URA Average Sigma 0 (dB)
ERS-2 RADAR ALTIMETER/CYCLE 58
From 30-OCT-2000 to 04-DEC-2000
Absolute orbit: 28913 to 29413

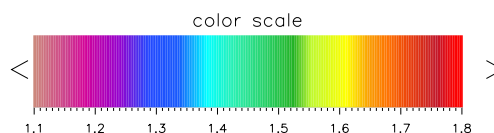




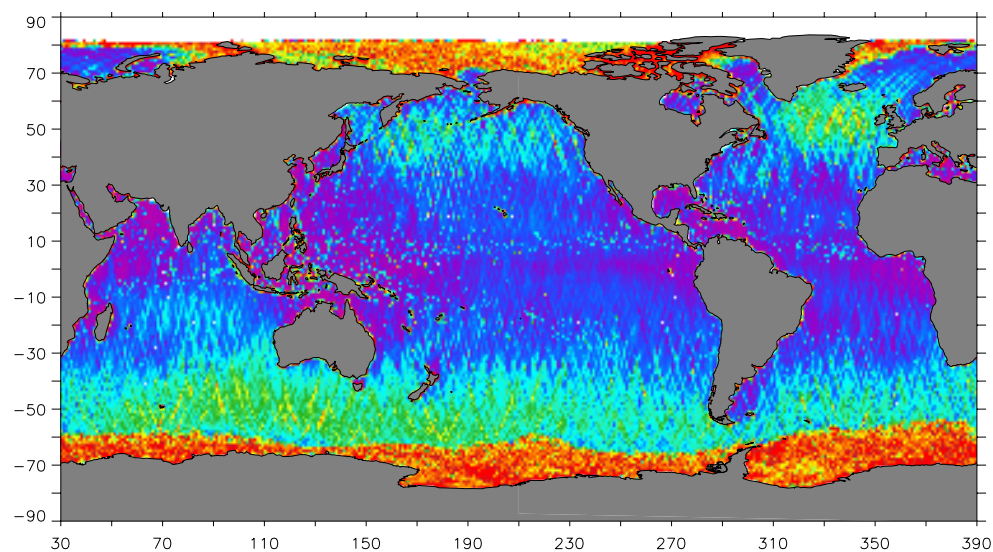
URA Average Peakiness
ERS-2 RADAR ALTIMETER/CYCLE 57
From 25-SEP-2000 to 30-OCT-2000
Absolute orbit: 28412 to 28912



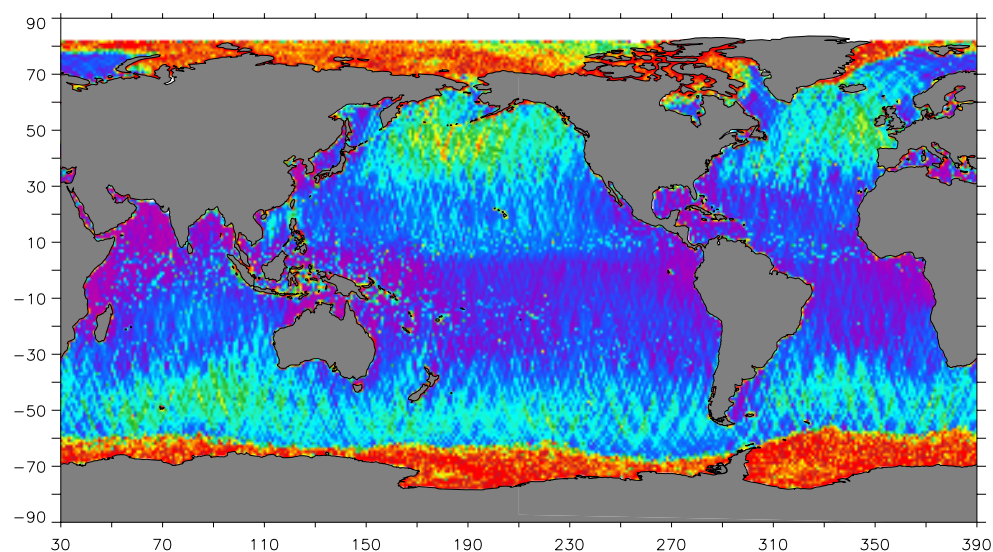
URA Average Peakiness
ERS-2 RADAR ALTIMETER/CYCLE 58
From 30-OCT-2000 to 04-DEC-2000
Absolute orbit: 28913 to 29413



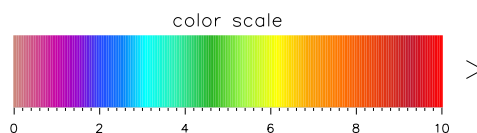
The Peakiness, being related to the peakedness of the returned echo waveforms, represents a valuable quality parameter for the raw data. Over Ocean areas you expect smooth waveforms (ref. par. 3.4) while over Ice area the expected shape is more peaky. For ocean-like waveforms the peakiness should be in the range [1.2, 1.7]; in case higher peakiness values over ocean surfaces would be recorded, this would be index of an anomalous received signal.



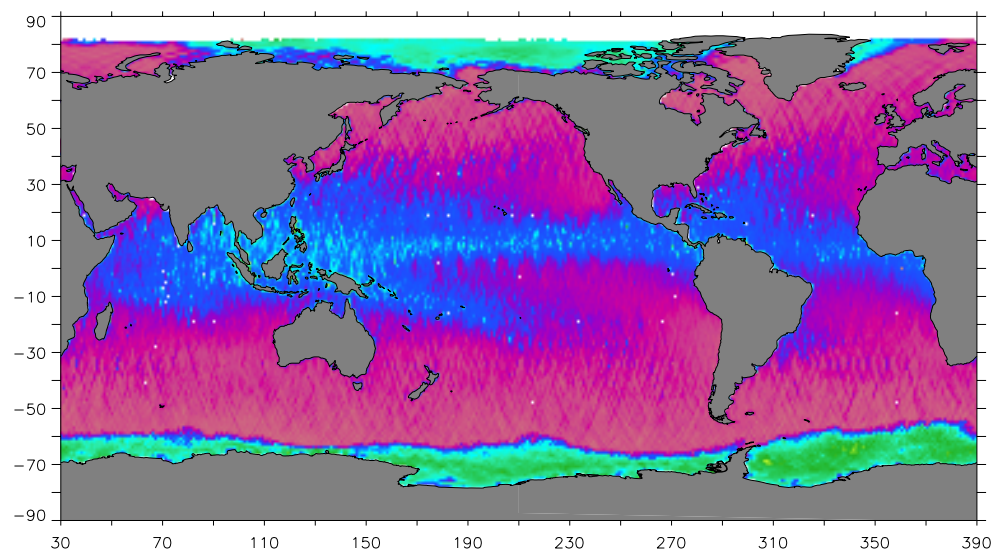
URA Average Significant Wave Height (m)
ERS-2 RADAR ALTIMETER/CYCLE 57
From 25-SEP-2000 to 30-OCT-2000
Absolute orbit: 28412 to 28912



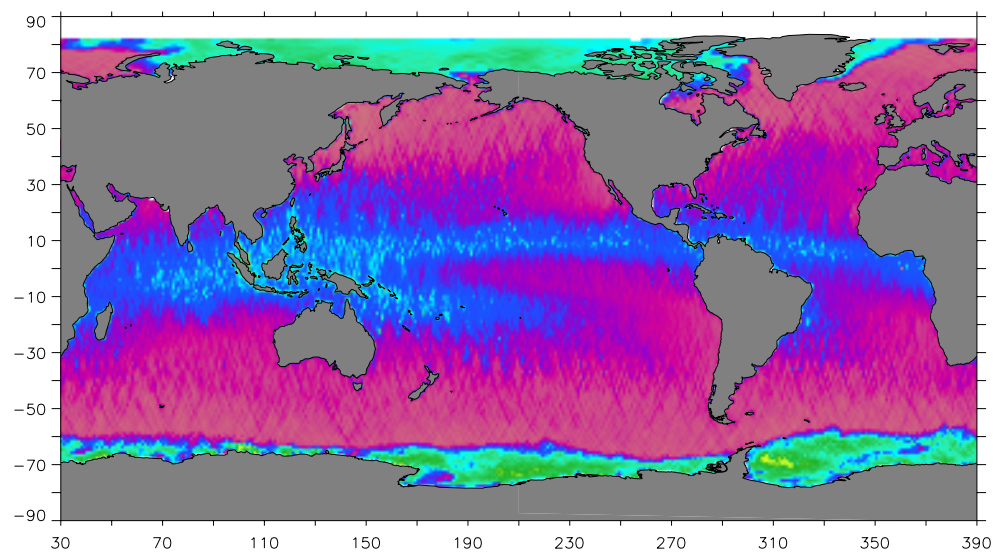
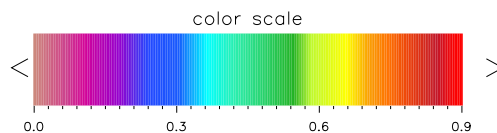
URA Average Significant Wave Height (m)
ERS-2 RADAR ALTIMETER/CYCLE 58
From 30-OCT-2000 to 04-DEC-2000
Absolute orbit: 28913 to 29413



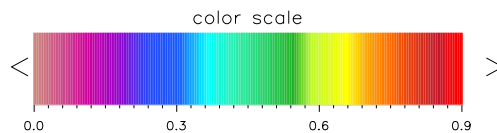
Together with the Wind Speed mentioned before, also the Wet Tropospheric correction values over the polar regions deserve a comment: the high values are not a consequence of the geophysical conditions in those areas; they are due the fact that the algorithm used to retrieve the correction from the brightness temperatures gives valid results only over ocean areas.



URA wet troposph. corr. (m)
ERS-2 RADAR ALTIMETER/CYCLE 57
From 25-SEP-2000 to 30-OCT-2000
Absolute orbit: 28412 to 28912



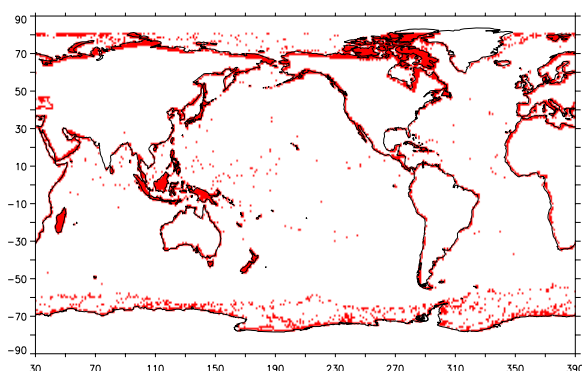
URA wet troposph. corr. (m)
ERS-2 RADAR ALTIMETER/CYCLE 58
From 30-OCT-2000 to 04-DEC-2000
Absolute orbit: 28913 to 29413



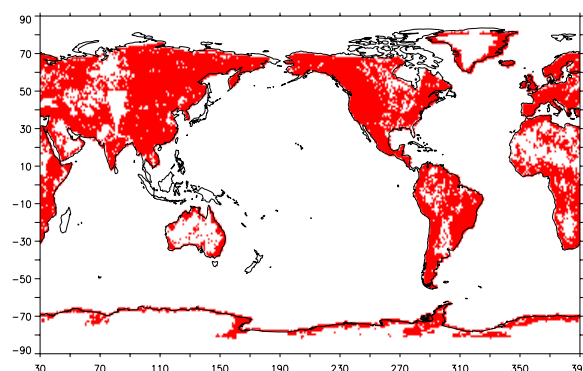
4.4 Instrument Mode

During nominal operations the Radar Altimeter works alternatively in Ocean and Ice Modes. The two modes differ basically on the resolution of the altimetric range measurements and on the capability to maintain the “lock” with the backscattered echo. In Ocean Mode the resolution is higher but the instrument can easily loose the tracking when flying over surfaces characterised by high slope variations. On the other hand in Ice Mode the resolution is lower but the instrument succeeds in keeping the tracking also when flying over very steep terrains. The switch from Ocean to Ice Mode and vice-versa is not performed automatically by the instrument, but it is commanded following the water/ground borders indicated by the Ice/Ocean mask. Within both the Ice and Ocean Modes, two sub-modes can be distinguished: Tracking and Acquisition Modes, which have been already mentioned in the paragraph dedicated to the Instrument Performances.

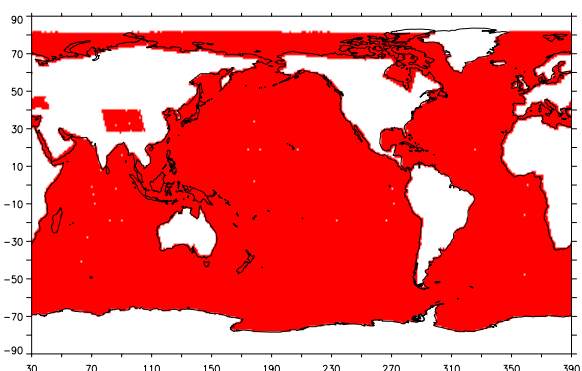
The following maps report a summary of the four principal operative working modes during cycles 57 and 58.



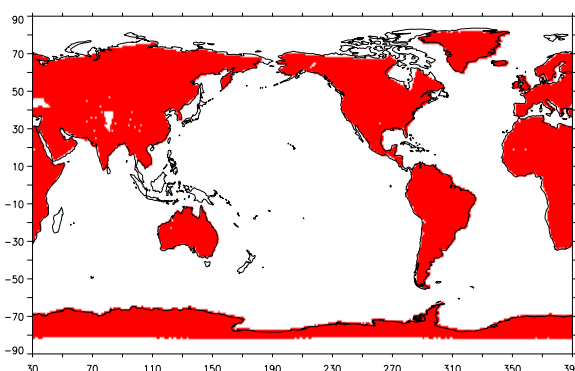
URA Acquisition on Ocean
ERS-2 RADAR ALTIMETER/CYCLE 57
From 25-SEP-2000 to 30-OCT-2000
Absolute orbit: 28412 to 28912



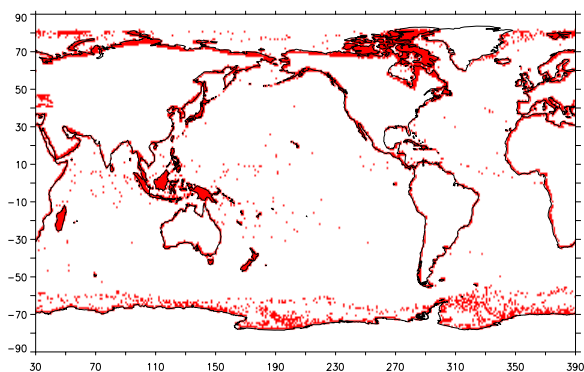
URA Acquisition on Ice
ERS-2 RADAR ALTIMETER/CYCLE 57
From 25-SEP-2000 to 30-OCT-2000
Absolute orbit: 28412 to 28912



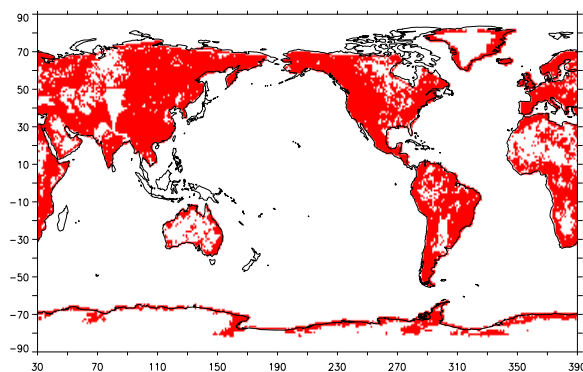
URA Tracking on Ocean
ERS-2 RADAR ALTIMETER/CYCLE 57
From 25-SEP-2000 to 30-OCT-2000
Absolute orbit: 28412 to 28912



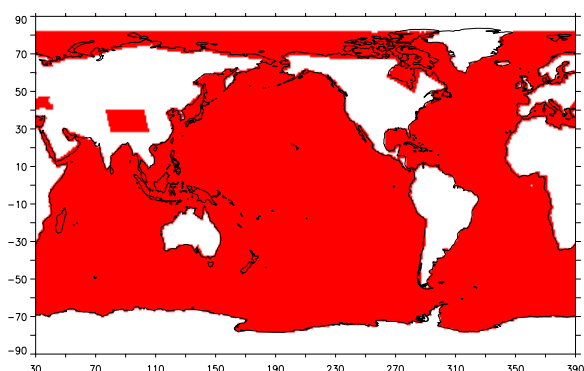
URA Tracking on Ice
ERS-2 RADAR ALTIMETER/CYCLE 57
From 25-SEP-2000 to 30-OCT-2000
Absolute orbit: 28412 to 28912



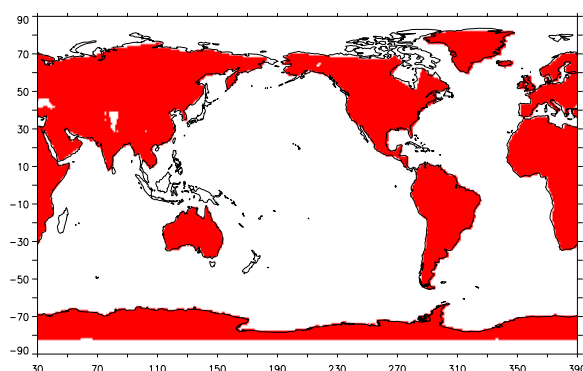
URA Acquisition on Ocean
ERS-2 RADAR ALTIMETER/CYCLE 58
From 30-OCT-2000 to 04-DEC-2000
Absolute orbit: 28913 to 29413



URA Acquisition on Ice
ERS-2 RADAR ALTIMETER/CYCLE 58
From 30-OCT-2000 to 04-DEC-2000
Absolute orbit: 28913 to 29413



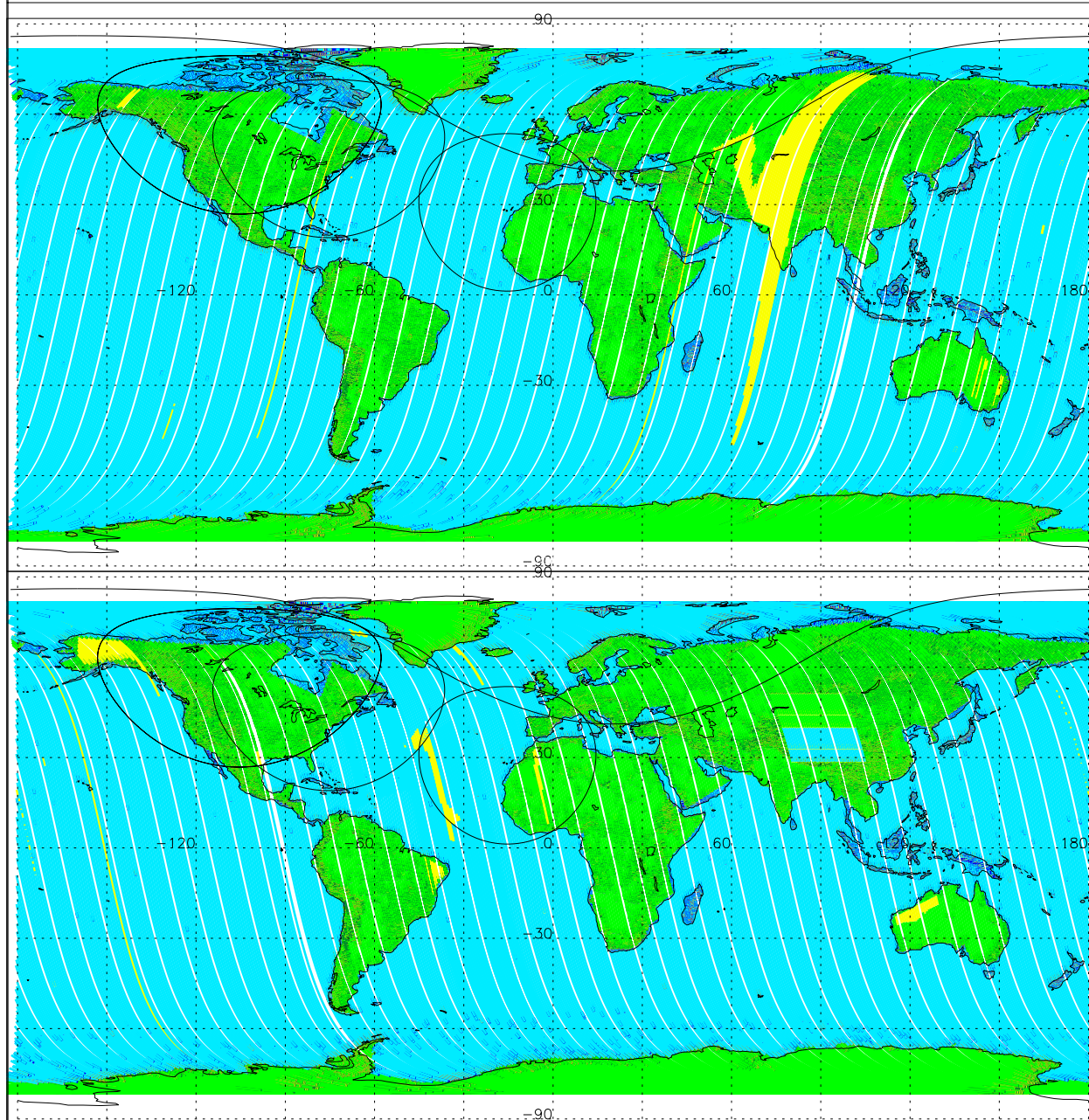
URA Tracking on Ocean
ERS-2 RADAR ALTIMETER/CYCLE 58
From 30-OCT-2000 to 04-DEC-2000
Absolute orbit: 28913 to 29413



URA Tracking on Ice
ERS-2 RADAR ALTIMETER/CYCLE 58
From 30-OCT-2000 to 04-DEC-2000
Absolute orbit: 28913 to 29413

The following two pictures report a global view of the modes the Radar Altimeter was operationally working in, during respectively cycle 57 and cycle 58.

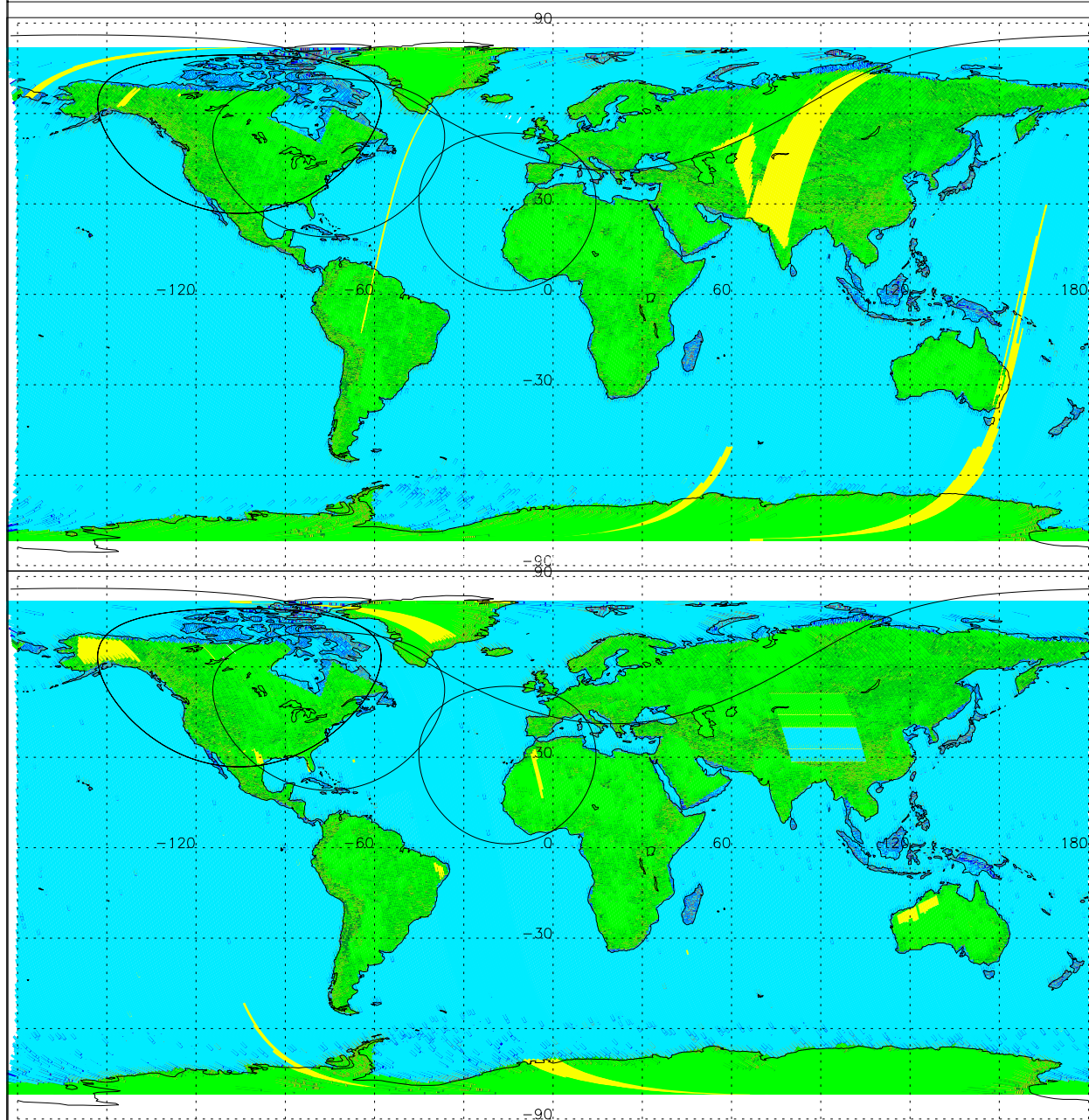
ERS-2 Radar Altimeter: Working modes, Cycle 57



RA Mode Decoding Key

Blank	Test	Calib	BITE	Acq. Ice	Acq. Ocean	Track. Ice	Track. Ocean

ERS-2 Radar Altimeter: Working modes, Cycle 58



RA Mode Decoding Key



The descoping strategy can be seen from to the clusters of blank products (yellow). (For more information on the descoping strategy: <http://earth1.esrin.esa.it/f/eeo4.42/oppla>)

The SPTR/PTN calibration strategy performed over central Asia is easily discernible. The Instrument works permanently first in Ocean Tracking and then in Ice Tracking Mode, due to the presetting mode used during the calibration. The data in SPTR Ice Mode measured during this campaign are used to evaluate the IF Filter Shape presented in par. 3.3.

The area covered by the SPTR/PTN campaign, starting from cycle 43, has been and will be in the future bigger than before. This because, from cycle 43 on, the campaign has been and will be performed in the future every day instead of every three days as it was previously planned. The decision of performing the calibration campaign more often has been taken in order to minimize the probability to have periods between two anomalies without any SPTR measurement. Being the SPTR measurements affected by quasi-random abrupt changes in case of instrument anomalies, the situation of having two subsequent anomalies without any SPTR calibration campaign will cause the impossibility to produce a completely trustable SPTR calibration correction for the altimetric range values recorded during that period. A solution to this problem had been proposed by Richard Francis and Monica Roca in early 1996, but it has been not yet operationally implemented due to difficulties in the operational retrieval of several parameters useful for the algorithm execution.

The mountainous structures can be noticed in relation to the dark green signs representing Ice Acquisition mode. Of course this is due to the loose of lock caused by the steep ground morphology in those zones.

In comparison to previous cycles up to cycle 40, the Ice/Ocean discrimination follows much better the shape of the continents. From cycle 41 a new Ocean/Ice mask have been used operationally. The improvements are related to the shape of the land (see South America, North Europe and Africa) and to the shape of the ice caps in Antarctica and in Greenland. (For more information <http://earth1.esrin.esa.it/f/eeo4.39/RA-Altimeter>).

4.5 Look Up Tables Status

The Look Up Tables (LUT) contain auxiliary parameters used in the on-ground processing. Those parameters need, from time to time, to be updated. In those cases, new versions of the tables containing the parameters have to be produced and loaded in memory at the ground stations. During the period covering cycles 57 and 58 no change on the look Up Tables was implemented.

Radar altimeter LUT Summary		
ID	LUT Name	Version
70	STATIC	13004
71	DYNAMIC	13003
72	TAU_G_REF	10006
73	TAB_TAU_1	10001
74	TAB_TAU_2	10001
76	SIG_G_REF	10001
77	TAB_S	10001
79	AGC_G_REF	13005
81	TAB_A2	10001
82	TAB_LOC	10001

LUT SUMMARY

ERS-2 RADAR ALTIMETER/CYCLE 57

From 25-SEP-2000 to 30-OCT-2000

Radar altimeter LUT Summary		
ID	LUT Name	Version
70	STATIC	13004
71	DYNAMIC	13003
72	TAU_G_REF	10006
73	TAB_TAU_1	10001
74	TAB_TAU_2	10001
76	SIG_G_REF	10001
77	TAB_S	10001
79	AGC_G_REF	13005
81	TAB_A2	10001
82	TAB_LOC	10001

LUT SUMMARY

ERS-2 RADAR ALTIMETER/CYCLE 58

From 30-OCT-2000 to 04-DEC-2000

4.6 Special Events

During cycle 57 one special event influenced the products performance:

- On the 7th of October 2000 a critical failure of Gyro 5 occurred. This was correlated in time to an anomaly which affected the whole payload. The Radar Altimeter stopped producing valid data at 17:30:33
- Gyro 6 was selected to overtake the work of piloting the ERS-2 platform during nominal operations. The Radar Altimeter started again to produce valid data on the 10th of October at 16:40:33.
- After having verified that the Gyro 6 performance was stable, it was decided to replace it with Gyro 1 during nominal operations. On the 24th of October at about 16:00 the platform was set in Fine Pointing Mode (pointing performance not controlled) until the 25th at about 12:00. Since then Gyro 1 pilotes the platform in nominal operations (Yaw Steering Mode).

During cycle 58 one special event influenced the products performance:

- On the 2nd of November 2000 the satellite was piloted in Fine Pointing Mode (less accurate than the nominal Yaw Steering Mode) from 10:28:00 to 17:08:00.

4.7 Data Comparison with forecasts

Extracted from the ECMWF report on ERS-2 RA for October and November 2000 we can report the following results related to the comparison between the ERS-2 measured parameters and the ones evaluated at the ECMWF (For more information: [ecmwf_alt_oct00.pdf](#) and [ecmwf_alt_nov00.pdf](#)):

For October 2000:

Wind Speed Comparison between the ECMWF and the ERS-2 RA wind speeds (bias):

- Global: 0.150 m/s
- Northern Hemisphere: 0.119m/s
- Tropics: 0.014 m/s
- Southern Hemisphere: 0.272 m/s

Significant Wave Height Comparison between the ECMWF and the ERS-2 RA significant wave heights (bias):

- Global: 0.014 m
- Northern Hemisphere: 0.105 m
- Tropics: -0.042 m
- Southern Hemisphere: -0.004 m

For November 2000:

Wind Speed Comparison between the ECMWF and the ERS-2 RA wind speeds (bias):

- Global: 0.091 m/s
- Northern Hemisphere: 0.346m/s
- Tropics: 0.012 m/s
- Southern Hemisphere: -1.05 m/s

Significant Wave Height Comparison between the ECMWF and the ERS-2 RA significant wave heights (bias):

- Global: -0.010 m
- Northern Hemisphere: 0.104 m
- Tropics: -0.066 m
- Southern Hemisphere: -0.039 m