DOCUMENT

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ENVISAT CYCLIC ALTIMETRIC REPORT

CYCLE 91 from 05-07-2010 to 09-08-2010

Quality Assessment Report

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reference	ENVI-GSOP-EOPG-03-0011
issue	1
date of issue	11 January 2011
status	Final
Document type	Technical Note

European Space Agency
Agence spatiale européenne

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1 INTRODUCTION

This document aims at reporting on the performance of the EnviSat Radar Altimeter, Microwave Radiometer and DORIS sensors, on the data quality of the corresponding Fast Delivery products as well as on the main events which occurred during cycle 91.

This report covers the period from 5th July 2010 to 8th August 2010.

2 DISTRIBUTION LIST

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http://earth.eo.esa.int/pcs/envisat/ra2/reports/pcs_cyclic/

3 ACRONYMS

ADF	Auxiliary Data File
AGC	Automatic Gain Control
APC	Antenna Pointing Controller
CFI	Customer Furnished Item
DORIS	Doppler Orbitography and Radiopositioning Integrated by Satellite
DSR	Data Set Record
EPC	Electronic Power Converter
ERS	European Remote Sensing satellite
ESRIN	European Space Research Institute
ESOC	European Space Operations Centre
FD	Fast Delivery products
FDGDR	Fast Delivery Geophysical Data Record
GS	Ground Segment
GTS	Global Telecommunication System
HTL	Height Tracking Loop
ICU	Instrument Control Unit
IECF	Instrument Engineering Calibration Facility
IF	Intermediate Frequency
IE	Individual Echoes
IPF	Instrument Processing Facility
HSM	High Speed Multiplexer
LUT	Look Up Table
MCMD	MacroCommand
MPH	Main Product Header
MSS	Mean Sea Surface
MWR	MicroWave Radiometer
MPS	Mission Planning System

MR	Microwave Receiver
NRT	Near Real Time
OBT	On-Board Time
OCM	Orbit Control Mode/Manoeuvres
PCS	ERS Products Control Service
PCF	EnviSat Product Control Facility
PDHS-E	ESRIN Processing and Data Handling Station
PDHS-K	Kiruna Processing and Data Handling Station
PDS	Payload Data Segment
PLSOL	Payload Switch-Off Line
PMC	Payload Main Computer
PSO	On-orbit Position
PTR	Point Target Response
RA-2	EnviSat Radar Altimeter bi-frequency
RSL	Resolution Selection Logic
SAD	Static Auxiliary Files
SBT	Satellite Binary Time
SEU	Single Event
SLA	Sea Level Anomalies
SFCM	Stellar Fine Control Mode
SPH	Specific Product header
SPSA	Signal Processing Sub-Assembly
SYSM	Stellar Yaw Steering Mode
S/W	Software
TM	Telemetry
TRP	Transponder
TWT	Traveling Wave Tube
UTC	Coordinated Universal Time
USO	Ultra Stable Oscillator
YSM	Yaw Stellar Mode

4 REFERENCE DOCUMENTS

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[R – 4] Instrument Performance Evaluation and Analysis Summary, PO-TR-ALS-RA-0042
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[R – 11] Envisat RA-2 Range Instrumental correction: USO clock period variations and associated auxiliary file, ENVI-GSEG-EOPG-TN-03-0009
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[R – 15] ENVISAT-1 Products Specifications - Vol. 14: RA-2 Products Specifications, PO-RS-MDA-GS-2009, Iss 3, Rev. N, 24/05/2004
[R – 16] Algorithm for Flag identification and waveforms reconstruction of RA-2 data affected by “S-Band anomaly”, ENVI-GSEG-TN-04-0004, Issue 1.4
[R-17] Envisat Cyclic Report Cycle 28, ENVI-GSOP-EOPG-03-0011
[R-18] ENVISAT RA-2 IF MASK AUX FILE - Updating Strategy: Investigation Report; C. Bignami and C.Loddo and N. Pierdicca.

5 GENERAL QUALITY ASSESSMENT

5.1 RA2 System Status Overview

The ENVISAT RA2 system is performing well, providing Ku band altimeter and radiometer parameters which have a very good stability and are consistent with expected values. There is a good availability over all surfaces (ocean, inland water, land and ice), meeting objectives set during the commissioning phase (> 99% over ocean, and > 95% over ice).

Major events since the beginning of the mission which effect data quality are:

- Failure of the S-Band at 23:23:40 on January 17th 2008 (Cycle 65 pass 289). All S-band parameter since that date should be considered invalid and should not be used. This includes the dual frequency ionospheric correction and rain flag. Users are instead advised to use the ionospheric correction from BENT model which is available in the FDGDR product.
- An anomaly in the Ultra Stable Oscillator (USO), which occurred intermittently between cycle 44 (01/02/2006) to cycle 65 pass 451 (23/01/2008). A procedure to correct for this anomaly is available at http://earth.esa.int/pcs/envisat/ra2/auxdata/
- In an attempt to address the USO anomaly, the RA2 was temporarily switched from its "A-side" to the "B-side", between 15/05/2006 (Cycle 47 pass 794) and 21/06/2006 (cycle 48 pass 847).
- In March 2008 (Cycle 66), a new procedure for the IF mask calibration mode was adopted, to correct an anomaly caused by a wrong setting of the AGC used for the IF Calibration Mode. This procedure is described in more detail in the Cyclic Report.
- There is a drift in the Microwave Radiometer instrumental parameters at 36.5 GHz, present since the beginning of the mission. It has been decided NOT to correct these values in the FDGDR, IGDR or GDR data.
- During cycle 86 a new IPF version 6.02L04 has been put in operations on 2nd February 2010 starting from absolute orbit #41443 (relative orbit 307). Main upgrades are the new USO correction implemented inside the processing and some new parameters used in the Level 1 and Level 2 processing (see Section 5.6.1 for more details). ***Please note that the USO correction is now included in the RA2 FD product and additional separate correction should not be applied.***

5.2 Cycle Overview

- RA-2 Ku Band is nominal.
- The RA-2 Ultra-Stable Oscillator (USO) was nominal on cycle 91;

- During cycle 91 RA2_SOL_AX has been updated on the 27th July 2010;
- Tracking performances in the different resolutions are well in line with the output figures and objectives of the Commissioning Phase;
- RA2 data availability was around 99.45 % during current cycle;
- MWR data availability was around 99.51 % during current cycle;
- DORIS data availability was around 94.01% during current cycle;
- RA2 instrument was unavailable on 15th July from 15:25:01 to 15:27:26;
- During cycle 91 a new IPF version v6.03 has been put in operations on 7th July 2010 starting from absolute orbit #43662. Main upgrade is the update of the ESA orbit CFI libraries (v5.8.1) able to handle the new satellite orbit foreseen for October 2010.

5.3 Payload status

5.3.1 ALTIMETER EVENTS

The Radar Altimeter 2, during cycle 91, was unavailable once:

Start: 15th July 2010 15:25:01 Orbit 43781
Stop: 15th July 2010 15:27:26 Orbit 43781.

5.3.1.1 RA-2 instrument planning

On cycle 91 the IF Calibration was performed only over the Himalaya site, as is the now usual practice. The operational acquisition was performed on ascending passes with the NEW procedure for IF Calibration described below. The map in Figure1 indicates the calibration site.
In-Flight Tests aimed to understand the origin of the IF Mask anomaly were carried out on cycle 66 and identified an occasional wrong setting of the AGC used for the IF Calibration Mode as the cause. The IF Calibration procedure now used in operational IF Calibration consists in setting all the AGCs to 3dB before entering the IF Calibration Mode. These parameters are restored to the original values when the IF Calibration mode ends, before entering in the Measurement mode.

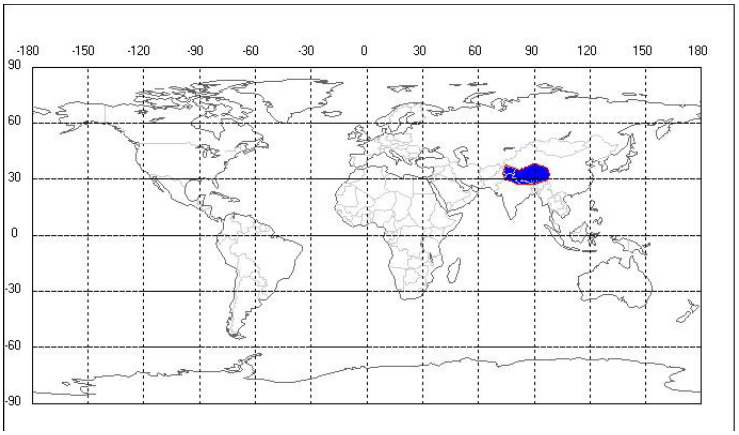

Figure 1: IF Calibration Acquisition sites

The RA-2 instrument planning was performed as follows:

- New procedure for IF calibration (through Digital BITE Mode command) over Himalaya for the entire cycle, 1 ascending pass per day
- No IF calibration on Rocky Mountains.
- Individual Echoes background planning: the buffering of 20 Data Blocks of Individual Echoes (1.114 sec.) transmitted every 160 Data Blocks starts after flying over the Himalayan region (both ascending and descending passes) and is operated for half a day.
- Individual Echoes acquisition (1 second length acquisition, 2 repetitions) over the following sites: Capraia, Toulon D, Vostok , Dome C.
  Appendix 6 contains a table with the coordinates.
- Individual Echoes acquisitions over the Uyuni Salar.
- Preset Loop Output mode for GAVDOS Range transponders, located in Creta; medium chirp resolution.
- Preset Loop Output mode over the ESA transponder located in Rome (permanent location); high chirp resolution.
- Individual Echoes acquisitions during PLO activity over ESA transponder located in Rome (1 second length acquisition, 1 repetition).
- Preset Loop Output acquisition over Svalbard transponder on 23rd July 2010 (orbit# 43396) with procedure P-H-N-07 (high chirp resolution) in order to support the CRYOSAT-2 pre-launch testing.

The map in Figure 2A shows the three acquisition sites for both the Range and Sigma_0 transponders.

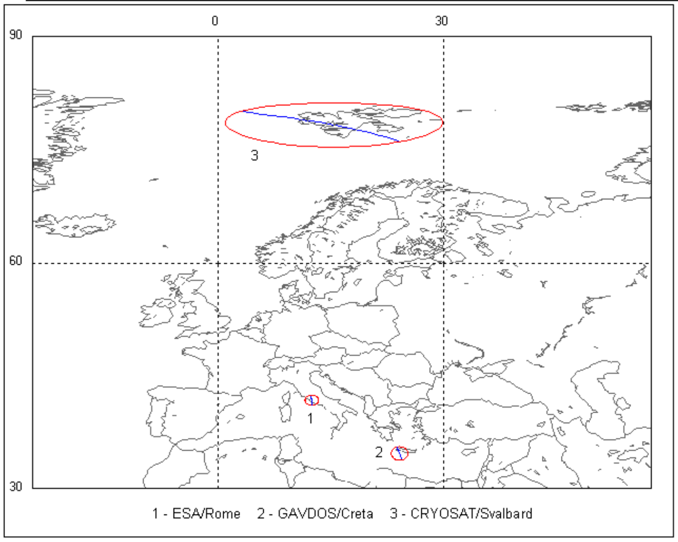

Figure 2A: Transponder Acquisition sites

5.3.2 MWR EVENTS

The MWR, during cycle 91, was never unavailable.

5.3.3 DORIS EVENTS

DORIS, during cycle 91, was never unavailable.

5.4 Availability

The summary of the RA-2 data products availability for the current cycle is reported in Appendix 2. Data availability was around 99.45% for RA-2 products, 99.51% for MWR products and 94.01% for DORIS products.

5.5 Orbit quality

On July 6th, 2010 (DOY 187) an orbit inclination correction manoeuvre took place. The characteristics of this manoeuvre were:
- Planned delta V size: 0.087 m/s, increasing orbit inclination by approximately 0.007 degree;
- Mid thrust time: 04:41:43 utc at ascending node;
- Thrust duration: 576.5 seconds;
- Measured delta V: 0.8743 m/s across track, 0.0078 m/s along track (towards flight direction), -0.027 m/s radial (towards downward vertical).

The scope of this inclination correction was threefold:

- keep the ground track within its deadband around the reference one in the high latitudes regions;
- keep the local time of ascending node crossings within the allowed range;
-continue inclination control cycles to allow interferometric applications started with the inclination correction performed on January 23, 2007 and carried over through other subsequent manoeuvres.

On July 7th, 2010 (DOY 188) a one-burn orbit in-plane correction manoeuvre took place. The characteristics of this manoeuvre were:
-Planned delta V size: -0.0024 m/s , decreasing the semi major axis by approximately 5 metres;
- Mid thrust times: 02:03:02 utc at PSO 265.388 degrees;
-Thrust duration: 2 seconds;
-Measured delta V: -0.0023 m/s against flight direction.

The scope of this in plane correction manoeuvre was to keep the spacecraft ground track within 200 metres from the reference ground track at ascending node over the next few weeks.

5.6 Ground Segment Processing Chain Status

5.6.1 IPF PROCESSING CHAIN

5.6.1.1 Version

Cycle 91 was processed with V6.02L04 and with V6.03 starting from 7th July 2010 (#43662) on the Linux chain installed in both PDHS-E and PDHS-K.

IPF V6.02L04 contains the following main evolutions:

1. New USO correction algorithm implemented in the IPF;
2. Update of transmission coefficients of the MWR reflector for 23.8 and 36.5 GHz ;
3. Efficiency factor for satellite contribution on the secondary lobes for 23.8 and 36.5 GHz;
4. Inclusion of a sea-ice algorithm,
5. Update the wind tables, the ocean tide and tidal loading models
6. New Product specification document 4/C

A complete table of IPF Level1b and Level2 upgrades is reported in Appendix 1 and in the "Information to the users on RA2MWR IPF v6.02L04" document.

IPF V6.03 contains the upgrade of CFI libraries to version 5.8.1 (a collection of software functions performing accurate computations of mission related parameters for Envisat) for the new foreseen ENVISAT spacecraft orbit, that is planned for October 2010.

5.6.1.2 Auxiliary Data File

The Auxiliary files actually used by the IPF ground processing are reported in Appendix 3.
The RA2_POL_AX, RA2_SOL_AX and RA2_PLA_AX have been regularly updated without problems. The RA2_IFF_AX has been updated during the reporting period. The RA2_USO_AX has never been updated during the reporting period. Data are corrected with the RA2_USO_AX estimated before the USO Clock anomaly (USO_Clock_Period = 12499999726, USO_Range_Correction= 17.3 mm).

The following auxiliary files have been updated for their usage in the IPF v6.02L04: AUX_DEM_AX, MWR_CHD_AX, MWR_SLT_AX, RA2_CHD_AX, RA2_CON_AX, RA2_OT2_AX, RA2_SOI_AX, RA2_SSB_AX, RA2_TLD_AX, RA2_USO_AX.

The RA-2 Auxiliary Data Files (ADF) are accessible from the Envisat Web pages under:
http://www.envisat.esa.int/services/auxiliary_data/ra2mwr/current/

6 INSTRUMENT PERFORMANCE

6.1 RA-2 Performance

6.1.1 TRACKING CAPABILITY

The percentages of acquisition in the different resolutions subdivided by surface type are given in the Table 1. The figures given for the RA-2 tracking performances during this cycle are in line with the ones recorded at the end of the Commissioning Phase reported in the second column and presented in [R – 8].

Surface type	320 MHz	Commissioning Phase objectives 320 MHz	80 MHz	20MHz
Open Ocean	99.99	>99%	0.01	0.00
Coastal Water (ocean depth < 200 m)	98.40	No specific requirement	1.42	0.17
Sea Ice	99.18	>95%	0.76	0.06
Ice Sheet	96.20	>95%	3.28	0.53
Land	81.29	No specific requirement	15.20	3.51
All world	95.16		3.96	0.87

Table 1: RA-2 Tracking capability: Chirp ID percentages discriminated by surface type

In Figure 2, Figure 3 and Figure 4 the cyclic tracking percentages for the three RA-2 bandwidths are reported.
The worsening in performance noticeable for cycle 20 was due to the up-load of wrong on-board software parameters which lasted for about three days whilst for cycle 47 a special operation has been performed to limit RA-2 Chirp Bandwidth to fixed values.

In general, even if a tiny evolution can be observed, the tracking performances are well in line with the output figures and objectives of the Commissioning Phase as given in Table 1.

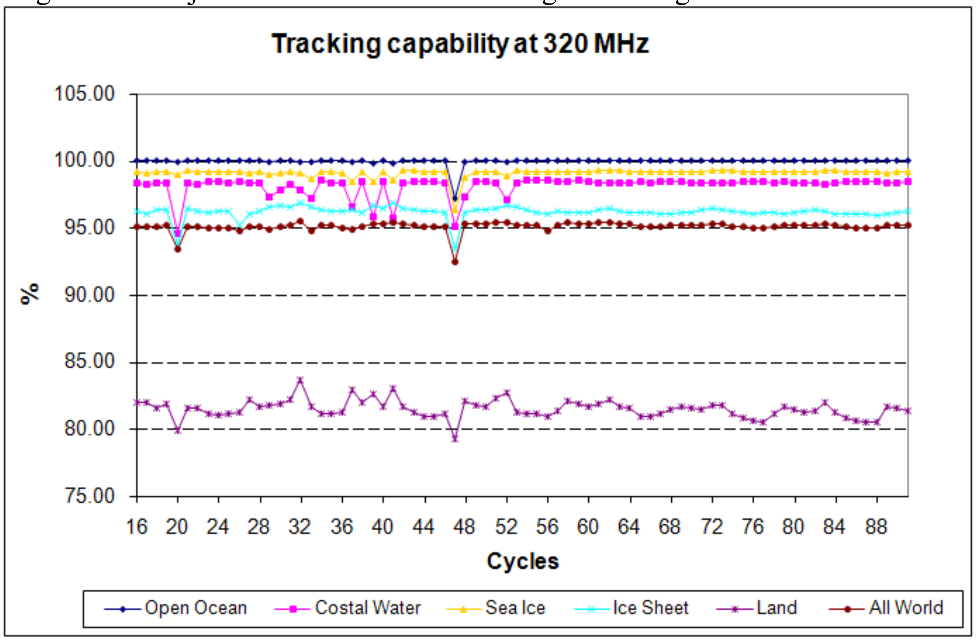

Figure 2: RA-2 Tracking percentage at 320MHz for different surfaces

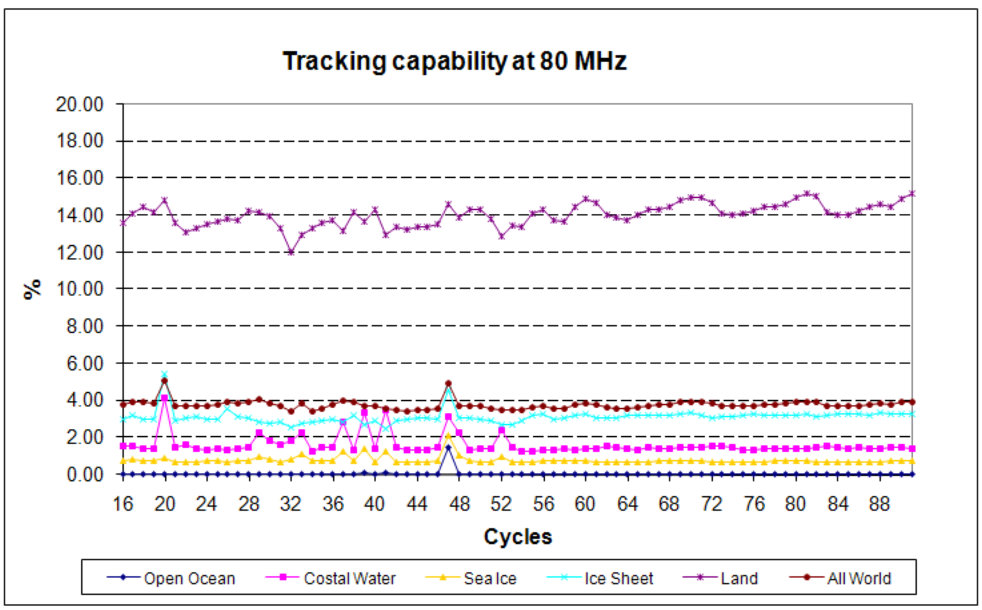

Figure 3: RA-2 Tracking percentage at 80MHz for different surfaces

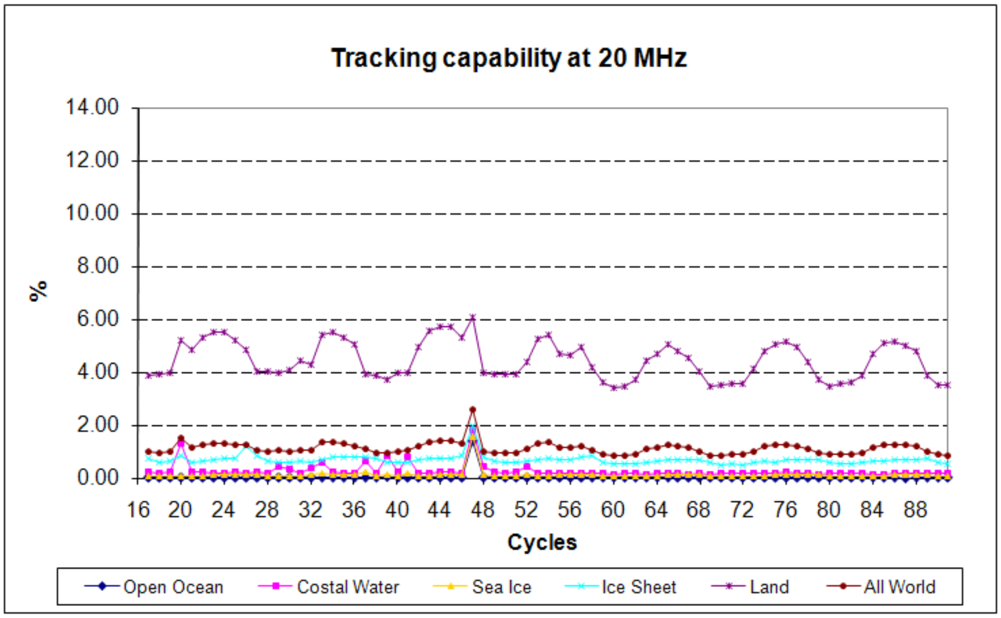

Figure 4: RA-2 Tracking percentage at 20MHz for different surfaces

6.1.2 IF FILTER MASK

In Figure 5 all IF masks retrieved during the current cycle are plotted in the left panel. The on-ground measured IF mask (ref [R – 4]) is also plotted in that panel with a solid line. In the right panel, the difference of each of the calculated IF masks with respect to the on-ground measured one is reported. The average difference with respect to the on-ground is used as the criteria for defining valid masks: if it is lower than 0.1 db, the mask is considered valid.

According to the planning defined for the IF Calibration acquisition on cycle 91 (ref. Par. 5.2.1.1), one daily pass over the Himalaya (ascending) has been performed with the New procedure for IF calibration.
The NEW procedure consists in setting all the AGC's to 3dB before entering the IF Calibration Mode and resetting all the parameters to the original values before entering in the Measurement mode. It is operationally used since cycle 66 for all IF Calibrations and this ensures 100% of valid IF Masks to be acquired.

The number of IF Masks acquired and processed on cycle 91 was 35. As expected, all 35 IF Masks acquired were valid:

- 100 % of the acquired and processed IF masks were valid.

All the IF masks are used to generate the final IF mask used in the Level 1B ground processing; the method used for generating it consists in a monthly average according to the strategy defined in [R-18] with an editing criteria based on the comparison between each of the single IF masks and the reference one (on-ground).

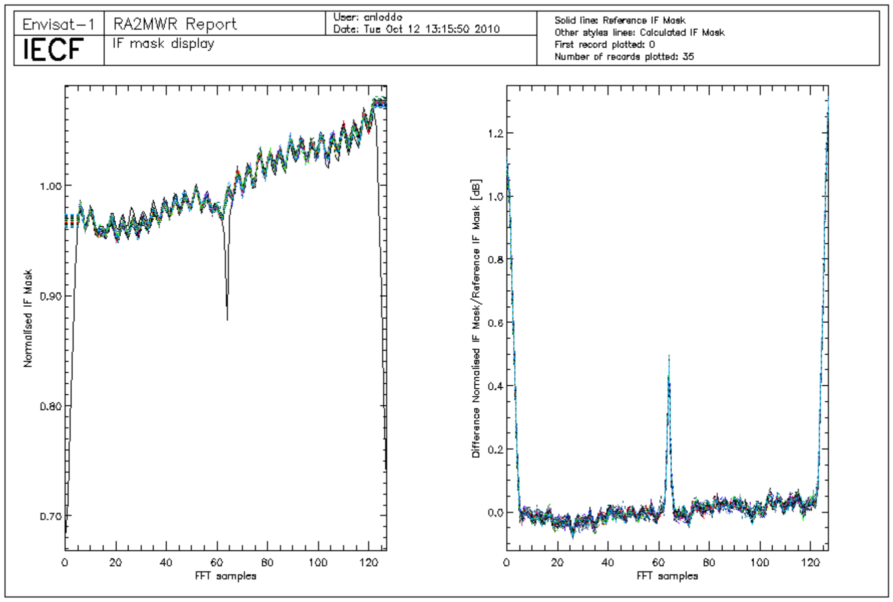

Figure 5: Valid IF masks retrieved during cycle 91 plotted together with the on-ground reference.

In Figure 6 the IF Mask, updated on the 4th October 2010 (with IF masks valid from 29th June 2010 to 28th July 2010), and the previous IF Masks used for processing are plotted.

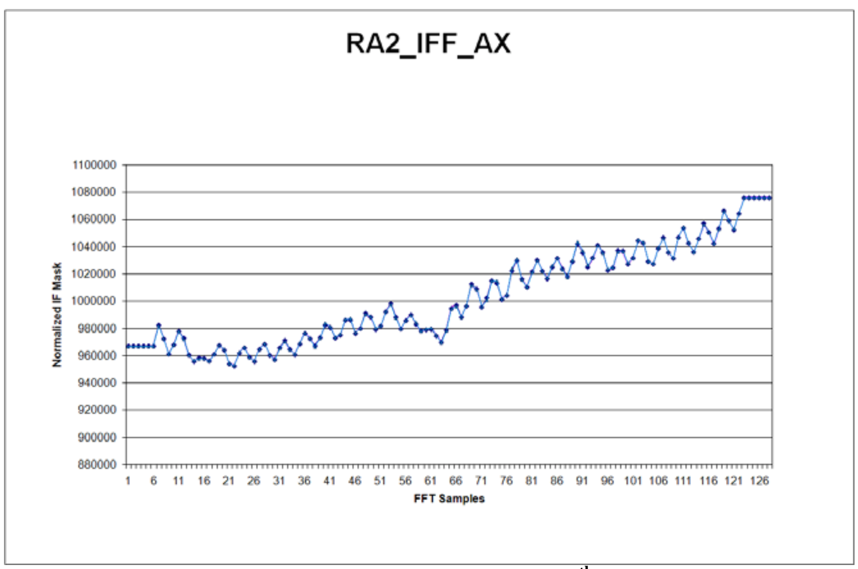

Figure 6: Previous and IF Mask updated on 4th October 2010

In Figure 7 the evolution of the IF mask quality parameters evaluated as in [R – 4] is reported only for valid data. It can be observed that the difference with respect to the on-ground reference presents an increasing trend due to the ageing of the instrument.

The differences have significantly increased since cycle 56. The masks obtained on the Rocky Mountains present a higher difference with respect to the on-ground mask. This is probably due to the fact that the calibration segments are shorter on this new site and therefore with more noise. However, the difference is always lower then 0.1 db and for this reason the masks are still valid
Some peaks are visible on the plot that correspond to the data acquired on September the 27th 2003 at 15:48, on October the 29th 2003 at 15:42, on May the 10th 2004 at 15:45, on April 9th 2006, on December 16th 2006 and on September 27th . The reason of this could be found in the instrument warming up considering that the IF Cal acquisition has been made, in the three first cases, only a couple of hours after an anomaly recovery. In the two last cases the unavailability was very long, more than two days, and the warming up effect lasted longer. The residual noise and the accuracy show a very constant behaviour over the whole period.
During the current cycle the IF Calibration Mode was nominal. The anomalous behaviour described in [R – 3] was no more present. According to the In-Flight Tests performed on cycle 62 63, 64 and 65 this problem, present since the beginning of the mission, seems to be related to the AGC used for the calibration mode.

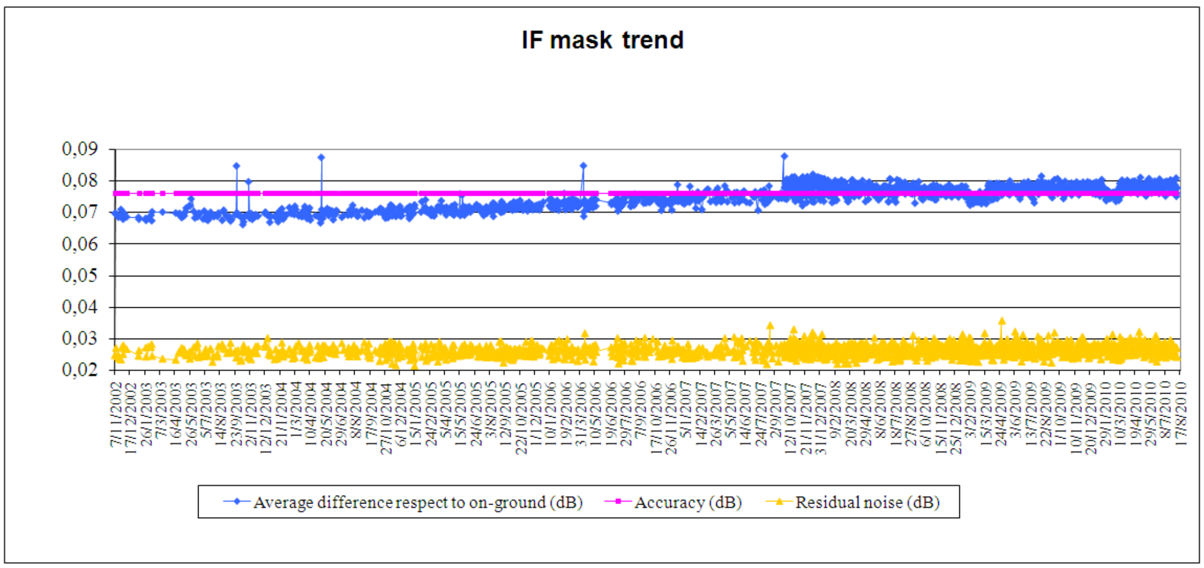

Figure 7: Evolution of the IF mask related parameters for valid IF masks retrieved up to cycle 91

In Figure 8 the percentages of valid IF masks from cycle 20 onwards is reported. This percentage is computed with reference to the acquired masks per cycle. The higher number of valid IF Masks in cycle 48 is a consequence of the special IF Calibration operations that took place on 8 and 9 June 2006 when the altimeter was on its side B. The number of valid IF Masks has decrease from cycle 56 until cycle 61. The high number of valid IF Masks in the last cycles is related to the NEW procedure for IF Calibration Mode applied from cycle 62 onwards, described at the beginning of this chapter. Starting on cycle 66, 100 % of IF Masks were valid because all IF Calibrations were performed using this new procedure.

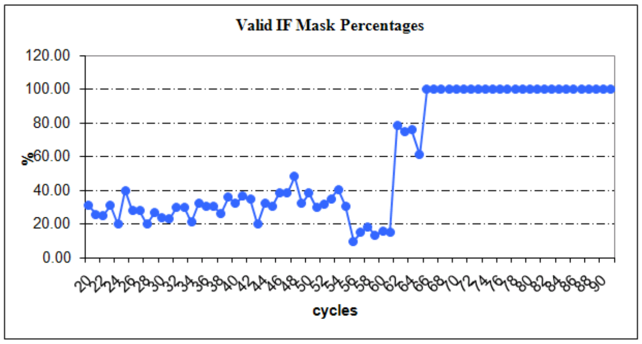

Figure 8: Percentages of valid IF Mask up to cycle 91

6.1.3 USO

The RA-2 Ultra-Stable Oscillator (USO) was nominal on cycle 91.
In Figure 9 the USO clock period trend is reported. In order to make the variability visible, the difference of the actual USO clock period with respect to the nominal one has been plotted in the upper panel. In the lower panel the Range error due to the USO clock variability has been reported taking a satellite altitude of 800 Km as a nominal value.

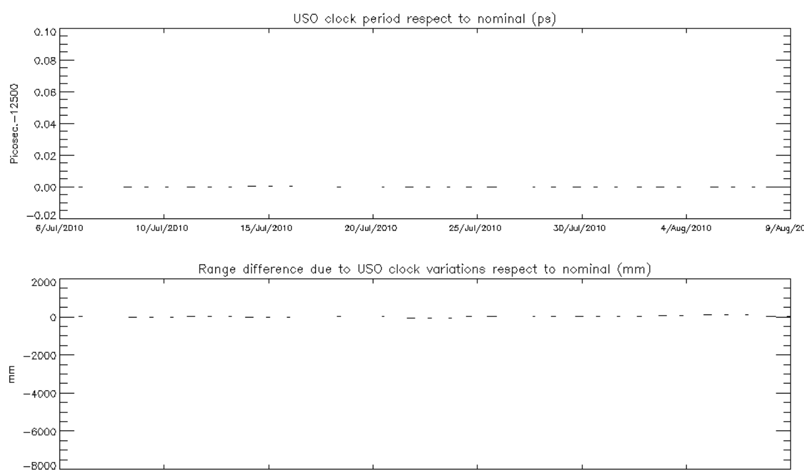

Figure 9: USO clock period (top) and range difference with nominal (bottom) for cycle 91

The USO Clock Period anomaly was almost permanently present during 2006 and 2007. It started in cycle 44, on date 1 Feb 2006 12:04:30, Orbit = 205181. It directly happened after the recovery of the RA-2 on-board anomaly which occurred on the 2006/02/01 at 05:17:56. During the anomalous period, the altimetric range jumped by several meters (about 5.6m) w.r.t. the Mean Sea Surface due to an anomaly in the USO clock period. Moreover, oscillations at the orbital period with an amplitude of 20-30 cm affect the Sea Level Anomaly making the range unusable for both Ku and S Band. The anomaly persisted intermittently until the 15th of May 2006 14:21:50, Orbit = 21994, when the instrument was configured to its RFSS B-side. It appeared again when the instrument was reconfigured to its nominal RFSS A-side on date 21 June 2006 13:20:15, Orbit = 22523. The anomaly reappeared after the instrument recovery on date 27th of September 2007 11:13:30 and disappeared again for an unknown reason on date 3rd of December 2007 03:00:00. The anomaly was back again on the 4th of December 2007 13:50:00 and it lasted until the 23rd January 2008 14:11:35, orbit nb 30840.

Note that the correction comes back to its nominal value in several steps, causing small uncertainties on the associated correction.

In Figure 10, the USO clock period trend retrieved from the beginning of the mission until the last week of cycle 49 is reported. In Figure 10A, the USO clock period trend retrieved from cycle 50 onwards is reported. The actual value of the USO clock period has been used within the L1b processing; only from the 24th of October 2005 (IPF V5.02) until the 1st of February 2006. This means that, during this period, the data are corrected for the bias and the drift correlated to the actual USO clock period. The evaluation of the actual USO clock period in this period was performed off-line respect to the IPF processing and it was updated once per week in the auxiliary file RA2_USO_AX. The method to correct the data from the USO period changes outside of this period is detailed in Part 7.2.6.

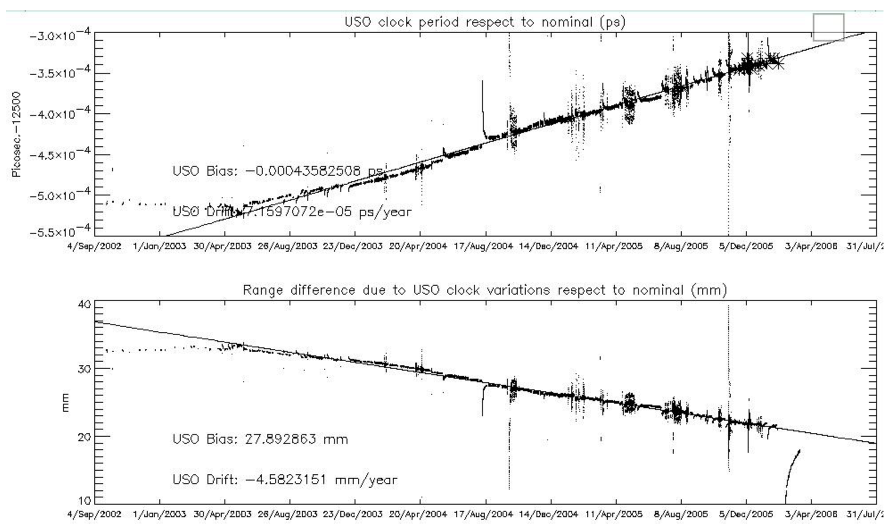

Figure 10: USO clock period (top) and associated range difference (bottom) until cycle 49

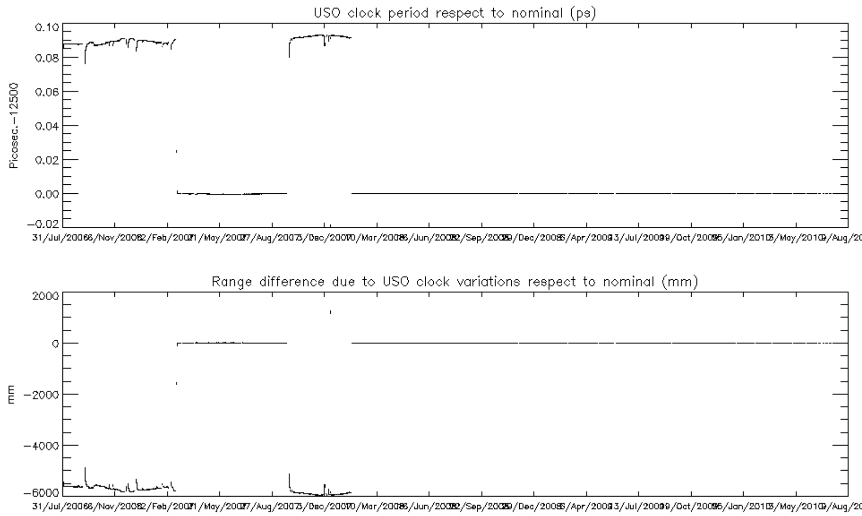

Figure 10A: USO clock period (top) and associated range difference (bottom) from cycle 50 onwards

6.1.4 DATATION

A significant part of an eventual error in the RA-2 products datation could result from imperfect synchronisation between the Satellite Binary Time and the UTC Time due to a drift of the ICU clock period. A correlation between those two times is performed at every Kiruna orbit dump and then extrapolated for the four non-Kiruna orbits. In the upper panel of Figure 11, the differences between the extrapolated UTC values and the corresponding real UTC values measured at the next Kiruna dump, are reported. In the lower panel, the ICU clock step for the same period is shown.

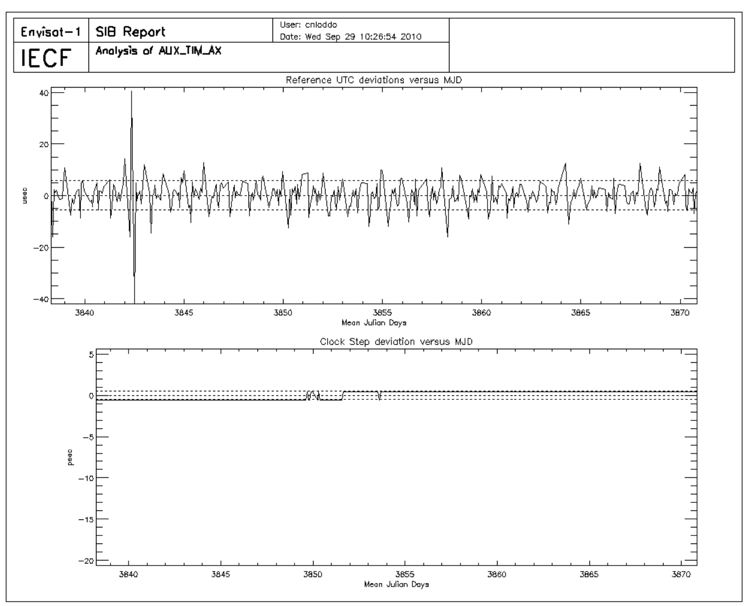

Figure 11: UTC deviations and ICU clock period for cycle 91

In Figure 12 (upper panel) the differences between the extrapolated UTC values and the corresponding real UTC values measured at the next Kiruna dump, are reported for data up to cycle 32. The UTC deviations for cycle 33 onwards reported in Figure 13.

Only a few anomalous events can be observed at the beginning of the period (cycles 16/17) for which the difference rises above the 20 microseconds warning threshold. However, starting from cycles 22/23, the number of small differences (10 microseconds plus or minus) has increased a lot. Furthermore, during the last ten days of the cycle 32 and for all cycle 33 and 34, the variability of the deviations has increased reporting many peaks just over the 20 microseconds threshold (first part of Figure 12); this phenomenon is now fixed. In the lower panel of both figures the ICU clock step for the same period is shown where big variations are reported. The jump observed around MJD 2288 (07-APR-2006) on Figure 13 is related to the reconfiguration of the Precise Time Correlation process, which became blocked with invalid data after the Service Module anomaly and reconfiguration occurred on 6 April 2006. This is however not a problem because the ICU clock period variations are included in the algorithm for the SBT/UTC correlation evaluation.

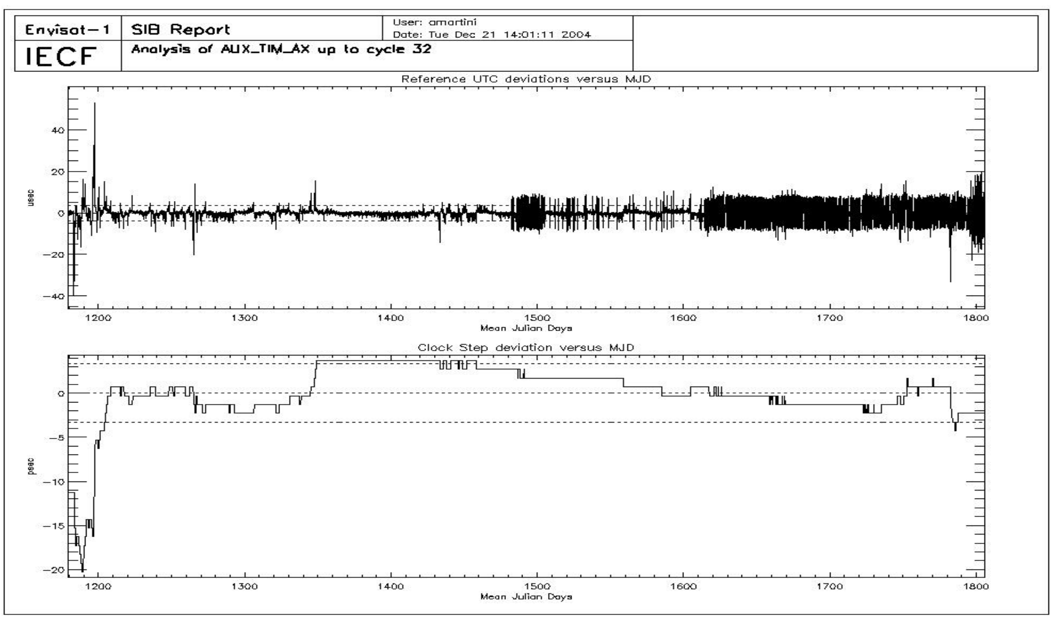

Figure 12: UTC deviations and ICU clock period up to cycle 32

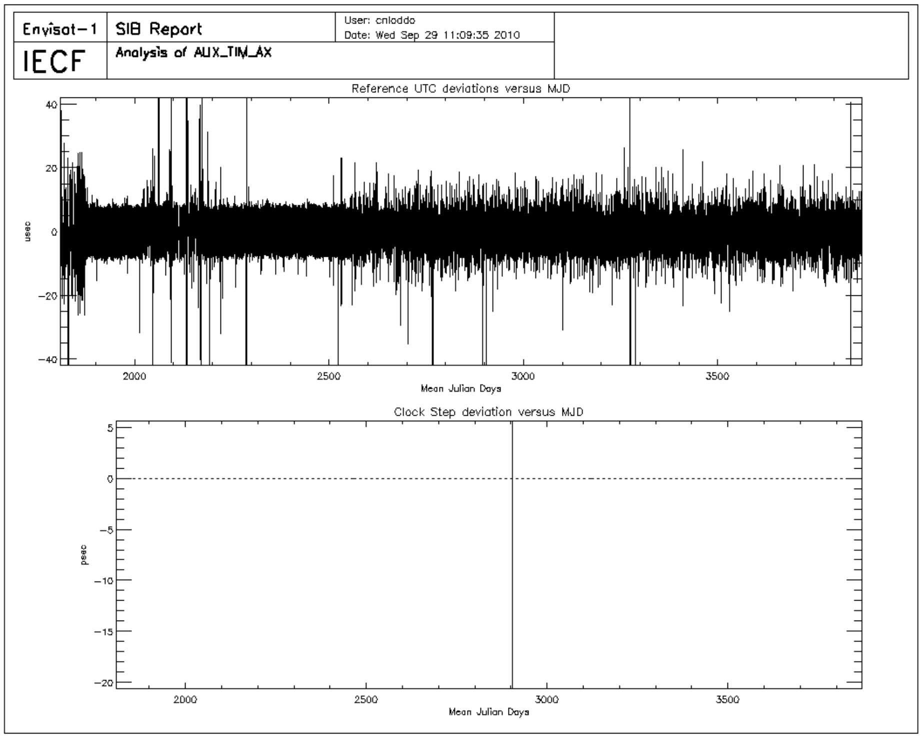

Figure 13: UTC deviations and ICU clock period from cycle 33 onwards

6.1.5 IN-FLIGHT INTERNAL CALIBRATION

The RA-2 Range and Sigma0 measurements are corrected to take into account the internal path delay and attenuation, respectively. This is done by measuring those two variables in relation to the internal Point Target Response. The two correction factors are calculated during the L1b processing and directly applied. They are also continuously monitored and the results for the current cycle (averaged per day) are reported in the next figures. The correction factors on S Band are no more being monitored from cycle 65 onwards due to the lost of the S-band transmission power, occurred on 17 January 2008, 23:23:40 (orbit 30759), see section 7.2.1.

The Ku Band Time delay in-flight calibration factor, reported in Figure 14, shows a regular behaviour as observed on previous cycles.

The Ku band Sigma0 calibration factor, reported in red in Figure15, is nominal even if with negative values slowly decreasing.

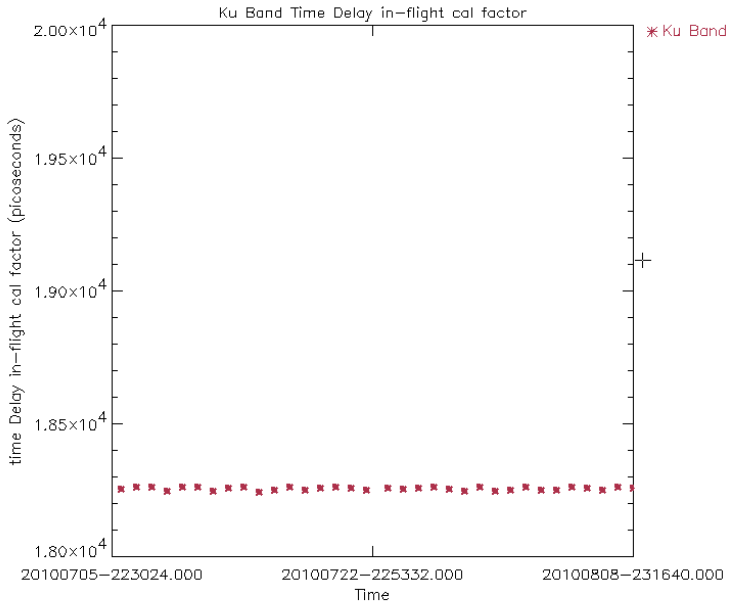

Figure 14: Ku Band in-flight time delay calibration factor for cycle 91 (averaged per day)

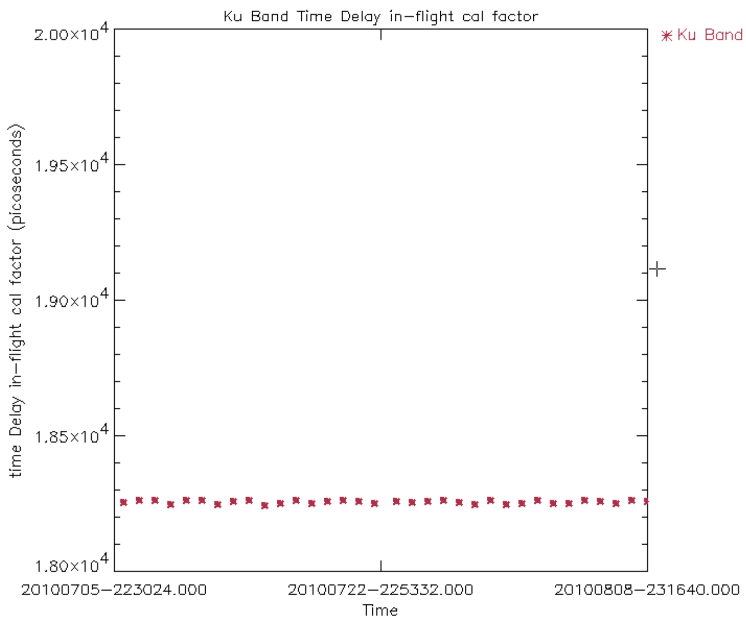

Figure 15: Ku Band in-flight Sigma0 calibration factor for cycle 91 (averaged per day)

Figure 16, Figure 16A, Figure 17 and Figure 17A report Ku and S Band in-flight calibration factors for Time Delay and Sigma0 respectively, daily averaged, up to the current cycle. The Time Delay factor is shown to be very stable for both the working frequencies. The Ku band Sigma0 factor reveals a decrease of about 0.5 dBs over the period starting from cycle 16. As this instability is quite small, it is not being considered a problem for the moment, since the calibration factor is

indeed introduced especially to correct for eventual instrumental changes. However, special attention is kept on the monitoring of this parameter. The jump observed on the last part of the plot is related to the period on which the instrument sub-system Radio Frequency Module (RFM) was switched to its B-side, occurred between 15 May and 21 June 2006.
Since Cycle 72 (2 October 2008) the Time Delay and Sigma 0 in-flight calibration factors have exhibited a wide range of variability. However, no impact has been observed on science data. Starting from Cycle 86 (2nd February 2010) a small decrease is visible in the Ku Band Time delay in-flight calibration factor (Figure 16A), due to the new PTR computation in the IPF v6.02L04.

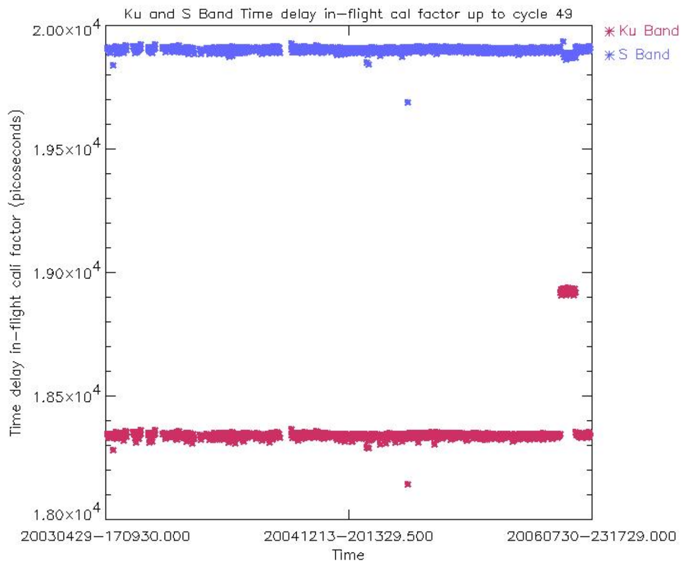

Figure 16: Ku and S Band in-flight time delay calibration factor up to cycle 49 (averaged per day)

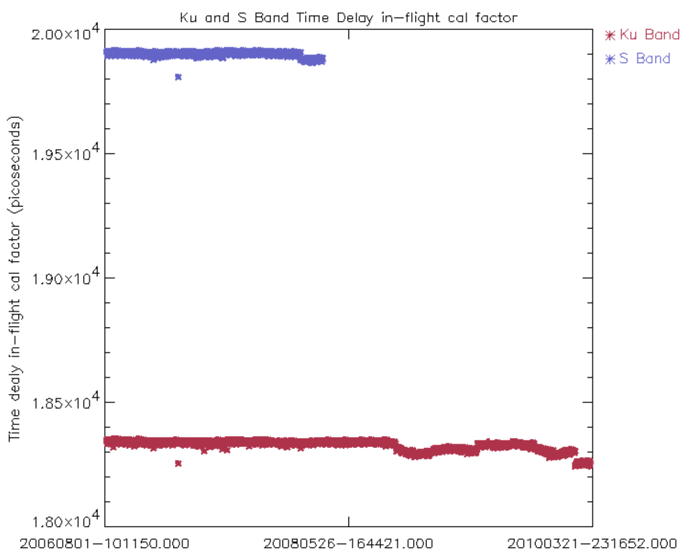

Figure 16A: Ku and S Band in-flight time delay calibration factor from cycle 50 to cycle 87 (averaged per day)

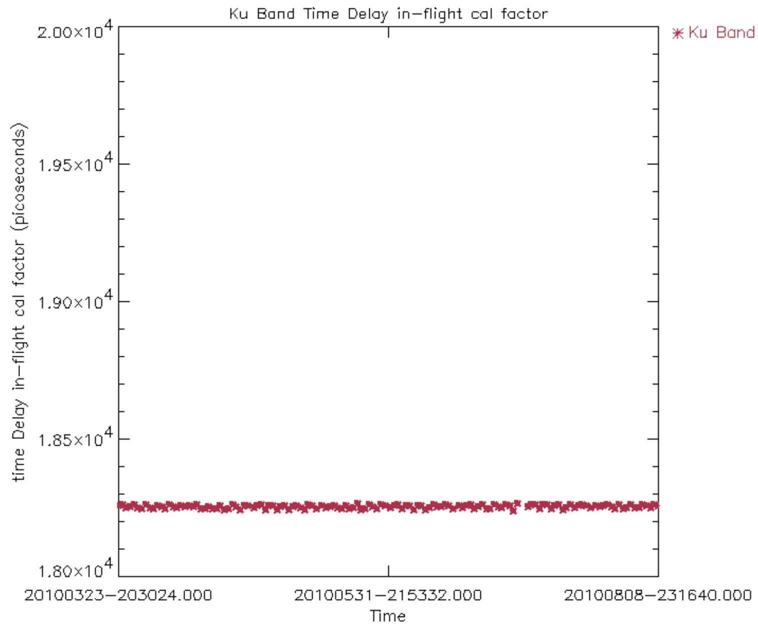

Figure 16B: Ku Band in-flight time delay calibration factor from cycle 88 onwards (averaged per day)

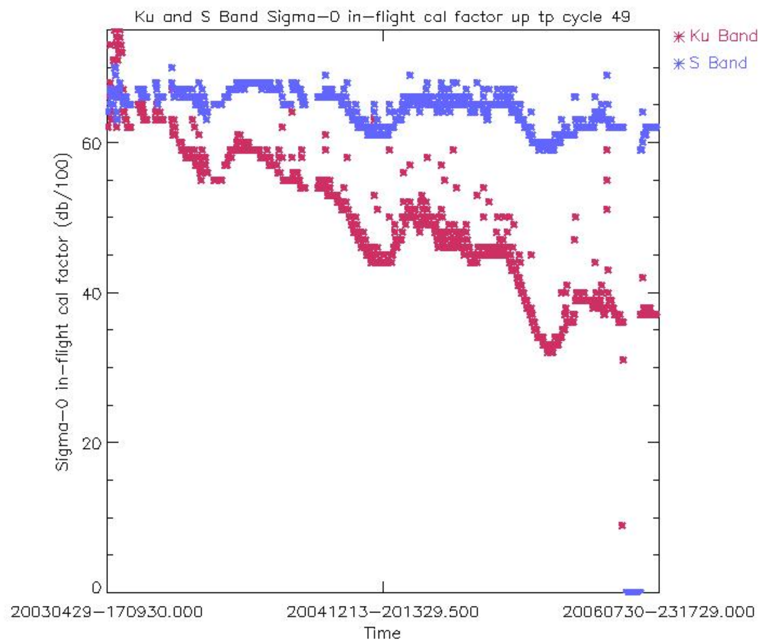

Figure 17: Ku and S Band in-flight Sigma0 calibration factor up to cycle 49 (averaged per day)

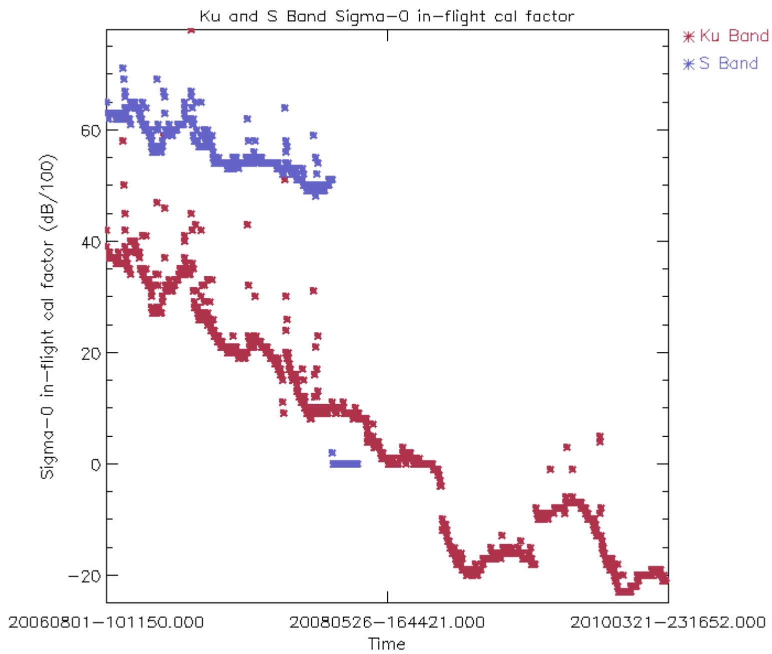

Figure 17A: Ku and S Band in-flight Sigma0 calibration factor from cycle 50 to cycle 87 (averaged per day)

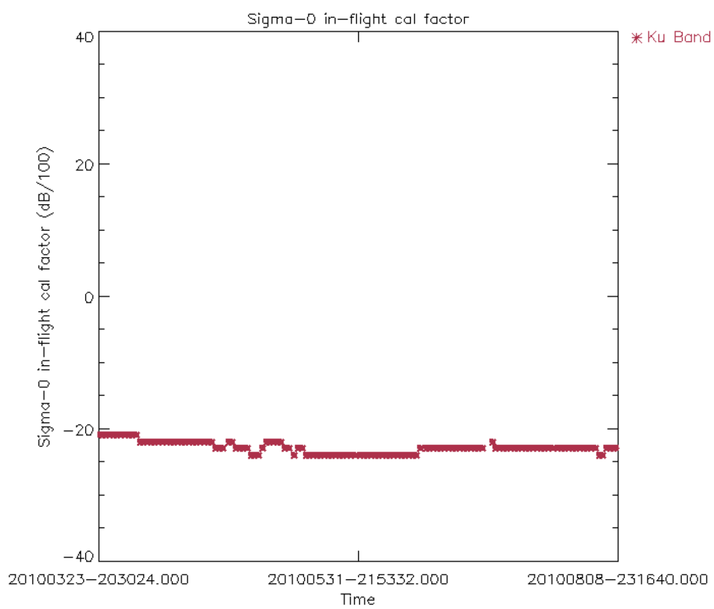

Figure 17B: Ku and S Band in-flight Sigma0 calibration factor from cycle 88 onwards (averaged per day)

6.1.6 SIGMA0 TRANSPONDER

The σ° absolute calibration of the RA-2 is performed using a reference target given by a transponder that has been developed at ESTEC. This has been exploited during the 6 month Commissioning phase to generate early calibration results. In order to consolidate the calibration results and to monitor the RA-2 calibration of σ° during the Envisat lifetime, continual monitoring is accomplished by operating the transponder for as many Envisat overpasses as possible.
Since the 11th of October 2005 the transponder has been moved to a permanent site located in Rome.
The acquisition planned for the 18th May 2010 has been performed and the results are listed in the table here below.

Absolute Orbit nb	Date of Measurement	Location / Rel. track	RA-2 resolution	Transponder Bias [dB]	ECMWF Wet Tropo. Corr. [dB]
43956	27-Jul-2010	Perm site Rome/315	High	0.74	0.0837

Appendix 4 reports the transponder measurements from cycle 24 onwards.
The mean value of the estimated bias at High Resolution is 1.00 dB with a standard deviation of 0.09 dB. It is possible to notice that the Low Resolution measurements are coherent among themselves but there is a bias with respect to the High Resolution ones. This is due to a processing problem with the internal calibration factor not taken into account in Low Resolution Mode.

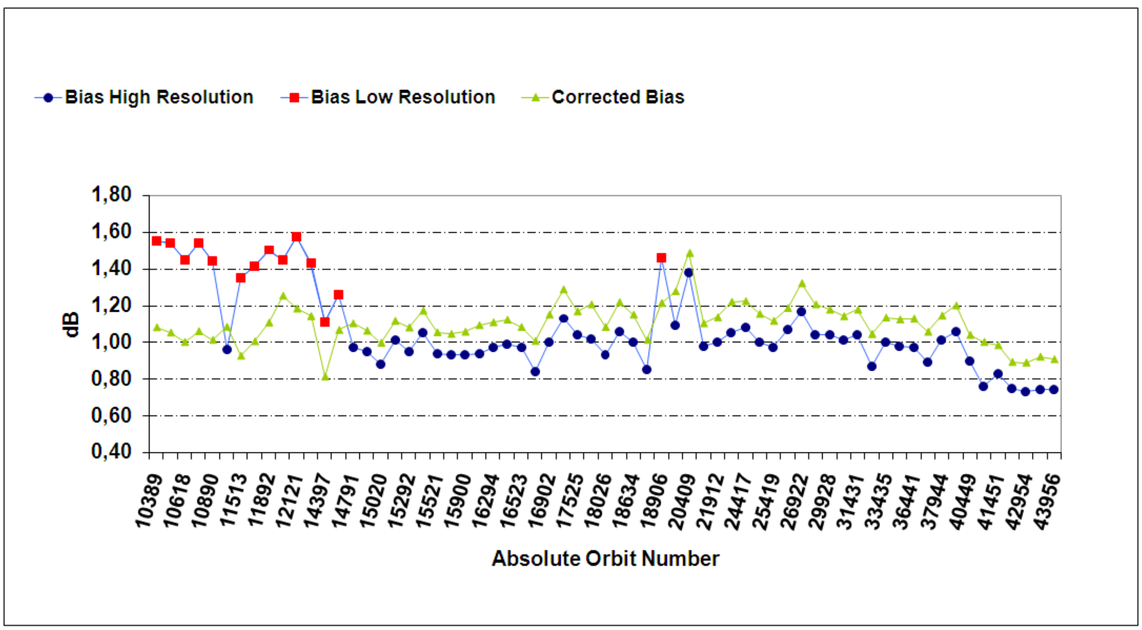

Figure 18: Time behaviour of the transponder bias

In Figure 18, the time behaviour of the bias is plotted for both Low and High Resolution. The green line represents the corrected bias for the internal calibration factor (only for the Low

Resolution data) and the tropospheric attenuation. The latter is estimated by using the ECMWF meteorological data. The low value of the corrected bias for the orbit 14397 is due to the dew air condition and a probable underestimation of the tropo-attenuation.

6.1.7 MISPOINTING

In Figure 19, the trend of the mispointing squared (averaged every orbit) is reported in deg^2*10e-4.
The average squared mispointing value, as extracted from the FDGDR data products, has decreased from about 0.028 deg^2, to 0.0075 deg^2. This is due to the new algorithm currently used to retrieve the mispointing value from the RA-2 waveform data, see section 5.5.1.1.
Since IPF version 5.02, the mispointing is estimated through the waveform trailing edge slope using an optimum and fixed gate and no longer an adaptive window as defined previously. This allows avoidance of the filter bump effect that leads to high values of the mispointing.

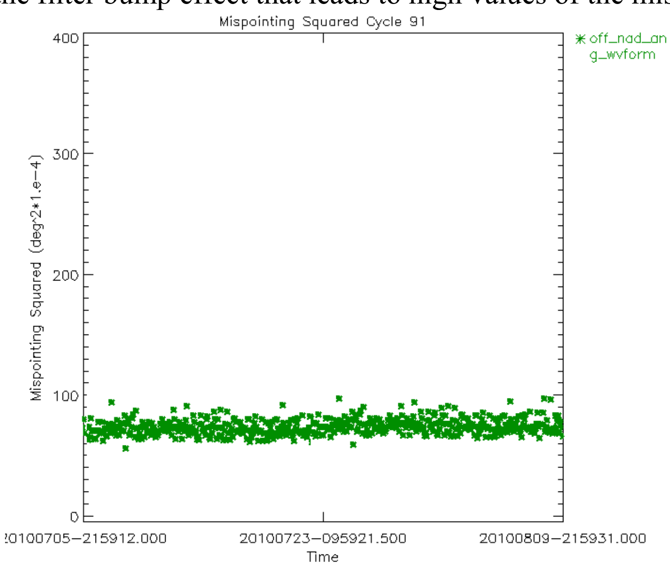

Figure 19: Smoothed mispointing squared trend for cycle 91 (deg^2*10^-4)

In Figures 20, 20A, and 20B the overall mispointing squared trend (averaged over each orbit) is plotted from cycle 16 onwards.
The low values at the end of the first plot are related to the acquisition in RFFS B-Side, occurred between 15 May and 21 June 2006.
The jump which occurred on date October 24th is related to the upload of IPF version 5.02. The abrupt decreasing of the mispointing squared value is related to the new algorithm, as described in the previous paragraph.
The jump which occurred on November the 26th 2003 is correlated to the upload of IPF version 4.56; the abrupt decrease of the mispointing squared value is due to the usage of a new RA2_IFF_AX IF mask auxiliary file. After the drop a very tiny increase of the mispointing squared could eventually be detectable. The most probable cause of this phenomenon could be a

change in the Intermediate Frequency Filter slope due to ageing effects. For this reason, the RA2_IFF_AX will be updated regularly, once per month.

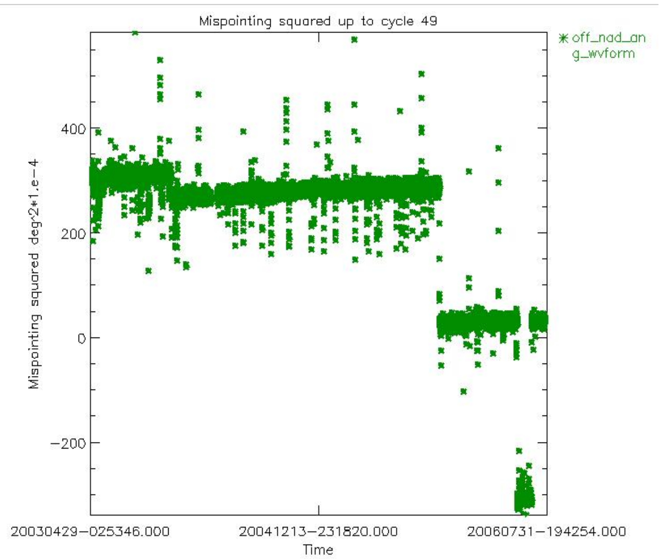

Figure 20: Smoothed mispointing squared trend until end of cycle 49 (deg^2*10e-4)

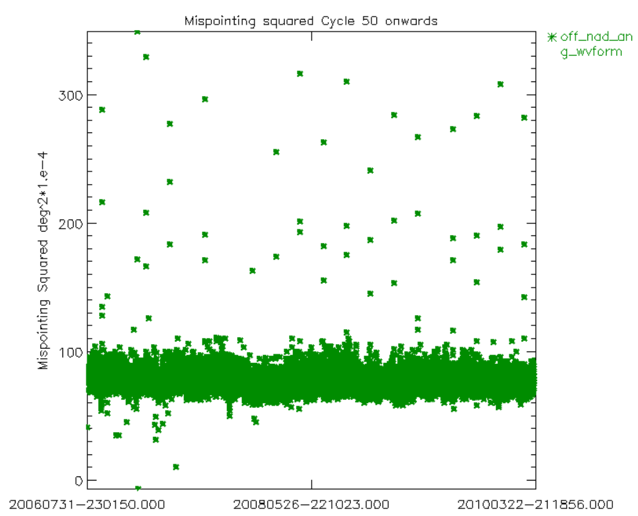

Figure 20A: Smoothed mispointing squared trend from cycle 50 to cycle 87 (deg^2*10e-4)

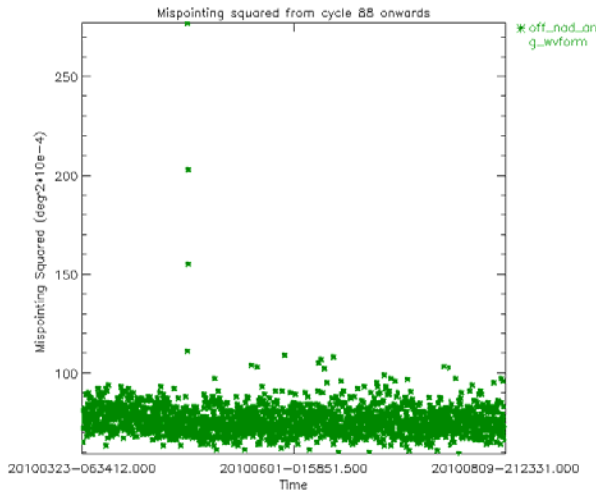

Figure 20B: Smoothed mispointing squared trend from cycle 88 onwards (deg^2*10e-4)

It can be noticed that the mispointing squared assumes lower values just after an instrument anomaly, showing an increasing trend until it reaches a standard mispointing value.
This problem has been reduced with the introduction of the updated mispointing retrieval algorithm as described in the previous paragraph.
This particular behaviour has always been explained by the different shape that the over-ocean average waveform has before and after an anomalous event as visible in Figure 21, i.e. the disappearance of the small dip in the waveforms acquired after the anomaly. Since the new strategy of updating once per month the RA2_IFF_AX file, the small bump is not present anymore in the waveforms, see Figure 21_A, so a new explanation is currently under investigation.

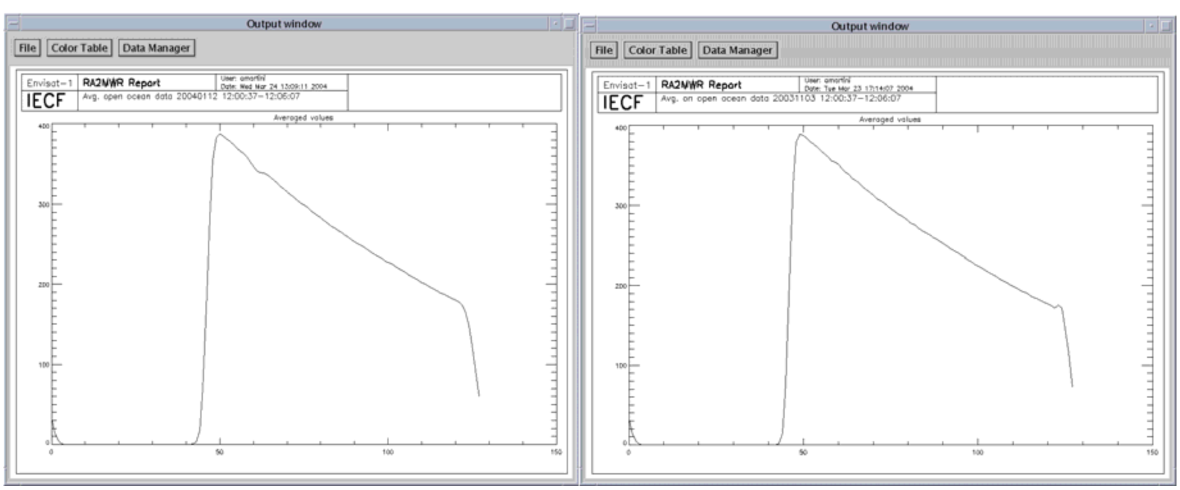

Figure 21: Open Ocean average waveforms before (left) and after an anomaly (right)

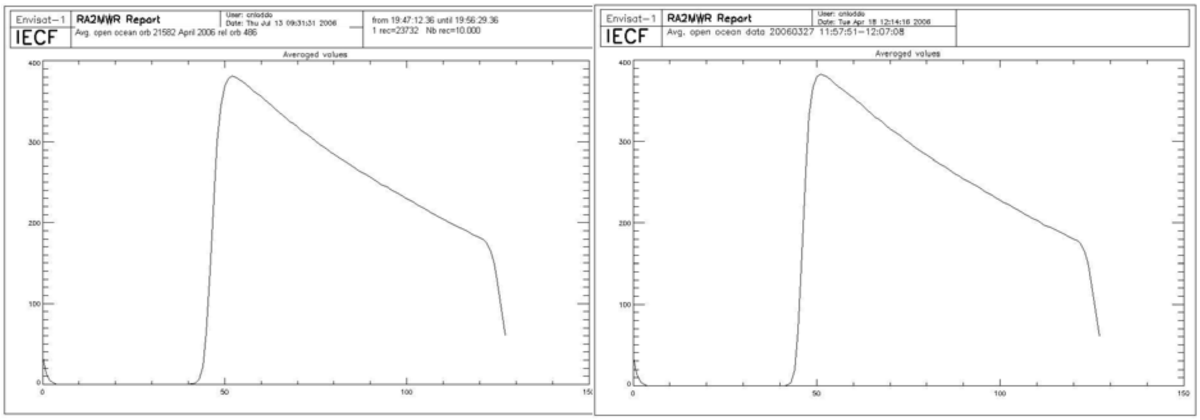

Figure 21_A: Open Ocean average waveforms before (left) and after an anomaly (right)

6.1.8 S-BAND ANOMALY

Due to the S Band Transmission failure occurred on cycle 65, on 17 January 2008, the S Band parameters are no more relevant. The S Band Anomaly, which consists in the accumulation of the S-Band echo waveforms, are therefore no more present. For this reason, the plot on Figure 22 will no more be updated.

The Patch that prevents the S Band Anomaly by correcting the SW/HW malfunctioning has been successfully uploaded on 27th of June. The Patch has been uploaded for the first time on 16th of January 2007, but it has been dismissed on 9th of April because it was causing the Instrument to switch down to Heater 0/Refuse Mode. An investigation has been carried out and some parameter monitoring thresholds causing the instrument to switch down have been modified.

The method used for the identification of the “S-Band anomaly” is statistical and requires a minimum of 1000 seconds of data over ocean. This choice is supported by the fact that the “S-Band anomaly” is associated with a particular instrumental behaviour that cannot appear and disappear within a short time frame. (ref. [R – 7])
A valuable algorithm to detect the RA-2 DSRs affected by the S-Band anomaly within the L2 products can be found in [R- 12]. Note that the algorithm is only valid for data acquired over open-ocean.
The IPF version 5.03 includes an algorithm that can detect the presence of the so-called “S-Band anomaly” over any surface. In case of S-Band anomaly detection, bit 1 of the L1b products MCD is set to one; the anomaly is properly detected in 99.9% of the cases.

In Figure 22, the percentage of data per cycle that are affected by the so-called “S-Band” anomaly is reported. The figures are variable between 0% and 8.1%.
The number of occurrences of the S Band anomaly decreased from a mean value of 4% to 2% from cycle 31 onwards due to the implementation of the IF CAL procedure (including Heater 2 for S Band anomaly suppression) twice per day over the Himalayan region.

The relatively high value recorded for cycle 27 is due to the fact that on the day 1st of June 2004, the S-band anomaly started at around 14:30 while the instrument didn't switch to mode Heater 2 when foreseen (at about 15:50). For this reason the S-Band anomaly continued for the next 24 hours until the next Heater 2 mode on June the 2nd.

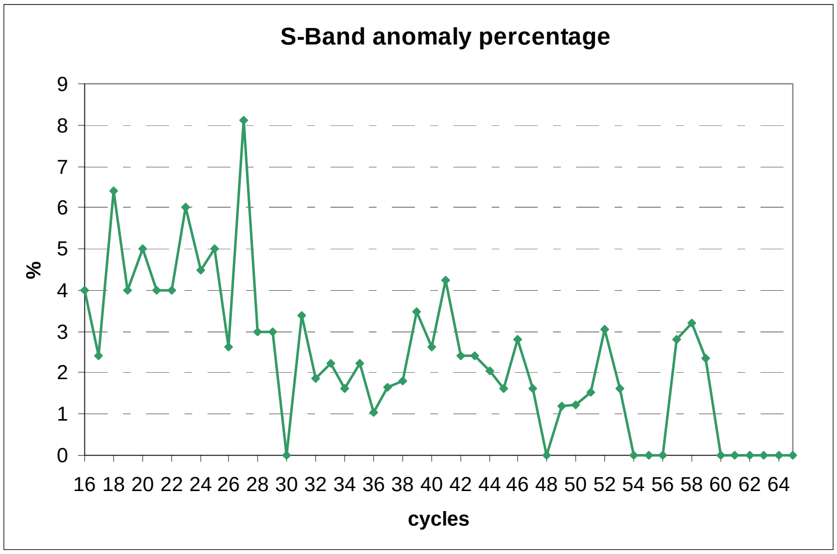

Figure 22: Percentage of data affected by the "S-Band Anomaly" for cycles 16 up to cycle 65

6.2 *MWR Performance*

For MWR performances please refer to the Reference CLS Cyclic Report of the type of [R – 2].

6.3 *DORIS Performance*

For DORIS performances please refer to the Reference F-PAC Monthly Report of the type of [R – 1a] and [R-1b].

7 PRODUCT PERFORMANCE

7.1 *Product disclaimer*

A summary of the products released to users and disclaimers on product quality have been established for some products and are available in the following web link: http://envisat.esa.int/dataproducts/availability/

7.2 Data handling recommendations

7.2.1 S BAND POWER DROP

Ten hours after the recovery of the HSM anomaly on the 17 January 2008, a drop of the RA2 S-band transmission power occurred. The drop occurred in the South Atlantic Anomaly, showing similar characteristics as for the RA-2 RFSS Side B S-band power drop anomaly occurred in May 2006.

Consequently, all the S-band parameters, as well as the dual ionospheric correction are not relevant and MUST NOT be used from the following date: 17 January 2008, 23:23:40, UTC, orbit nb 30759.

Users are advised to use the Ionospheric correction from Bent model, which is available in FGDR data products:

FGDR *(Ionospheric correction from model on Ku-band: field #47)*

Investigations have been conducted and the failure of the S Band power stage is considered to be permanent.

7.2.2 SEA-ICE FLAG

The following algorithm is proposed for the determination of a sea-ice flag, presently missing in the Level 2 Ra-2 and MWR data products. (See [R – 14]):

|Latitude *(lat: field#4 of L2 data)*| >50 deg
AND
The number of 20Hz valid data *(num_18hz_ku_ocean: field#23 of L2 data)* < 17
OR
|MWR Wet Tropospheric Correction *(mwr_wet_tropo_corr: field#42 of L2 data)*–ECMWF Wet Tropospheric Correction *(mod_wet_tropo_corr: field#42 of L2 data)*| > 10 cm
OR
Peakiness *(Ku_peak: field#139 of L2 data)* >2

7.2.3 OCEAN S-BAND ANOMALIES DETECTION

A valuable algorithm to detect the Level 2 DSR affected by the RA-2 S-Band anomaly is proposed in [R- 12].

7.2.4 WARNING ON IPF 4.56 VERSION IDENTIFICATION FIELD

All RA-2 and MWR level 1B and NRT Level 2 products generated after November 26, 2003 report a software version as being 4.54 (available in MPH field 8).

Nevertheless those products have been generated with the IPF V4.56 operational since November 26, 2003. The first nominal generated product, using the new SW version, will be the one relevant to the absolute orbit number 9094.
The software version ID is correct since December 4, 2003.

7.2.5 S-BAND BACKSCATTERING COEFFICIENT

For the data processed with IPF version 4.56 on, the S-Band Backscattering coefficient has been demonstrated to be on average about 0.65 dBs higher than for the previous versions of the processor. This is due to the algorithm used for the retrieval of the AGC in S-Band, corrected in IPF version 4.56 to be closer to the real functioning of the instrument.

An average value of 0.65 dBs is suggested to be added to the old software versions S-Band Sigma0 in order to be in line with the new IPF V4.56 version.

7.2.6 USO RANGE CORRECTION

Four different periods can be distinguished:

1st period
From the beginning of the mission until the 24th of October 2005 the Nominal USO clock period has been used in the processing. The data was not corrected for the bias and the drift correlated to the actual USO clock period. All data acquired before 24th October 2005, beginning of cycle 42, have thus to be corrected using the old correction files available on the web site:
http://earth.esa.int/pcs/envisat/ra2/auxdata/OldCorrection.html.
The measured Range shall be corrected considering a drift of -4.58 mm per year and a bias of 29.6 mm.
Warning for data acquired before cycle 42: bias and drift have to be **SUBTRACTED** from the original altimetric range, according to the following equation:
Rtrue=Roriginal-dR
where Roriginal is the range in the GDR products and Rtrue is the true (corrected) range.

2nd period
From the 24th of October 2005 until the 13th of March 2006, outside of the anomaly periods, the actual USO clock period has been used within the processing. The data was corrected for the bias and the drift correlated to the actual USO clock period. Those values, translated into altimetric range figures, are respectively of 28.5 mm and –4.58 mm/year as calculated with data covering the period 13 June 2003 to 01 February 2006.

3rd period
From the 13th of March 2006 to 2nd February 2010, and during the early occurrences of the USO anomaly, data have not been corrected with the proper value of the USO Clock period. All data

acquired during this period have thus to be corrected using the new correction files. Three USO corrections have been developed for the different Envisat Level 2 altimetry data products for correcting the abnormal RA-2 USO behaviour affecting the Altimetric Range by few meters w.r.t. the Mean Sea Surface:

- A NRT orbit based USO correction for FDGDR products , available from `http://earth.esa.int/pcs/envisat/ra2/auxdata/NewCorrection.html`; or `ftp://ftp.esrin.esa.it/pub/RA2_MWR/USO/auxdata/`
- An Interim daily USO correction for IGDR products, available at the same F-PAC location as for IGDR, in the directory igdr_ous_corr
- An OFL cycle USO correction for GDR products, available at the same F-PAC location as for GDR, in the directory gdr_ous_corr.

Warning for data acquired after 1st February 2006: This correction has to be **ADDED** to the Ku and S Band altimetric range.

The USO smoothing factor of the NRT USO Correction Tool for periods of NO-USO anomaly was updated from $90*10^{-6}$ ps to $120*10^{-6}$ ps on 12:00 on 28th November 2008 .

A software routine has been developed to allow users to insert the RA-2 Ultra-Stable Oscillator (USO) corrections into Envisat Level 2 altimetry data products and is available in the same web site than the correction files.

> **WARNING: Users are still advised to apply the correction auxiliary files even during the non-anomalous period in order to correct for the nominal ageing drift of the USO device.**

4th period

From 2nd February 2010 the Ultra Stable Oscillator (USO) clock period correction is included in the RA-2 product and already applied. For this reason, the external USO clock period correction shall not be applied anymore to the RA-2 products starting from absolute orbit #41443 and the generation of the USO correction files was stopped.

7.2.7 KU-BAND BACKSCATTERING COEFFICIENT CALIBRATION

The results of the Ku-Band Sigma0 absolute calibration performed with a transponder have been presented in par. 6.1.4. Those results are going to be consolidated and are summarized in appendix 4, table 18. In order to absolutely calibrate the backscattering coefficient given in the RA2 L2 products, the following shall be used by the end user to get to the real Sigma0 measurement:

Sigma_0_true = Sigma_0_prod + G_tx_rx_prod - G_tx_rx_real - Bias [dB]

Where:
Bias: Bias retrieved from the Sigma0 Absolute Calibration (see 6.1.5)

G_tx_rx_prod: Current effective Tx-Rx Gain value used in the operational ground processing chain (ADF file RA2_CHD_AX). The value nominally used since IPF V4.54 is (for configuration RFSS=A and HPA=A) is 170.70 dB

G_tx_rx_real: Pre-launch characterization value (configuration value RFSS=A and HPA=A is 167.46 dB)

7.2.8 RA-2 RADIO FREQUENCY MODULE SWITCHED BACK TO A-SIDE

The Envisat RA-2 sensor has been successfully reconfigured on its nominal side (RFSS A-side) and was commanded back into Measurement Mode on June 21, 2006 at 13.20.15.000 UTC time, Orbit = 22523 after a switch to RFSS B-Side on 15 May at 14:21:50 UTC Orbit=21994
The analysis of the RA-2 data shows an expected behaviour of the RA-2 parameters but also confirmed the persistence of the abnormal RA-2 Ultra-Stable Oscillator (USO) behaviour affecting the Altimetric Range by few meters.

Data from 15 May 2006 until 21 June 2006 was acquired with RFSS B-side and on-ground data processing has been performed with ADFs configured for A-side. For this reason data should be used with maximum care.

7.3 Availability of data

7.3.1 RA-2

In Figure 23 and Table 9 (Appendix 2) the summary of unavailable RA2 L0 products is given.

Figure 23: RA-2 L0 unavailable products for cycle 91

It is easy to notice that close to the Himalaya region two small gaps are present per pass, one of about 77/80 seconds and another of about 10 seconds. This is due to the daily instrument switch-offs (Heater 2 mode) performed as part of the IF calibration commands sequence.
Another recurrent gap of around 179-180 seconds is due to an instrument anomaly under investigation. It occurred 6 times on cycle 89.

In Figure 24 and Table 11 (Appendix 2) the summary of unavailable RA2 L1b products is given. Starting from cycle 65, the reported gaps, both in the map and table, are related to the RA2 L0 products and not to the Mission Planning. No gaps are observed for cycle 89.

Figure 24: RA-2 L1b unavailable (with respect to RA2 L0) products for cycle 91

Hereafter the percentage of the different levels of products availability is reported.
Since cycle 66 the situation is improved for all levels of products. The low percentage of data from cycles 56 to 59 was due to the high number of occurrences of RA-2 Instrument unavailability which occurred as a side effect of the SPSA Patch uploaded to prevent the S Band anomaly.
An improvement can be observed on the data coverage since cycle 69. Two separate occurrences of instrument unavailability occurred in cycles 78 and 79, resulting in the reduction seen in figure 25. For cycle 83 and 84 data availability is slightly lower than instrument availability due to ARTEMIS and ESRIN antenna failures.

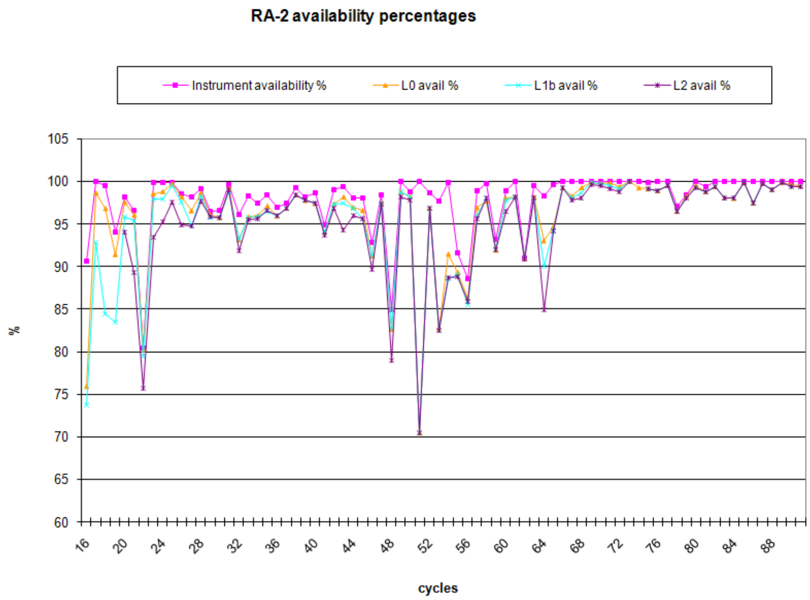

Figure 25: Percentage of Products unavailability

7.3.2 MWR

In Figure 26 and Table 10 (Appendix 2) the summary of unavailable MWR L0 products is given. Small gaps of 24 s can be seen on cycle 91.

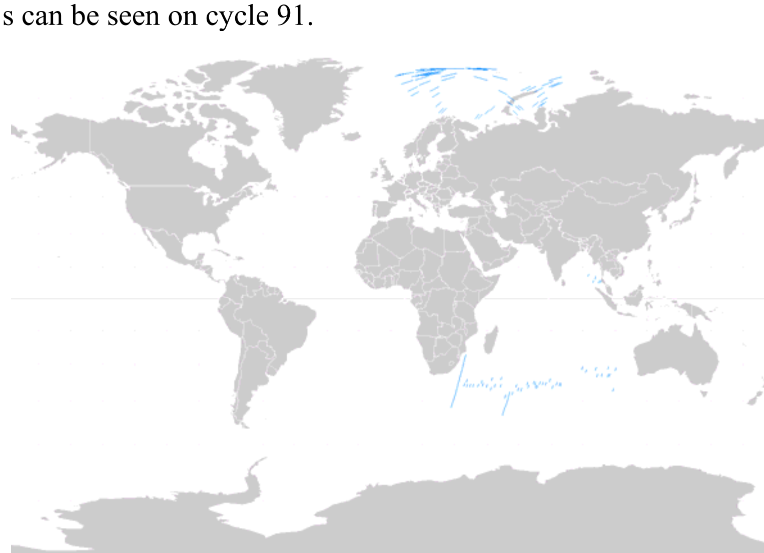

Figure 26: MWR L0 unavailable products for cycle 91

7.4 RA-2 Altimeter Parameters

Hereafter a summary of the main altimetric parameters performances is reported; these results have been obtained using only ocean surface type for the NRT product type, FDGDR.

7.4.1 ORBIT

Since the 20th of June 2007, operations date of IPF version 5.06, the DORIS Navigator data usage within the NRT processing has increased and it is now being nominally used for 99% of the products. On Table 3 the filenames of the FDGDR products processed without DORIS Navigator on the current cycle are reported. . During the reporting cycle 42 FDGDR products have been processed without DORIS Navigator. This generally occurs when short products (~600 seconds) are processed (in Cycle 91, 14 products). On 28th July 2010 some products processed in ESRIN station have been generated without the DORIS navigator file due to an anomaly in the processing station.

The usage of the DORIS Navigator data within the NRT processing increases the quality of the FDGDR SLA, leading to a SLA variability of about 50 cm (to be compared to 20 m when using predicted orbital information).

FDGDR
RA2_FGD_2PNPDK20100707_160538_00005962091_00026_43667_1895.N1
RA2_FGD_2PNPDK20100709_164253_00005902091_00055_43696_2525.N1
RA2_FGD_2PNPDK20100717_155141_00005772091_00169_43810_5627.N1
RA2_FGD_2PNPDE20100720_050234_000060552091_00205_43846_0501.N1
RA2_FGD_2PNPDE20100721_013424_000045352091_00217_43858_0525.N1
RA2_FGD_2PNPDK20100722_163501_000005292091_00241_43882_7510.N1
RA2_FGD_2PNPDK20100723_160253_000006242091_00255_43896_7835.N1
RA2_FGD_2PNPDE20100724_214934_000061592091_00272_43913_8813.N1
RA2_FGD_2PNPDK20100725_164024_000005382091_00284_43925_8489.N1
RA2_FGD_2PNPDK20100726_160828_000005842091_00298_43939_8958.N1
RA2_FGD_2PNPDE20100728_011708_000001242091_00317_43958_0502.N1
RA2_FGD_2PNPDE20100728_014957_000076392091_00318_43959_6169.N1
RA2_FGD_2PNPDK20100728_164525_000005572091_00327_43968_9690.N1
RA2_FGD_2PNPDK20100803_151715_000007032091_00412_44053_1873.N1
RA2_FGD_2PNPDE20100804_005204_000003722091_00417_44058_2103.N1
RA2_FGD_2PNPDK20100807_163205_000005362091_00470_44111_3355.N1
RA2_FGD_2PNPDK20100808_160006_000006032091_00484_44125_4066.N1
RA2_FGD_2PNPDK20100809_152904_000006132091_00498_44139_4314.N1

Table -3: FDGDR products processed without DORIS on cycle 91

Feature of the ENVISAT Altimetry NRT processing:
The ENVISAT downlink strategy leads to the non-availability of one DORIS Instrument Source Packet (ISP) per orbit for the NRT operations, which corresponds to around 5 minutes per acquired orbit (e.g. number N). The ISP data are not lost but dumped during the following orbit (number N+1, i.e. too late for the NRT ground processing of orbit N).

The ISP DORIS gaps occur in the southern Atlantic (for ascending passes) and in the Indian Ocean and Asia (for the descending passes), Figure 27.

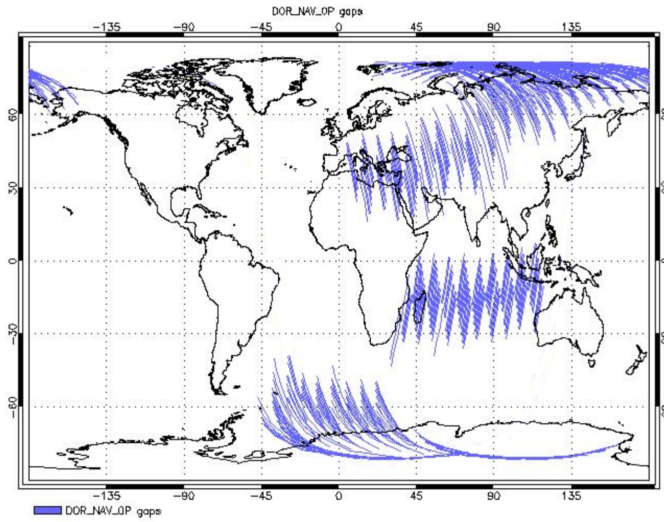

Figure -27: DORIS Navigator missing ISP NRT

In the ground segment processing of NRT data, the last orbit state vector available in the DORIS Navigator is extrapolated until the end of the RA2 product being processed. Given that the extrapolation is not as accurate as the interpolation, the quality of the SLA in the part of the FDGDR products not covered by DORIS Navigator results to be degraded.

An orbit quality flag is available in RA2MWR L1B and L2 products as follows:

- L1B RA2 MDSR: bit 0 of MCD (field 14)
- L2-RA2 MDSR: bit 27 of MCD (field 8)
- L1B/L2-MWR MDSR: bit 1 of MCD (field 8)

The Orbit quality flag is set to 1 when DORIS Navigator has been used in the MDSR processing.

The Orbit quality flag is set to 0 when the DORIS Navigator has not been used in the MDSR processing and this might happen in two different cases:

1. DORIS Navigator is not used on the RA2 processing and the state vector available in the MPH is propagated to the full orbit. In this case all MDSRs in the products present flag set to 0;
2. DORIS Navigator is shorter then RA2 due to the dump issue explained above, in this case only MDSRs not covered by DORIS Navigator are set to 0.

The distinction between these two cases can only be performed in a file basis, by checking the SPH field named DS_NAME="ORBIT_STATE_VECTOR_FILE”. The filename is provided for case 2 whilst *NOT USED* is reported for case 1.

7.4.2 ALTIMETER RANGE

On Figure 27A, it can be observed that the altimetric range was nominal on cycle 91. The gaps observed in Figure 27A are related to some PDS failures which prevented the usage of DORIS in NRT products (the large gap corresponds to the failure on 28th July 2010 in ESRIN station). Some orbits present anomalously large ± values (as on 17th and 24th July 2010) due to missing ECMWF meteo files.

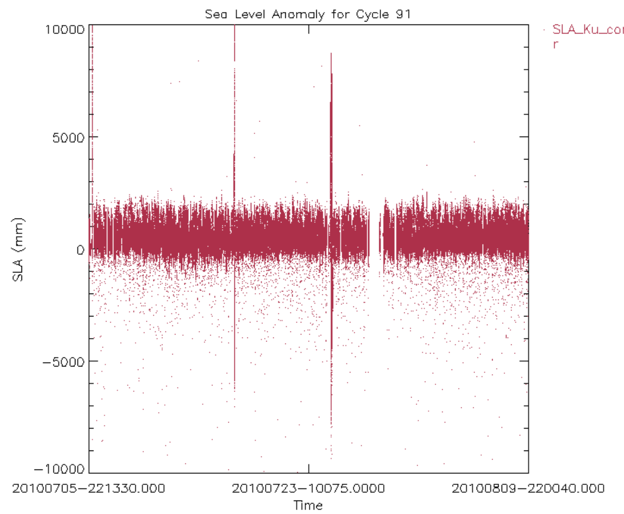

Figure 27A: Sea Level Anomalies Cycle 91 only MDSRs with valid DORIS Flag

The Ku Band SLA has been computed with the following corrections:
MWR_WET_TROPO, DRY_TROPO, INV_BMETER_HEIGHT, SEA_KU_BIAS, IONO_CORR
Due to the S Band Power drop anomaly, started on the 17th of January 2008, see section 7.2.1, the ionospheric correction used for the computation was the Bent model ionospheric correction

In Figure 27B the Histogram of Sea Level Anomalies is reported for the Ku Band. Only MDSRs processed with DORIS have been considered. The peak of the histogram is slightly less than 0.5 m as expected.

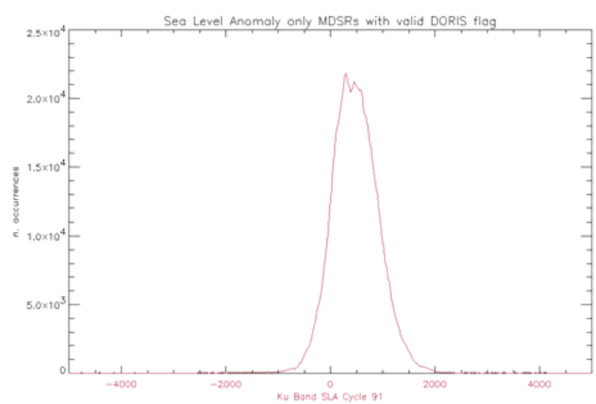

Figure 27B: Histogram of Sea Level Anomalies on Ku Band computed on MDSRs with valid DORIS Flag

7.3.3 SIGNIFICANT WAVE HEIGHT

The histogram of the SWH reported in Figure 28 shows a nominal behaviour on the Ku Band. The S Band is no more being monitored due to the S Band Power drop, which started on cycle 65, 17th January 2008, see section 7.2.1. The distribution shape is consistent with that of previous cycles. The largest peak (about 60000 data for SWH = 0m) was removed from the plot in order to have the complete picture of the SWH histogram.

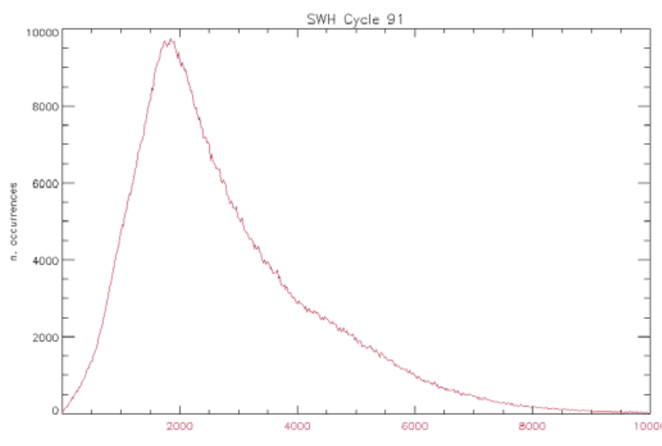

Figure 28: Histogram of Ku Band SWH for cycle 91

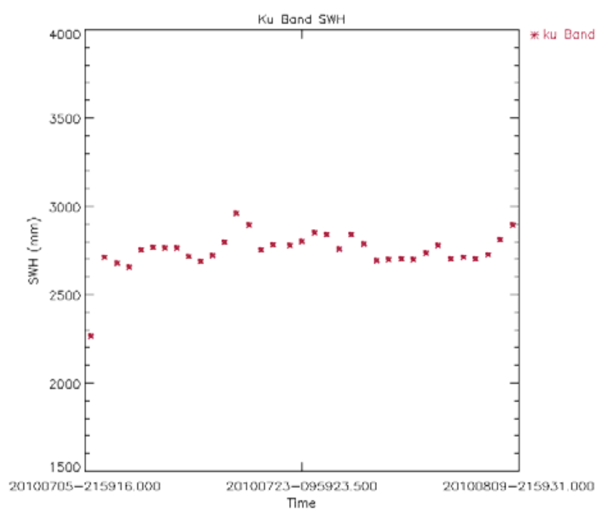

Figure 29: Ku Band SWH daily average for Cycle 91 (mm)

Figure 29 shows the Ku Band SWH daily mean for the current reporting cycle. The new version of the IPF was introduced on 2nd February. Although not evident in Figure 29 analysis by ECMWF (through comparisons against operational model SWH predictions) has shown that the new computation of the PTR in this version of the IPF has resulted in a slight drop in SWH of just over

0.1m. The SWH long term plot is reported in three plots: first plot represents cycle 16 until cycle 49 on Figure 30, second plot (Figure 30A) from cycle 50 to cycle 87 and the third plot from cycle 88 onwards on Figure 30B. It can be noticed that the SWH in both bands shows a trend which follows the seasonal variability. The high daily averages reported (sometimes plotted outside the figure's range) are due to the so-called S-Band anomaly (ref. par.6.1.8).

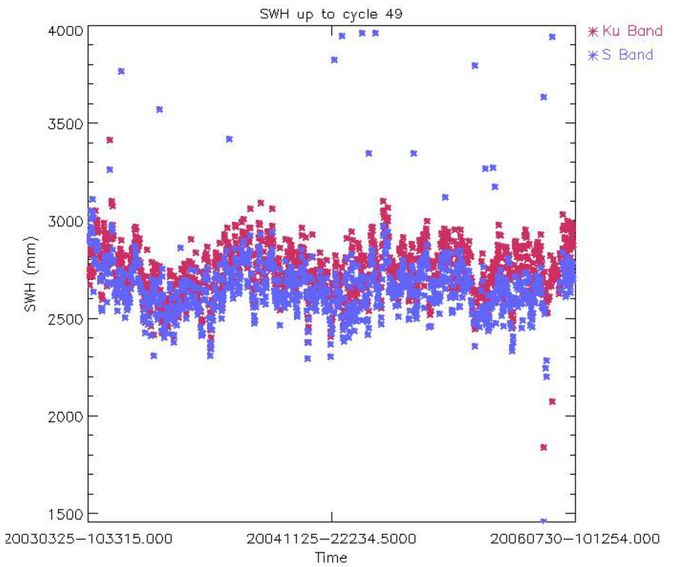

Figure 30: Ku and S SWH daily average up to cycle 49 (mm)

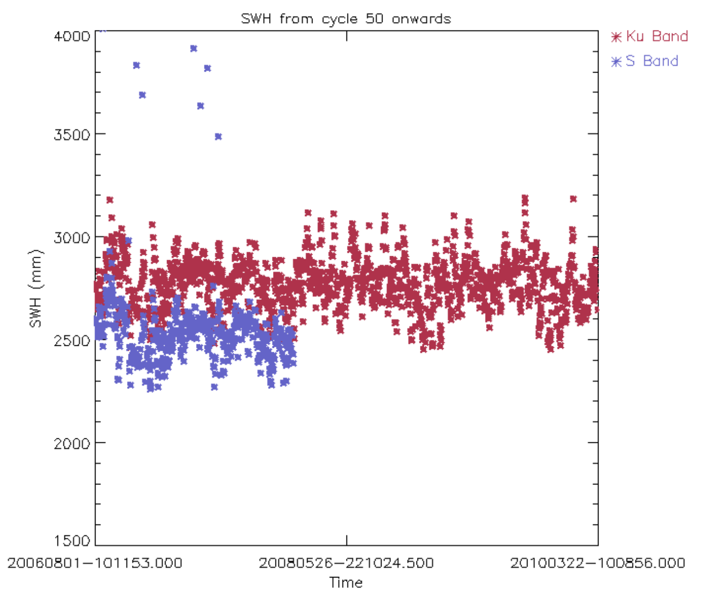

Figure 30A: Ku and S SWH daily average from cycle 50 to cycle 87 (mm)

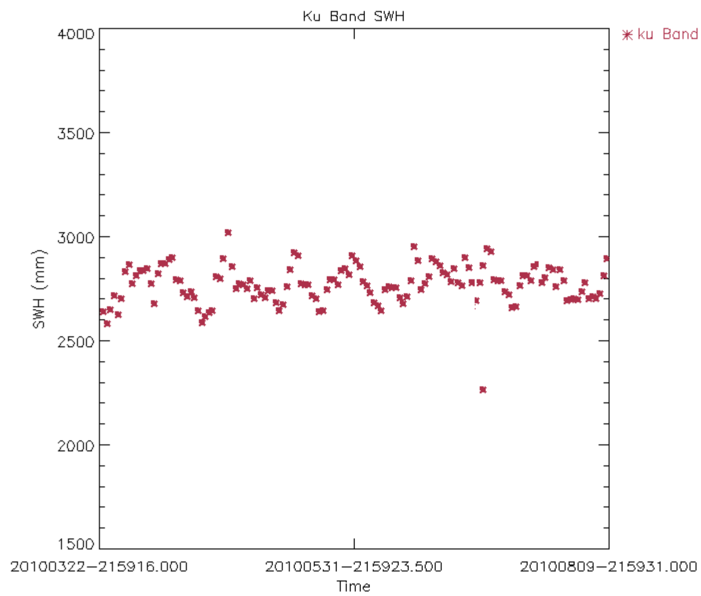

Figure 30B: Ku SWH daily average from cycle 88 onwards

7.3.4 BACKSCATTER COEFFICIENT – WIND SPEED

The Sigma-0 histogram in Ku Band is reported in Figure 31. The S Band is no longer monitored due to the S Band Power drop, started on date 17th of January 2008, see section 7.2.1.
The Sigma_0 histogram in Ku Band is nominal. It shows secondary peaks as in the previous cycles. A small investigation on this problem, performed on the data of cycle 29, demonstrated that the backscattering distribution assumes a different behaviour for different sea conditions [R-17]. Indeed the majority of the data is concentrated on lower values for rough sea state (southern hemisphere, winter conditions) and on higher values for calm sea state (northern hemisphere, summer conditions).

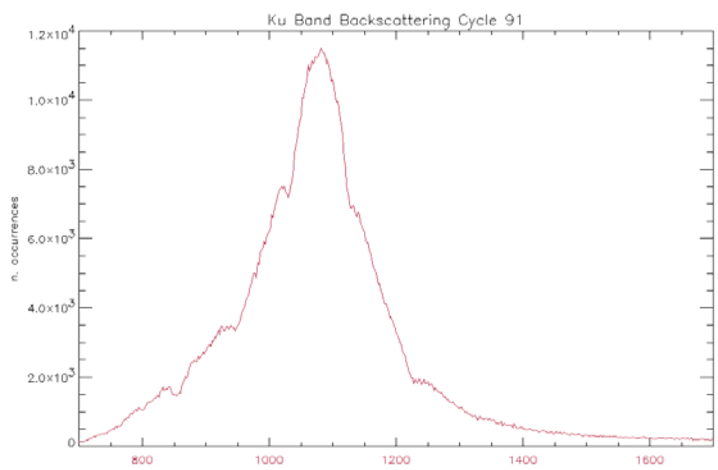

Figure 31: Histogram of Ku Band Backscattering Coefficient for cycle 91

In Figure 32, the backscattering coefficient daily average, computed for only ocean data, trend is reported. The Ku Band shows a nominal behaviour.

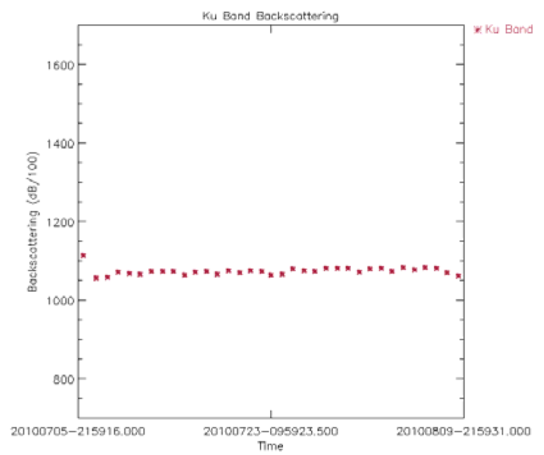

Figure 32: Ku Band Sigma_0 daily average for cycle 91 (dB/100)

The histograms of Wind Speed computed for the Ku-band and the time behaviour during the current cycle are reported in Figure 33 and 34, respectively. Given that the wind speed table has been updated since IPF version 5.02, S.Abdallah Table is now used, the wind speed takes values between 1.18m/ and 21.30m/s.
The largest peak present in the histogram (about 50000 data for wind speed < 1.2m/s) was removed from the plot in order to have the complete picture of the wind histogram.

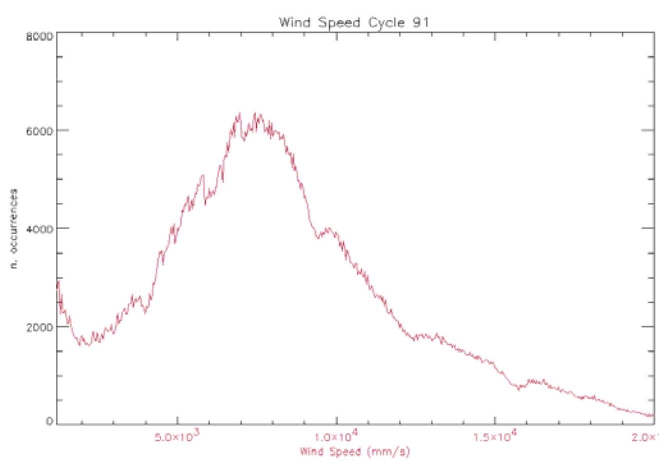

Figure 33: Histogram of Ku Wind Speed for cycle 91(mm/sec)

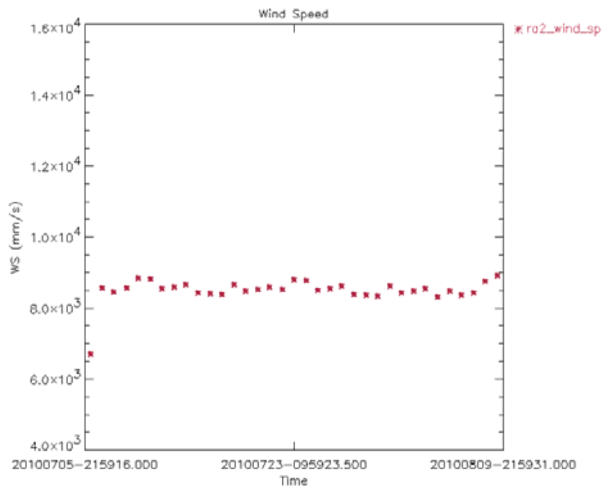

Figure 34: Ku Band Wind Speed daily average for cycle 91 (mm/s)

The Ku-Band Sigma_0 trend, reported hereafter (Figure 35, 35A, and 35B), is characterized by a jump of on average 3.24 dBs concomitant with the operational up-load of IPF version 4.54 which occurred on the 9th of April 2003. This change is due to the upload of a new RA2_CHD_AX ADF file that artificially shifted the RA-2 real Sigma_0 in order to align it with ERS-2 Sigma_0 and make it coherent with the Witter and Chelton empirical wind model. A similar change in trend, but in the opposite direction, is also visible in the Wind Speed trend reported in Figure 36.
Beyond the huge jump that occurred in April 2003, the S-Band Sigma_0 reports a smaller jump occurring on November the 26th 2003. Following the installation of the IPF processing chain V4.56, the average values of the RA-2 S-Band backscattering parameter, shows an increase of ~0.65 dBs, the new S-band sigma0 being higher with respect to the previous versions. The very low values of the S Band Backscattering around 30th July 2006 are related to the S Band Power Drop Anomaly occurred when the instrument was operating on RFFS B-side from 15 May until 21st June 2006 and from the 17th of January onwards due to the S Band Power Drop Anomaly affecting RFFS A-side. The S-Band Sigma_0 daily means that are plotted outside the figure range can be traced back to the so-called S-Band anomaly (ref. par. 6.1.8).
In Figure 35A, the S Band is no more being monitored starting from cycle 65 due to the S Band Power drop, started on date 17th of January 2008, see section 7.2.1.

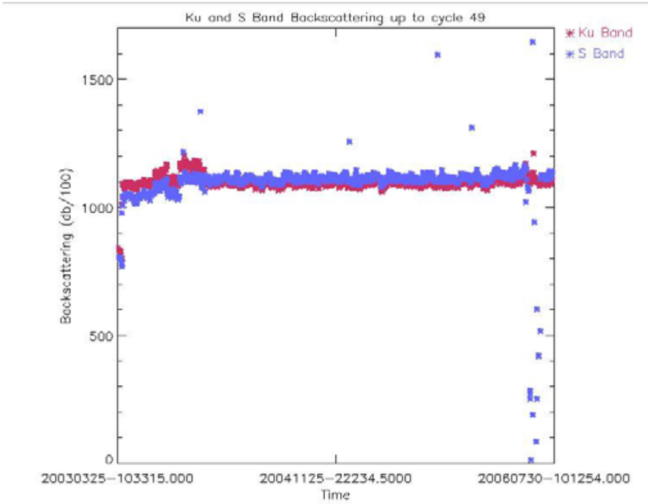

Figure 35: Ku and S band Backscattering daily averages up to cycle 49 (dB/100)

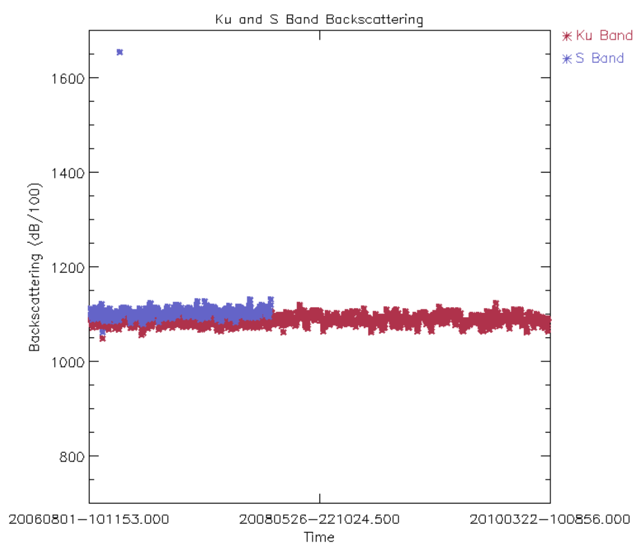

Figure 35A: Ku and S band Backscattering daily averages from cycle 50 to cycle 87 (dB/100)

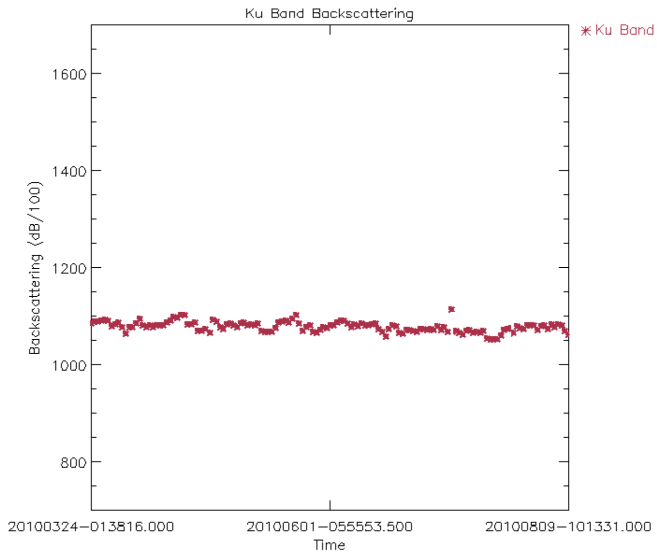

Figure 35B: Ku and S band Backscattering daily averages from cycle 88 onwards (dB/100)

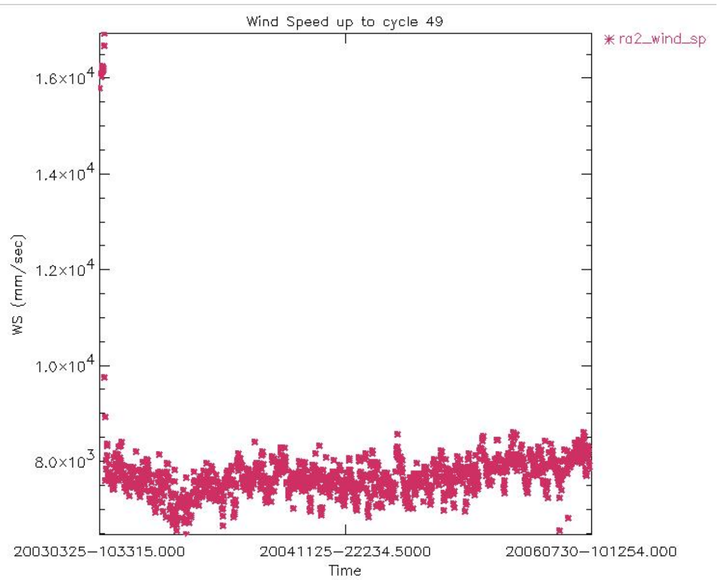

Figure 36: Wind Speed daily averages up to cycle 49 (mm/s)

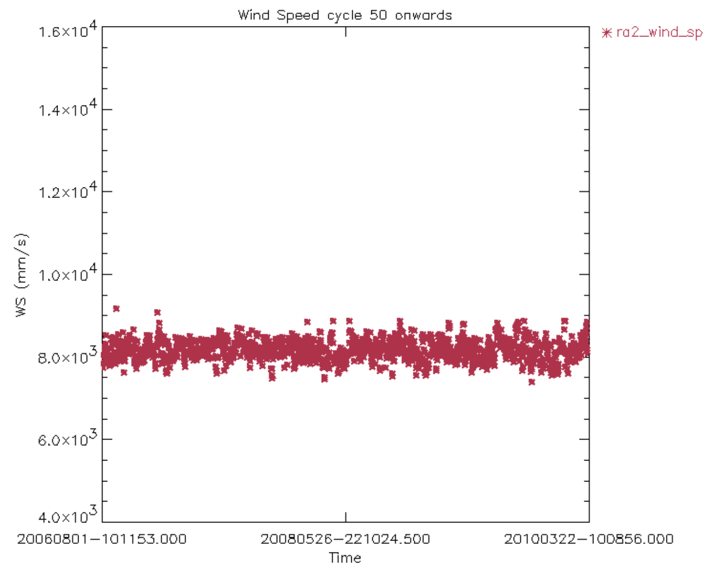

Figure 36A: Wind Speed daily averages from cycle 50 to cycle 87 (mm/s)

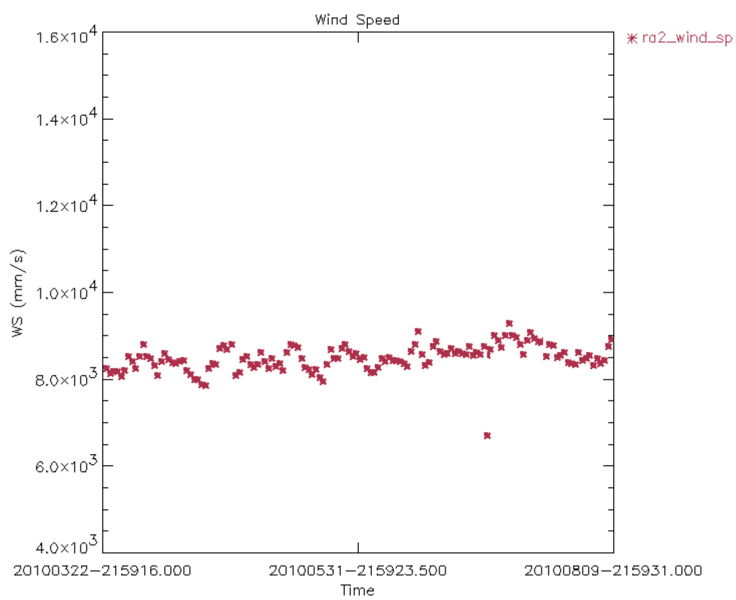

Figure 36B: Wind Speed daily averages from cycle 88 onwards (mm/s)

8 PARTICULAR INVESTIGATIONS

No particular investigations have been performed during the current cycle.

APPENDIX 1: IPF UPGRADES

Table 4: L1B IPF version

IPF Version	Date of issue PDHSK& E, LRAC	L1B Algortihm upgrades	L1B ADF updates	ADF filename
V4.53	Nov. 27, 2002			
V4.54	Apr. 7, 2003	*Wrong sign in AGC calibration estimation *Missing integrity check for the Data Block number read from the Level 0 Data Blocks *The altitude above CoG and the altitude rate have to be included in the records also in case of dummy records *1Hz data should be referenced to data block 9.5 not block 10	Correction of the Tx-Rx gain of Ku and S band parameters (3.5 dB)	RA2_CHD_AX
V4.56	Nov. 26, 2003	1- Extrapolation of AGC value to the Waveform center (49.5) for both Ku- and Sband. 2 - Correction for an error found in the evaluation of S band AGC.	RA2 IF Mask	RA2_IFF_AX
V4.57	PDHS-K: 29-04-2004 PDHS-E: 28-04-2004			
V4.58	Aug. 9, 2004			
V5.0.2	Oct. 24, 2005	MWR Side Lobe correction upgrade USO clock period units correction RA-2 alignment: OBDH & USO datation, IE flags correction Rain Flag tunning to compensate for the increase of the S band Sigma0 Monthly IF estimation Level 1B S-Band anomaly flag DORIS Navigator CFI	side lobe table and Config param New ADF format - clock period unit New table in SOI file New format	MWR_SLT_AX MWR_CON_AX RA2_USO_AX RA2_CHD_AX RA2_CON_AX RA2_SOI_AX RA2_IFF_AX RA2_CON_AX

		upgrade (RA-2 & MWR) Orbit Flag not well implemented: when a DORIS product is used for the processing, the Orbit flag is set to 1 for the whole length of the RA2 L1b product file while it should be set to 1 only for the part of the RA2 product overlapping with the DORIS one. Problem has been traced on OAR 1938 to be solved on next IPF delivery. Correction of the Rx_dist_fine from the Level 0 product, leading to an error in the calculation of the Window_delay (SPR-058).		
V5.03	Sep. 19, 2006	Level 1B S-Band anomaly flag well implemented Orbit Flag well implemented Correction of the Rx_dist_fine (for 80 and 20 MHz) from the Level 0 product, leading to an error when applying the IF mask correction on to the waveforms (SPR-059)		
V 5.06	Jun. 20, 2007	DORIS Navigator threshold update to 900 seconds coverage RA2/DORIS Alignment of Chain B to Prod Spec 3/N		
V 6.02L04	Feb. 2, 2010	- New S-Band Waveform Reconstruction Algorithm - New USO correction algorithm	New parameters in the following ADF after Linux IPF validation: RA2_CON_AX (Zero Padding Factor, Minimum and Maximum value of length of the stack used for averaging the inflight time dalay calibrationfactor, max_time_lag_s	RA2_CON_AX RA2_CHD_AX MWR_CHD_AX MWR_SLT_AX

			p_Ku_ptr and max_time_lag_s p_S_ptr values) RA2_CHD_AX (sigmap parameter) MWR_CHD_AX (deactivated the 36.5GHz drift correction) MWR_SLT_AX (eta_sky and eta_refl parameters)	
IPF6.03	Jul 7th , 2010	Updated CFI libraries for new ENVISAT orbit (CFI libraries v.5.8.1)	N/A	N/A

Table 5: L2 IPF version

PF Version	Date of issue PDHS	L2 Algortihm upgrades	L2 ADF updates	ADF filename
V4.53	Nov. 27, 2002			
V4.54	Apr. 7, 2003			
V4.56	Nov. 26, 2003	SPR 26 Tuning of the Ice2 retracking New MWR NN algorithm	MSS CLS01 Rain flag Updated OCOG retracker thresholds Ice1/Sea Ice Conf file Sea State Bias Table file GOT00.2 Ocean Tide Sol 1 Map file FES 2002 Ocean Tide Sol 2 Map file FES 2002 Tidal Loading Coeff Map	RA2_MSS_AX RA2_SOI_AX RA2_ICT_AX RA2_SSB_AX RA2_OT1_AX RA2_OT2_AX RA2_TLD_AX
V4.57	PDHS-K: 29-04-2004 PDHS-E: 28-04-2004	ECMWF meteo files handling		
V4.58	Aug. 9, 2004	Addition of a Pass Number Field in FD Level		
	Oct. 24, 2005	- Handling of the new RA2_CHD_AX ADF - Rain Flag tuning to compensate for the increase of the S band Sigma0 - Improving the mispointing estimation - Export of the Level 1B S-band flag into the Level 2 data product - Export of the Level 1B NRT orbit quality flag - Addition of a Pass Number Field	New table in SOI file Two needed parameters in SOI file New format	RA2_CHD_AX RA2_SOI_AX RA2_SOI_AX RA2_SOI_AX

		in FD Level 2 SPH product - Addition of peakiness in Ku and S band in FDMAR - Addition of square of the SWH in Ku and S band - Correction of MCD flag - SPH pass number (field 8) set to 0 in SPH NRT Level 2 data products	Addition of GOT2000.2 TLD New DEM AUX file (MACESS) merge of ACE land elevation data and Smith and Sandwell ocean bathymetry	RA2_TLG_AX AUX_DEM_AX
V 5.03	Sep. 19, 2006			
V 5.06	Jun. 20, 2007			
V 6.02L04	Feb. 2, 2010	Updated Rain flag algorithm Updated wind table according to ECMWF requirement New Sea_Ice flag algorithm New Ocean Tide and TLD for FES 2004 + additional changes (inc sea state bias)	Updated values in SOI Added new parameters in SOI file New ADF for OT2 and TLD for FES2004 and updated SOI	RA2_SOI_AX RA2_OT2_AX RA2_TLD_AX RA2_SSB_AX
IPF6.03	Jul 7th , 2010	Updated CFI libraries for new ENVISAT orbit (CFI libraries v.5.8.1)	N/A	N/A

APPENDIX 2: AVAILABILITY:

Table 6: RA-2 L0, L1b and L2 FGD Data products availability summary for Cycle 91

Start Orbit	Stop Orbit	Inst. Unav Time (sec)	Data Unav Time (sec)	Time L0 gaps (sec)	Time L1b gaps (sec)	Time L2 FGD gaps (sec)	Inst. Avail %	Data Avail %	L0 Avail %	L1b Avail %	L2 FGD Avail %
43642	43742	0	12964	12964	13058	13074	100	97,85	97,85	97,83	97,84
43742	43842	152	854	854	855	868	99,99	99,86	99,86	99,86	99,86
43842	43942	0	936	936	937	944	100	99,83	99,83	99,83	99,83
43942	44042	0	821	821	2667	2680	100	99,86	99,86	99,54	99,54
44042	44142	0	817	817	817	830	100	99,86	99,86	99,86	99,86

Table 7: MWR L0 Data products availability summary for Cycle 91

Start Orbit	Stop Orbit	Time Instrument Unavailability (sec)	Time L0 gaps (sec)	Instrument Availability %	L0 Availability %
43642	43742	0	12600	100	97,92
43742	43842	0	504	100	99,92
43842	43942	0	576	100	99,9
43942	44042	0	480	100	99,92
44042	44142	0	552	100	99,91

Table 8: DORIS L0 Data products availability summary for Cycle 91

Start Orbit	Stop Orbit	Time Instrument Unavailability (sec)	Time L0 gaps (sec)	Instrument Availability %	L0 Availability %
43642	43742	0	12600	100	97,92
43742	43842	0	504	100	99,92
43842	43942	0	576	100	99,9
43942	44042	0	480	100	99,92
44042	44142	0	552	100	99,91

Table 9: List of gaps for RA-2 L0 Cycle 91

The list below only contains gaps larger than 200 seconds.
Small gaps occurring everyday due to calibration or PDS anomalies have been suppressed.

RA2_ME__0P			
start time	**stop time**	**Duration (seconds)**	**Downlink**
08/07/2010 12:30	08/07/2010 14:07	5777	43679@KS
09/07/2010 06:58	09/07/2010 11:28	5993	43690@KS

Table 10: List of gaps for MWR L0 Cycle 91

The list below only contains gaps larger than 200 seconds.

MWR_NL__0P			
start time	**stop time**	**Duration (seconds)**	**downlink**
08/07/2010 12:30	08/07/2010 14:07	5777	43679@KS
09/07/2010 06:58	09/07/2010 11:28	5993	43690@KS

Table 11: List of gaps for RA-2 L1b Cycle 91 (gaps with respect to L0 products)

The list of gaps below is referred to the L0 production and not to the planning.

RA2_MW__1P				
predecessor name	**start time**	**stop time**	**coverage missing (seconds)**	**ancestor coverage missing**
RA2_ME__0PNPDK20100728_011939_000062462091_00122_43958_1901.N1	28/07/2010 01:19	28/07/2010 01:49	1845	27.43%

APPENDIX 3: LEVEL 2 STATIC AUXILIARY DATA FILES

AUX_DEM_AXNIEC20100114_180551_20020101_000000_20200101_000000
AUX_ATT_AXVIEC20020924_131534_20020703_120000_20781231_235959
AUX_LSM_AXVIEC20020123_141228_20020101_000000_20200101_000000
MWR_LSF_AXVIEC20020313_172218_20020101_000000_20200101_000000
MWR_CHD_AXNIEC20090713_172710_20020101_000000_20200101_000000
MWR_SLT_AXNIEC20090713_172949_20020101_000000_20200101_000000
RA2_IFA_AXVIEC20050216_125529_20020101_000000_20200101_000000
RA2_IFB_AXVIEC20050216_125738_20020101_000000_20200101_000000
RA2_CHD_AXNIEC20100112_160023_20020101_000000_20200101_000000
RA2_CON_AXNIEC20100107_163055_20080123_140000_20200101_000000
RA2_CST_AXVIEC20020621_135858_20020101_000000_20200101_000000
RA2_DIP_AXVIEC20020122_134206_20020101_000000_20200101_000000
RA2_GEO_AXVIEC20020314_093428_20020101_000000_20200101_000000
RA2_ICT_AXVIEC20031208_143628_20020101_000000_20200101_000000
RA2_IOC_AXVIEC20020122_141121_20020101_000000_20200101_000000
RA2_MET_AXVIEC20020204_073357_20020101_000000_20200101_000000
RA2_MSS_AXVIEC20031208_145545_20020101_000000_20200101_000000
RA2_OT1_AXVIEC20040120_082051_20020101_000000_20200101_000000
RA2_OT2_AXNIEC20090713_142737_20020101_000000_20200101_000000
RA2_SET_AXVIEC20020122_150917_20020101_000000_20200101_000000
RA2_SL1_AXVIEC20030131_100228_20020101_000000_20200101_000000
RA2_SL2_AXVIEC20030131_101757_20020101_000000_20200101_000000
RA2_SOI_AXNIEC20090713_132100_20020101_000000_20200101_000000
RA2_SSB_AXNIEC20090713_130625_20020101_000000_20200101_000000
RA2_TLD_AXNIEC20090713_140728_20020101_000000_20200101_000000
RA2_TLG_AXVIEC20040310_110000_20020101_000000_20200101_000000
RA2_USO_AXNIEC20100114_090543_20020101_000000_20200101_000000

APPENDIX 4: SIGMA0 ABSOLUTE CALIBRATION

Table 18: Transponder measurement results up to cycle 91

Absolute Orbit nb	Date of Measurement	Location / Rel. track	RA-2 resolution	Transponder Bias [dB]	ECMWF Wet Tropo. Corr. [dB]
10389	24-feb-04	Rome / 315	Low	1,552	0,120
10511	04-mar-04	Valmontone / 437	Low	1,542	0,102
10618	11-mar-04	Fiuggi / 43	Low	1,447	0,135
10783	23-mar-04	Maccarese / 208	Low	1,540	0,142
10890	30-mar-04	Rome / 315	Low	1,442	0,152
11119	15-apr-04	Fiuggi / 43	High	0,963	0,122
11513	13-mag-04	Valmontone / 437	Low	1,353	0,133
11620	20-mag-04	Fiuggi / 43	Low	1,427	0,139
11892	08-giu-04	Rome / 315	Low	1,504	0,154
12014	17-giu-04	Valmontone / 437	Low	1,448	0,348
12121	24-giu-04	Fiuggi / 43	Low	1,576	0,149
14290	23-nov-04	Maccarese / 208	Low	1,43	0,164
14397	30-nov-04	Rome / 315	Low	1,11	0,142
14519	9-dic-04	Valmontone / 437	Low	1,26	0,248
14791	28-dic-04	Maccarese / 208	High	0,97	0,134
14898	4-gen-05	Rome / 315	High	0,95	0,114
15020	13-gen-05	Valmontone / 437	High	0,88	0,118
15127	20-gen-05	Fiuggi / 43	High	1,01	0,108
15292	1-feb-05	Maccarese / 208	High	0,95	0,132
15399	8-feb-05	Rome / 315	High	1,05	0,124
15521	17-feb-05	Valmontone / 437	High	0,94	0,115
15793	8-mar-05	Maccarese / 208	High	0,93	0,116
15900	15-mar-05	Rome / 315	High	0,93	0,128
16022	24-mar-05	Valmontone / 437	High	0,94	0,154
16294	12-apr-05	Maccarese / 208	High	0,97	0,140
16401	19-apr-05	Rome / 315	High	0,99	0,134
16523	28-apr-05	Valmontone / 437	High	0,97	0,114
16795	17-may-05	Maccarese / 208	High	0,84	0,168
16902	24-may-05	Rome / 315	High	1,00	0,152
17403	28-jun-05	Rome / 315	High	1,13	0,16
17525	7-jul-05	Valmontone / 437	High	1,04	0,13
17904	02-aug-05	Rome / 315	High	1,02	0,188
18026	11-aug-05	Valmontone / 437	High	0,93	0,154
18405	06-sep-05	Rome / 315	High	1,06	0,16
18634	22-Sep-05	Fiuggi/43	High	1,00	0,152
18799	04-Oct-05	Maccarese/208	High	0,85	0,164
18906	11-Oct-05	Perm site Rome / 315	Low	1,46	0,156
19407	15-Nov-05	Perm site Rome / 315	High	1,09	0,19
20409	24-Jan-06	Perm site Rome / 315	High	1,38	0,110
20910	28-Feb-06	Perm site Rome / 315	High	0,98	0,124
21912	9-May-06	Perm site Rome / 315	High	1,0	0,138
23916	26-Sep-06	Perm site Rome / 315	High	1,05	0,172
24417	31-Oct-06	Perm site Rome / 315	High	1,08	0,146
24918	05-Dec-06	Perm site Rome / 315	High	1,00	0,156

25419	09-Jan-2007	Perm site Rome / 315	High	0,97	0,148
25929	13-Feb-2007	Perm site Rome / 315	High	1,07	0,118
26922	24-Apr-2007	Perm site Rome / 315	High	1,17	0,154
27423	29-May-2007	Perm site Rome / 315	High	1,04	0,168
29928	20-Nov-2007	Perm site Rome / 315	High	1,04	0,139
30930	29-Jan-2008	Perm site Rome / 315	High	1,01	0,013
31431	04-Mar-2008	Perm site Rome / 315	High	1,04	0,139
32433	13-May-2008	Perm site Rome / 315	High	0,87	0,1758
33435	22-Jul-2008	Perm site Rome / 315	High	1,0	0,1356
35439	09-Dec-2008	Perm site Rome / 315	High	0,98	n/a
36441	17-Feb-2009	Perm site Rome / 315	High	0,97	0,0803
36942	24-Mar-2009	Perm site Rome / 315	High	0,89	0.084
37944	6-Jun-2009	Perm site Rome/315	High	1.01	0.0683
39948	20-Oct-2009	Perm site Rome/315	High	1.06	0.071
40449	24-Nov-2009	Perm site Rome/315	High	0.90	0.0707
40950	29-Dec-2009	Perm site Rome/315	High	0.76	0.1213
41451	2-Feb-2010	Perm site Rome/315	High	0.83	0.0773
42453	13-Apr-2010	Perm site Rome/315	High	0.75	0.0713
42954	18-May-2010	Perm site Rome/315	High	0.73	0.0797
43455	22-Jun-2010	Perm site Rome/315	High	0.74	0.0797
43956	27-Jul-2010	Perm site Rome/315	High	0.74	0.0837

APPENDIX 5: S-BAND ANOMALY

RA-2 S Band failed on cycle 65.

APPENDIX 6: IE SITES COORDINATES

ZONE_ID="CapraiaA"
RECORD polygon_pt: LONG=+009.934000<deg> LAT=+042.970000<deg>
ENDRECORD
RECORD polygon_pt: LONG=+009.863000<deg> LAT=+042.970000<deg>
ENDRECORD
RECORD polygon_pt: LONG=+009.863000<deg> LAT=+043.166000<deg>
ENDRECORD
RECORD polygon_pt: LONG=+009.934000<deg> LAT=+043.166000<deg>
ENDRECORD
ZONE_ID="Toulon_D"
RECORD polygon_pt: LONG=+005.500000<deg> LAT=+043.070000<deg>
ENDRECORD
RECORD polygon_pt: LONG=+005.473000<deg> LAT=+043.070000<deg>
ENDRECORD
RECORD polygon_pt: LONG=+005.473000<deg> LAT=+043.160000<deg>
ENDRECORD
RECORD polygon_pt: LONG=+005.500000<deg> LAT=+043.160000<deg>
ENDRECORD
ZONE_ID="Vostok_x"
RECORD polygon_pt: LONG=+106.500000<deg> LAT=-078.000000<deg>
ENDRECORD
RECORD polygon_pt: LONG=+105.500000<deg> LAT=-078.000000<deg>
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ENDRECORD
RECORD polygon_pt: LONG=+106.500000<deg> LAT=-077.500000<deg>
ENDRECORD
ZONE_ID="Dome_x__"
RECORD polygon_pt: LONG=+124.000000<deg> LAT=-075.250000<deg>
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RECORD polygon_pt: LONG=+122.000000<deg> LAT=-075.250000<deg>
ENDRECORD
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ENDRECORD
RECORD polygon_pt: LONG=+124.000000<deg> LAT=-074.750000<deg>
ENDRECORD