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ENVISAT CYCLIC ALTIMETRIC REPORT

CYCLE 61 from 20-08-2007 to 24-09-2007

Quality Assessment Report

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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 61.

This report covers the period from 20th of August 2007 until 24th of September 2007.

2 DISTRIBUTION LIST

This report is available in PDF format at the internet address
http://earth.esa.int/pcs/envisat/ra2/reports/pcs_cyclic/

3 ACRONYMS

AGC	Automatic Gain Control
APC	Antenna Pointing Controller
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
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
LUT	Look Up Table
MCMD	MacroCommand
MPH	Main Product Header
MSS	Mean Sea Surface
MWR	MicroWave Radiometer
MPS	Mission Planning System
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
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 – 2] ENVISAT Microwave Radiometer Assessment Report Cycle, CLS.DOS/07.182, http://earth.esa.int/pcs/envisat/mwr/reports/
[R – 3] Envisat RA-2 IF Mask weird behavior: Investigation Report
[R – 4] Instrument Performance Evaluation and Analysis Summary, PO-TR-ALS-RA-0042
[R – 5] Instrument Corrections Applied on RA-2 Level 1b products, Paper presented at the ENVISAT Calibration Review in September 2002
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[R – 7] RA-2 S-Band Anomaly Investigation, PO-TN-ESA-RA-1342, http://earth.esa.int/pcs/envisat/ra2/articles/
[R – 8] RA-2 Performance Results, Paper presented at the ENVISAT Calibration Review in September 2002
[R – 9a] ECMWF Report on ENVISAT RA- 2 for July 2005, Report on ENVISAT Radar Altimeter - 2 (RA- 2), Wind/ Wave Product with Height Information (RA2_ WWV_ 2P),
[R – 9b] ECMWF Report on ENVISAT RA- 2 for August 2005, Report on ENVISAT Radar Altimeter - 2 (RA- 2), Wind/ Wave Product with Height Information (RA2_ WWV_ 2P), http://earth.esa.int/pcs/envisat/ra2/reports/ecmwf/

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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
[R – 12] Defining a Rain flag for the Envisat altimeter, G. Quartly, study presented to the final CCVT plenary meeting, http://earth.esa.int/pcs/envisat/ra2/articles/
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[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 Cycle Overview

- No orbits were affected by the S Band Anomaly on cycle 61. The patch correcting the SW/HW anomaly, the original cause of the S Band Anomaly, was uploaded for the second time on date 27 June 2007. Some thresholds for telemetry monitoring parameters have been updated and since the 19th of July the instrument was never unavailable.
- The analysis of the RA-2 data confirmed the RA-2 Ultra-Stable Oscillator (USO) anomaly that was affecting the Altimetry data products for a year, disappeared on the 1st of March 2007.
  WARNING: Users are advised not to use the range parameter in Ku and S Band during the current cycle without applying the USO correction. The auxiliary files should be applied even in the non anomalous period in order to correct for the nominal ageing drift of the USO device.
- 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:
  1. NRT orbit basis USO correction for FDGDR products , available from `http://earth.esa.int/pcs/envisat/ra2/auxdata/`;
  2. An Interim daily USO correction for IGDR products, available at the same F-PAC location as for IGDR, in the directory igdr_ous_corr
  3. An OFL cycle USO correction for GDR products, available at the same F-PAC location as for GDR, in the directory gdr_ous_corr.

- 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 as the correction files, see above.
- The NRT USO correction has been made available from July 24, 2006 onwards.
- Starting on Cycle 56, a new planning for IF calibration was put in place in order to partially free Himalaya. New calibration site is Rocky Mountains. For Continuity and homogenous reasons ascending passes are still used for calibration over Himalaya.
- Over the 75 IF masks acquired and processed, there are 11 valid IF masks over the two defined zones (15% of acquired and processed masks). The auxiliary file RA2_IFF_AX was updated on date 5 September 2007.
- Tracking performances in the different resolutions are well in line with the output figures and objectives of the Commissioning Phase.
- During cycle 61, RA2_SOL_AX has been updated on 5 September 2007.
- RA2 was unavailable once, data availability was around 98 %
- MWR was unavailable once, data availability was around 99 %
- DORIS was unavailable once, data availability was around 99 %
- A platform incident occurred on the 24 of September 2007 at 12h27 UTC (9 hours before the end of the cycle) which caused the switch-off of all instruments

5.2 Payload status

5.2.1 ALTIMETER EVENTS

The Radar Altimeter 2, during cycle 61, was unavailable once, at the very end of the cycle and was recovered three days later, on cycle 62 as follows:

Start: 24 Sep 2007 12:27:00 Orbit = 29107
Stop: 27 Sep 2007 11:13:30 (cycle 62) Orbit = 29149

Payload switch-off due to Service Module Anomaly (Global AOCS Surveillance triggered).

5.2.1.1 RA-2 instrument planning

Starting on Cycle 56, a new calibration site has been defined for the IF masks mode acquisition. The new site is on the Rocky Mountains. The nominal operational acquisition over Himalaya is still being performed, but only on ascending passes. Below a map is reported indicating the two calibration sites:

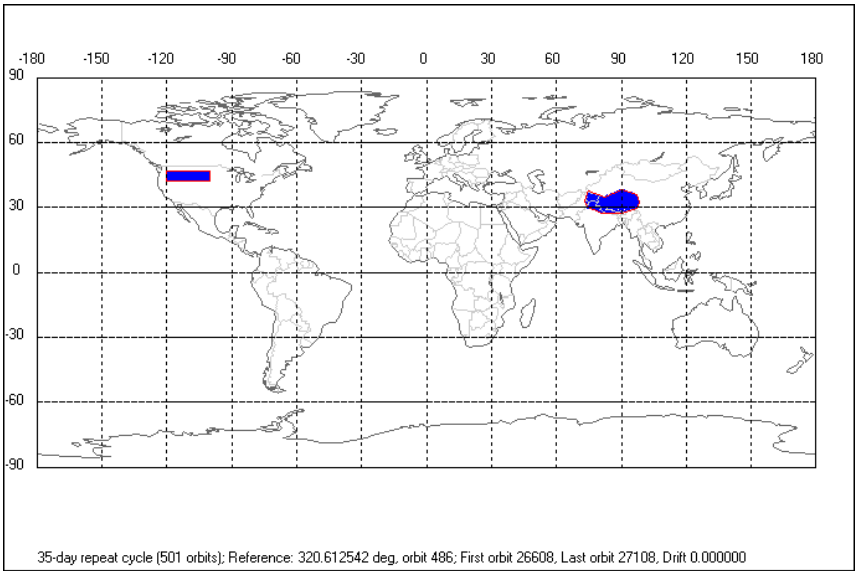

Figure 1: IF Calibration Acquisition sites

The RA-2 instrument planning was performed as follows:

- IF Calibration Mode according to the nominal operational acquisition scheme: 100 seconds of data once per day over Himalayan region (ascending passes).
- IF Calibration Mode according to the new operational acquisition scheme: 50 seconds of data once or twice per day over Rocky Mountains region (ascending and descending passes).
- 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 acquisitions during PLO activity over ESA transponder located in Rome (1 second length acquisition, 1 repetition)
- Individual Echoes acquisition (1 second length acquisition, 1 repetition) 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.
- Preset Loop Output mode over the ESA transponder located in Rome (permanent location); high chirp resolution.

Hereafter the map is reported showing the acquisition sites for both the Range and Sigma_0 transponders.

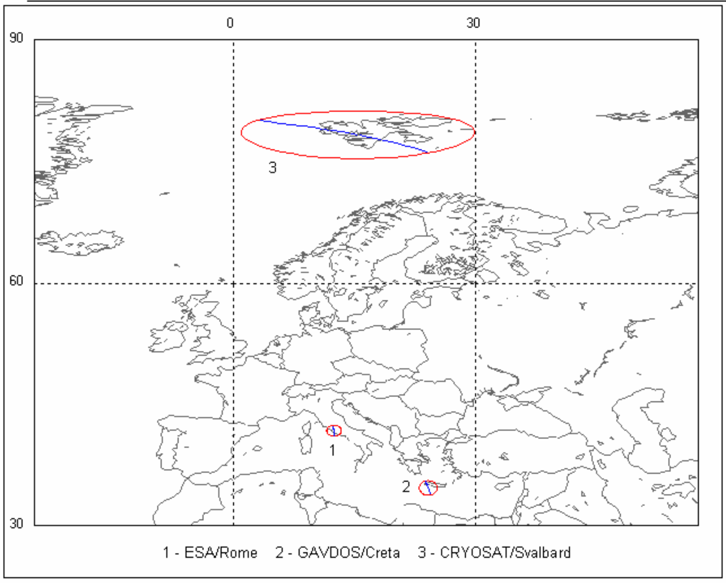

Figure 2A: Transponder Acquisition sites

5.2.2 MWR EVENTS

The MWR, during cycle 61, was unavailable once, at the very end of the cycle and was recovered three days latter, on cycle 62 as follows:

Start: 24 Sep 2007 12:27:00 Orbit = 29107
Stop: 27 Sep 2007 14:11:16 (cycle 62) Orbit = 29151

Payload switch-off due to Service Module Anomaly (Global AOCS Surveillance triggered).

5.2.3 DORIS EVENTS

DORIS, during cycle 61, was unavailable once, at the very end of the cycle and was recovered three days latter, on cycle 62 as follows:

Start: 24 Sep 2007 12:27:00 Orbit = 29107
Stop: 27 Sep 2007 11:03:43 (cycle 62) Orbit = 29149

Payload switch-off due to Service Module Anomaly (Global AOCS Surveillance triggered).

5.3 Availability

The summary of the RA-2 data products availability for the current cycle is reported in Appendix 2. Data availability was around 98% for RA-2 products, 99% for MWR products and 99% for DORIS products.

5.4 Orbit quality

During the period covered by cycle 61, the spacecraft ground track remained within the +/- 200 m deadband around the reference ground track at ascending node without any orbit control manoeuvre.

5.5 Ground Segment Processing Chain Status

5.5.1 IPF PROCESSING CHAIN

5.5.1.1 Version

Cycle 61 has been processed with IPF processing chain V5.06, installed in both PDHS-E and PDHS-K on 20th June 2007, orbit 27729.

IPF V5.06 contains the following main evolutions:

1. Increase performance in the usage of DORIS Navigator in NRT products due to DORIS Navigator threshold update to 900 seconds coverage RA2/DORIS;

2. Alignment of Chain B to Prod Spec 3/N

A complete table of IPF Level1b and Level2 upgrades is reported in Appendix 1.

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

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 bellow:

Surface type	320 MHz	Commissioning Phase objectives 320 MHz	80 MHz	20MHz
Open Ocean	99,99	>99%	0,01	0,00
Costal Water (ocean depth < 200 m)	98,39	No specific requirement	1,43	0,19
Sea Ice	99,24	>95%	0,70	0,07
Ice Sheet	96,40	>95%	3,05	0,55
Land	81,83	No specific requirement	14,70	3,47
All world	95,35		3,79	0,86

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

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 last column and presented in [R – 8].

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.

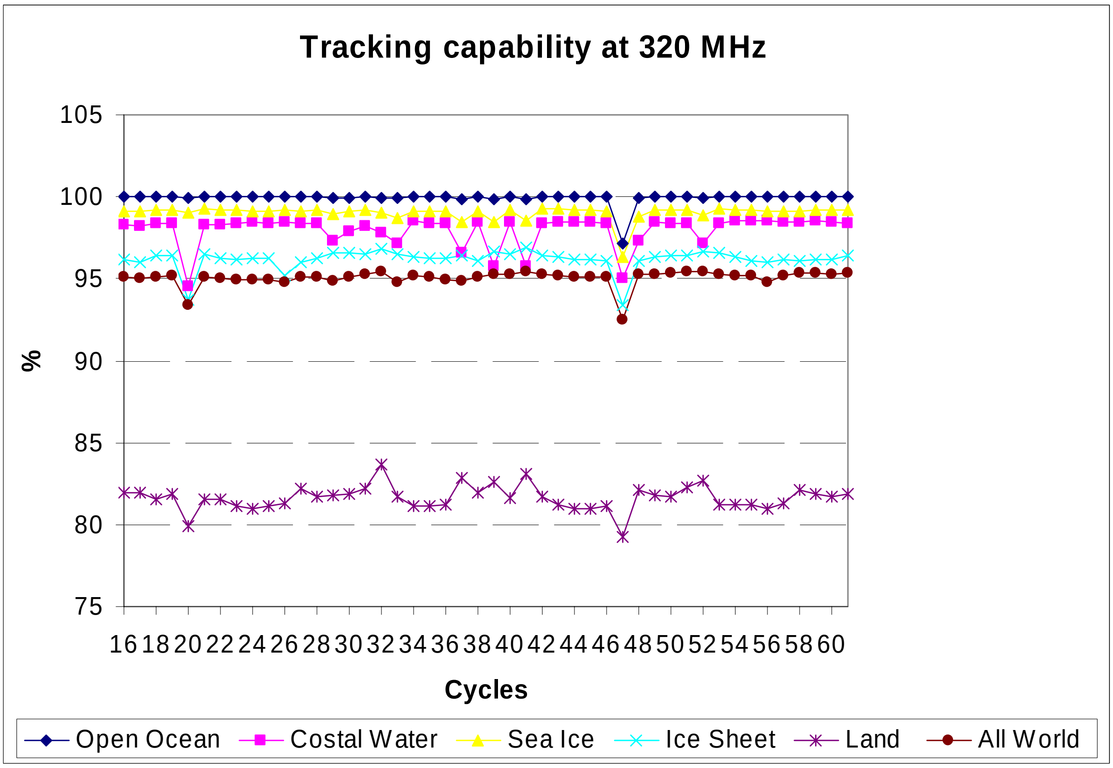

Figure 2: RA-2 Tracking percentage at 320MHz for different surfaces

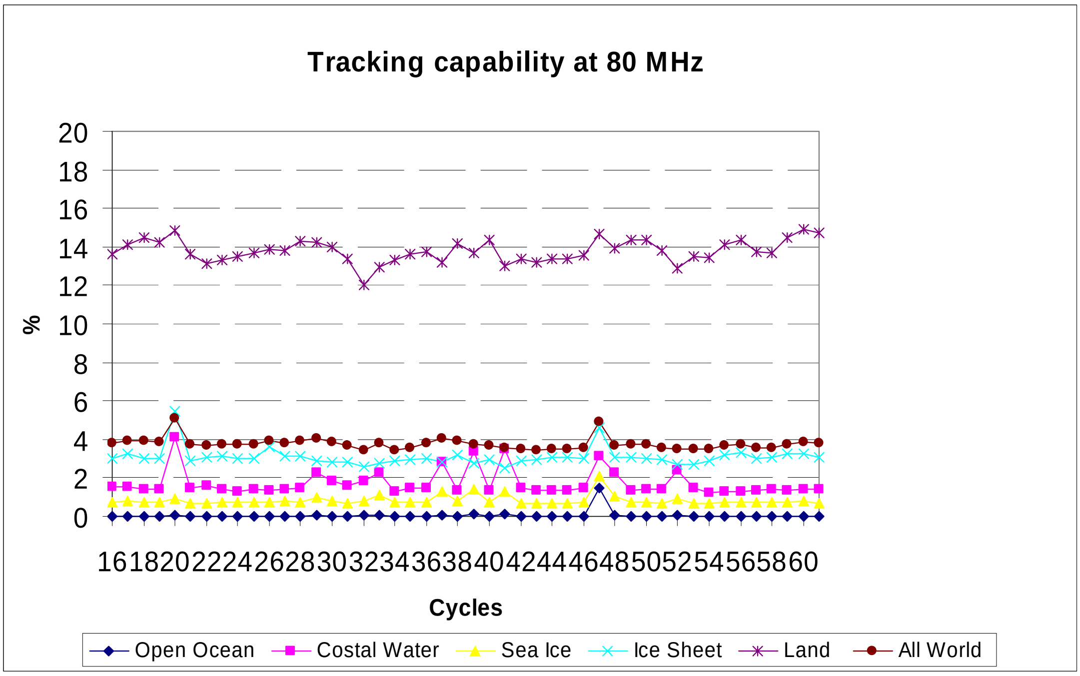

Figure 3: RA-2 Tracking percentage at 80MHz for different surfaces

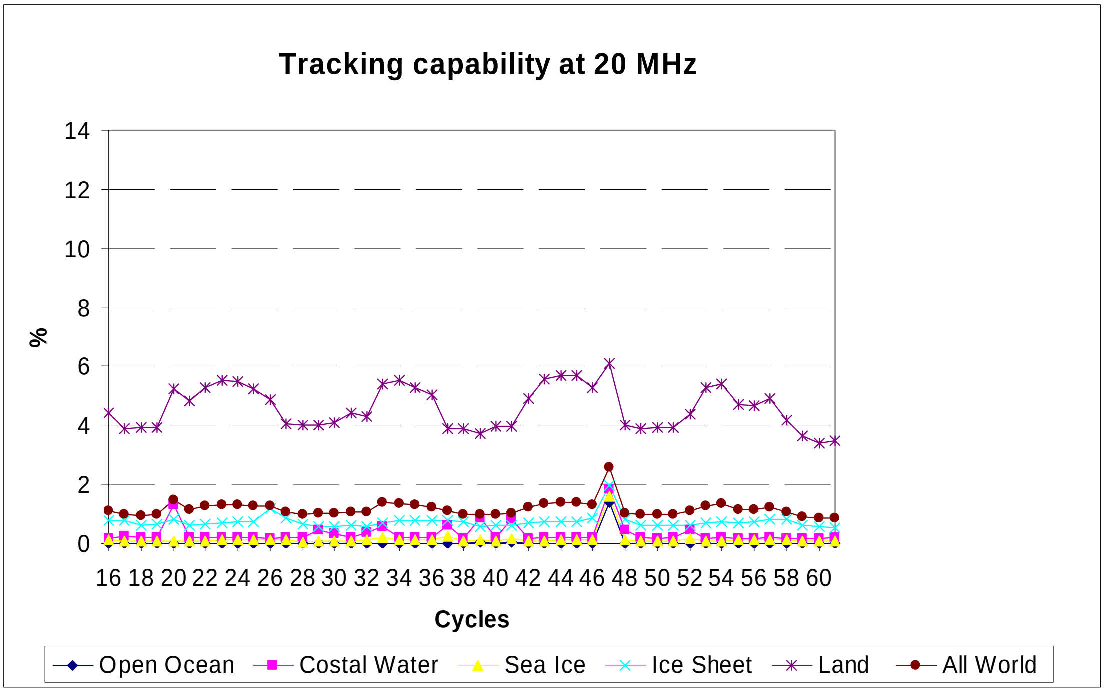

Figure 4: RA-2 Tracking percentage at 20MHz for different surfaces

6.1.2 IF FILTER MASK

In Figure 5 all valid IF masks retrieved during cycle 61 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 0.01 dbs, the mask is considered valid.

During cycle 61, according to the new planning defined for the IF Calibration acquisition from cycle 56 onwards (ref. Par. 5.2.1.1), one daily pass over the site Himalaya (35 ascending passes) and 61 passes over Rocky Mountains (both ascending and descending tracks; less than two per day) have been performed.

- The number of valid IF Masks acquired on the Rocky Mountains site was 3
- The number of valid IF Masks acquired on the Himalaya site was 8

The overall number of valid IF masks has been 11, representing 15 % of the 75 acquired and processed IF masks.

Only valid 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).

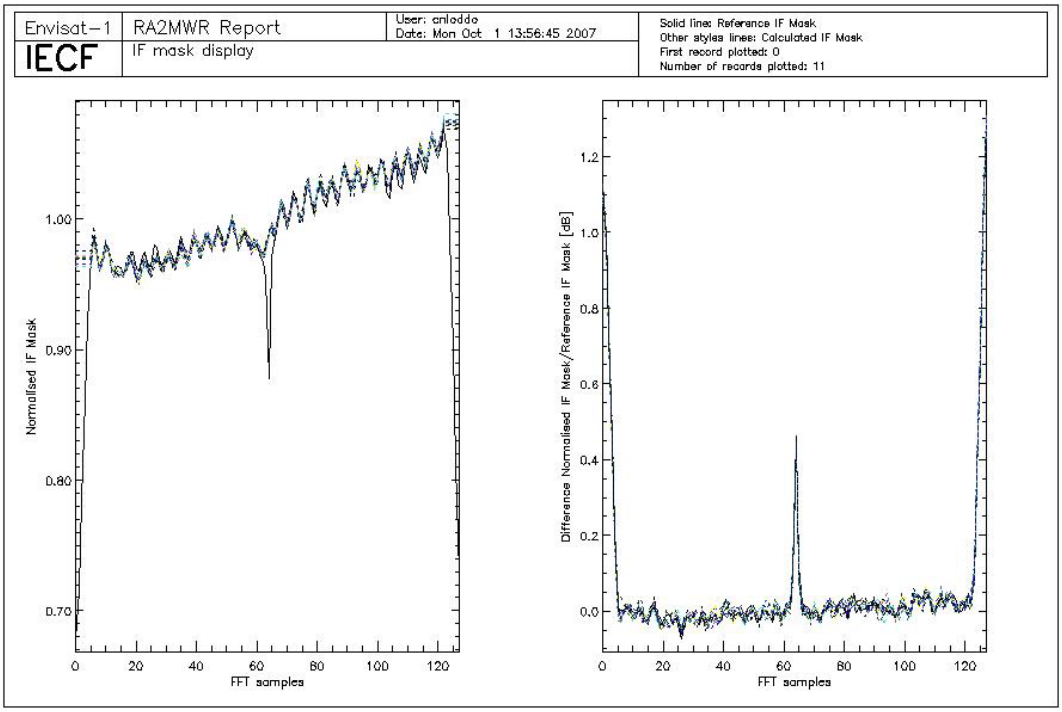

Figure 5: Valid IF masks retrieved during cycle 61 plotted together with the on-ground reference.

In Figure 6 the IF Mask, updated on the 5th of September 2007, and the previous IF Mask used for processing are plotted.

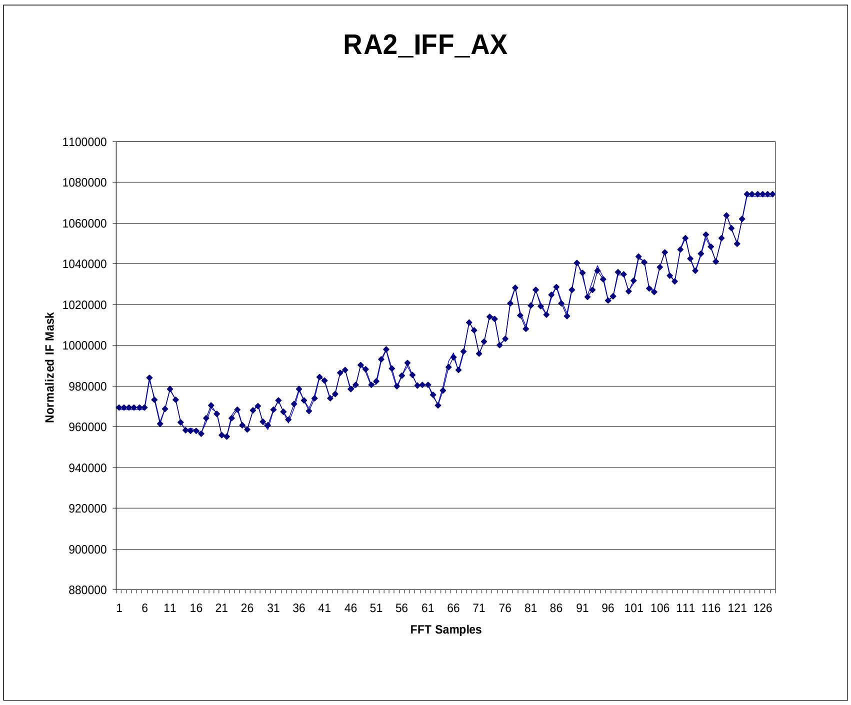

Figure 6: Previous and IF Mask updated on 5th of September 2007

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.
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 and on December 16th 2006. 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 behavior over the whole period.
During the current cycle the IF Calibration Mode still shows the weird behavior described in [R – 3]. This problem, present since the beginning of the mission, is under investigation. The anomaly directly affects the number of valid RA-2 IF masks obtained per cycle, but does not prevent the generation of the IF mask correction file, used in input to the Level 1B ground processing as far as at least 10 of them are valid Mask.
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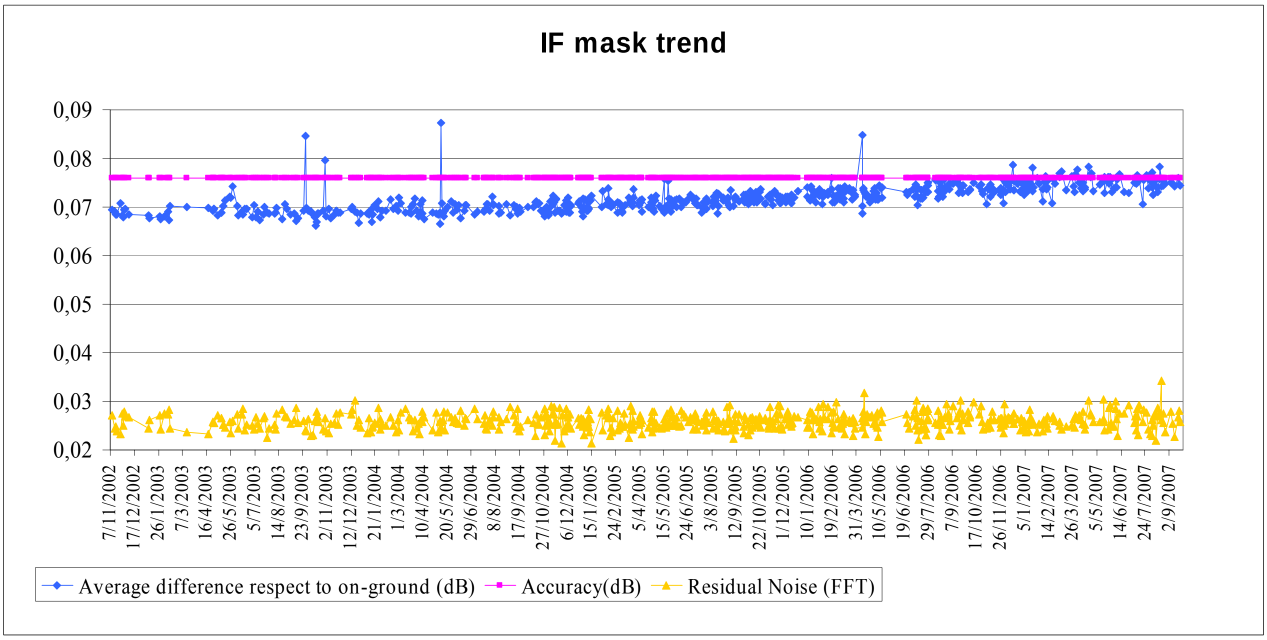

Figure 7: Evolution of the IF mask related parameters for valid IF masks retrieved up to cycle 61

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 which 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 onwards. This problem is under investigation.

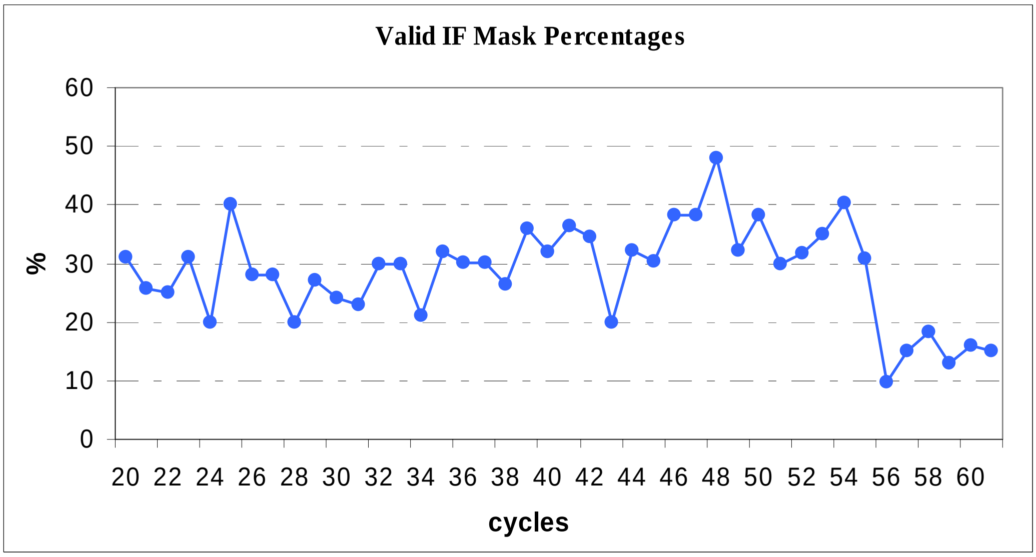

Figure 8: Percentages of valid IF Mask up to cycle 61

6.1.3 USO

The USO Clock Period anomaly **IS NO MORE PRESENT** in cycle 61. It disappeared on date 1st March 2007, after the recovery of a RA-2 on-board anomaly. This anomaly lasted for about 11 cycles (from cycle 44 to beginning of cycle 56).

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.

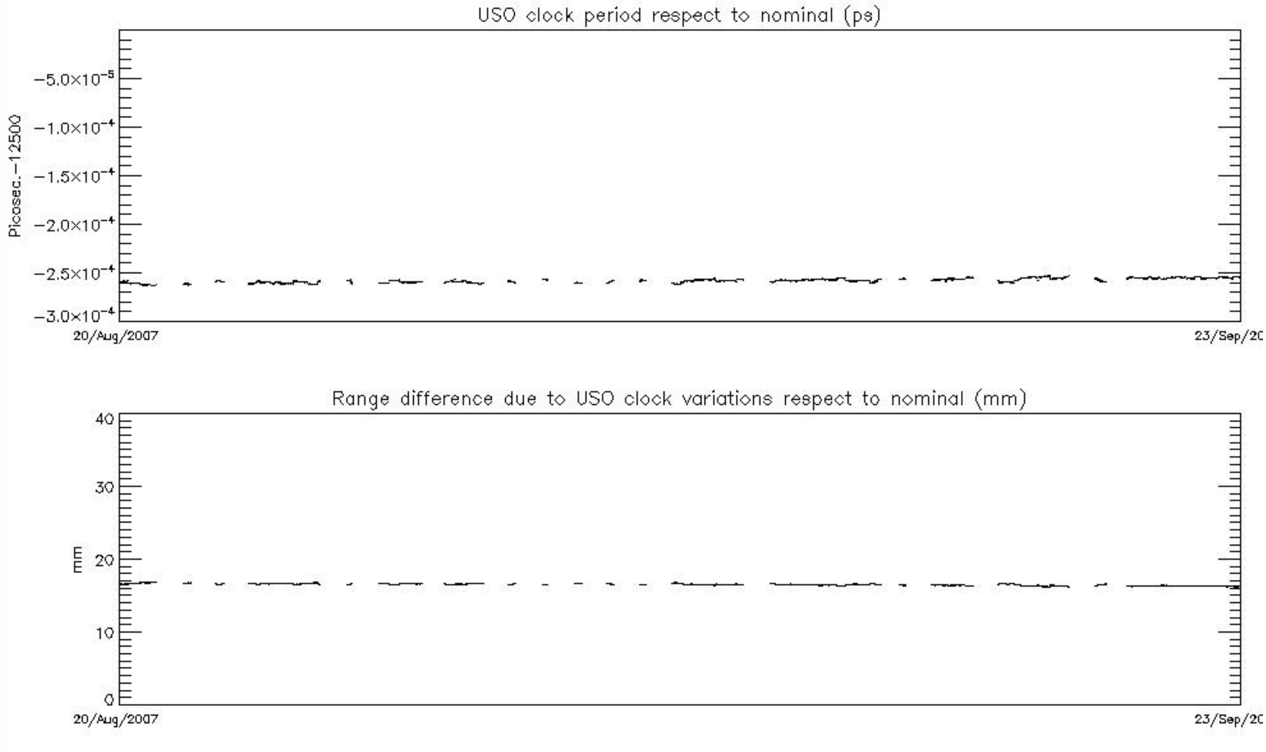

Figure 9: USO clock period for cycle 61

The USO Clock Period was almost permantly present in the last year. It started in cycle 44, on date 1 Feb 2006 12:04:30, Orbit = 205181. It directly happened after the recovery of a RA-2 on-board anomaly 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 Anomalies during the anomaly that make 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.

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 is performed off-line respect to the IPF processing and it is 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.

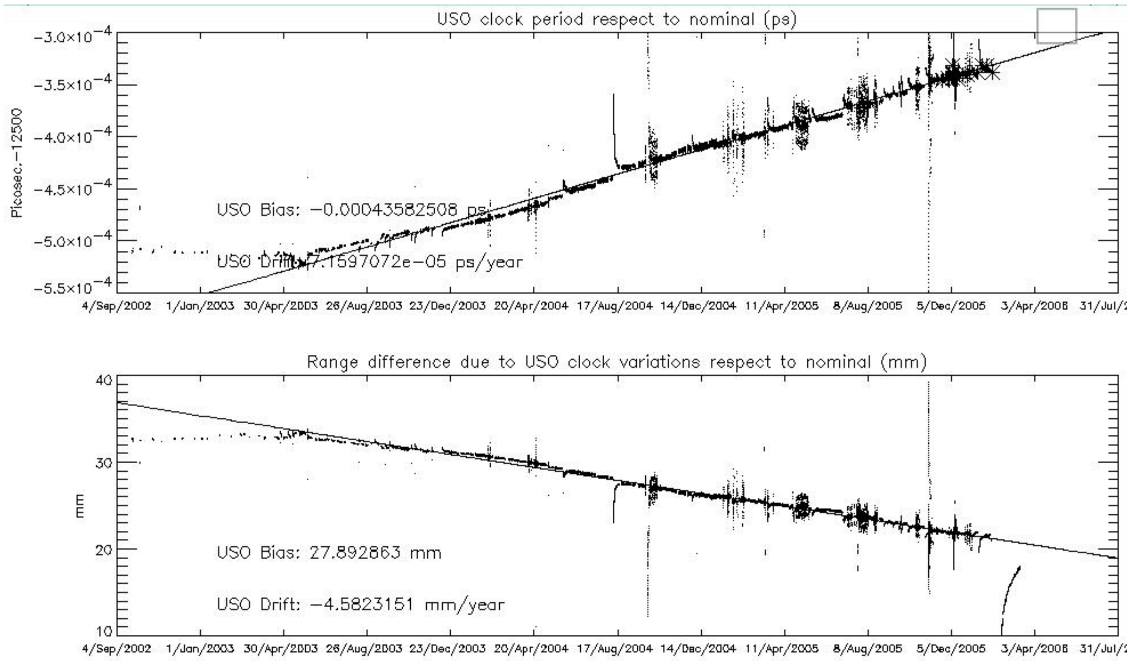

Figure 10: USO clock period until cycle 49

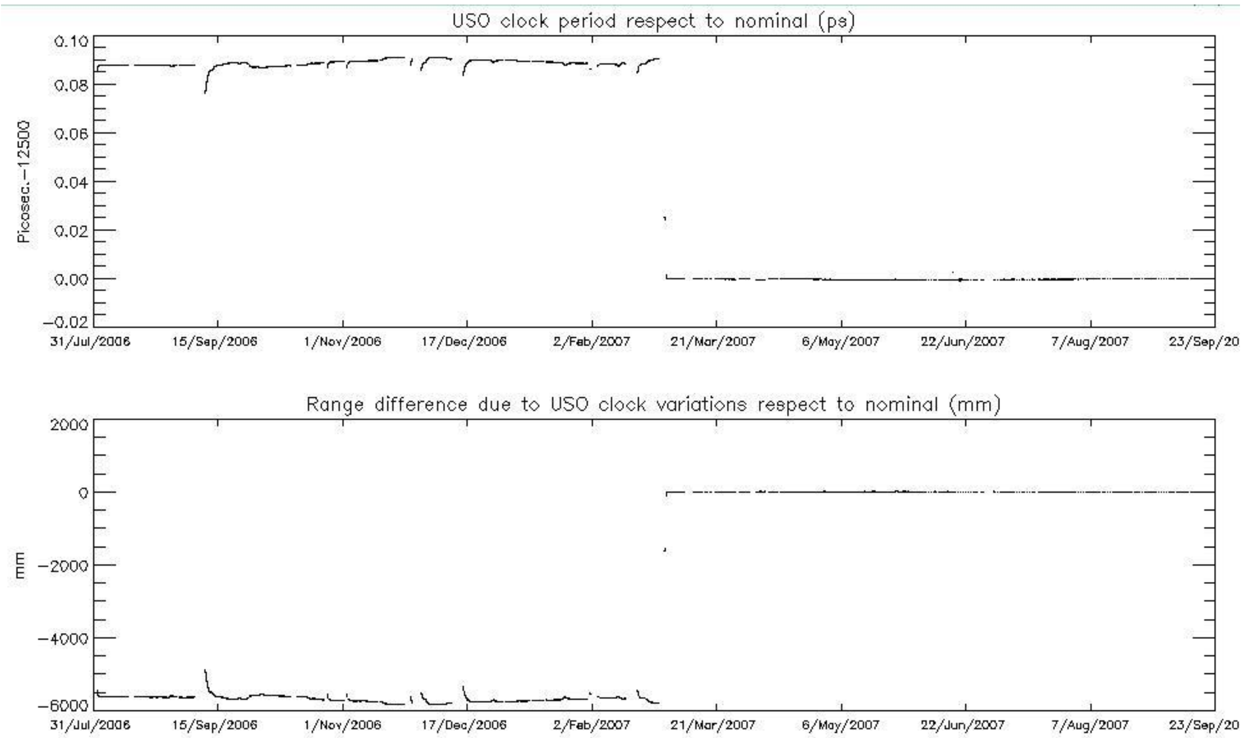

Figure 10A: USO clock period from cycle 50 onwards

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.

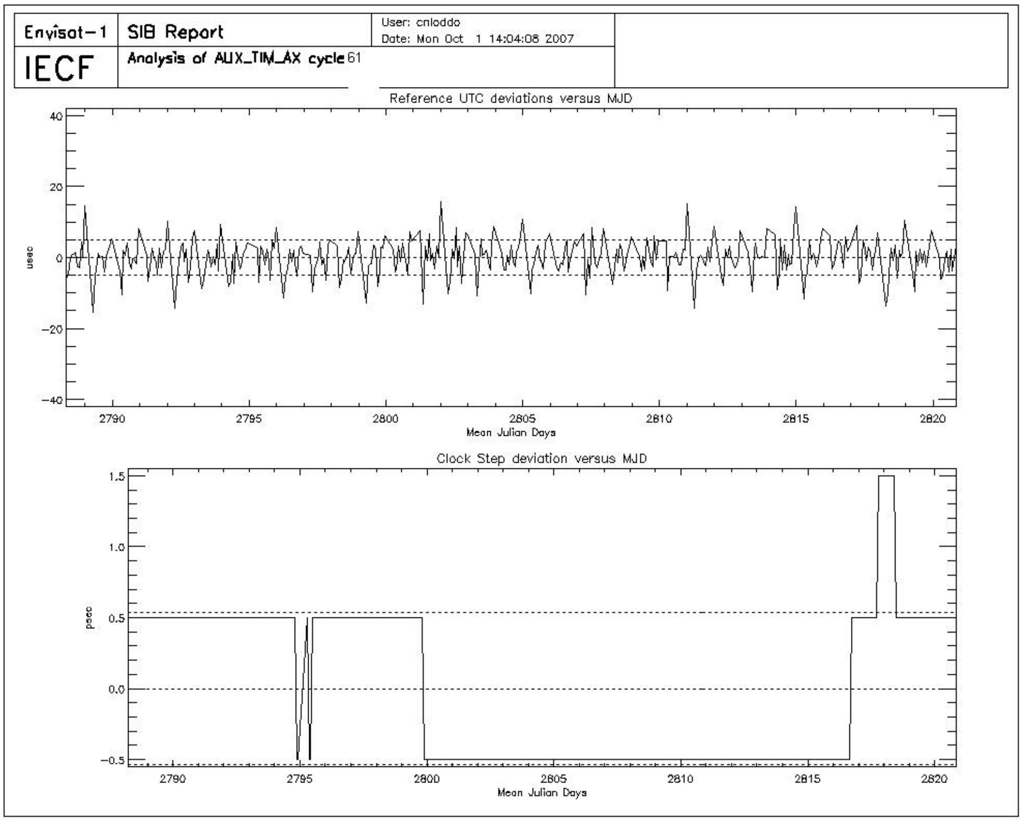

Figure 11: UTC deviations and ICU clock period for cycle 61

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 could not be updated due to operational problems.

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.

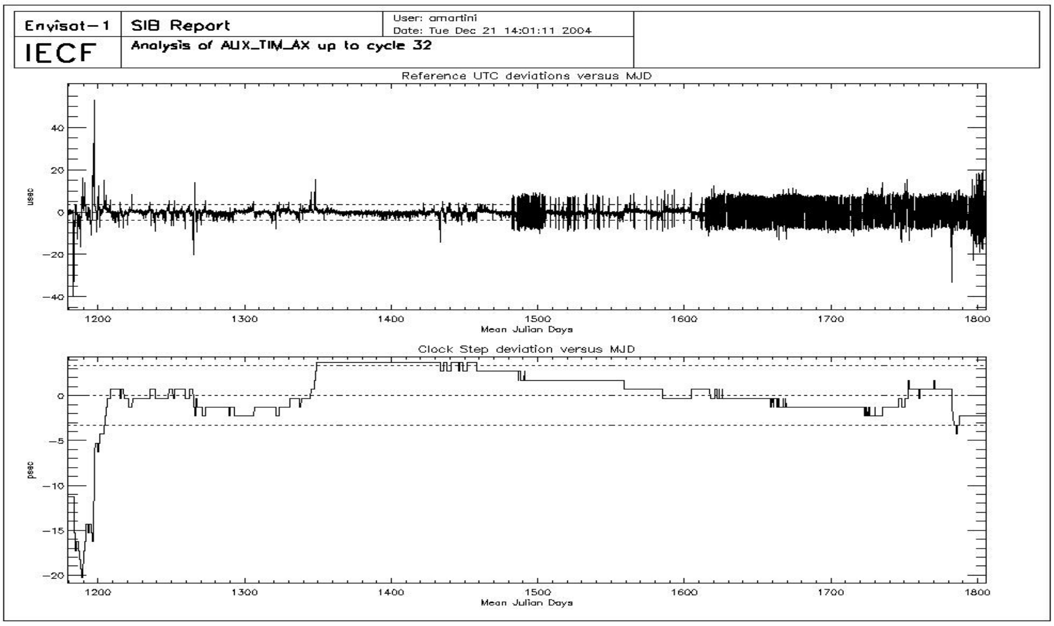

Figure 12: UTC deviations and ICU clock period up to cycle 32

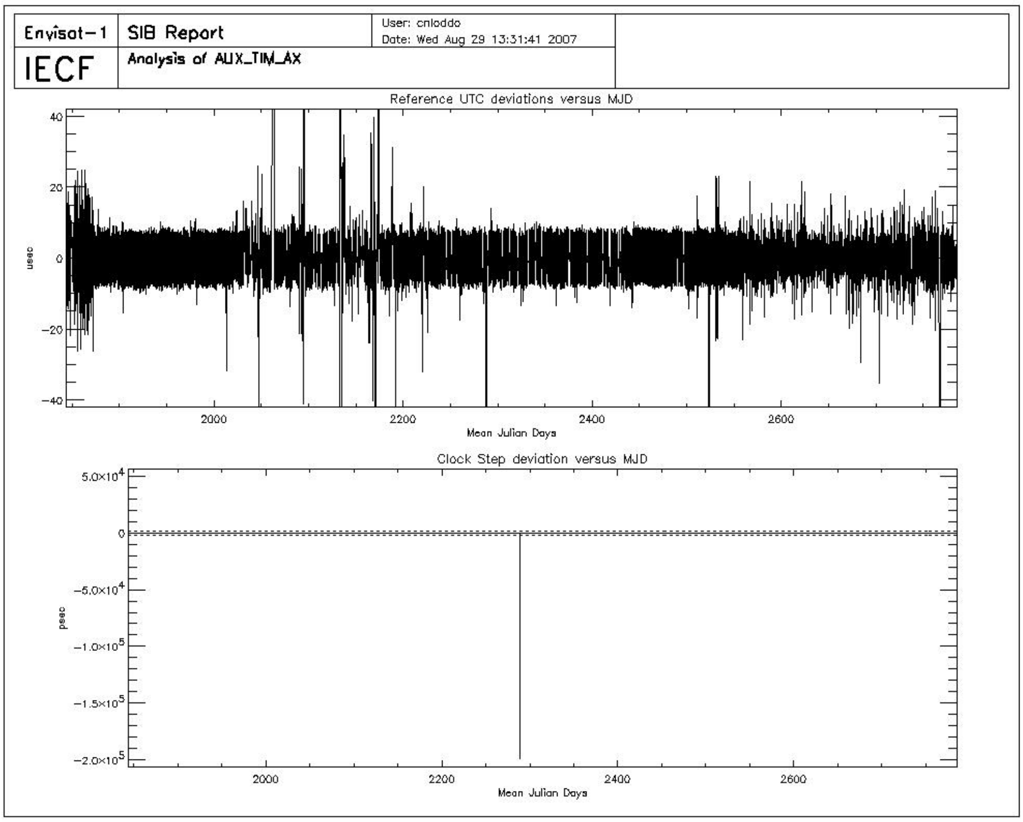

Figure 13: UTC deviations and ICU clock period from cycle 33 onwards

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 Time delay in-flight calibration factor, reported in Figure 14, shows a regular behavior as observed on previous cycles. The Ku band Sigma0 calibration factor, reported in red in Figures 15, presents a decreasing trend specially at the end of the cycle.

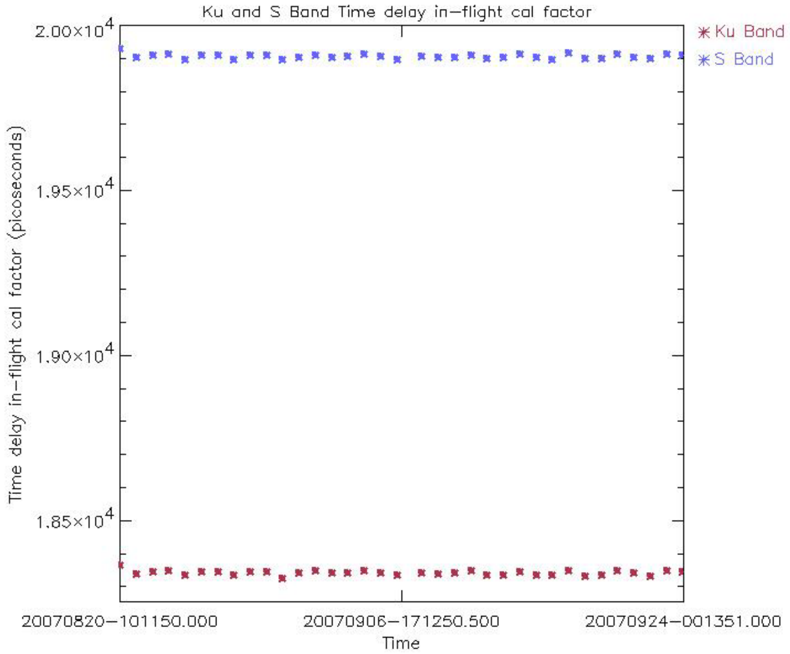

Figure 14: Ku and S Band in-flight time delay calibration factor for cycle 61 (averaged per day)

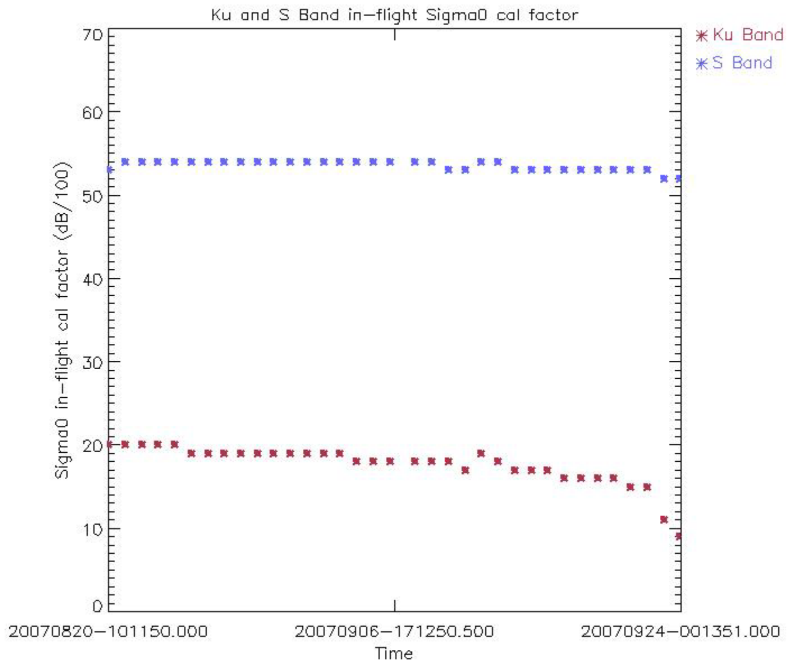

Figure 15: Ku and S Band in-flight Sigma0 calibration factor for cycle 61 (averaged per day)

Figure 16 and Figure 17 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 0.2 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.

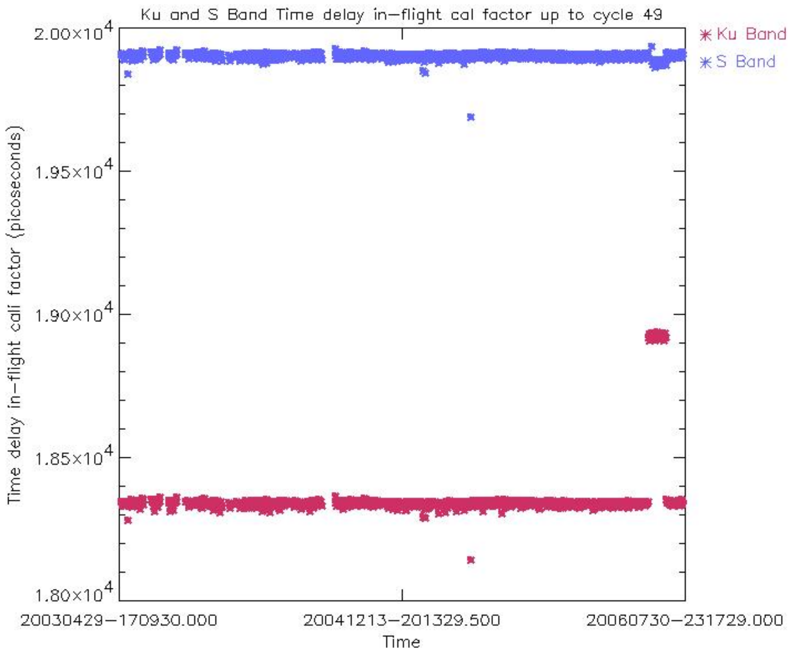

Figure 16: Ku and S Band in-flight time delay calibration factor up to cycle 49 (averaged per day)

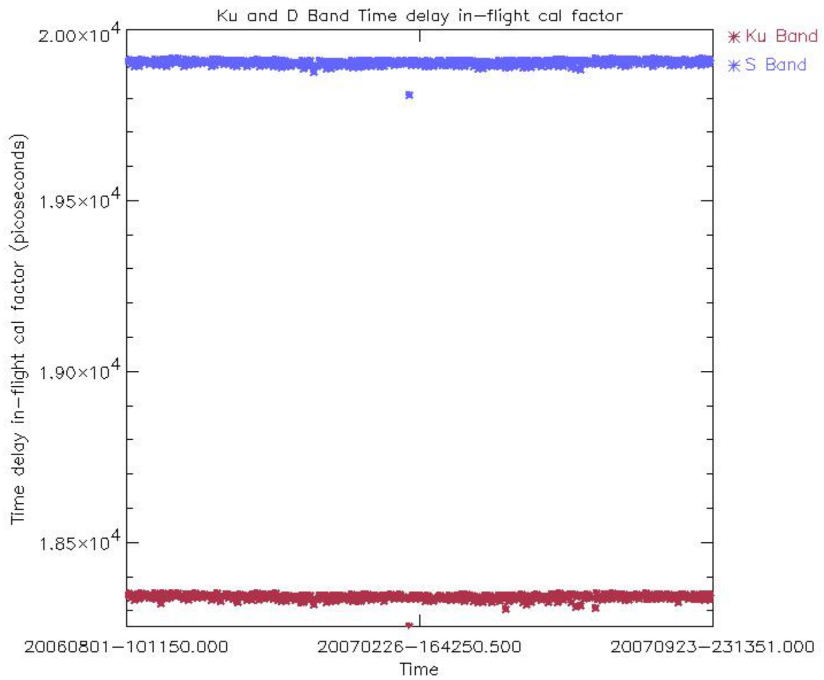

Figure 16A: Ku and S Band in-flight time delay calibration factor from cycle 50 onwards (averaged per day)

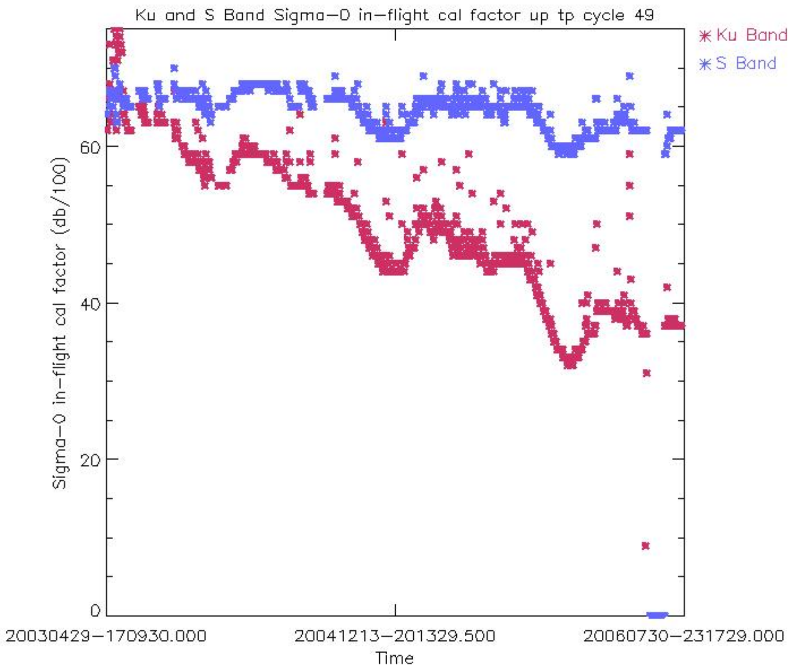

Figure 17: Ku and S Band in-flight Sigma0 calibration factor up to cycle 49 (averaged per day)

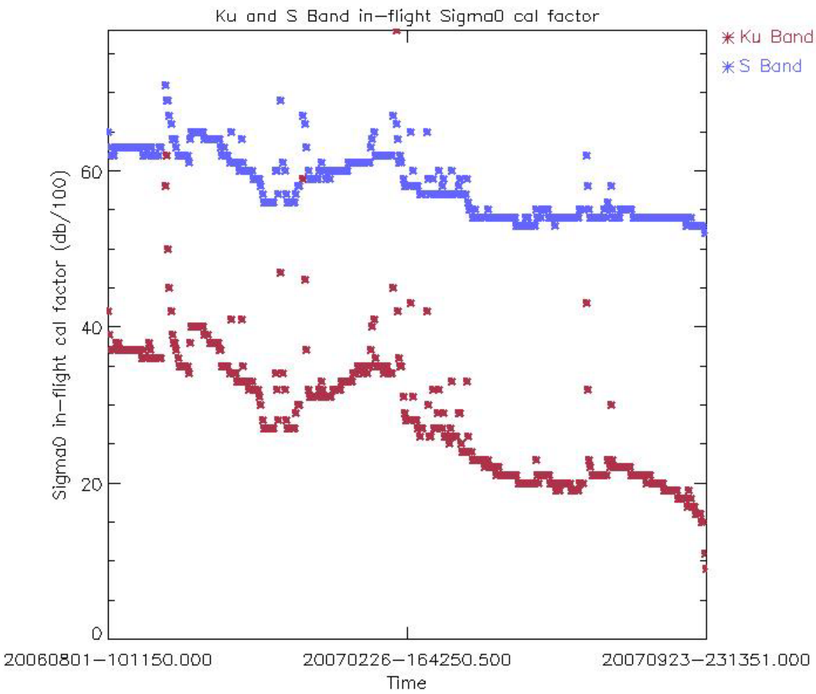

Figure 17A: Ku and S Band in-flight Sigma0 calibration factor from cycle 50 onwards (averaged per day)

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 the transponder has been moved to a permanent site located in Rome.

The acquisition planned for the 11th of September has been not been performed due to operational problems.

Absolute Orbit nb	Date of Measurement	Location / Rel. track	RA-2 resolution	Transponder Bias [dB]	ECMWF Wet Tropo. Corr. [dB]

Appendix 4 reports the transponder measurements from cycle 24 onwards.
The mean value of the estimated bias at High Resolution is 0.96 dB with a standard deviation of 0.2 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.

In Figure 18, the time behavior 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.

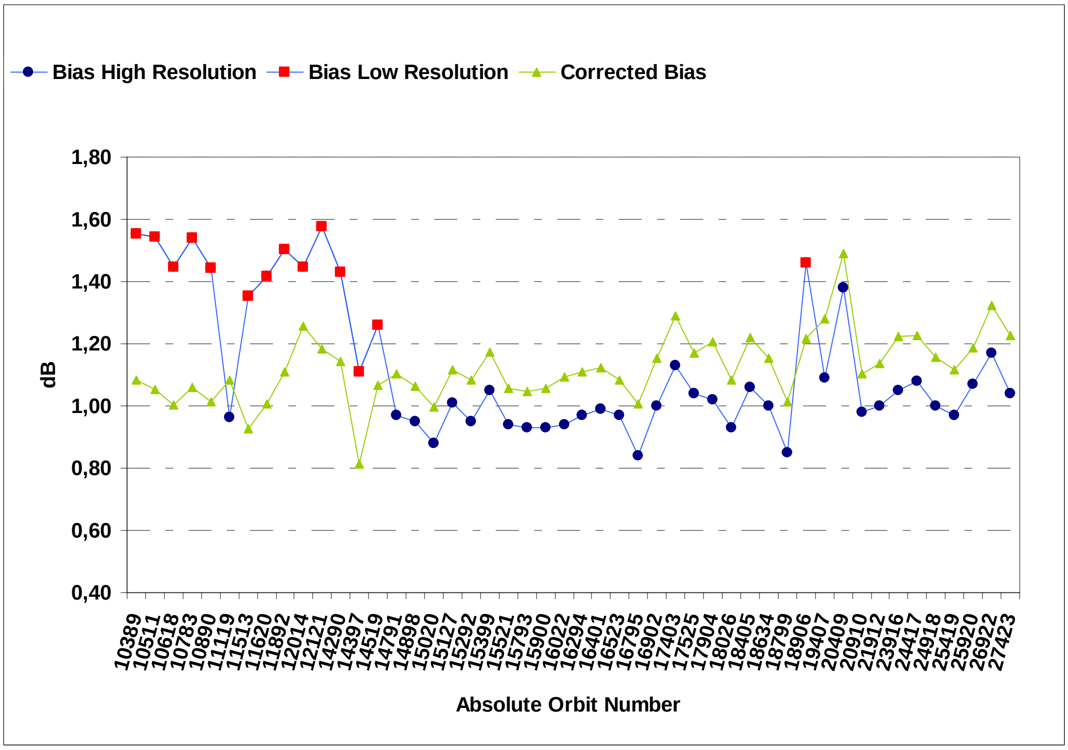

Figure 18: Time behavior of the transponder bias

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 RA2_FGD_2P 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 5.1.1.1.

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.

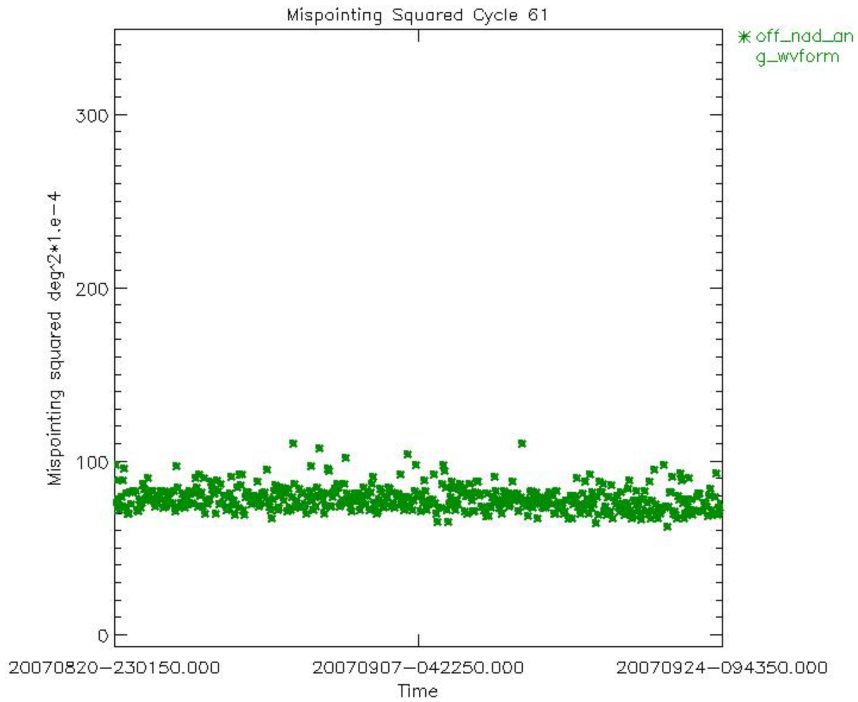

Figure 19: Smoothed mispointing squared trend for cycle 61 (deg^2*10^-4)

In Figures 20 and 20A, the overall mispointing squared trend (averaged over each orbit) is plotted for cycles 16 onwards.

The low values at the end of the 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.

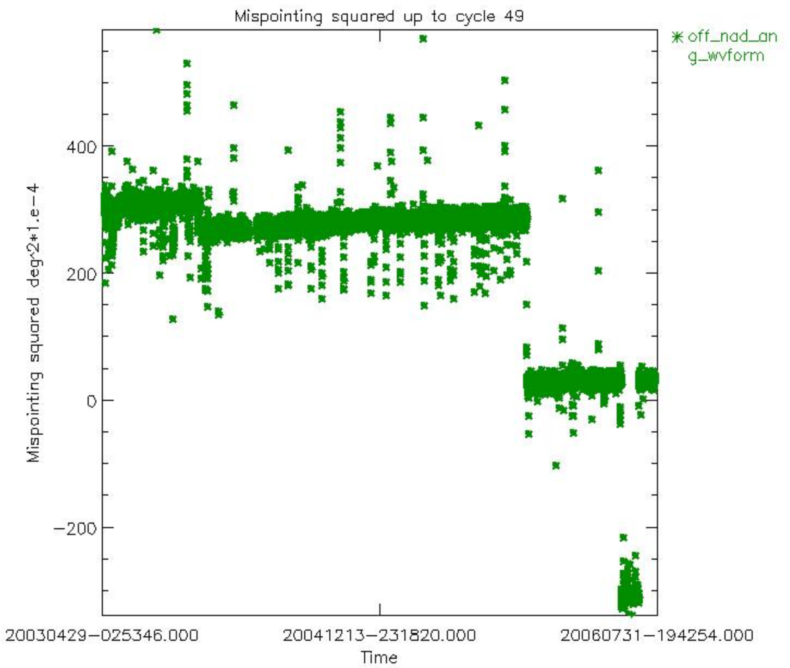

Figure 20: Smoothed mispointing squared trend until end of cycle 49 (deg^2*10e-4)

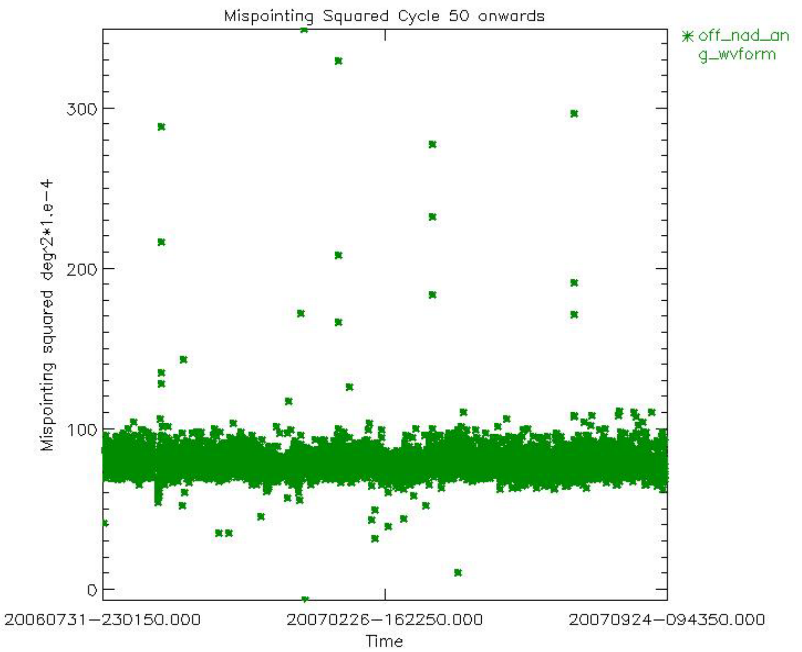

Figure 20A: Smoothed mispointing squared trend until from cycle 50 onwards (deg^2*10e-4)

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 behavior 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.

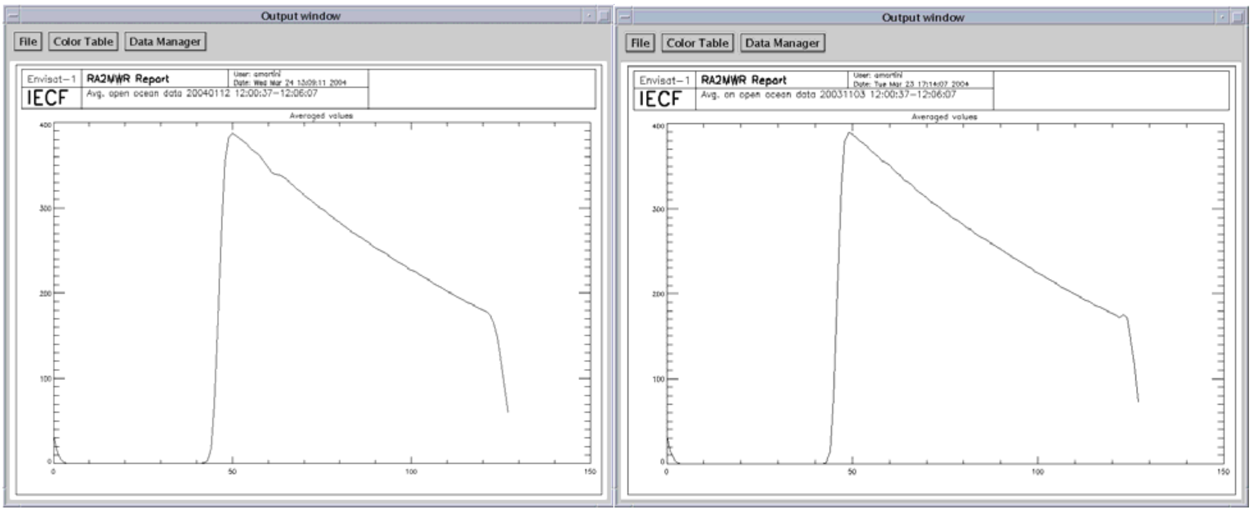

Figure 21: Open Ocean average waveforms before (left) and after an anomaly (right)

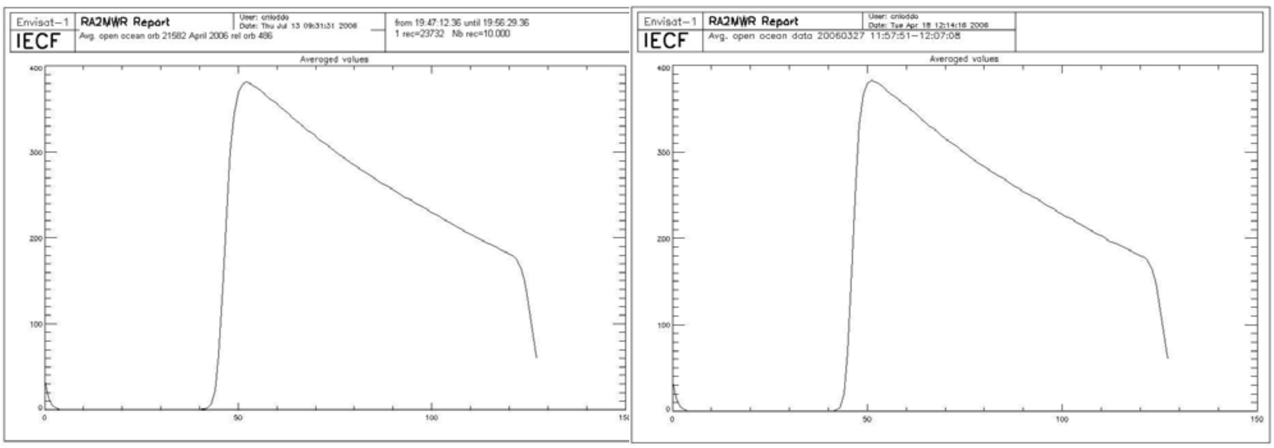

Figure 21_A: Open Ocean average waveforms before (left) and after an anomaly (right)

6.1.8 S-BAND ANOMALY

The Patch that prevents the S Band Anomaly by correcting the SW/HW malfunctioning has been uploaded again 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.

No orbits were affected by the S Band Anomaly on the current cycle.

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 behavior 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.

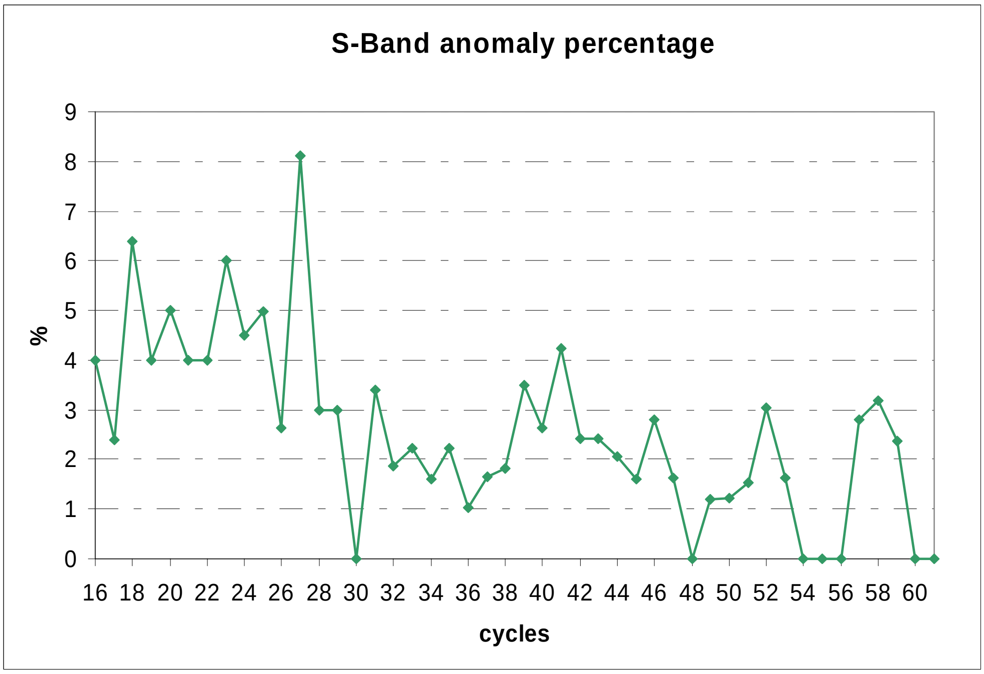

Figure 22: Percentage of data affected by the “S-Band Anomaly” for cycles 16 onwards

6.2 MWR Performance

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

6.3 DORIS Performance

For DORIS performance 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 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

7.2.2 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].

7.2.3 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.

7.2.4 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.

7.2.5 USO RANGE CORRECTION

Three different periods can be distinguished:

1) 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.

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 onwards, 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; 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.

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 of the new correction files.

> **<u>WARNING:</u> 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.**

7.2.6 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 12. 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 9.1.4)
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)

7.2.7 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 RA-2 L0 products is given.
It is easy to notice that close to the Himalayan and Rocky Mountain region one small gap, about 77 seconds, in the data is present. This is due to the daily instrument switch-offs (Heater 2 mode) performed to prevent the S-Band anomaly lasting more than half a day if it occurs.

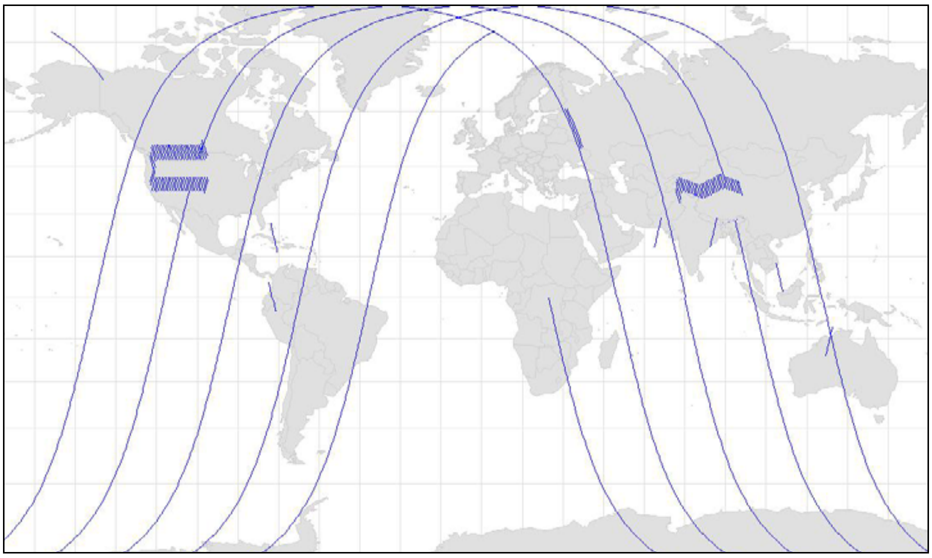

Figure 23: RA-2 L0 unavailable products for cycle 61

In Figure 24 and Table 11 (Appendix 2) the summary of unavailable RA-2 L1b products is given.

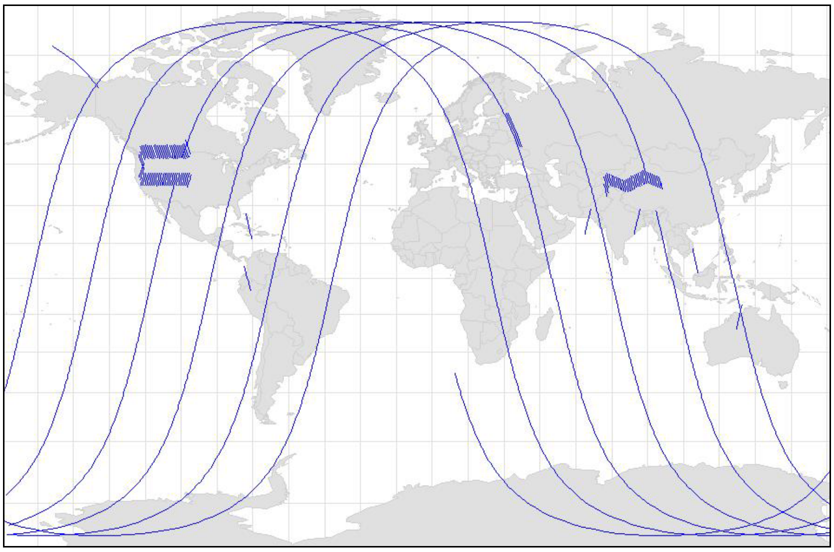

Figure 24: RA-2 L1b unavailable products for cycle 61

Hereafter the percentage of the different levels of products availability is reported.
Considering as reference the instrument unavailability, it is possible to notice that since cycle 32 the situation is slightly improved for all levels of products. The low percentage of data from cycle 56 until cycle 59 is due to the high number of RA-2 Instrument Unavailability occurred as side effect of the SPSA Patch uploaded to prevent the S Band anomaly.

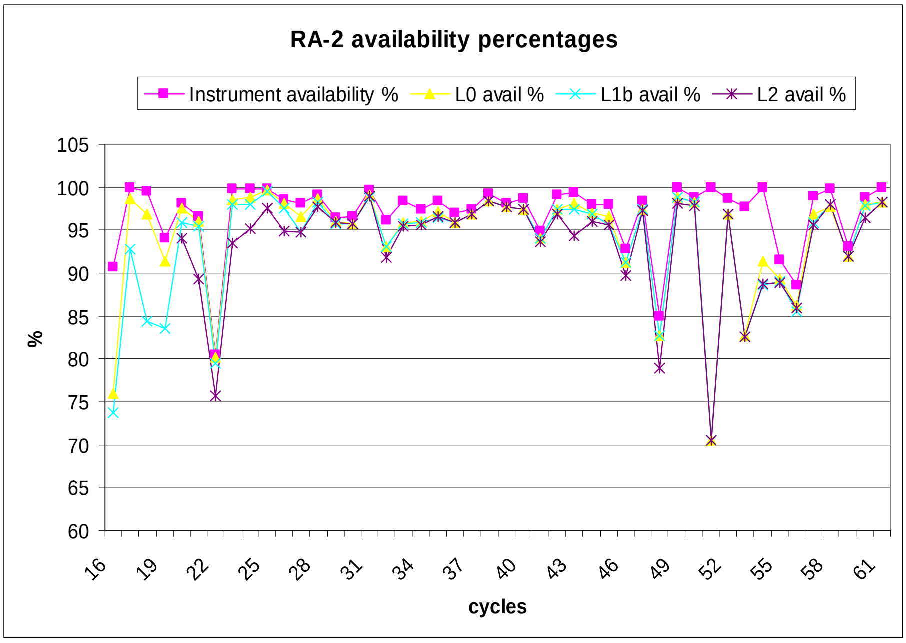

Figure 25: Percentage of Products unavailability

7.3.2 MWR

In Figure 26 and Table 10 (Appendix 2) the summary of unavailable MWR L0 products is given.

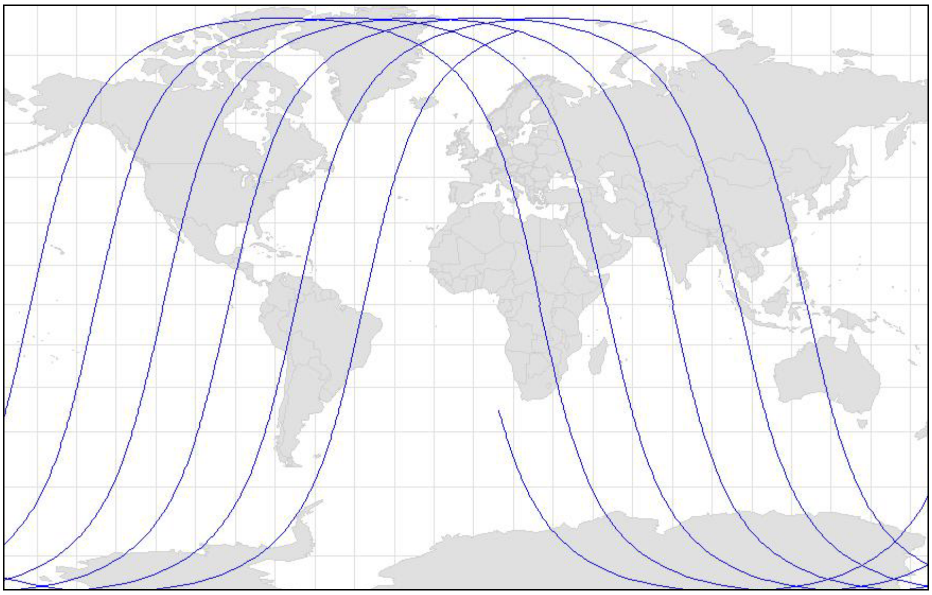

Figure 26: MWR L0 unavailable products for cycle 61

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 and all world zone criteria for RA2_FGD products.

7.4.1 ORBIT

Since the 20th of June 2007, operations date of IPF version 5.06, the DORIS Navigator usage on NRT processing has increased. The usage of DORIS on NRT processing increases the quality of FDGDR SLA. The SLA variability has decreased from 20m to about 50 cm.

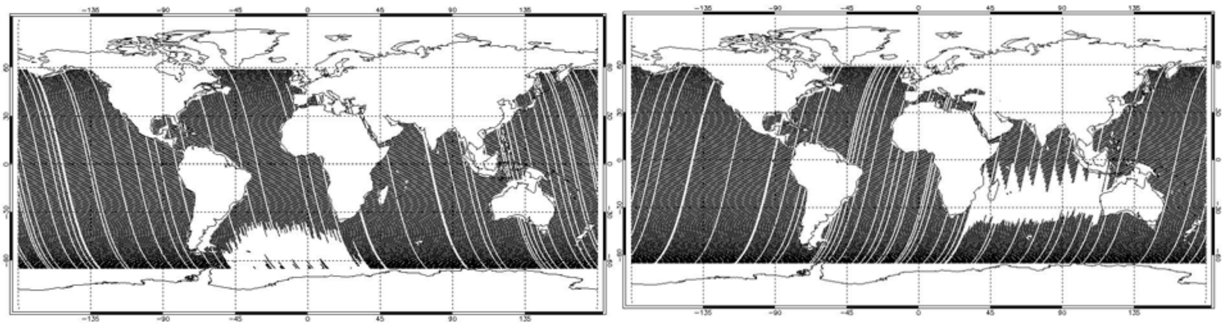

Figure 27: Ascending and Descending passes processed with DORIS on cycle 61

The quality of this Doris Navigator orbit is estimated by comparison to the MOE orbit available in the IGDR products. Figure 27A shows the [Doris navigator-MOE] radial differences on ascending

and descending passes. We can observe that the differences are between -0.4 and 0.4m with systematic ascending/descending + North/South differences.
The statistics of differences are

- mean[Doris navigator-MOE] ~-0.8cm
- standard deviation [Doris navigator-MOE] ~19.0cm

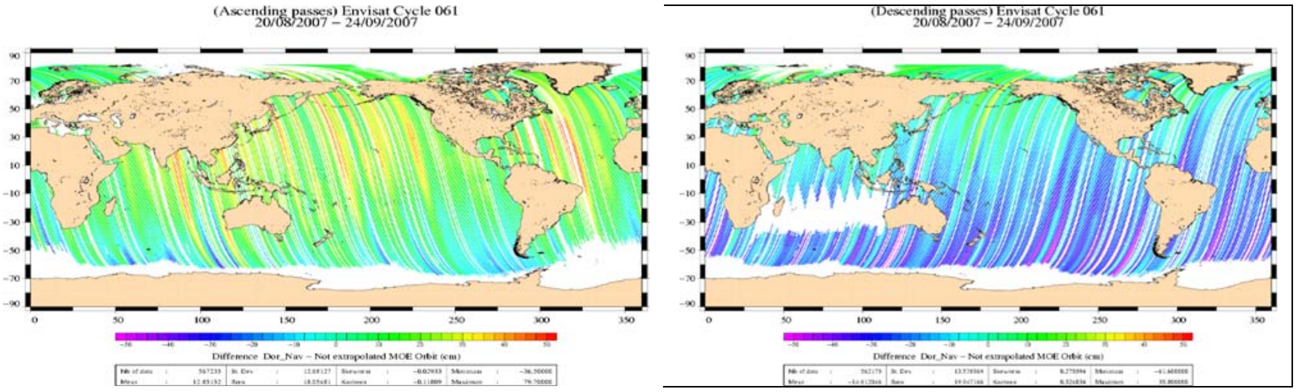

Figure 27A: [Doris navigator-MOE] differences on ascending and descending passes

7.4.2 ALTIMETER RANGE

In Figure 27B it can be observed that the altimetric range was nominal over the entire cycle 61. Some gaps can be observed and are related to some PDS failures which prevented the usage of DORIS on NRT products. The gap at the end of the plot is due to the lack of usage of meteotables, the Dry Tropospheric correction and Inverse Barometric correction were both set to default value.
The un-expected behavior of the Envisat RA-2 sensor observed since cycle 44 has disappeared on date 1st March 2007.

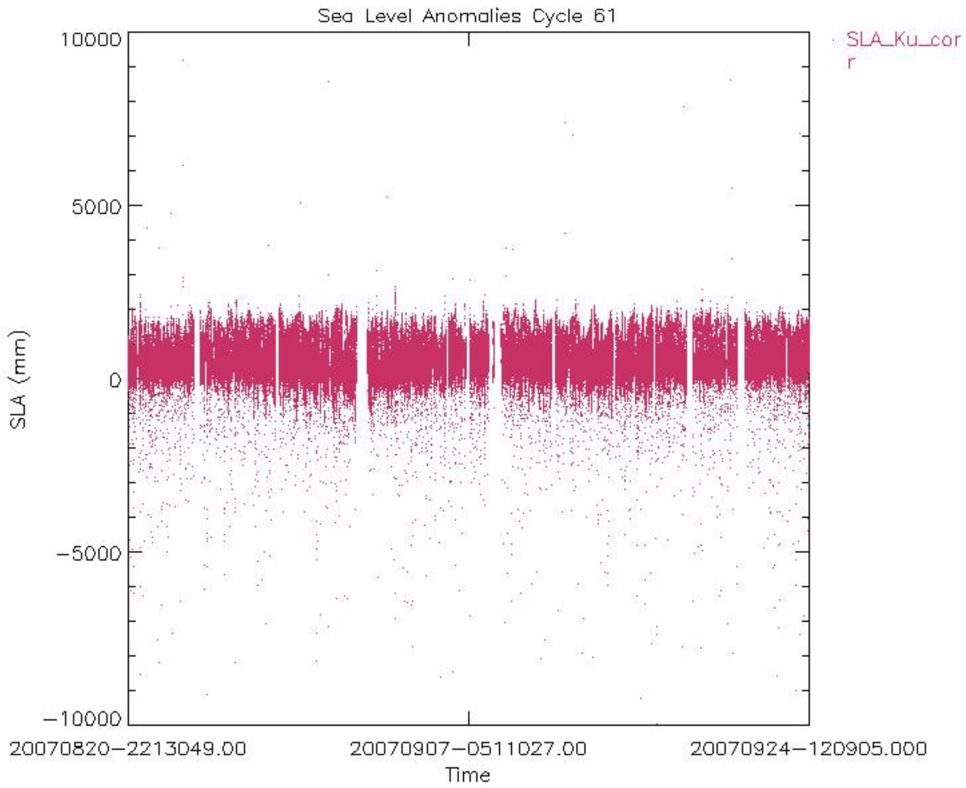

Figure 27B: Sea Level Anomalies Cycle 61, only MDSRs with valid DORIS Flag

SLA has been computed for the Ku Band, with the following corrections:
RA2_Ku_IONO, MWR_WET_TROPO, DRY_TROPO, INV_BMETER_HEIGHT, SEA_KU_BIAS

In Figure 27C 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 meter as expected. The form of the histogram is symmetric and the most of the SLA are within +-1.5 m of the peak of the histogram, which is also correct.

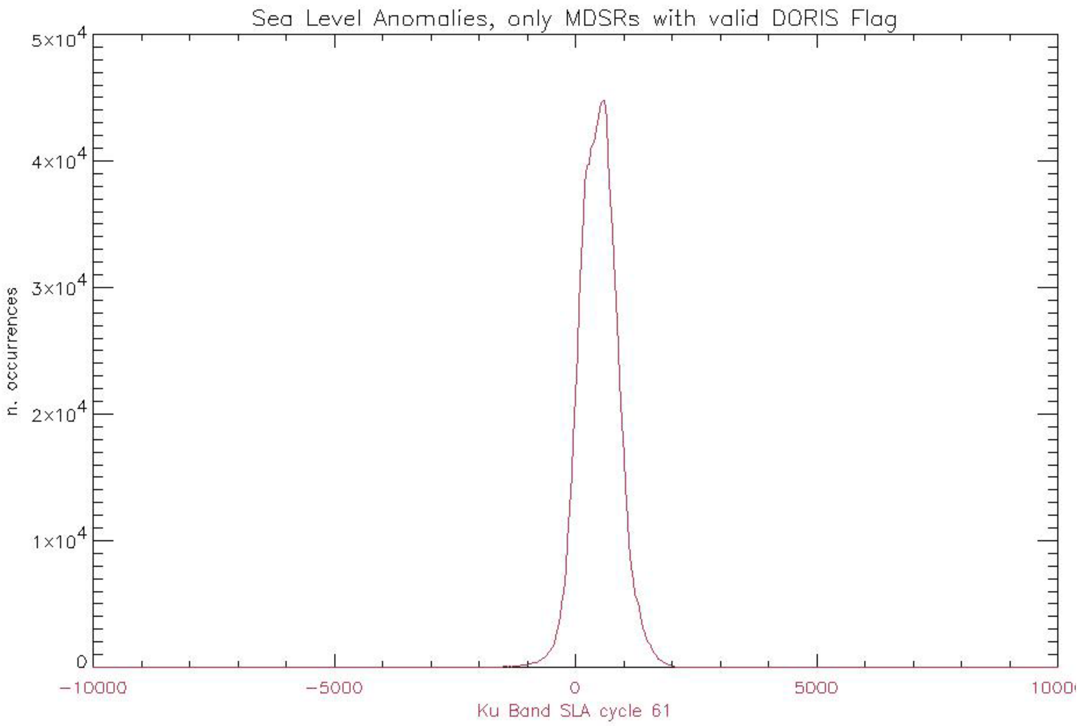

Figure 27C: Histogram of Sea Level Anomalies on Ku Band computed on MDSRs with valid DORIS Flag

7.4.3 SIGNIFICANT WAVE HEIGHT

The histogram of the SWH reported in Figure 28 shows a nominal behavior for the current cycle. The trend goes on following the behavior as detected for the previous cycle. 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 29 shows the SWH daily mean.

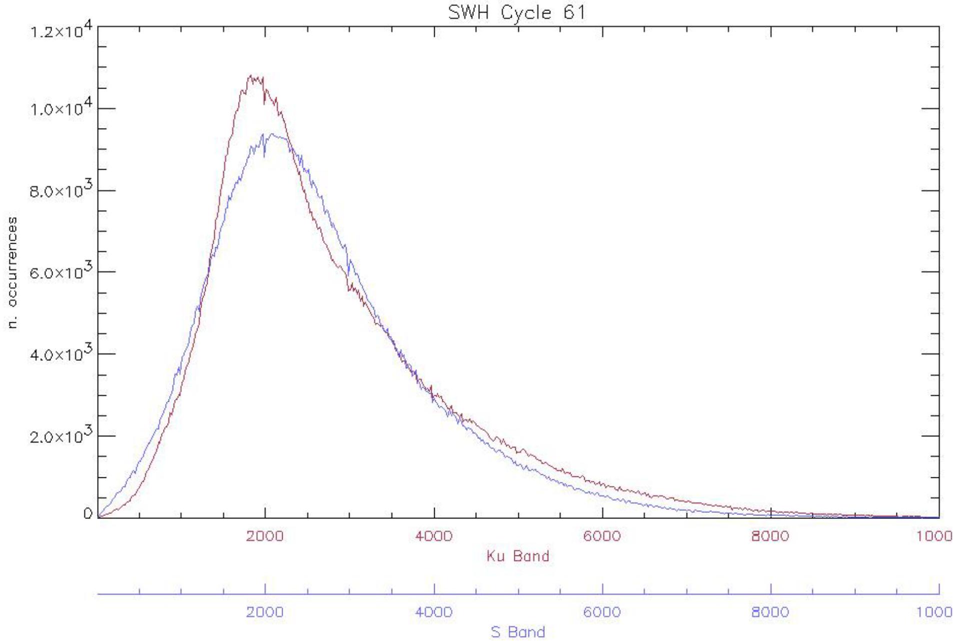

Figure 28: Histogram of Ku and S Band SWH for cycle 61

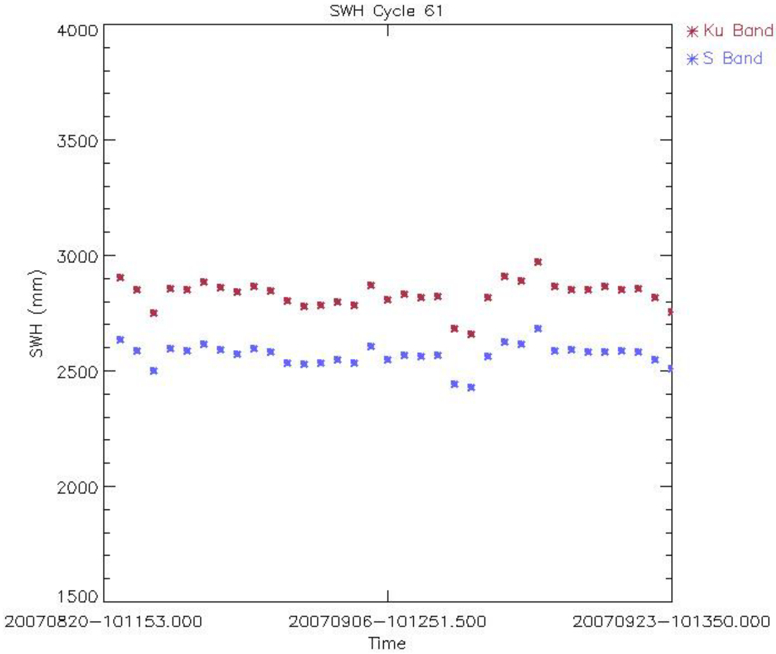

Figure 29: Ku and S SWH daily average for Cycle 61 (mm)

The SWH long term plot is reported in two plots, cycle 16 until cycle 49 on Figure 30 and cycle 50 onwards on Figure 30A. 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).

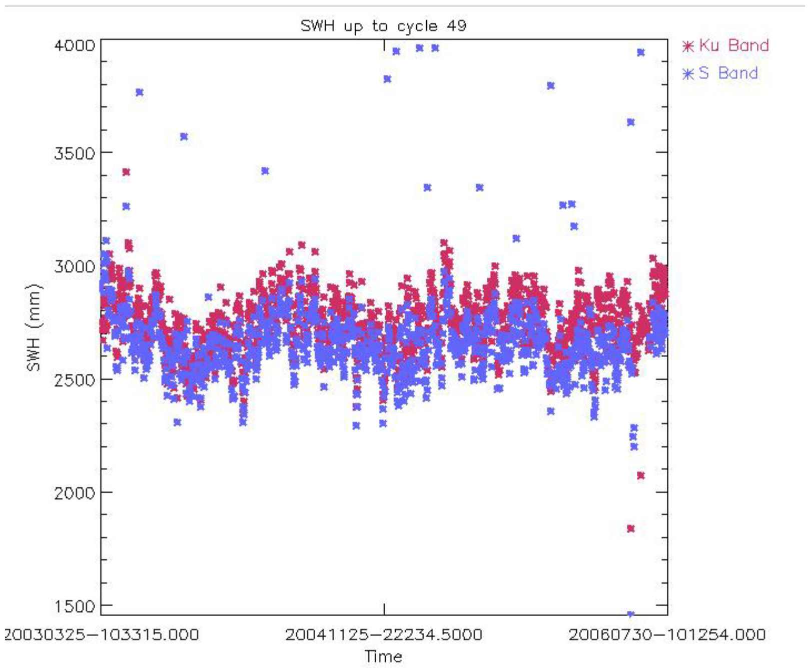

Figure 30: Ku and S SWH daily average up to cycle 49 (mm)

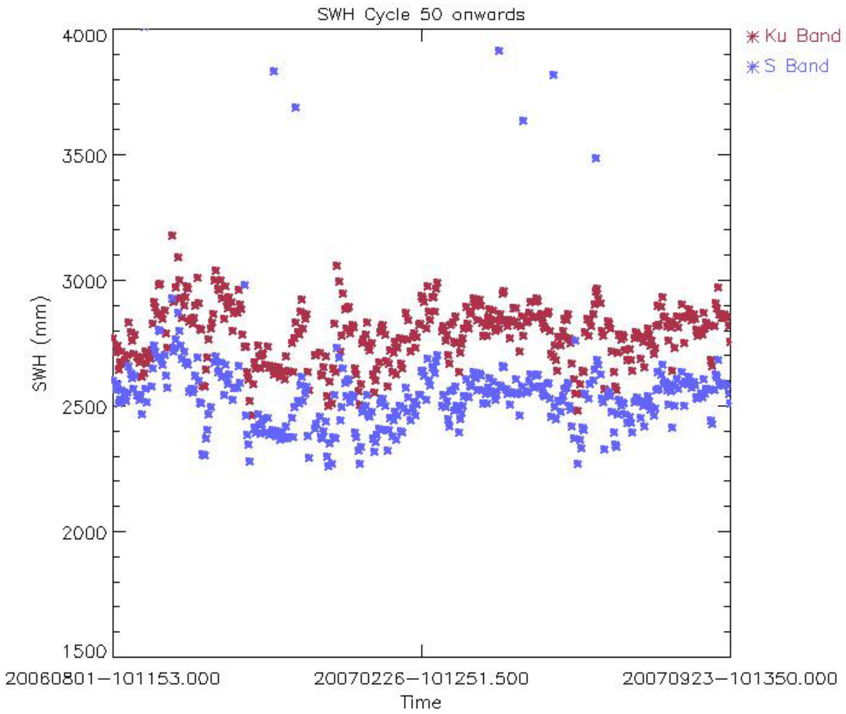

Figure 30A: Ku and S SWH daily average from cycle 50 onwards (mm)

7.4.4 BACKSCATTER COEFFICIENT – WIND SPEED

The Sigma_0 histogram both in Ku and S Band, shows secondary peaks, see Figure 31. A small investigation on this problem, performed on the data of cycle 29, demonstrated that the backscattering distribution assumes a different behavior for different sea conditions [R-17]. Indeed, for both bands, 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).

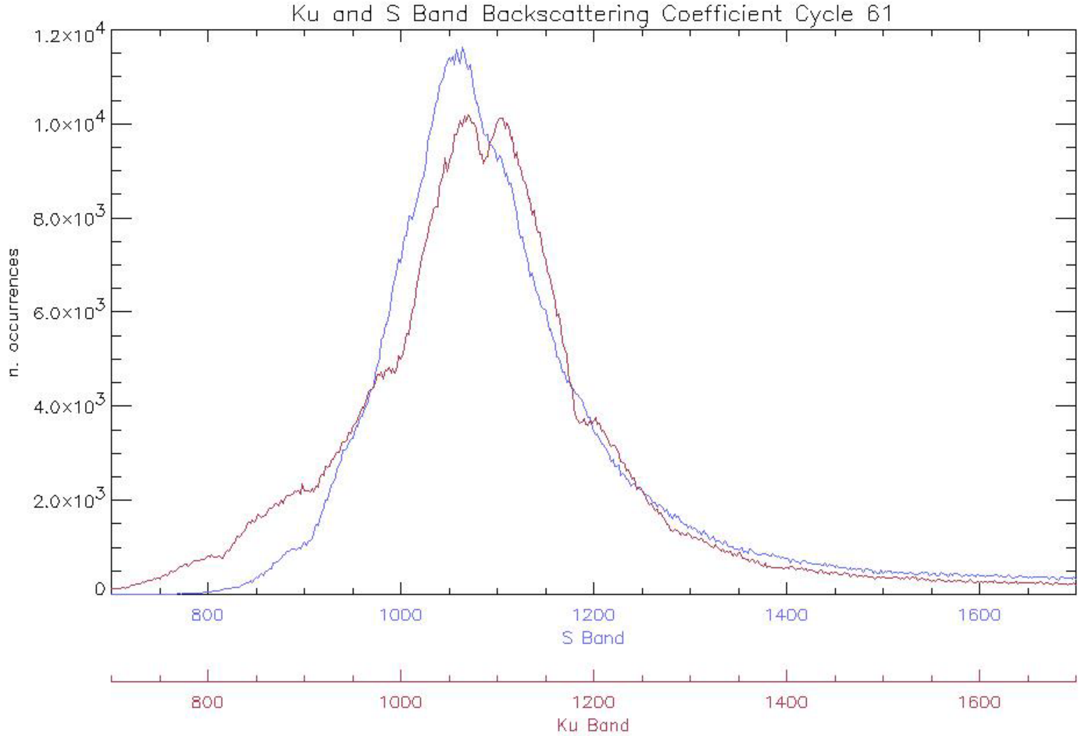

Figure 31: Histogram of Ku and S Band Backscattering Coefficient for cycle 61

In Figure 32, the backscattering coefficient daily average, computed for only ocean data, trend is reported. The trend shows a nominal behavior for both bands.

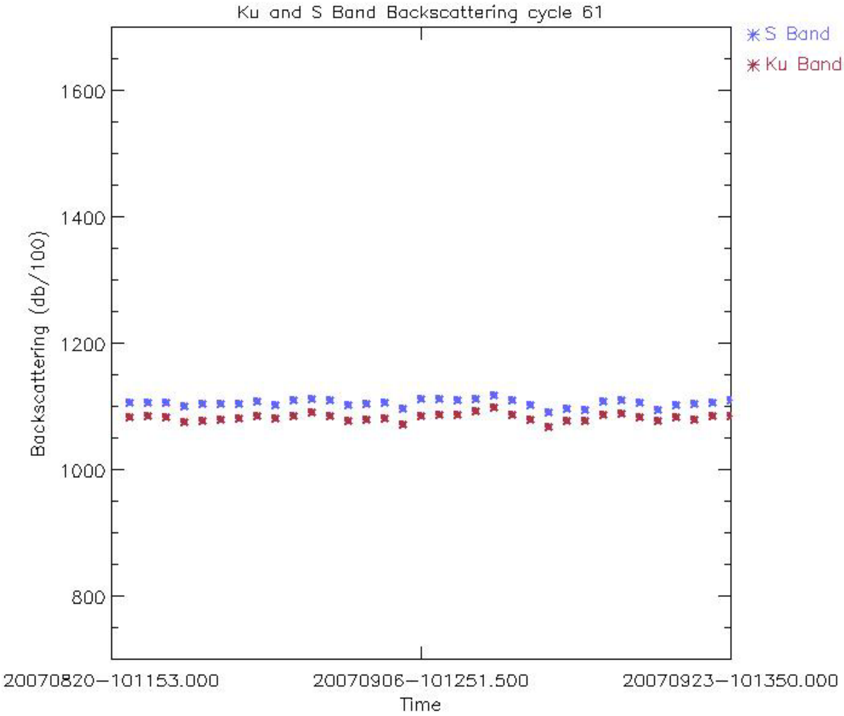

Figure 32: Ku and S Sigma_0 daily average for cycle 61 (dB/100)

The histograms of Wind Speed computed for the Ku-band and the time behavior during the current cycle are reported in Figure 33 and 34, respectively. Given that the wind table has been updated since IPF version 5.02, S.Abdallah Table is now used, the wind takes values between 1.18m/ and 21.30m/s.

The largest peak present in the histogram (about 50000 data for Wind < 1.2m/s) was removed from the plot in order to have the complete picture of the wind histogram.

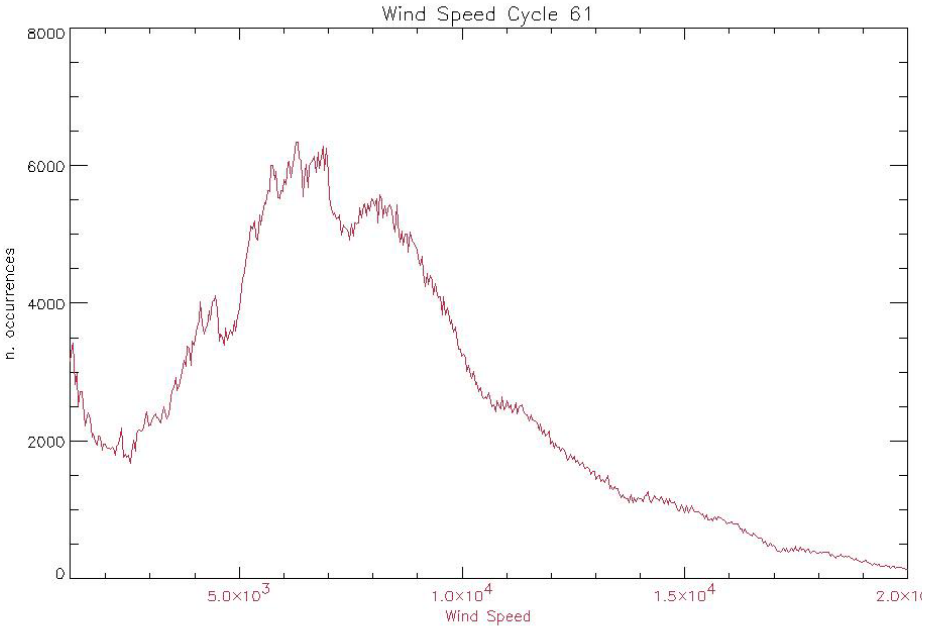

Figure 33: Histogram of Ku Wind Speed for cycle 61 (mm/sec)

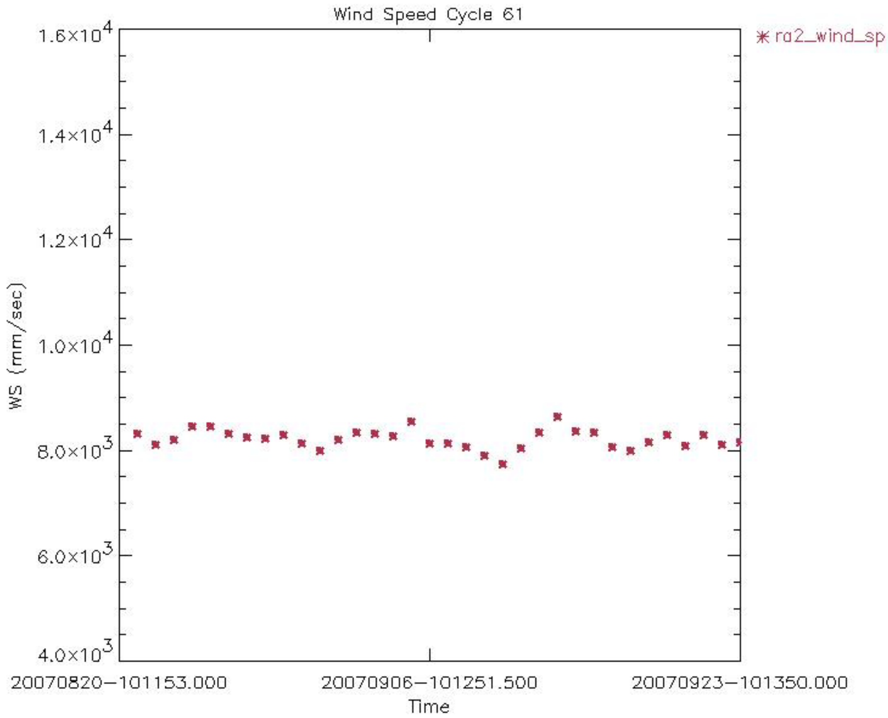

Figure 34: Ku Band Wind Speed daily average for cycle 61 (mm/s)

The Ku-Band Sigma_0 trend, reported hereafter (Figure 35 and 35A), 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 30 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 21 June 2006. 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).

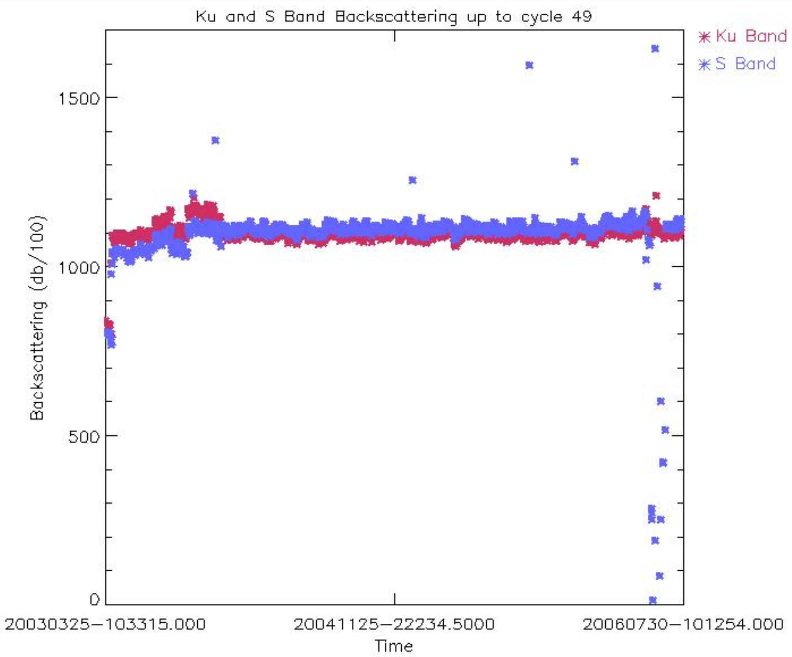

Figure 35: Ku and S band Backscattering daily averages up to cycle 49 (dB/100)

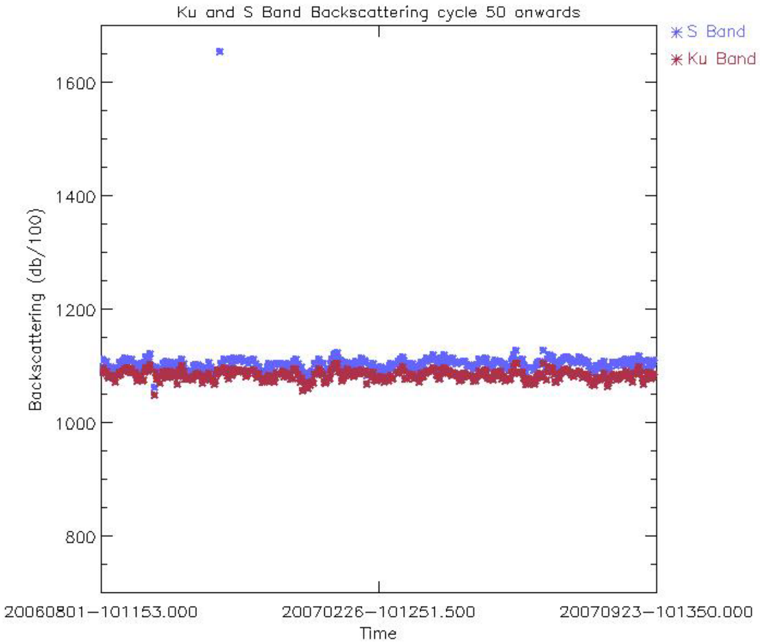

Figure 35A: Ku and S band Backscattering daily averages from cycle 50 onwards (dB/100)

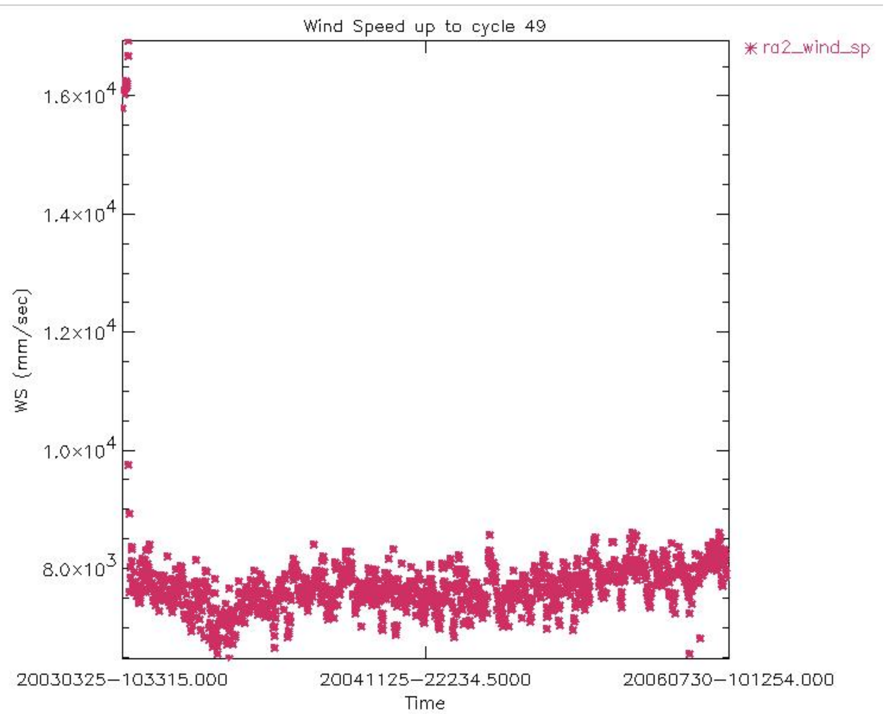

Figure 36: Wind Speed daily averages up to cycle 49 (mm/s)

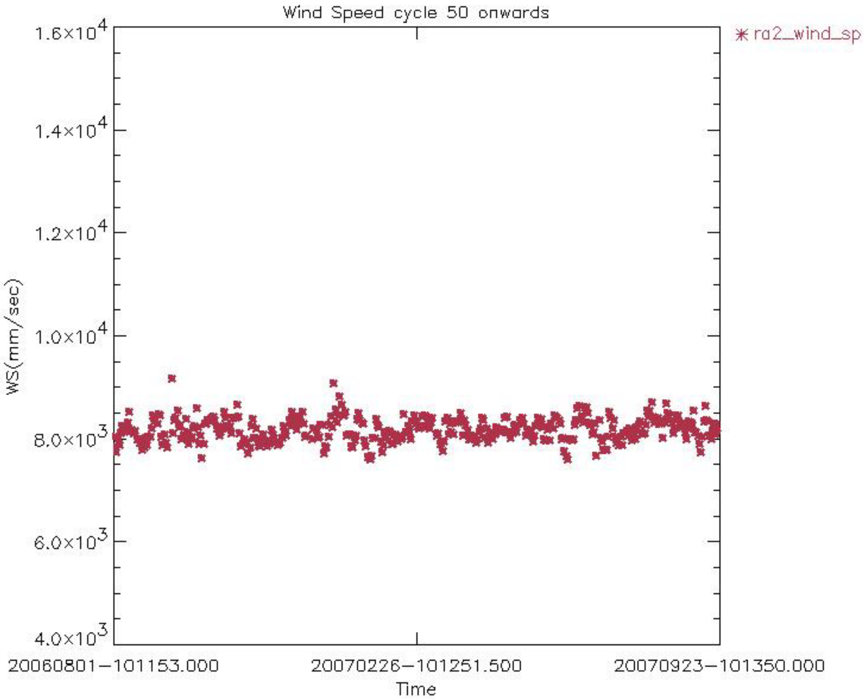

Figure 36A: Wind Speed daily averages from cycle 50 onwards (mm/s)

8 PARTICULAR INVESTIGATIONS

The Patch that prevents the S Band Anomaly by correcting the SW/HW malfunctioning has been uploaded again on 27th of June 2007. 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.

A low number of valid IF Masks has been obtained since cycle 56. On the current cycle the number of valid IF Masks remains the same as previous cycle.
The problem is under investigation and new in-flight tests will be performed during cycle 62 aimed to understand and possibly fix the problem.

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 upgrade (RA-2 & MWR)	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

		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 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		

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		
V5.0.2	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 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	New table in SOI file Two needed parameters in SOI file New format Addition of GOT2000.2 TLD New DEM AUX file (MACESS) merge of ACE land elevation data and Smith and Sandwell ocean bathymetry	RA2_CHD_AX RA2_SOI_AX RA2_SOI_AX RA2_SOI_AX RA2_TLG_AX AUX_DEM_AX
V 5.03	Sep. 19, 2006			
V 5.06	Jun. 20, 2007			

APPENDIX 2: AVAILABILITY:

Table 6: RA-2 L0, L1b and L2 FGD Data products availability summary for Cycle 61

Start orbit	Stop orbit	Time [sec] instrum. Unavail-ability	Data Unav Time [sec]	Time [sec] L0 gaps	Time [sec] L1b gaps	Time [sec] L2 (FGD) gaps	% instrum. avail.	% data avail.	% L0 avail.	% L1b avail.	% L2 (FGD) avail.
28612	28712	0,00	1878,85	1505,07	1499,73	1522,16	100	99,69	99,44	99,44	99,44
28712	28812	0,00	2314,39	1811,57	1811,57	1835,13	100	99,62	99,32	99,32	99,31
28812	28913	0,00	2156,58	1842,27	1836,87	1854,35	100	99,64	99,34	99,34	99,34
28913	29013	0,00	2068,42	2196,41	2187,91	2218,62	100	99,66	99,29	99,30	99,29
29013	29113	33636,00	2456,88	35662,30	35648,84	35677,91	99%	99,59	93,70	93,70	93,69

Table 7: MWR L0 Data products availability summary for Cycle 61

Start orbit	Stop orbit	Time [sec] instrum. unavailability	Time [sec] L0 gaps	% instrum. avail.	% L0 avail.
28612	28712	0,00	0,00	100	100
28712	28812	0,00	0,00	100	100
28812	28913	0,00	0,00	100	100
28913	29013	0,00	0,00	100	100
29013	29113	33636,00	34386,91	99,97	94,28

Table 8: DORIS L0 Data products availability summary for Cycle 61

Start orbit	Stop orbit	Time [sec] instrum. unavailability	Time [sec] L0 gaps	% instrum. avail.	% L0 avail.
28612	28712	0,00	2425,00	100,00	99,80
28712	28812	0,00	2679,00	100,00	99,78
28812	28913	0,00	1658,00	100,00	99,86
28913	29013	0,00	2802,00	100,00	99,77
29013	29113	33636,00	71460,82	99,97	94,09

Table 9: List of gaps for RA-2 L0 Cycle 61

Start date	Start time	Stop date	Stop time	Duration [sec]	Start orbit	Stop orbit	Reason
21-AUG-2007	4.55.21	21-AUG-2007	4.56.39	78	28616	28616	PDS_UNKNOWN_FAILURE
21-AUG-2007	16.36.40	21-AUG-2007	16.37.58	78	28623	28623	PDS_UNKNOWN_FAILURE
22-AUG-2007	4.23.44	22-AUG-2007	4.25.02	78	28630	28630	PDS_UNKNOWN_FAILURE
22-AUG-2007	16.04.37	22-AUG-2007	16.05.54	77	28637	28637	PDS_UNKNOWN_FAILURE
22-AUG-2007	18.13.38	22-AUG-2007	18.14.56	78	28638	28638	PDS_UNKNOWN_FAILURE
23-AUG-2007	15.33.51	23-AUG-2007	15.35.09	78	28651	28651	PDS_UNKNOWN_FAILURE
23-AUG-2007	17.42.01	23-AUG-2007	17.43.19	78	28652	28652	PDS_UNKNOWN_FAILURE
24-AUG-2007	3.05.46	24-AUG-2007	3.08.45	179	28657	28658	PDS_UNKNOWN_FAILURE
24-AUG-2007	5.01.06	24-AUG-2007	5.02.23	77	28659	28659	PDS_UNKNOWN_FAILURE
24-AUG-2007	16.41.50	24-AUG-2007	16.43.08	78	28666	28666	PDS_UNKNOWN_FAILURE
25-AUG-2007	4.29.28	25-AUG-2007	4.30.46	78	28673	28673	PDS_UNKNOWN_FAILURE
25-AUG-2007	16.10.19	25-AUG-2007	16.11.36	77	28680	28680	PDS_UNKNOWN_FAILURE
25-AUG-2007	18.19.23	25-AUG-2007	18.20.41	78	28681	28681	PDS_UNKNOWN_FAILURE
26-AUG-2007	15.36.26	26-AUG-2007	15.36.28	2	28694	28694	PDS_UNKNOWN_FAILURE

26-AUG-2007	15.39.27	26-AUG-2007	15.40.44	77	28694	28694	PDS_UNKNOWN_FAILURE
26-AUG-2007	17.47.46	26-AUG-2007	17.49.04	78	28695	28695	PDS_UNKNOWN_FAILURE
27-AUG-2007	5.06.50	27-AUG-2007	5.08.08	78	28702	28702	PDS_UNKNOWN_FAILURE
27-AUG-2007	15.05.59	27-AUG-2007	15.06.01	2	28708	28708	PDS_UNKNOWN_FAILURE
27-AUG-2007	15.07.18	27-AUG-2007	15.08.36	78	28708	28708	PDS_UNKNOWN_FAILURE
27-AUG-2007	17.16.09	27-AUG-2007	17.17.27	78	28709	28709	PDS_UNKNOWN_FAILURE
28-AUG-2007	4.35.13	28-AUG-2007	4.36.31	78	28716	28716	PDS_UNKNOWN_FAILURE
28-AUG-2007	16.16.13	28-AUG-2007	16.17.31	78	28723	28723	PDS_UNKNOWN_FAILURE
28-AUG-2007	18.25.08	28-AUG-2007	18.26.26	78	28724	28724	PDS_UNKNOWN_FAILURE
29-AUG-2007	4.03.59	29-AUG-2007	4.05.17	78	28730	28730	PDS_UNKNOWN_FAILURE
29-AUG-2007	15.45.02	29-AUG-2007	15.46.19	77	28737	28737	PDS_UNKNOWN_FAILURE
29-AUG-2007	17.53.31	29-AUG-2007	17.54.48	77	28738	28738	PDS_UNKNOWN_FAILURE
30-AUG-2007	5.12.35	30-AUG-2007	5.13.53	78	28745	28745	PDS_UNKNOWN_FAILURE
30-AUG-2007	15.13.12	30-AUG-2007	15.14.30	78	28751	28751	PDS_UNKNOWN_FAILURE
30-AUG-2007	17.21.53	30-AUG-2007	17.23.11	78	28752	28752	PDS_UNKNOWN_FAILURE
31-AUG-2007	4.40.58	31-AUG-2007	4.42.15	77	28759	28759	PDS_UNKNOWN_FAILURE
31-AUG-2007	14.31.54	31-AUG-2007	14.34.53	179	28765	28765	PDS_UNKNOWN_FAILURE
31-AUG-2007	16.22.07	31-AUG-2007	16.23.25	78	28766	28766	PDS_UNKNOWN_FAILURE
31-AUG-2007	18.30.52	31-AUG-2007	18.32.10	78	28767	28767	PDS_UNKNOWN_FAILURE
01-SEP-2007	4.09.21	01-SEP-2007	4.10.38	77	28773	28773	PDS_UNKNOWN_FAILURE
01-SEP-2007	15.50.37	01-SEP-2007	15.51.55	78	28780	28780	PDS_UNKNOWN_FAILURE
01-SEP-2007	17.59.15	01-SEP-2007	18.00.33	78	28781	28781	PDS_UNKNOWN_FAILURE
02-SEP-2007	5.18.19	02-SEP-2007	5.19.37	78	28788	28788	PDS_UNKNOWN_FAILURE
02-SEP-2007	15.19.07	02-SEP-2007	15.20.24	77	28794	28794	PDS_UNKNOWN_FAILURE
02-SEP-2007	17.27.38	02-SEP-2007	17.28.56	78	28795	28795	PDS_UNKNOWN_FAILURE
03-SEP-2007	4.46.42	03-SEP-2007	4.48.00	78	28802	28802	PDS_UNKNOWN_FAILURE
03-SEP-2007	16.28.02	03-SEP-2007	16.29.20	78	28809	28809	PDS_UNKNOWN_FAILURE
03-SEP-2007	18.35.47	03-SEP-2007	18.37.05	78	28810	28810	PDS_UNKNOWN_FAILURE
04-SEP-2007	4.15.05	04-SEP-2007	4.16.23	78	28816	28816	PDS_UNKNOWN_FAILURE
04-SEP-2007	15.56.12	04-SEP-2007	15.57.30	78	28823	28823	PDS_UNKNOWN_FAILURE
04-SEP-2007	18.05.00	04-SEP-2007	18.06.18	78	28824	28824	PDS_UNKNOWN_FAILURE
05-SEP-2007	5.23.55	05-SEP-2007	5.25.13	78	28831	28831	PDS_UNKNOWN_FAILURE
05-SEP-2007	5.52.54	05-SEP-2007	5.55.53	179	28831	28831	PDS_UNKNOWN_FAILURE
05-SEP-2007	15.22.17	05-SEP-2007	15.22.20	3	28837	28837	PDS_UNKNOWN_FAILURE
05-SEP-2007	15.25.01	05-SEP-2007	15.26.19	78	28837	28837	PDS_UNKNOWN_FAILURE
05-SEP-2007	17.33.23	05-SEP-2007	17.34.40	77	28838	28838	PDS_UNKNOWN_FAILURE
05-SEP-2007	18.49.53	05-SEP-2007	18.52.53	180	28839	28839	PDS_UNKNOWN_FAILURE
06-SEP-2007	4.52.27	06-SEP-2007	4.53.44	77	28845	28845	PDS_UNKNOWN_FAILURE
06-SEP-2007	16.33.56	06-SEP-2007	16.35.13	77	28852	28852	PDS_UNKNOWN_FAILURE
07-SEP-2007	4.20.50	07-SEP-2007	4.22.07	77	28859	28859	PDS_UNKNOWN_FAILURE
07-SEP-2007	16.01.47	07-SEP-2007	16.03.05	78	28866	28866	PDS_UNKNOWN_FAILURE
07-SEP-2007	18.10.44	07-SEP-2007	18.12.02	78	28867	28867	PDS_UNKNOWN_FAILURE

08-SEP-2007	5.28.53	08-SEP-2007	5.30.11	78	28874	28874	PDS_UNKNOWN_FAILURE
08-SEP-2007	15.27.56	08-SEP-2007	15.27.58	2	28880	28880	PDS_UNKNOWN_FAILURE
08-SEP-2007	15.30.55	08-SEP-2007	15.32.13	78	28880	28880	PDS_UNKNOWN_FAILURE
08-SEP-2007	17.39.07	08-SEP-2007	17.40.25	78	28881	28881	PDS_UNKNOWN_FAILURE
09-SEP-2007	4.58.11	09-SEP-2007	4.59.29	78	28888	28888	PDS_UNKNOWN_FAILURE
09-SEP-2007	16.39.18	09-SEP-2007	16.40.36	78	28895	28895	PDS_UNKNOWN_FAILURE
10-SEP-2007	4.26.34	10-SEP-2007	4.27.52	78	28902	28902	PDS_UNKNOWN_FAILURE
10-SEP-2007	16.07.22	10-SEP-2007	16.08.40	78	28909	28909	PDS_UNKNOWN_FAILURE
10-SEP-2007	18.16.29	10-SEP-2007	18.17.46	77	28910	28910	PDS_UNKNOWN_FAILURE
11-SEP-2007	1.13.47	11-SEP-2007	1.16.46	179	28914	28914	PDS_UNKNOWN_FAILURE
11-SEP-2007	15.36.37	11-SEP-2007	15.37.54	77	28923	28923	PDS_UNKNOWN_FAILURE
11-SEP-2007	17.44.51	11-SEP-2007	17.46.09	78	28924	28924	PDS_UNKNOWN_FAILURE
12-SEP-2007	5.03.56	12-SEP-2007	5.05.13	77	28931	28931	PDS_UNKNOWN_FAILURE
12-SEP-2007	16.44.18	12-SEP-2007	16.45.36	78	28938	28938	PDS_UNKNOWN_FAILURE
12-SEP-2007	17.13.26	12-SEP-2007	17.14.44	78	28938	28938	PDS_UNKNOWN_FAILURE
13-SEP-2007	4.32.18	13-SEP-2007	4.33.36	78	28945	28945	PDS_UNKNOWN_FAILURE
13-SEP-2007	16.13.14	13-SEP-2007	16.14.31	77	28952	28952	PDS_UNKNOWN_FAILURE
13-SEP-2007	18.22.13	13-SEP-2007	18.23.31	78	28953	28953	PDS_UNKNOWN_FAILURE
14-SEP-2007	4.29.31	14-SEP-2007	4.32.30	179	28959	28959	PDS_UNKNOWN_FAILURE
14-SEP-2007	15.42.12	14-SEP-2007	15.43.29	77	28966	28966	PDS_UNKNOWN_FAILURE
14-SEP-2007	17.50.36	14-SEP-2007	17.51.54	78	28967	28967	PDS_UNKNOWN_FAILURE
15-SEP-2007	5.08.03	15-SEP-2007	5.08.05	2	28974	28974	PDS_UNKNOWN_FAILURE
15-SEP-2007	5.09.40	15-SEP-2007	5.10.58	78	28974	28974	PDS_UNKNOWN_FAILURE
15-SEP-2007	15.10.13	15-SEP-2007	15.11.30	77	28980	28980	PDS_UNKNOWN_FAILURE
15-SEP-2007	17.18.59	15-SEP-2007	17.20.16	77	28981	28981	PDS_UNKNOWN_FAILURE
16-SEP-2007	2.48.46	16-SEP-2007	2.51.45	179	28987	28987	PDS_UNKNOWN_FAILURE
16-SEP-2007	4.38.03	16-SEP-2007	4.39.21	78	28988	28988	PDS_UNKNOWN_FAILURE
16-SEP-2007	16.19.08	16-SEP-2007	16.20.25	77	28995	28995	PDS_UNKNOWN_FAILURE
16-SEP-2007	18.27.57	16-SEP-2007	18.29.15	78	28996	28996	PDS_UNKNOWN_FAILURE
17-SEP-2007	4.06.33	17-SEP-2007	4.07.51	78	29002	29002	PDS_UNKNOWN_FAILURE
17-SEP-2007	5.53.00	17-SEP-2007	5.56.00	180	29003	29003	PDS_UNKNOWN_FAILURE
17-SEP-2007	15.44.54	17-SEP-2007	15.44.56	2	29009	29009	PDS_UNKNOWN_FAILURE
17-SEP-2007	15.47.47	17-SEP-2007	15.49.04	77	29009	29009	PDS_UNKNOWN_FAILURE
17-SEP-2007	17.56.20	17-SEP-2007	17.57.38	78	29010	29010	PDS_UNKNOWN_FAILURE
18-SEP-2007	5.15.24	18-SEP-2007	5.16.42	78	29017	29017	PDS_UNKNOWN_FAILURE
18-SEP-2007	15.13.47	18-SEP-2007	15.13.50	3	29023	29023	PDS_UNKNOWN_FAILURE
18-SEP-2007	15.16.07	18-SEP-2007	15.17.24	77	29023	29023	PDS_UNKNOWN_FAILURE
18-SEP-2007	17.23.06	18-SEP-2007	17.23.08	2	29024	29024	PDS_UNKNOWN_FAILURE
18-SEP-2007	17.24.43	18-SEP-2007	17.26.01	78	29024	29024	PDS_UNKNOWN_FAILURE
19-SEP-2007	4.43.47	19-SEP-2007	4.45.05	78	29031	29031	PDS_UNKNOWN_FAILURE
19-SEP-2007	16.25.02	19-SEP-2007	16.26.19	77	29038	29038	PDS_UNKNOWN_FAILURE
19-SEP-2007	18.32.05	19-SEP-2007	18.32.07	2	29039	29039	PDS_UNKNOWN_FAILURE

19-SEP-2007	18.33.10	19-SEP-2007	18.34.28	78	29039	29039	PDS_UNKNOWN_FAILURE
20-SEP-2007	4.12.10	20-SEP-2007	4.13.28	78	29045	29045	PDS_UNKNOWN_FAILURE
20-SEP-2007	15.50.38	20-SEP-2007	15.50.40	2	29052	29052	PDS_UNKNOWN_FAILURE
20-SEP-2007	15.53.21	20-SEP-2007	15.54.39	78	29052	29052	PDS_UNKNOWN_FAILURE
20-SEP-2007	18.02.05	20-SEP-2007	18.03.22	77	29053	29053	PDS_UNKNOWN_FAILURE
21-SEP-2007	5.19.31	21-SEP-2007	5.19.34	3	29060	29060	PDS_UNKNOWN_FAILURE
21-SEP-2007	5.21.09	21-SEP-2007	5.22.26	77	29060	29060	PDS_UNKNOWN_FAILURE
21-SEP-2007	15.22.01	21-SEP-2007	15.23.19	78	29066	29066	PDS_UNKNOWN_FAILURE
21-SEP-2007	17.30.27	21-SEP-2007	17.31.45	78	29067	29067	PDS_UNKNOWN_FAILURE
21-SEP-2007	18.46.59	21-SEP-2007	18.49.58	179	29068	29068	PDS_UNKNOWN_FAILURE
22-SEP-2007	4.49.31	22-SEP-2007	4.50.49	78	29074	29074	PDS_UNKNOWN_FAILURE
22-SEP-2007	16.30.56	22-SEP-2007	16.32.14	78	29081	29081	PDS_UNKNOWN_FAILURE
23-SEP-2007	4.17.54	23-SEP-2007	4.19.12	78	29088	29088	PDS_UNKNOWN_FAILURE
23-SEP-2007	15.58.56	23-SEP-2007	16.00.14	78	29095	29095	PDS_UNKNOWN_FAILURE
23-SEP-2007	18.07.49	23-SEP-2007	18.09.07	78	29096	29096	PDS_UNKNOWN_FAILURE
24-SEP-2007	5.25.13	24-SEP-2007	5.25.16	3	29103	29103	PDS_UNKNOWN_FAILURE
24-SEP-2007	5.26.15	24-SEP-2007	5.27.32	77	29103	29103	PDS_UNKNOWN_FAILURE
24-SEP-2007	12.23.51	24-SEP-2007	15.25.06	10875	29107	29109	Instrument Unavailability
24-SEP-2007	15.27.55	24-SEP-2007	17.34.37	7602	29109	29110	Instrument Unavailability
24-SEP-2007	17.36.12	24-SEP-2007	21.48.51	15159	29110	29112	Instrument Unavailability

Table 10: List of gaps for MWR L0 Cycle 61

Start date	Start time	Stop date	Stop time	Duration [sec]	Start orbit	Stop orbit	Reason
24-SEP-2007	12.22.57	24-SEP-2007	21.48.51	33954	29107	29112	Instrument Unavailability

Table 11: List of gaps for RA-2 L1b Cycle 61

Start date	Start time	Stop date	Stop time	Duration [sec]	Start orbit	Stop orbit	Reason
21-AUG-2007	4.55.21	21-AUG-2007	4.56.39	78	28616	28616	PDS_UNKNOWN_FAILURE
21-AUG-2007	16.36.40	21-AUG-2007	16.37.58	78	28623	28623	PDS_UNKNOWN_FAILURE
22-AUG-2007	4.23.44	22-AUG-2007	4.25.02	78	28630	28630	PDS_UNKNOWN_FAILURE
22-AUG-2007	16.04.37	22-AUG-2007	16.05.54	77	28637	28637	PDS_UNKNOWN_FAILURE
22-AUG-2007	18.13.38	22-AUG-2007	18.14.56	78	28638	28638	PDS_UNKNOWN_FAILURE
23-AUG-2007	15.33.51	23-AUG-2007	15.35.09	78	28651	28651	PDS_UNKNOWN_FAILURE
23-AUG-2007	17.42.01	23-AUG-2007	17.43.19	78	28652	28652	PDS_UNKNOWN_FAILURE
24-AUG-2007	3.05.47	24-AUG-2007	3.08.45	178	28657	28658	PDS_UNKNOWN_FAILURE
24-AUG-2007	5.01.06	24-AUG-2007	5.02.23	77	28659	28659	PDS_UNKNOWN_FAILURE
24-AUG-2007	16.41.50	24-AUG-2007	16.43.08	78	28666	28666	PDS_UNKNOWN_FAILURE
25-AUG-2007	4.29.28	25-AUG-2007	4.30.46	78	28673	28673	PDS_UNKNOWN_FAILURE

25-AUG-2007	16.10.19	25-AUG-2007	16.11.36	77	28680	28680	PDS_UNKNOWN_FAILURE
25-AUG-2007	18.19.23	25-AUG-2007	18.20.41	78	28681	28681	PDS_UNKNOWN_FAILURE
26-AUG-2007	15.39.27	26-AUG-2007	15.40.44	77	28694	28694	PDS_UNKNOWN_FAILURE
26-AUG-2007	17.47.46	26-AUG-2007	17.49.04	78	28695	28695	PDS_UNKNOWN_FAILURE
27-AUG-2007	5.06.50	27-AUG-2007	5.08.08	78	28702	28702	PDS_UNKNOWN_FAILURE
27-AUG-2007	15.07.18	27-AUG-2007	15.08.36	78	28708	28708	PDS_UNKNOWN_FAILURE
27-AUG-2007	17.16.09	27-AUG-2007	17.17.27	78	28709	28709	PDS_UNKNOWN_FAILURE
28-AUG-2007	4.35.13	28-AUG-2007	4.36.31	78	28716	28716	PDS_UNKNOWN_FAILURE
28-AUG-2007	16.16.13	28-AUG-2007	16.17.31	78	28723	28723	PDS_UNKNOWN_FAILURE
28-AUG-2007	18.25.08	28-AUG-2007	18.26.26	78	28724	28724	PDS_UNKNOWN_FAILURE
29-AUG-2007	4.03.59	29-AUG-2007	4.05.17	78	28730	28730	PDS_UNKNOWN_FAILURE
29-AUG-2007	15.45.02	29-AUG-2007	15.46.19	77	28737	28737	PDS_UNKNOWN_FAILURE
29-AUG-2007	15.46.19	29-AUG-2007	15.46.20	1	28737	28737	PDS_UNKNOWN_FAILURE
29-AUG-2007	17.53.31	29-AUG-2007	17.54.48	77	28738	28738	PDS_UNKNOWN_FAILURE
30-AUG-2007	5.12.35	30-AUG-2007	5.13.53	78	28745	28745	PDS_UNKNOWN_FAILURE
30-AUG-2007	15.13.12	30-AUG-2007	15.14.30	78	28751	28751	PDS_UNKNOWN_FAILURE
30-AUG-2007	17.21.53	30-AUG-2007	17.23.11	78	28752	28752	PDS_UNKNOWN_FAILURE
31-AUG-2007	4.40.58	31-AUG-2007	4.42.15	77	28759	28759	PDS_UNKNOWN_FAILURE
31-AUG-2007	14.31.55	31-AUG-2007	14.34.53	178	28765	28765	PDS_UNKNOWN_FAILURE
31-AUG-2007	16.22.07	31-AUG-2007	16.23.25	78	28766	28766	PDS_UNKNOWN_FAILURE
31-AUG-2007	18.30.52	31-AUG-2007	18.32.10	78	28767	28767	PDS_UNKNOWN_FAILURE
01-SEP-2007	4.09.21	01-SEP-2007	4.10.38	77	28773	28773	PDS_UNKNOWN_FAILURE
01-SEP-2007	15.50.37	01-SEP-2007	15.51.55	78	28780	28780	PDS_UNKNOWN_FAILURE
01-SEP-2007	17.59.15	01-SEP-2007	18.00.33	78	28781	28781	PDS_UNKNOWN_FAILURE
02-SEP-2007	5.18.19	02-SEP-2007	5.19.37	78	28788	28788	PDS_UNKNOWN_FAILURE
02-SEP-2007	15.19.07	02-SEP-2007	15.20.24	77	28794	28794	PDS_UNKNOWN_FAILURE
02-SEP-2007	17.27.38	02-SEP-2007	17.28.56	78	28795	28795	PDS_UNKNOWN_FAILURE
03-SEP-2007	4.46.42	03-SEP-2007	4.48.00	78	28802	28802	PDS_UNKNOWN_FAILURE
03-SEP-2007	16.28.02	03-SEP-2007	16.29.20	78	28809	28809	PDS_UNKNOWN_FAILURE
03-SEP-2007	18.35.47	03-SEP-2007	18.37.05	78	28810	28810	PDS_UNKNOWN_FAILURE
04-SEP-2007	4.15.05	04-SEP-2007	4.16.23	78	28816	28816	PDS_UNKNOWN_FAILURE
04-SEP-2007	15.56.12	04-SEP-2007	15.57.30	78	28823	28823	PDS_UNKNOWN_FAILURE
04-SEP-2007	18.05.00	04-SEP-2007	18.06.18	78	28824	28824	PDS_UNKNOWN_FAILURE
05-SEP-2007	5.23.55	05-SEP-2007	5.25.13	78	28831	28831	PDS_UNKNOWN_FAILURE
05-SEP-2007	5.52.55	05-SEP-2007	5.55.53	178	28831	28831	PDS_UNKNOWN_FAILURE
05-SEP-2007	15.22.18	05-SEP-2007	15.22.20	2	28837	28837	PDS_UNKNOWN_FAILURE
05-SEP-2007	15.25.01	05-SEP-2007	15.26.19	78	28837	28837	PDS_UNKNOWN_FAILURE
05-SEP-2007	17.33.23	05-SEP-2007	17.34.40	77	28838	28838	PDS_UNKNOWN_FAILURE
05-SEP-2007	18.49.54	05-SEP-2007	18.52.53	179	28839	28839	PDS_UNKNOWN_FAILURE
06-SEP-2007	4.52.27	06-SEP-2007	4.53.44	77	28845	28845	PDS_UNKNOWN_FAILURE

06-SEP-2007	16.33.56	06-SEP-2007	16.35.13	77	28852	28852	PDS_UNKNOWN_FAILURE
07-SEP-2007	4.20.50	07-SEP-2007	4.22.07	77	28859	28859	PDS_UNKNOWN_FAILURE
07-SEP-2007	16.01.47	07-SEP-2007	16.03.05	78	28866	28866	PDS_UNKNOWN_FAILURE
07-SEP-2007	18.10.44	07-SEP-2007	18.12.02	78	28867	28867	PDS_UNKNOWN_FAILURE
08-SEP-2007	5.28.53	08-SEP-2007	5.30.11	78	28874	28874	PDS_UNKNOWN_FAILURE
08-SEP-2007	15.30.55	08-SEP-2007	15.32.13	78	28880	28880	PDS_UNKNOWN_FAILURE
08-SEP-2007	17.39.07	08-SEP-2007	17.40.25	78	28881	28881	PDS_UNKNOWN_FAILURE
09-SEP-2007	4.58.11	09-SEP-2007	4.59.29	78	28888	28888	PDS_UNKNOWN_FAILURE
09-SEP-2007	16.39.18	09-SEP-2007	16.40.36	78	28895	28895	PDS_UNKNOWN_FAILURE
10-SEP-2007	4.26.34	10-SEP-2007	4.27.52	78	28902	28902	PDS_UNKNOWN_FAILURE
10-SEP-2007	16.07.22	10-SEP-2007	16.08.40	78	28909	28909	PDS_UNKNOWN_FAILURE
10-SEP-2007	18.16.29	10-SEP-2007	18.17.46	77	28910	28910	PDS_UNKNOWN_FAILURE
11-SEP-2007	1.13.48	11-SEP-2007	1.16.46	178	28914	28914	PDS_UNKNOWN_FAILURE
11-SEP-2007	15.36.37	11-SEP-2007	15.37.54	77	28923	28923	PDS_UNKNOWN_FAILURE
11-SEP-2007	17.44.51	11-SEP-2007	17.46.09	78	28924	28924	PDS_UNKNOWN_FAILURE
12-SEP-2007	5.03.56	12-SEP-2007	5.05.13	77	28931	28931	PDS_UNKNOWN_FAILURE
12-SEP-2007	16.44.18	12-SEP-2007	16.45.36	78	28938	28938	PDS_UNKNOWN_FAILURE
12-SEP-2007	17.13.26	12-SEP-2007	17.14.44	78	28938	28938	PDS_UNKNOWN_FAILURE
13-SEP-2007	4.32.18	13-SEP-2007	4.33.36	78	28945	28945	PDS_UNKNOWN_FAILURE
13-SEP-2007	16.13.14	13-SEP-2007	16.14.31	77	28952	28952	PDS_UNKNOWN_FAILURE
13-SEP-2007	18.22.13	13-SEP-2007	18.23.31	78	28953	28953	PDS_UNKNOWN_FAILURE
14-SEP-2007	4.29.32	14-SEP-2007	4.32.30	178	28959	28959	PDS_UNKNOWN_FAILURE
14-SEP-2007	15.42.12	14-SEP-2007	15.43.29	77	28966	28966	PDS_UNKNOWN_FAILURE
14-SEP-2007	17.50.36	14-SEP-2007	17.51.54	78	28967	28967	PDS_UNKNOWN_FAILURE
15-SEP-2007	5.09.40	15-SEP-2007	5.10.58	78	28974	28974	PDS_UNKNOWN_FAILURE
15-SEP-2007	15.10.13	15-SEP-2007	15.11.30	77	28980	28980	PDS_UNKNOWN_FAILURE
15-SEP-2007	17.18.59	15-SEP-2007	17.20.16	77	28981	28981	PDS_UNKNOWN_FAILURE
16-SEP-2007	2.48.47	16-SEP-2007	2.51.45	178	28987	28987	PDS_UNKNOWN_FAILURE
16-SEP-2007	4.38.03	16-SEP-2007	4.39.21	78	28988	28988	PDS_UNKNOWN_FAILURE
16-SEP-2007	16.19.08	16-SEP-2007	16.20.25	77	28995	28995	PDS_UNKNOWN_FAILURE
16-SEP-2007	18.27.57	16-SEP-2007	18.29.15	78	28996	28996	PDS_UNKNOWN_FAILURE
17-SEP-2007	4.06.33	17-SEP-2007	4.07.51	78	29002	29002	PDS_UNKNOWN_FAILURE
17-SEP-2007	5.53.01	17-SEP-2007	5.56.00	179	29003	29003	PDS_UNKNOWN_FAILURE
17-SEP-2007	15.47.47	17-SEP-2007	15.49.04	77	29009	29009	PDS_UNKNOWN_FAILURE
17-SEP-2007	17.56.20	17-SEP-2007	17.57.38	78	29010	29010	PDS_UNKNOWN_FAILURE
18-SEP-2007	5.15.24	18-SEP-2007	5.16.42	78	29017	29017	PDS_UNKNOWN_FAILURE
18-SEP-2007	15.16.07	18-SEP-2007	15.17.24	77	29023	29023	PDS_UNKNOWN_FAILURE
18-SEP-2007	15.17.24	18-SEP-2007	15.17.25	1	29023	29023	PDS_UNKNOWN_FAILURE
18-SEP-2007	17.24.43	18-SEP-2007	17.26.01	78	29024	29024	PDS_UNKNOWN_FAILURE
19-SEP-2007	4.43.47	19-SEP-2007	4.45.05	78	29031	29031	PDS_UNKNOWN_FAILURE

19-SEP-2007	16.25.02	19-SEP-2007	16.26.19	77	29038	29038	PDS_UNKNOWN_FAILURE
19-SEP-2007	16.26.19	19-SEP-2007	16.26.20	1	29038	29038	PDS_UNKNOWN_FAILURE
19-SEP-2007	18.33.10	19-SEP-2007	18.34.28	78	29039	29039	PDS_UNKNOWN_FAILURE
20-SEP-2007	4.12.10	20-SEP-2007	4.13.28	78	29045	29045	PDS_UNKNOWN_FAILURE
20-SEP-2007	15.53.21	20-SEP-2007	15.54.39	78	29052	29052	PDS_UNKNOWN_FAILURE
20-SEP-2007	18.02.05	20-SEP-2007	18.03.22	77	29053	29053	PDS_UNKNOWN_FAILURE
21-SEP-2007	5.19.32	21-SEP-2007	5.19.34	2	29060	29060	PDS_UNKNOWN_FAILURE
21-SEP-2007	5.21.09	21-SEP-2007	5.22.26	77	29060	29060	PDS_UNKNOWN_FAILURE
21-SEP-2007	15.22.01	21-SEP-2007	15.23.19	78	29066	29066	PDS_UNKNOWN_FAILURE
21-SEP-2007	17.30.27	21-SEP-2007	17.31.45	78	29067	29067	PDS_UNKNOWN_FAILURE
21-SEP-2007	18.47.00	21-SEP-2007	18.49.58	178	29068	29068	PDS_UNKNOWN_FAILURE
22-SEP-2007	4.49.31	22-SEP-2007	4.50.49	78	29074	29074	PDS_UNKNOWN_FAILURE
22-SEP-2007	16.30.56	22-SEP-2007	16.32.14	78	29081	29081	PDS_UNKNOWN_FAILURE
23-SEP-2007	4.17.54	23-SEP-2007	4.19.12	78	29088	29088	PDS_UNKNOWN_FAILURE

APPENDIX 3: LEVEL 2 STATIC AUXILIARY DATA FILES

AUX_DEM_AXVIEC20031201_000000_20031201_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_AXVIEC20021111_131410_20020101_000000_20200101_000000
MWR_LSF_AXVIEC20020313_172218_20020101_000000_20200101_000000
MWR_SLT_AXVIEC20050426_120000_20020101_000000_20200101_000000
RA2_IFA_AXVIEC20050216_125529_20020101_000000_20200101_000000
RA2_IFB_AXVIEC20050216_125738_20020101_000000_20200101_000000
RA2_CHD_AXVIEC20051017_093900_20020101_000000_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_AXVIEC20031208_150159_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_AXVIEC20051003_170000_20020101_000000_20200101_000000
RA2_SSB_AXVIEC20051129_111810_20020101_000000_20200101_000000
RA2_TLD_AXVIEC20031208_151137_20020101_000000_20200101_000000
RA2_TLG_AXVIEC20040310_110000_20020101_000000_20200101_000000

APPENDIX 4: SIGMA0 ABSOLUTE CALIBRATION

Table 18: Transponder measurement results up to cycle 61

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

APPENDIX 5: S-BAND ANOMALY

Table 13: List of L2 FGD Files affected by S-Band anomaly during cycle 61
No files affected by S Band Anomaly on cycle 61

File name	Start date	Start time	Stop date	Sto

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>
ENDRECORD
RECORD polygon_pt: LONG=+105.500000<deg> LAT=-077.500000<deg>
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>
ENDRECORD
RECORD polygon_pt: LONG=+122.000000<deg> LAT=-075.250000<deg>
ENDRECORD
RECORD polygon_pt: LONG=+122.000000<deg> LAT=-074.750000<deg>
ENDRECORD
RECORD polygon_pt: LONG=+124.000000<deg> LAT=-074.750000<deg>
ENDRECORD