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ENVISAT CYCLIC ALTIMETRIC REPORT

CYCLE 41 from 19-09-2005 to 24-10-2005

Quality Assessment Report

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1 INTRODUCTION

This documents aims at reporting on the performances 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 occurred during cycle 41.

This report covers the period from the 19th of September to the 24th of October 2005.

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
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	Globa l 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
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
YSM	Yaw Stellar Mode

4 REFERENCE DOCUMENTS

[R – 1a] F-PAC MONTHLY REPORT, SALP-RP-M-OP-15389-CN, July 2005
[R – 1b] F-PAC MONTHLY REPORT, SALP-RP-M-OP-15387-CN, August 2005
[R – 2] ENVISAT Microwave Radiometer Assessment Report Cycle 041, CLS.DOS/05.147, 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
[R – 6] ENVISAT Phase E Cal/Val Acquisition Plan, ENVI-SPPA-EOPG-TN-03-0008
[R – 7] RA-2 S-Band Anomaly Investigation, PO-TN-ESA-RA-1341, 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/
[R – 10] Envisat GDR Quality Assessment Report, SALP-RP-P2-EX-21121-CLS015
[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/
[R – 13] ENVISAT Weekly Mission Operations Reports # 171-175, ENVI-ESOC-OPS-RP-1011-TOS-OF
[R – 14] Envisat validation and cross calibration activities during the verification phase. Synthesis Report ESTEC contract No. 16243/02/NL/FF WP6, http://earth.esa.int/pcs/envisat/ra2/articles/
[R – 15] ENVISAT-1 Products Specifications - Vol. 14: RA-2 Products Specifications, PO-RS-MDA-GS-2009, Iss 3, Rev. K, 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

5 GENERAL QUALITY ASSESSMENT

5.1 *Cycle Overview*

- During cycle 41 the Radar Altimeter 2 was unavailable twice, for a total of 6 orbits.
- Data availability is around 94.5%.
- The total percentage of data affected by the so called "S-Band anomaly" corresponds to about 4.24% of the acquired data.
- The number of valid IF masks is 20, which represents about 28% of the planned IF masks.
- Tracking performances in the different resolutions are well in line with the output figures and objectives of the Commissioning Phase.
- The USO clock period trend retrieved for cycle 41 shows a drift=-2.4 mm/year and a bias=22.6 mm.
- The MWR and DORIS is never unavailable, with data availability of 99% for MWR and almost 99% for DORIS.

5.2 *Payload status*

5.2.1 ALTIMETER EVENTS

The Radar Altimeter 2, during cycle 41, was unavailable two times in the following time frames:

Start: 20 Sep 2005 12:19:17, Orbit = 18600
Stop: 20 Sep 2005 18:56:00, Orbit = 18604

Start: 4 Oct 2005 12:47:33, Orbit = 18801
Stop: 4 Oct 2005 16:35:30, Orbit = 18803

Cause: RA-2 switched to Suspend due to a multiple SEU anomaly. This is a repeat of an anomaly that has been observed a few times before, and is under investigation (ref: AR ENV-614)

5.2.1.1 RA-2 instrument planning

The RA-2 instrument planning was performed as follows:

- IF Calibration Mode according to the nominal operational acquisition scheme: 100 seconds of data twice per day over Himalayan region (ascending and descending passes).
- Preset Loop Output mode for GAVDOS Range transponders, located in Creta.
- Preset Loop Output acquisition over ESA transponders, located near Rome; for both ascending and descending passes. The PLO planning has been updated to the High Chirp Resolution for the ESA TRP overpasses, starting from orbit #14790.
- 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 the 4 ESA transponders near Rome (1 second length acquisition, 1 repetition)

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

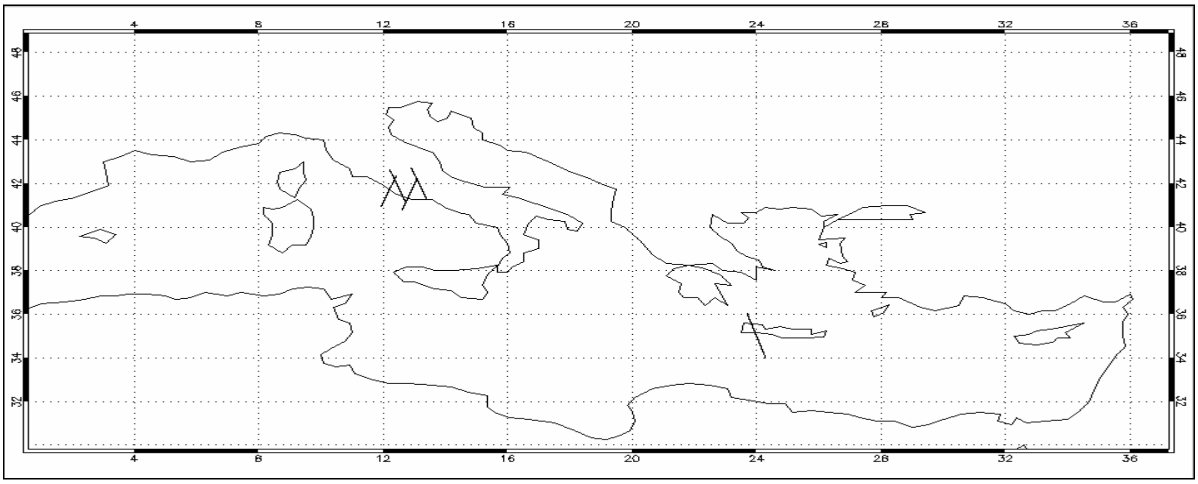

Figure 1: Transponder Acquisition sites for cycle 41

5.2.2 MWR EVENTS

The MWR, during cycle 41 was never unavailable [R-13].

5.2.3 DORIS EVENTS

The DORIS, during cycle 41 was never unavailable [R-13].

5.3 Availability

The summary of the RA-2 data products availability for this cycle is reported in Appendix 1.
Data availability was 94.5% for RA2 products, 99% for MWR and almost 99% for DORIS products.

5.4 Orbit quality

During cycle 41 one in-plane manoeuvre was executed, on October 6th, 2005 (DOY 279) whose details are given hereafter:

- Planned delta V size: 0.0074 m/s (in the flight direction)
- Mid thrust time: 02:18:40 UTC at PSO 217.356 degrees
- Thrust duration: 4 seconds
- Measured delta V: 0.0073 m/s (in the flight direction)

The orbit was maintained within the +/- 1km to the reference ground track during cycle 41.

5.5 Ground Segment Processing Chain Status

5.5.1 IPF PROCESSING CHAIN

5.5.1.1 Version

The current version of the IPF processing chain is V4.58, installed in both PDHS-E and PDHS-K on July the 16th 2004. This is equivalent to the previous version for all the algorithms and auxiliary files, only a new parameter has been added in the SPH that is the pass number which, for NRT data is nominally set to 0. This was done in order to be compliant with the off-line products version that indeed includes the pass number.

The previous IPF version V4.57 was operational at the Envisat PDHS-K and PDHS-E since April 29th and 28th 2004 respectively.

5.5.1.2 Auxiliary Data File

The Auxiliary files actually used by the IPF ground processing are reported in Appendix 2.
The RA2_POL_AX, the RA2_SOL_AX and the RA2_PLA_AX have been regularly updated every week without problems.

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

5.5.1.3 Planned upgrades

An evolution of the IPF Level 1B and Level 2 processing chain is intended to be operational by the end of 2005. The next IPF version release shall nominally contain the following:

1. USO instrumental correction within the RA-2 L1b processor.
2. New MWR Side Lobes correction algorithm within MWR L1b processor
3. Correction of the mispointing evaluation algorithm within the RA-2 L2 processor
4. Inclusion of the loading tide for the GOT2000.2 model.
5. Addition of the peakiness fields in Ku and S band to the RA-2 and MWR FD/I/MAR meteorological products
6. Inclusion of the square of the significant wave height in Ku and S band
7. Inclusion of an S-band anomaly flag, see [R – 16]
8. Upgrade of the Level 1B and Level 2 processing for DORIS NRT orbital information computation
9. New ADF for Digital Elevation Model (DEM): AUX_DEM_AX
10. Adjustment of the S Band computation for the rain flag

5.5.2 F-PAC PROCESSING CHAIN

The current version of CMA is V6.3 operational since Apr. 29, 2004.
F-PAC CMA anomalies: anomalies are detailed in the F-PAC Monthly Report [R – 1a] and [R-1b].
The F-PAC CMA processing chain will include all the IPF evolutions plus some others like:
- Inclusion of GPS Ionospheric correction
- Inclusion of MOG2D Inverse Barometer Geophysical Correction in Level 2 products
- FES2004
- Addition of a field for Level 1B SW ID in Level 2 products
- Inclusion of nadir location not corrected for slope model

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	99,85	>99%	0,12	0,03
Costal Water (ocean depth < 200 m)	95,73	No specific requirement	3,47	0,80
Sea Ice	98,55	>95%	1,27	0,18
Ice Sheet	96,90	>95%	2,50	0,61
Land	83,06	No specific requirement	12,98	3,96
All world	95,42		3,55	1,03

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 very much in line with the ones recorded at the end of the Commissioning Phase reported in the last column and presented in [R – 8]. The slight differences are in part due to the different algorithms used to discriminate the surface types.
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.

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.

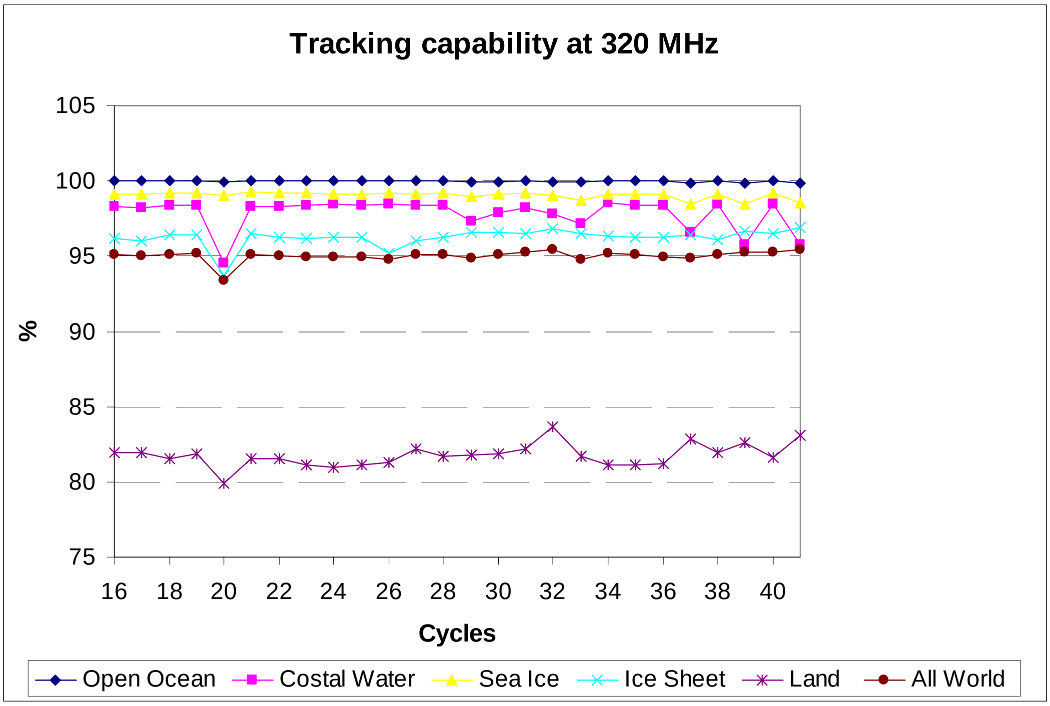

Figure 2: RA-2 Tracking percentage at 320MHz for different surfaces

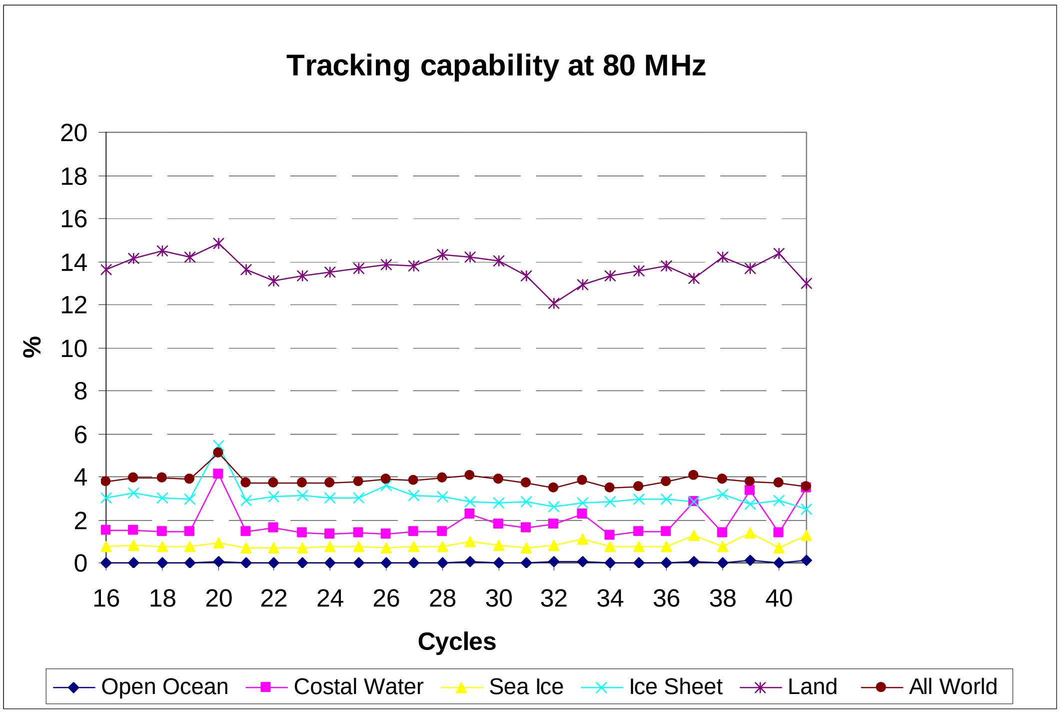

Figure 3: RA-2 Tracking percentage at 80MHz for different surfaces

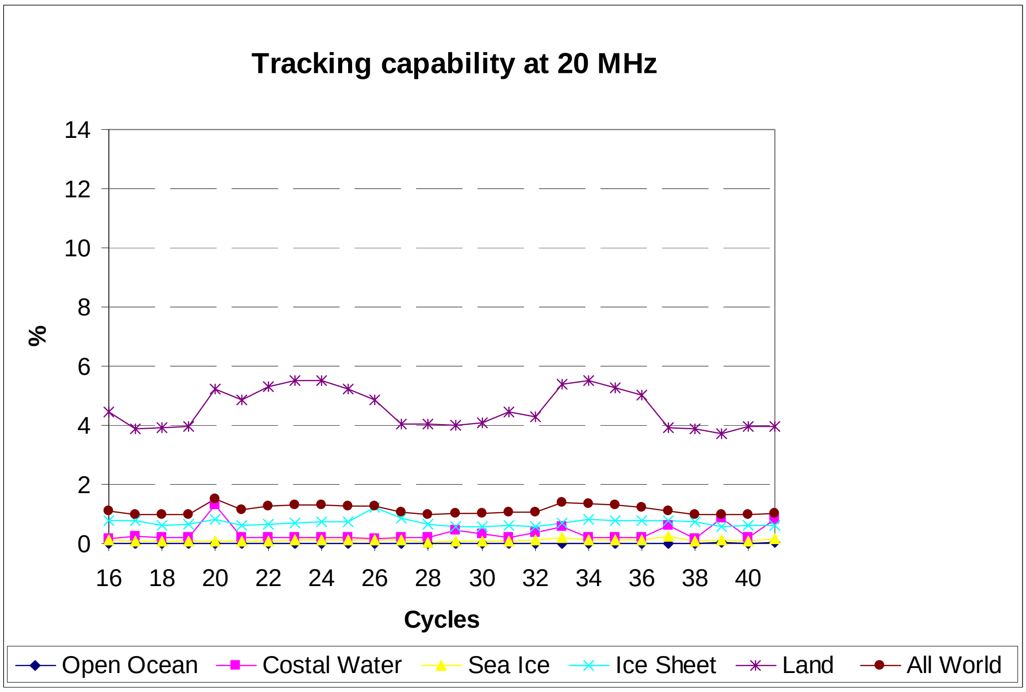

Figure 4: RA-2 Tracking percentage at 20MHz for different surfaces

6.1.2 IF FILTER MASK

In Figure 5 all valid IF masks retrieved by averaging the 100 seconds of data acquired daily during cycle 41 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 41, the number of valid IF masks has been 20, representing about the 28% of the planned IF masks (70 per cycle). Only valid IF masks are used to generate the final IF mask used in the Level 1B ground processing; the method used for editing the data is based on the comparison between each of the single IF masks and the reference one (on-ground).

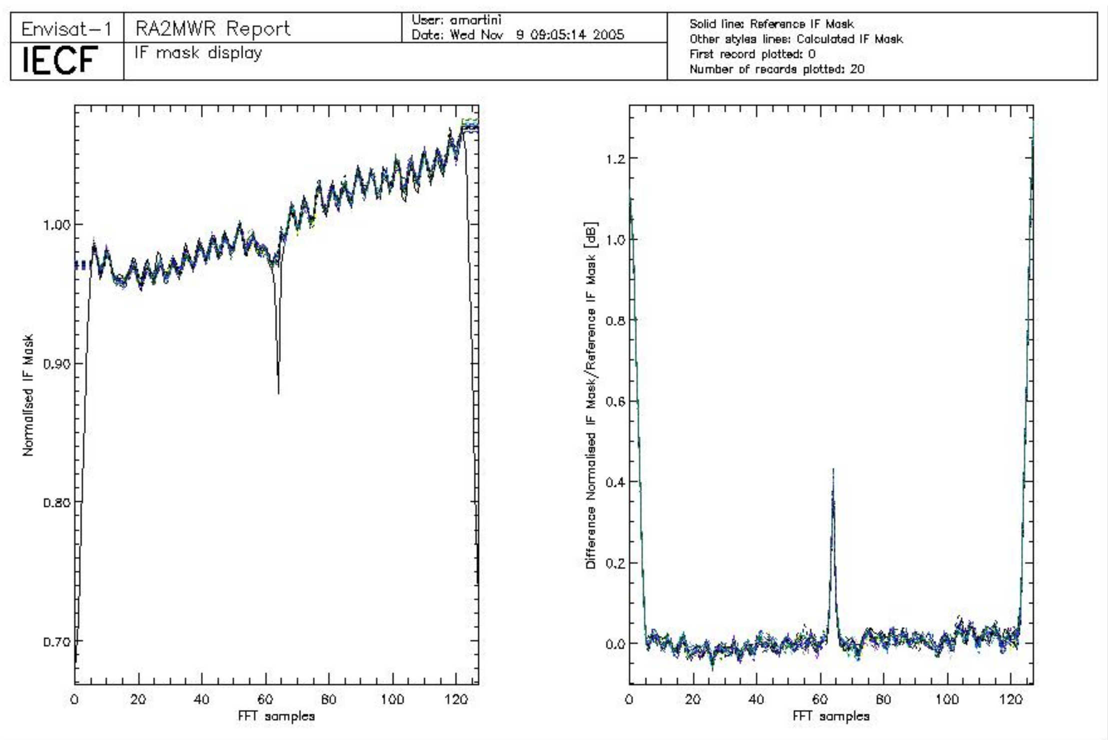

Figure 5: Valid IF masks retrieved daily during cycle 41 plotted together with the on-ground reference.

In Figure 6 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 stays quite constant around 0.07 dBs.

Three 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 and on May the 10th 2004 at 15:45. The reason of this could be found in the instrument warming up considering that the IF Cal acquisition has been made, in all the cases, only a couple of hours after an anomaly recovery. The residual noise and the accuracy show a very constant behavior over the whole period.

A weird behavior has been observed during the validation of several newly created IF mask correction auxiliary files. After an investigation, it has been recently found out that the phenomenon was due to an error done by the operator while manually creating the auxiliary files.
During cycle 41 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.

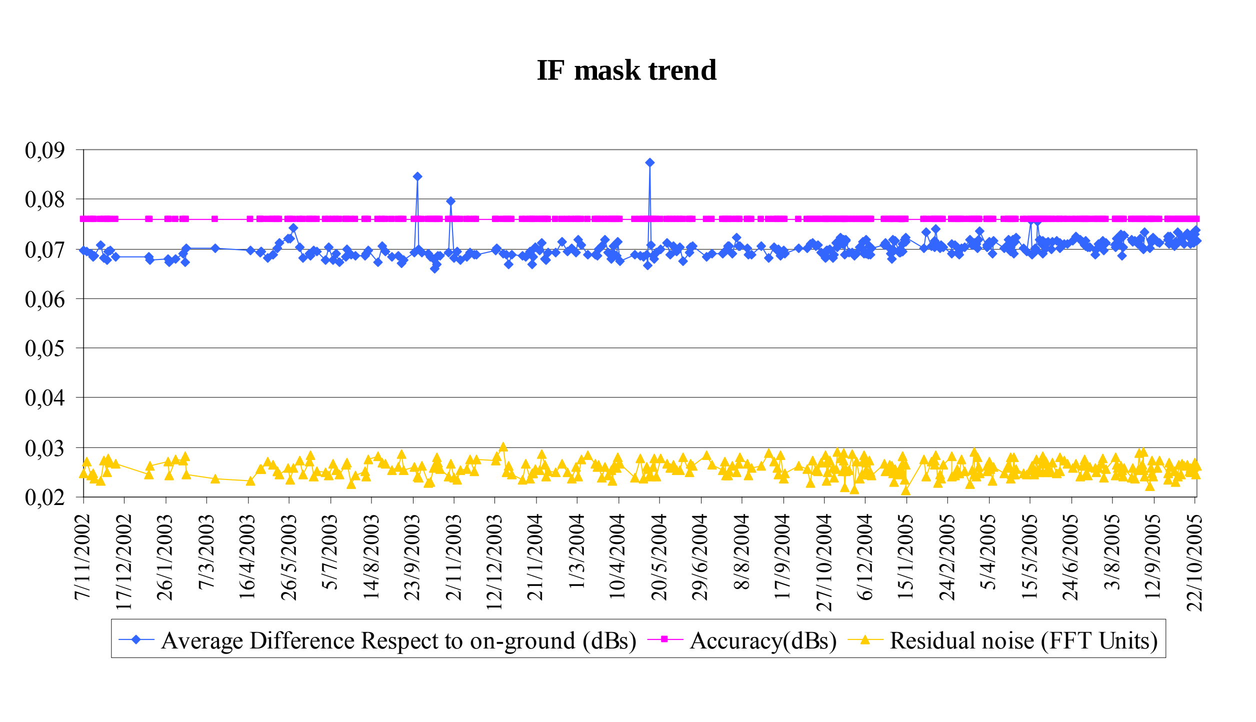

Figure 6: Evolution of the IF mask related parameters for valid IF masks retrieved up to cycle 41

In Figure 7 the percentages of valid IF masks from cycle 20 up to cycle 41 are reported.

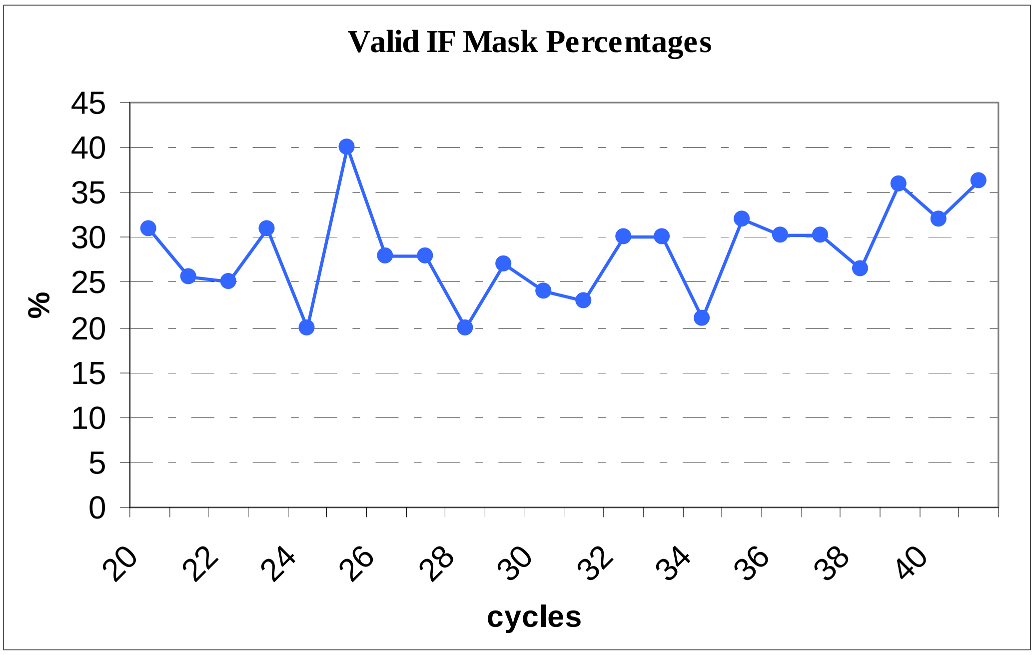

Figure 7: Percentages of valid IF Mask up to cycle 41

6.1.3 USO

In Figure 8, the USO clock period trend retrieved for cycle 41 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.

Currently the nominal USO clock period (12500 ps) is used within the processing; this means that the data are not corrected for the bias and the drift correlated to the actual USO clock period.

A particular investigation has been performed regarding the USO clock trend and the associated auxiliary file; this is described in [R – 11]. The conclusion can be summarized as follows: the precision of 1 ps available in the current USO auxiliary file is not enough to appreciate its trend and it is too rough for any altimetric application. A suitable resolution is considered to be of 10^{-6} ps. This problem will be corrected with the following upgrade of the IPF as described in par. 5.5.1.3.

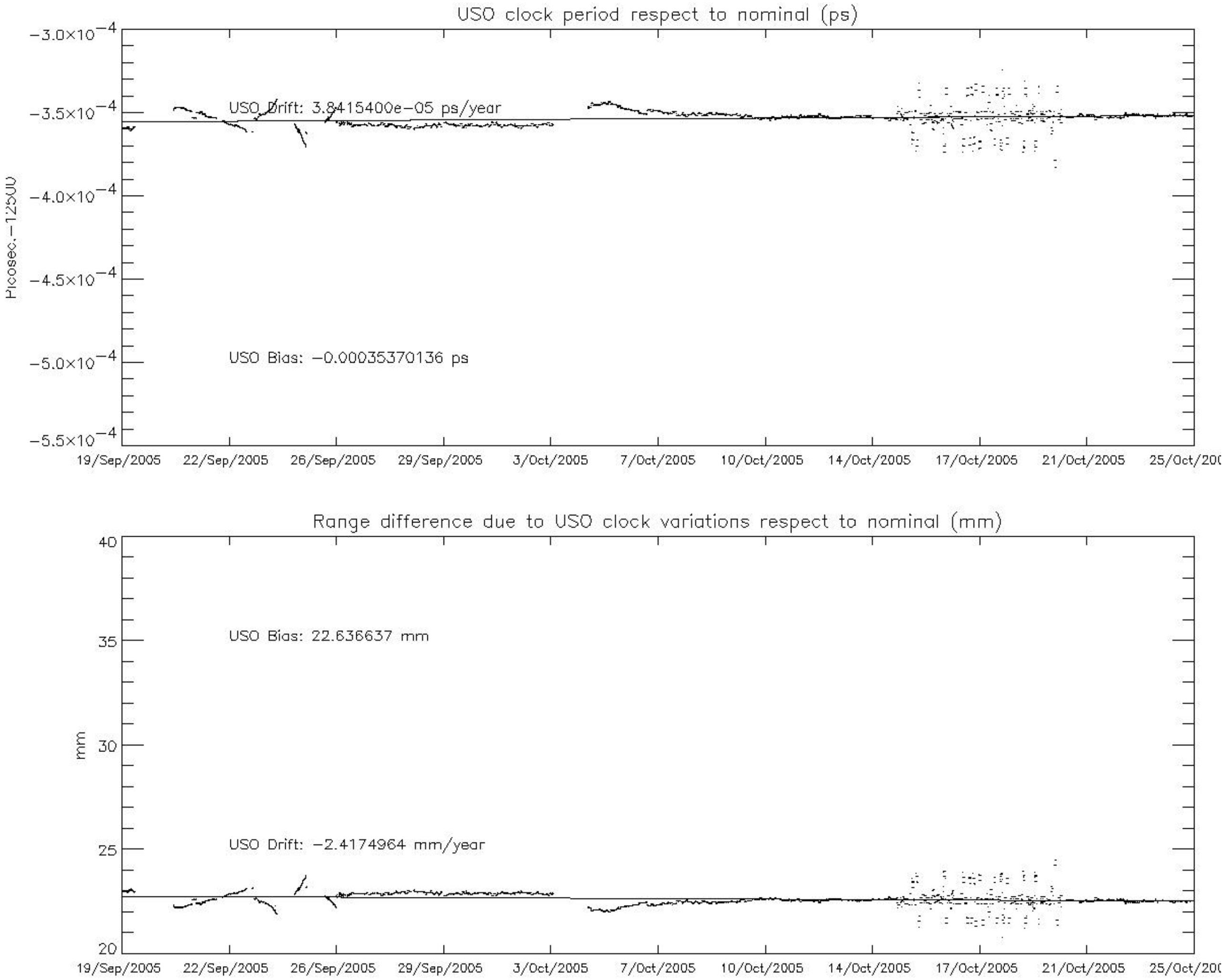

Figure 8: USO clock period for cycle 41

In Figure 9, the USO clock period trend retrieved until the end of cycle 41 is reported.
Given that the nominal USO clock period (12500 ps) is used within the processing, the data are not corrected for the bias and the drift correlated to the actual USO clock period. Those values, translated into altimetric range figures, are respectively of 29.6 mm and –4.5 mm/year as calculated with data covering the period 4 August 2004 to 19 September 2005 (the data covering the anomalous period between 2004/09/27 at ~16:00 and 2004/09/29 at ~12:00 AM have not been used to evaluate these figures).

WARNING: the given bias and drift have to be **SUBTRACTED** to the original altimetric range, according to the definition reported in par. 7.2.5.

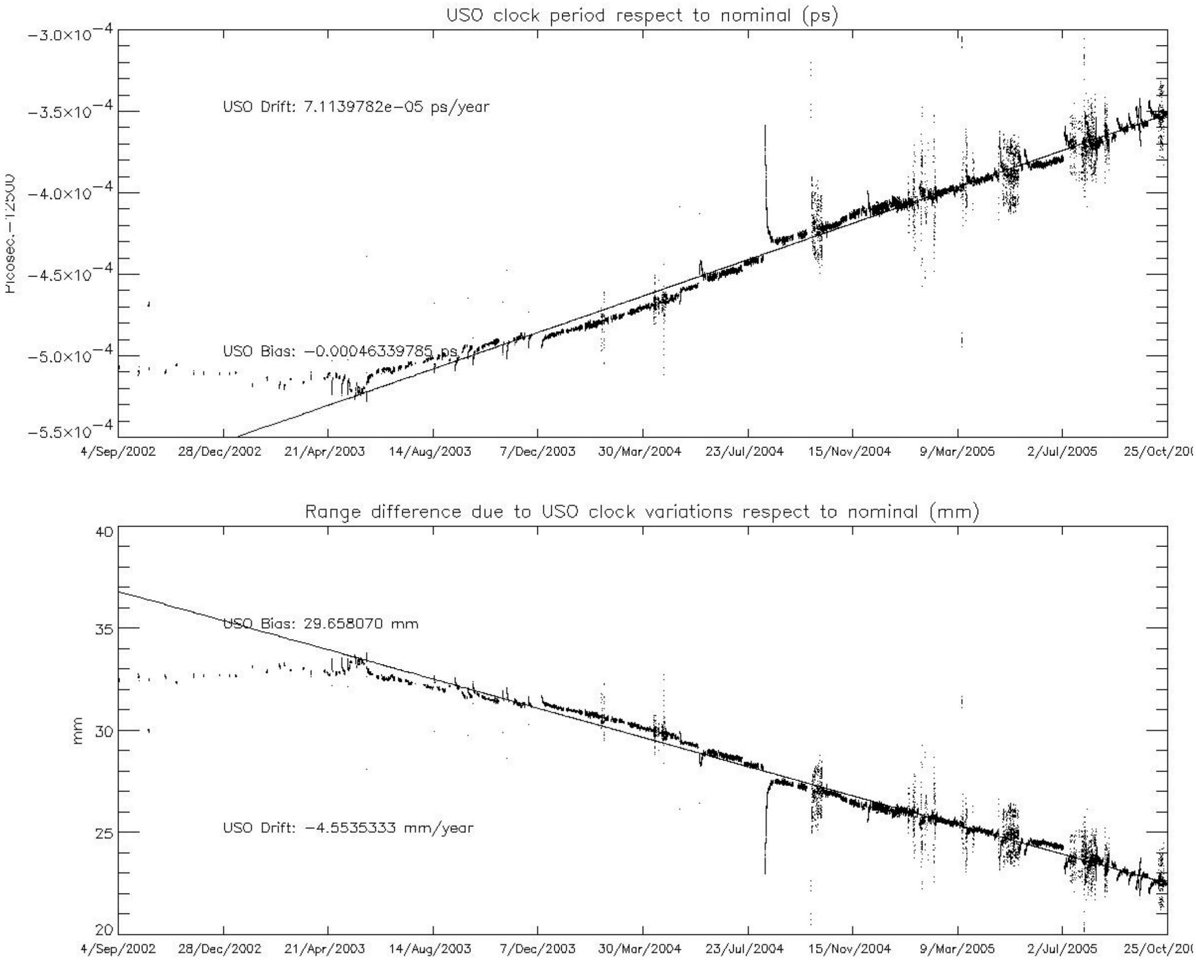

Figure 9: USO clock period until end of cycle 41

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 10, 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.

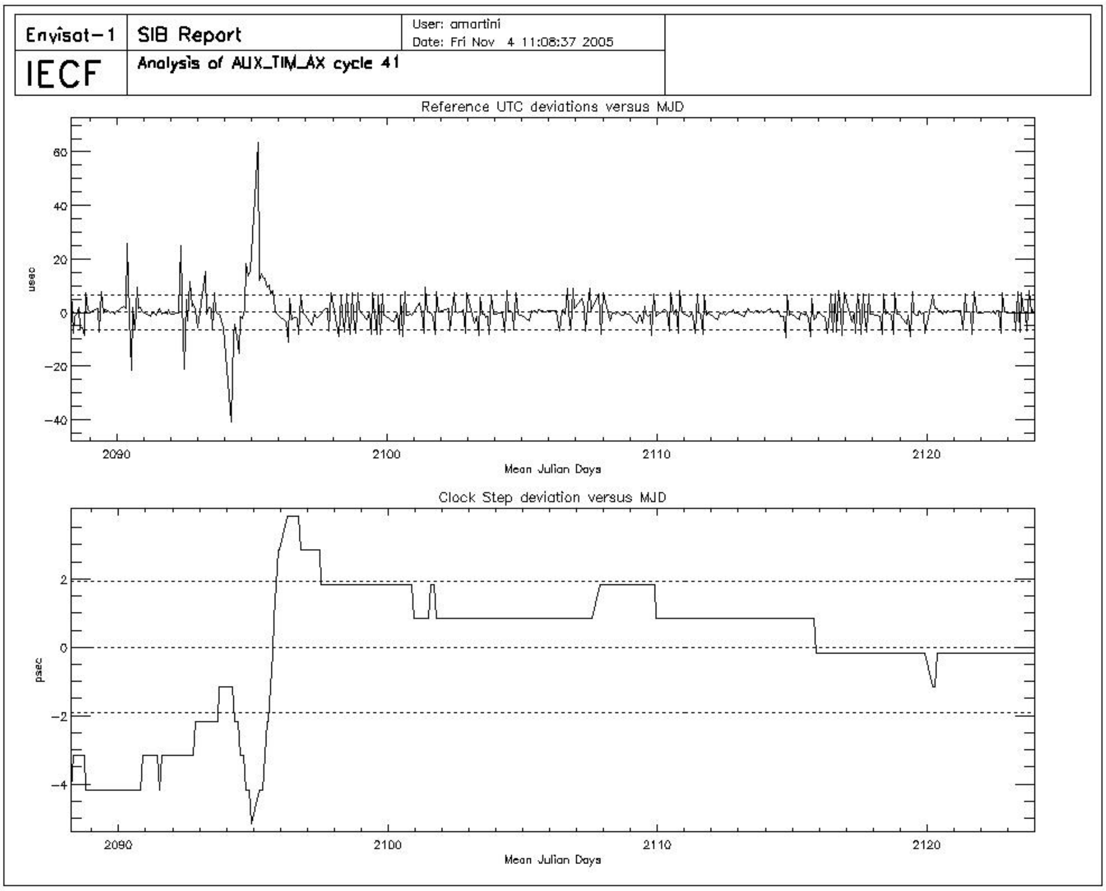

Figure 10: UTC deviations and ICU clock period for cycle 41

In Figure 11 (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 up to cycle 41 are reported in Figure 12.

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 16); 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. This is however not a problem because the ICU clock period variations are included in the algorithm for the SBT/UTC correlation evaluation.

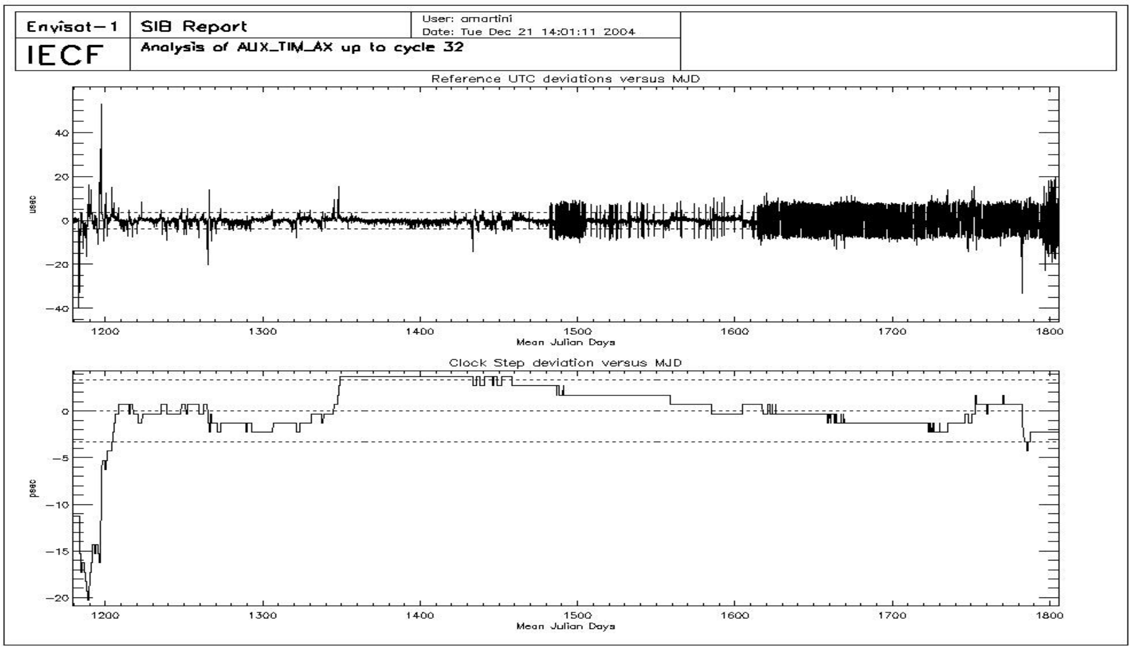

Figure 11: UTC deviations and ICU clock period up to cycle 32

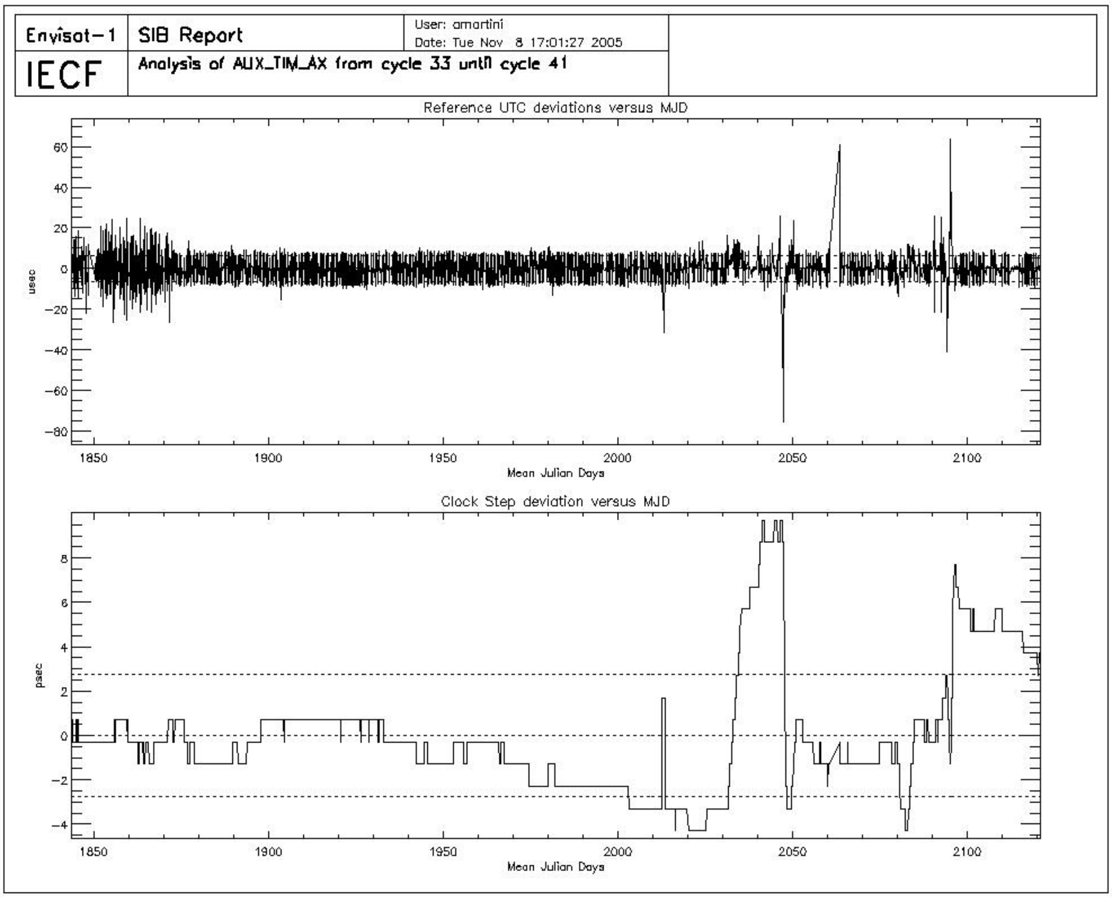

Figure 12: UTC deviations and ICU clock period from cycle 33 up to cycle 41

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 cycle 41 (averaged per day) are reported in the next figures. The high values of the Sigma0 calibration factor plotted in Figure 14 are related to the RA-2 anomaly recovery (see section 5.2.1). The Time delay in-flight calibration factor shows a regular behaviour as observed on previous cycles. The Sigma0 in-flight calibration factor shows a more pronounced drift respect to the previous cycles, decreasing from 0.43db to 0.38db.

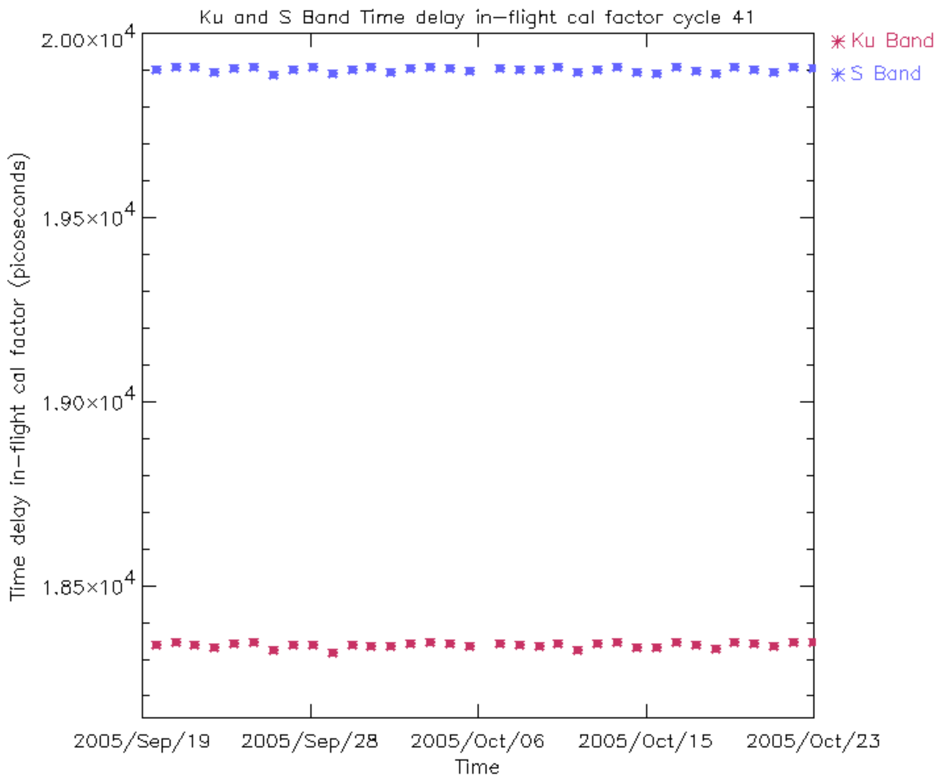

Figure 13: Ku and S Band in-flight time delay calibration factor for cycle 41

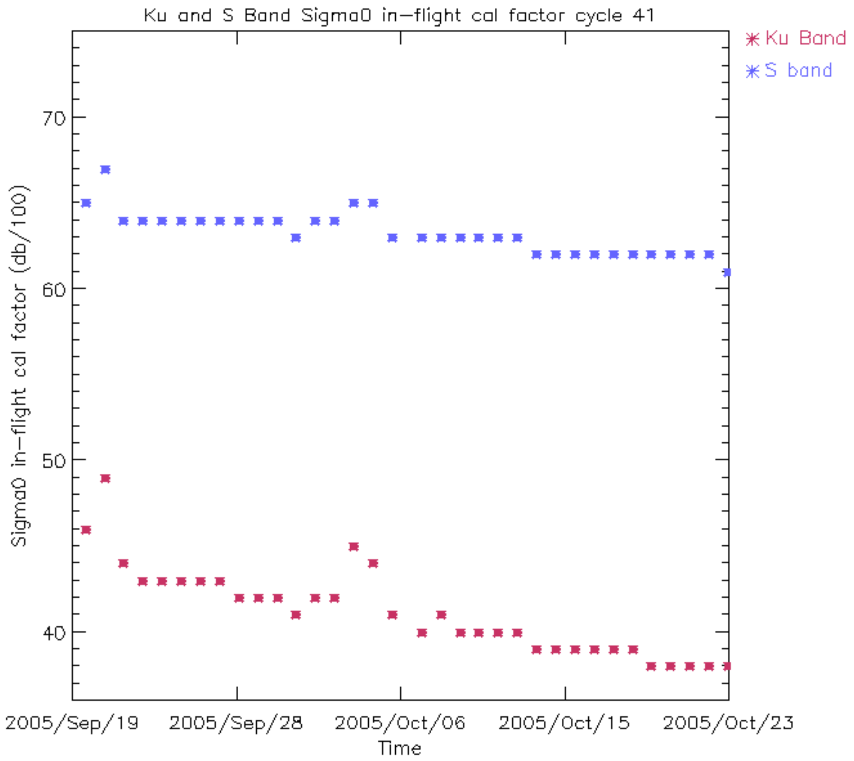

Figure 14: Ku and S Band in-flight Sigma0 calibration factor for cycle 41

Figure 15 and Figure 16 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.

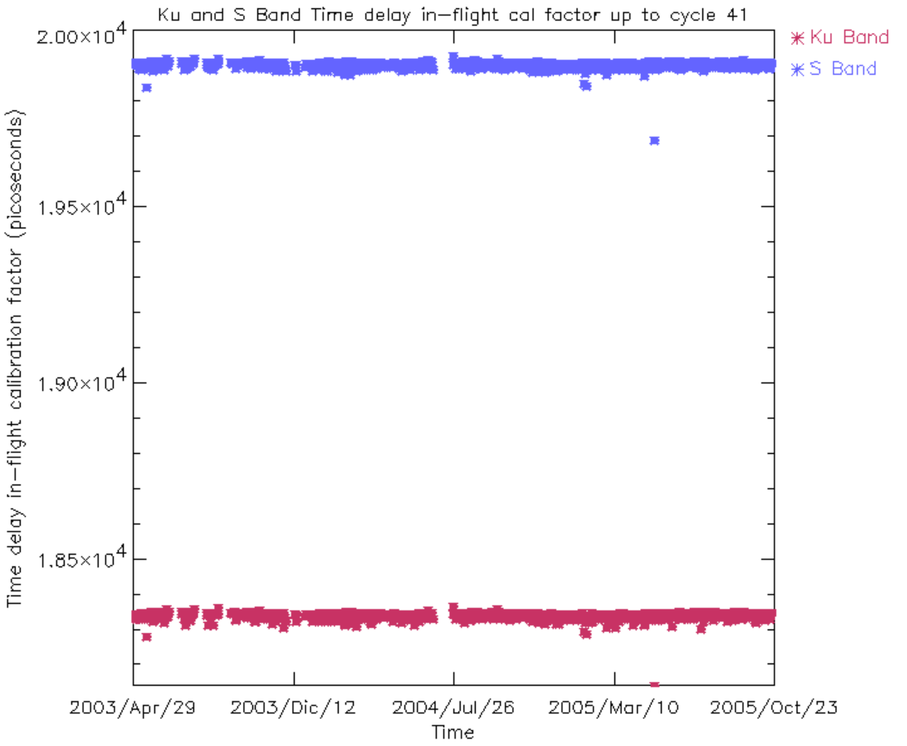

Figure 15: Ku and S Band in-flight time delay calibration factor up to cycle 41

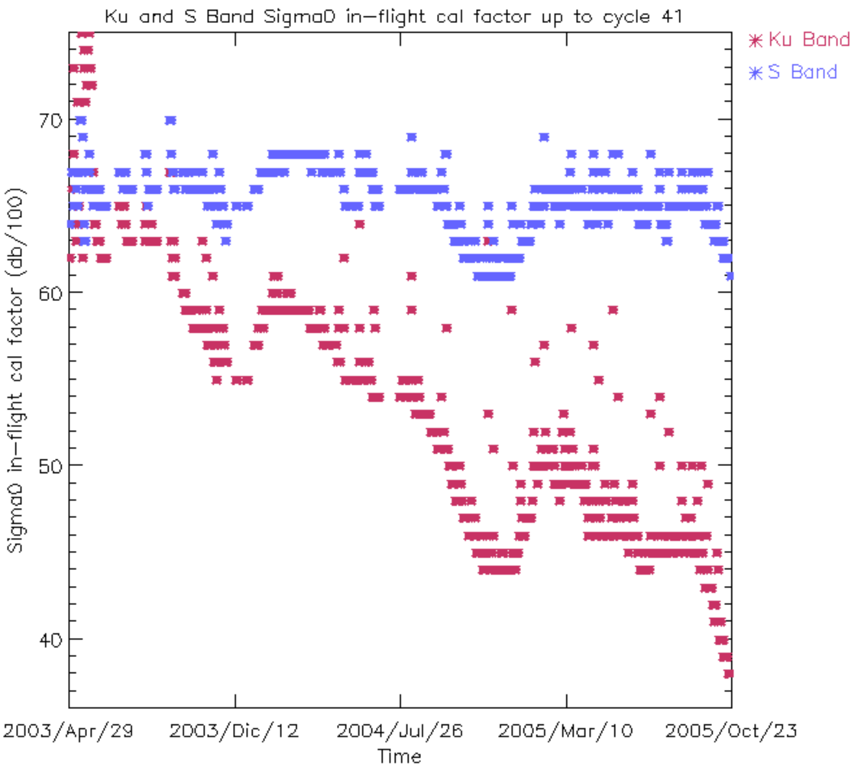

Figure 16: Ku and S Band in-flight Sigma0 calibration factor up to cycle 41

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, a continuous monitoring is needed by operating the transponder as many as possible Envisat overpasses.
Three Sigma_0 Transponder acquisitions were planned for cycle 41, all acquisitions were positive. Two of them have been performed in high resolution and one in low resolution. Since the 11th of October the transponder has been moved to a permanent site located in Rome. The date and time of the acquisitions are reported hereafter:

22-Sep-05, Fiugi, 20:36:27
04-Oct-05, Maccarese, 09:41:54
11-Oct-05, Permanent site/Rome, 20:39:22

The results are reported in the following Table, including the tropospheric attenuation estimated from ECMWF data.

Orbit	Date	Location/Rel. Track	Coordinates	Resolution	Not Corrected Backscattering Bias [dB]	Tropospheric Correction (one way) [dB]
18634	22-Sep-05	Fiuggi/43	41.7875, 13.2212	High	1.00	0.076
18799	04-Oct-05	Maccarese/208	41.8605, 12.2385	High	0.85	0.082
18906	11-Oct-05	Permanent site Rome / 315	41.8719, 12.4731	Low	1.46	0.078

Table 2: Absolute backscattering calibration results obtained with Transponder measurements

Since December 2004, all acquisitions have been performed in High Resolution Mode (320 MHz). Only the last acquisition, October 11th, was performed in Low Resolution Mode (20MHz) in order to test the new permanent site location. The mean value of the estimated bias at High Resolution is 1.110 dB with a standard deviation of 0.07 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. Appendix 3 reports the transponder measurements from cycle 24 up to cycle 41.

In Figure 17, 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.

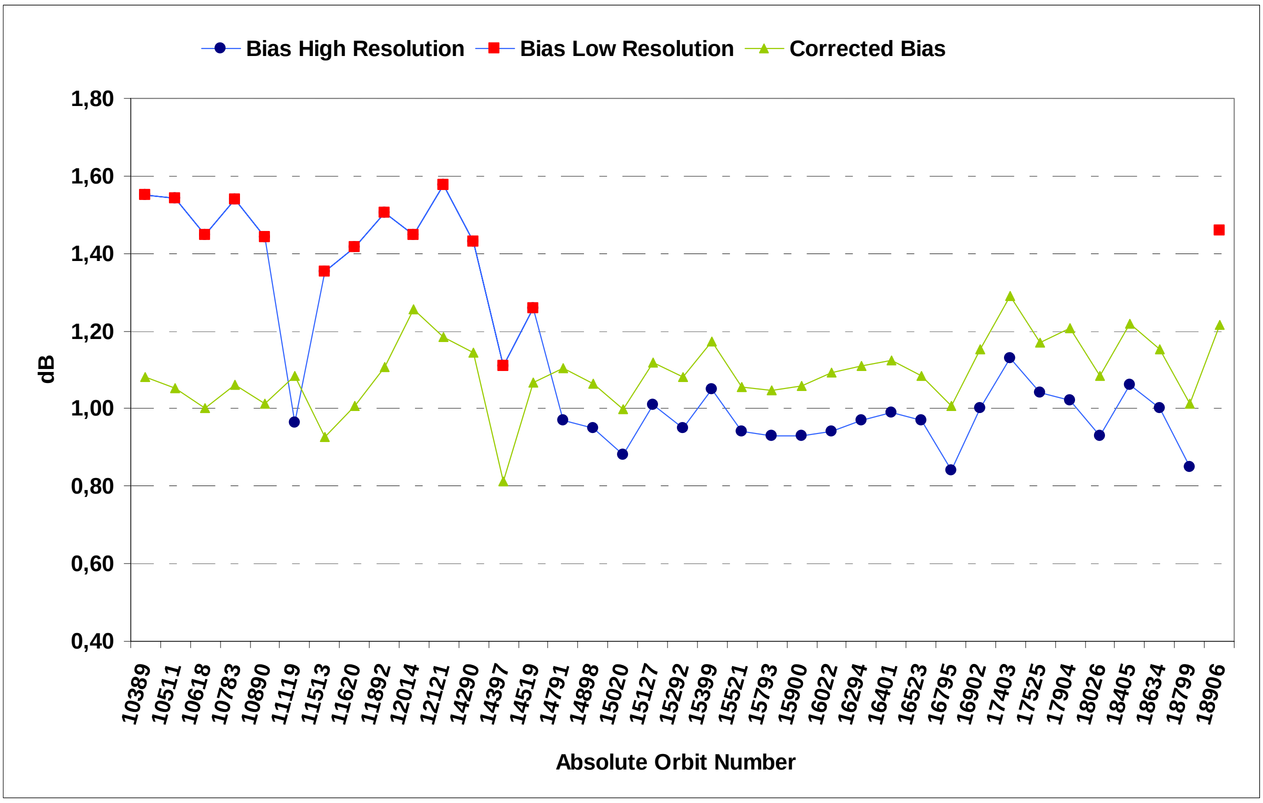

Figure 17: Time behavior of the transponder bias

6.1.7 MISPOINTING

In Figure 18, 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, is around 0.028 deg^2, which is known to be higher than the one reported at platform level [R – 13]. This is due to an imperfect tuning of the algorithm currently used to retrieve the mispointing value from the RA-2 waveform data.
For this cycle, two events of low mispointing values are present and visible in the plot of Figure 18. These events correspond to the instrument anomalies occurred on the 20th of September and on the 3rd of October, as reported in par. 5.2.1.

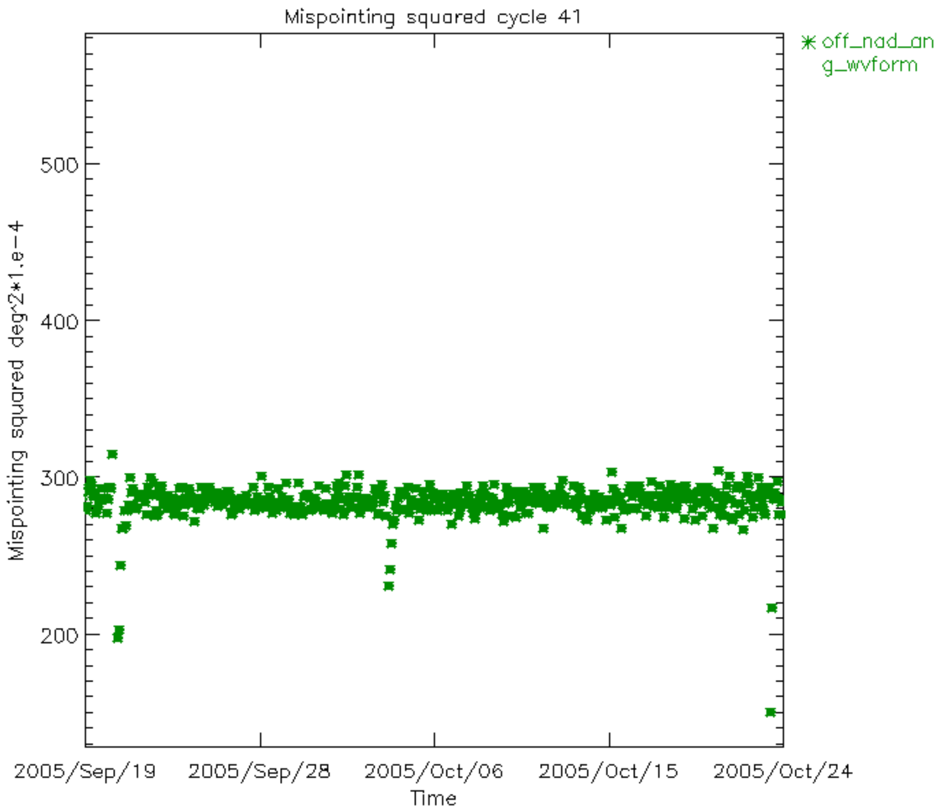

Figure 18: Smoothed mispointing squared trend for cycle 41 (deg^2*10^4)

In Figure 19, the overall mispointing squared trend (averaged over each orbit) is plotted for cycles 16 to 41. The jump which occurred on November the 26th 2003 is correlated to the upload of IPF version 4.56; the abrupt decreasing 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.

On the other hand, 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 particular behavior can be explained by the different shape that the over-ocean average waveform has before and after an anomalous event as visible in Figure 20. Observe, in particular, the disappearance of the small dip in the waveforms acquired after the anomaly. This problem will be solved with the introduction of an updated mispointing retrieval algorithm with the next version of the processing software as described in par. 5.5.1.3.

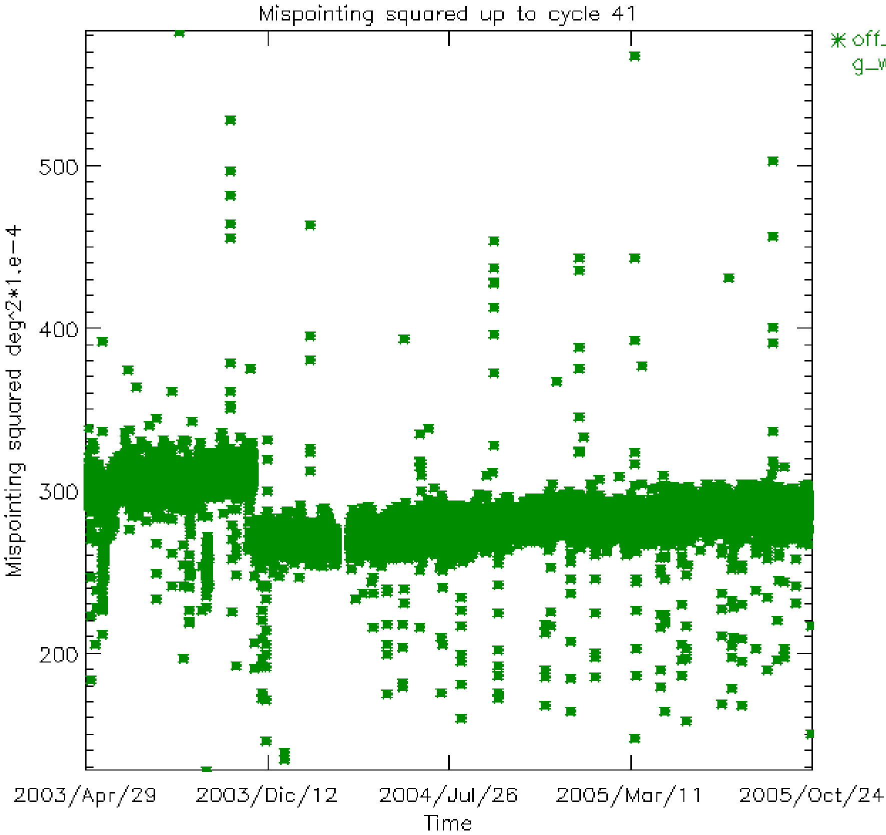

Figure 19: Smoothed mispointing squared trend until end of cycle 41 (deg^2*10e-4)

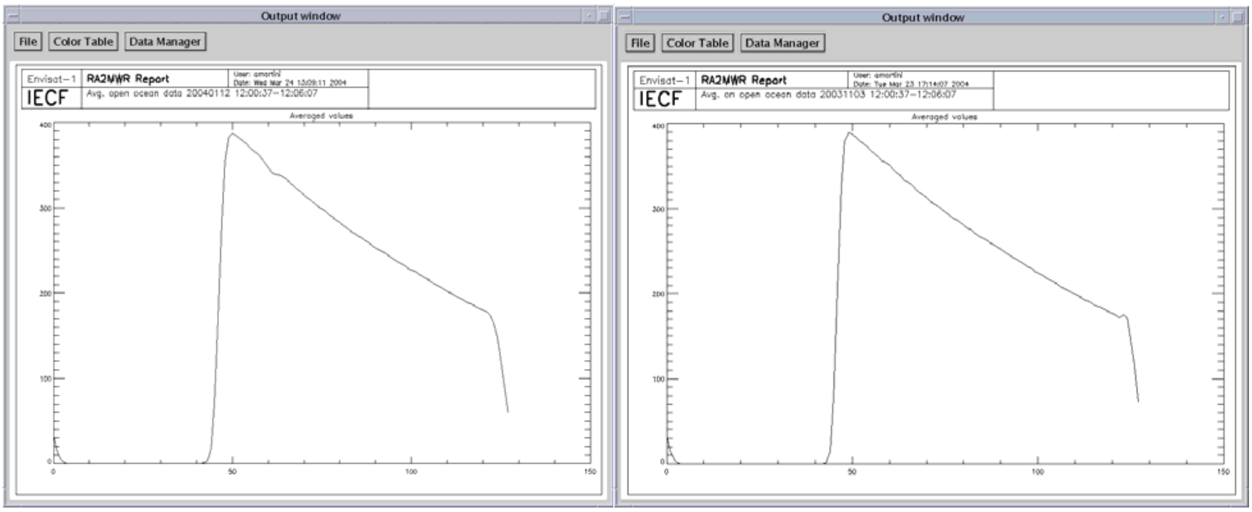

Figure 20: Open Ocean average waveforms before (left) and after an anomaly (right)

6.1.8 S-BAND ANOMALY

The so-called "S-Band anomaly" affects the RA-2 data products quality. Appendix 4 reports the list of the product files affected by the S-band anomaly problem during cycle 41. This corresponds to a total percentage of about 4.24% of the acquired data.

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.
In Figure 21, 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 until cycle 38 due to the implementation of the IF CAL procedure (including Heater 2 for S Band anomaly suppression) twice per day over the Himalayan region. However, this number increased during the last three cycles.
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.

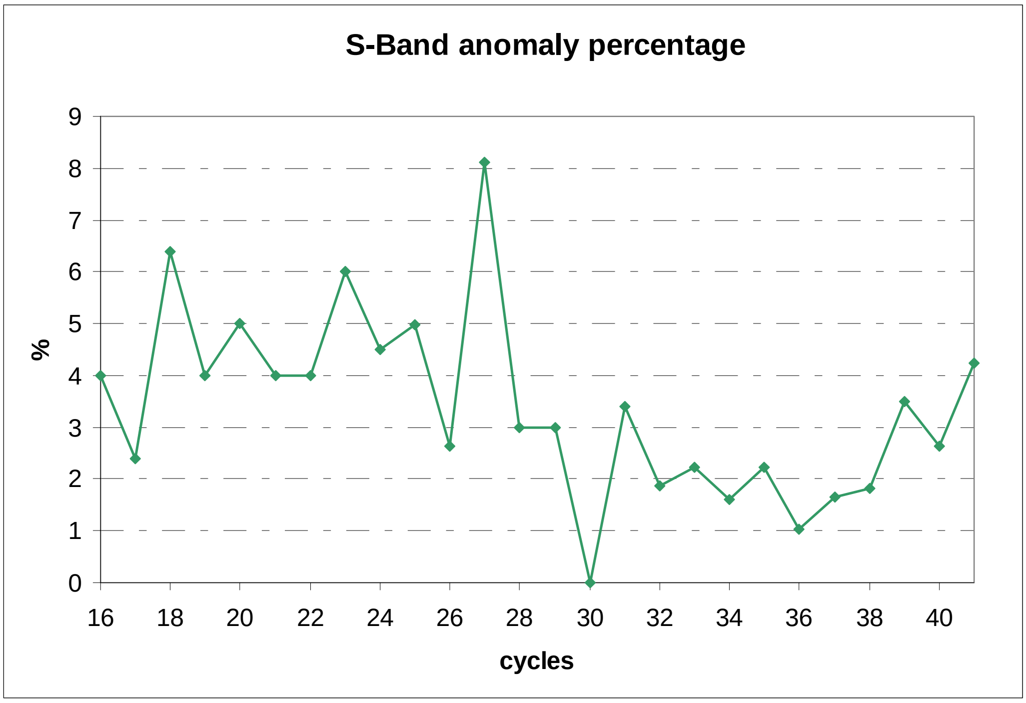

Figure 21: Percentage of data affected by the "S-Band Anomaly" for cycles 16-41

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 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#41 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]. Note that its validity is limited to the data acquired over open-ocean.

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

The actual data of cycle 41 have to be corrected to compensate for the Ultra Stable Oscillator drift shown in Figure 3. The measured Range shall be corrected considering a drift of -2.4 mm per year. Eventually it could also be corrected for the cyclic average given bias of 22.6 mm.

Warning: bias and drift have to be **SUBTRACTED** to 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.

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 chapter 9.1.4. 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 ABNORMAL RA-2 RANGE BEHAVIOR AFTER ANOMALY RECOVERY

An un-expected behavior of the Envisat RA-2 sensor was observed in the period from 2004/09/27 at ~16:00 and ending on 2004/09/29 at ~12:00 AM. This directly happened after the recovery of a RA-2 on-board anomaly occurred on the 2004/09/26 at ~13:40. The altimetric range jumped by several meters w.r.t. the Mean Sea Surface; on the other hand everything came back to normal as from the 29th of September around noon. RA-2 data from the above period have to be considered with caution.

7.3 Availability of data

7.3.1 RA-2

In Figure 22 and Table 7 (Appendix 1) the summary of unavailable RA-2 L0 products is given.
It is easy to notice that close to the Himalayan region two small gaps in the data are 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.

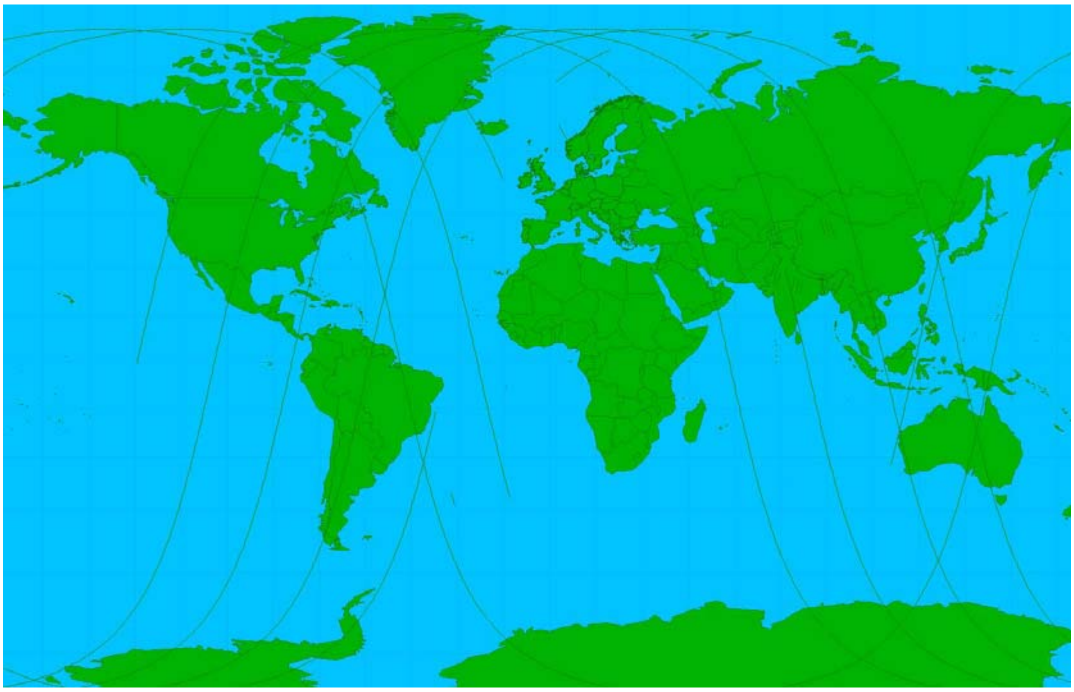

Figure 22: RA-2 L0 unavailable products for cycle 41

In Figure 23 and Table 9 (Appendix) the summary of unavailable RA-2 L1b products is given. Please notice that for L1b products, gaps due to instrument unavailabilities are not reported. Only gaps due to technical problems in the PDS are reported.

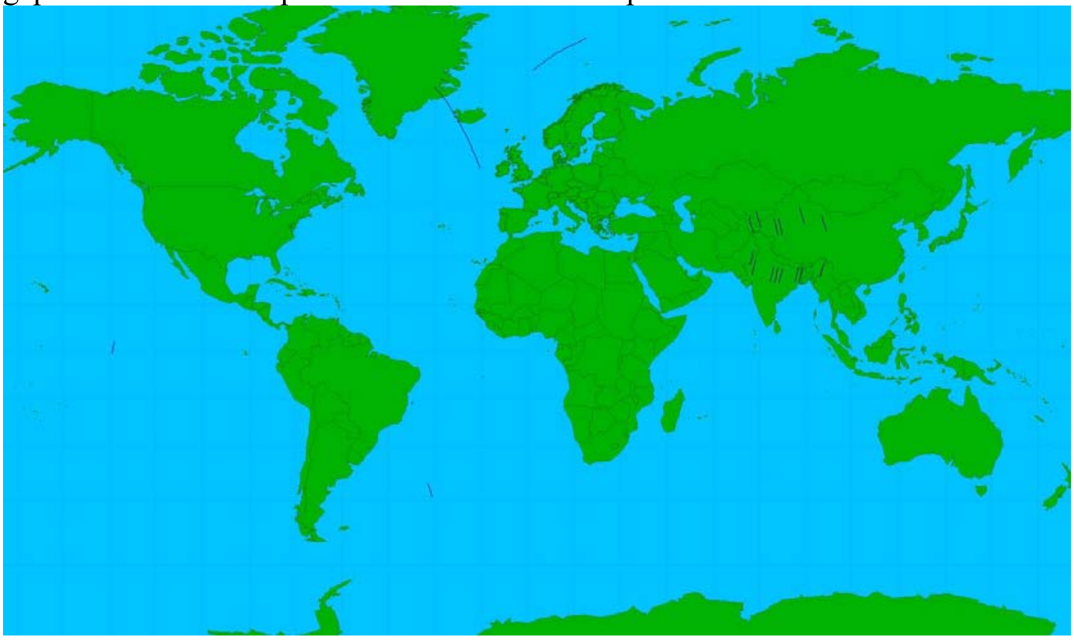

Figure 23: RA-2 L1b unavailable products for cycle 41

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.

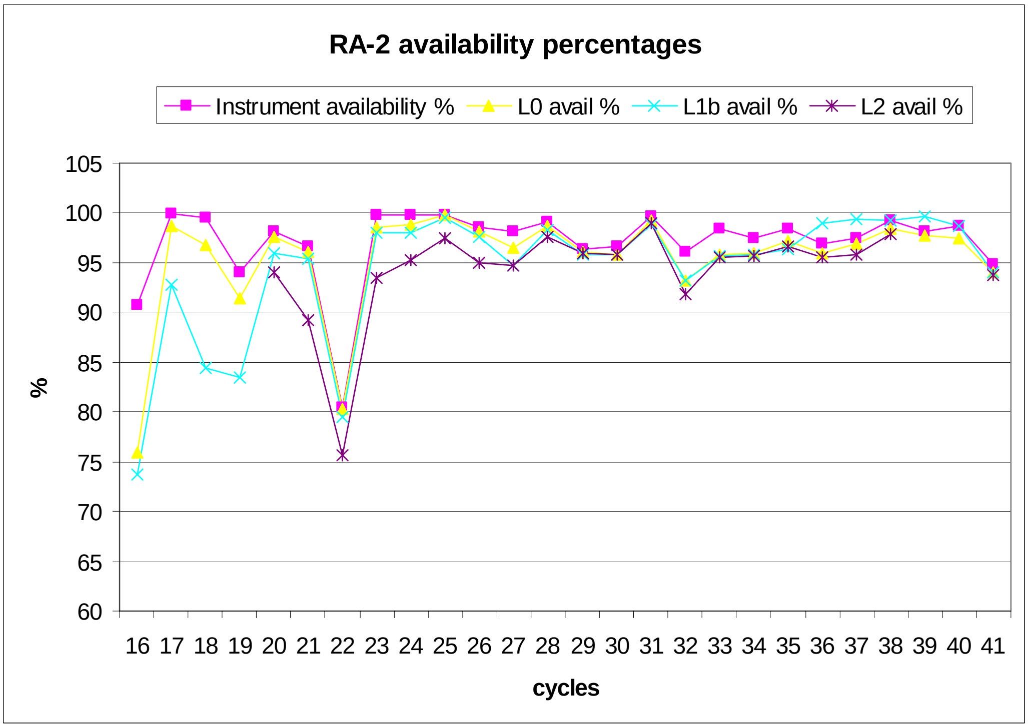

Figure 24: Percentage of Products unavailability up to cycle 41

7.3.2 MWR

In Figure 25 and Table 8 (Appendix) the summary of unavailable MWR L0 products is given.

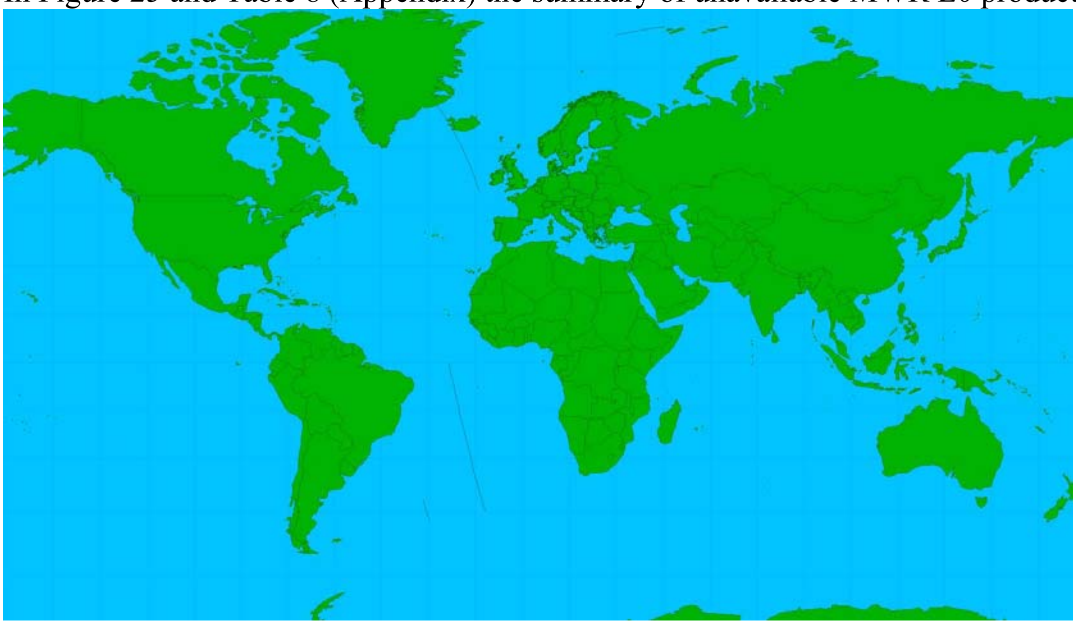

Figure 25: MWR L0 unavailable products for cycle 41

7.4 Edited measurements

In order to produce the statistics reported in section 7.5, the following editing criteria have been used before using RA2_FGD products:

Parameter	Surface type	Zone	Range
Ku SWH	Open Ocean	All world	[0, 10] (m)
Ku Backscattering Coeff.	Open ocean	All world	[7, 17] (dBs)
Ku Wind Speed	Open ocean	All world	[0, 20] (m/s)

Table 3: Editing criteria for RA-2 parameters statistics

7.5 RA-2 Altimeter Parameters

Hereafter a summary of the main Altimetric parameters performances is reported; these results have been obtained with the editing criteria mentioned in par.7.4.

7.5.1 ALTIMETER RANGE

The monitoring of the RA-2 FD altimetric range shall be done once the NRT products are upgraded with the DORIS navigator NRT orbital information. For NRT products, there are no current results for the time being.

7.5.2 SIGNIFICANT WAVE HEIGHT

The histogram of the SWH, reported in Figure 26, shows a nominal behaviour for this cycle. The trend goes on following the behaviour 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 27 shows the SWH daily mean. The possible high values, plotted outside the figure range, reported for the S-Band data are due to the so-called S-Band anomaly (ref. par.6.1.8).

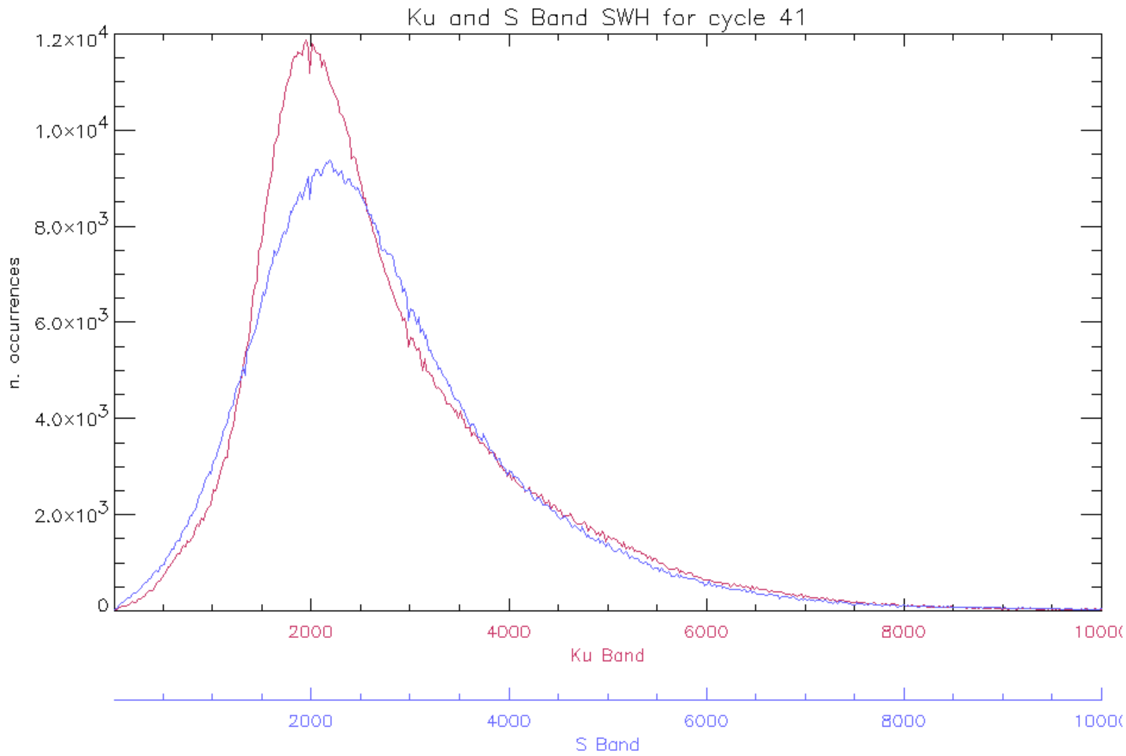

Figure 26: Histogram of Ku and S Band SWH for cycle 41 (mm)

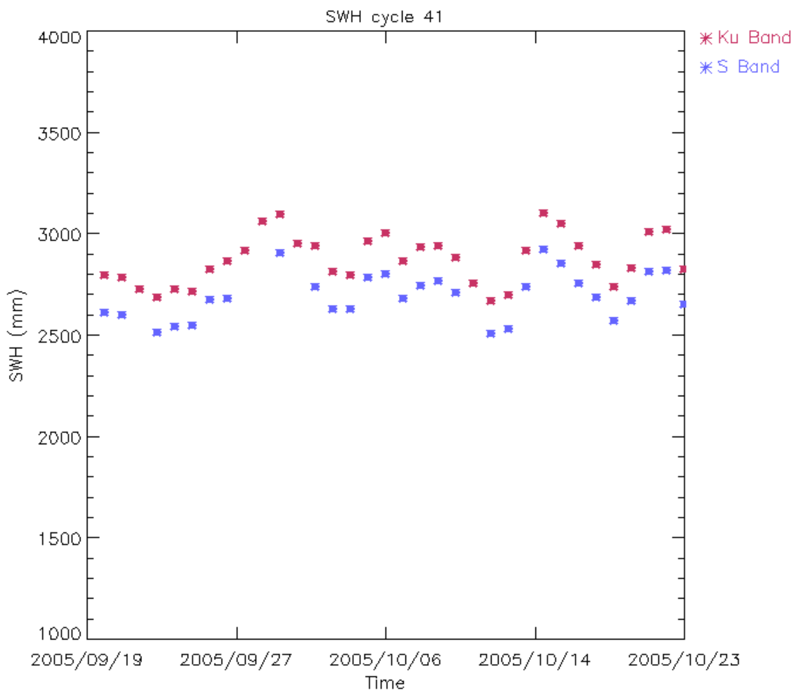

Figure 27: Ku and S SWH daily average for cycle 41 (mm)

In Figure 28, the SWH is reported from cycle 16 until cycle 41. It can be noticed that the SWH in both bands shows a trend which follows the seasonal variability. The high daily means reported (sometimes plotted outside the figure's range) are due to the so-called S-Band anomaly (ref. par.6.1.8).

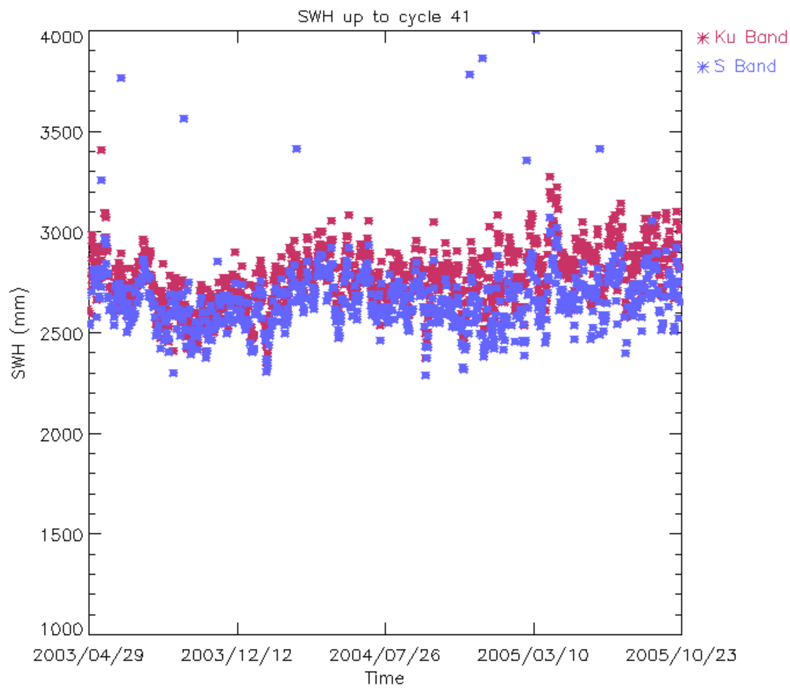

Figure 28: Ku and S SWH daily average up to cycle 41 (mm)

7.5.3 BACKSCATTER COEFFICIENT – WIND SPEED

The Sigma_0 histogram both in Ku and S Band shows secondary peaks, see Figure 29. A small investigation on this problem, performed on the data of cycle 28, demonstrated that the backscattering distribution assumes a different behaviour 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).

In Figure 30, the backscattering coefficient daily average trend is reported. The trend shows a nominal behavior for both bands. 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).

The histogram of Wind Speed computed for the Ku-band and the time behavior during cycle 41 are reported in Figure 31 and Figure 32, respectively. They are similar to the previous cycle.

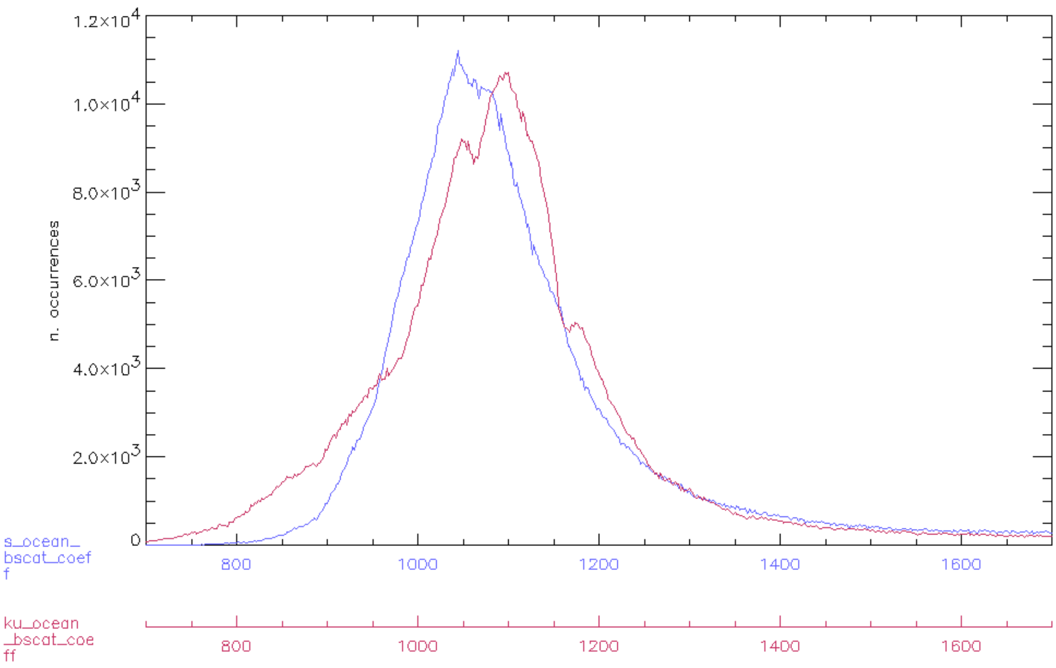

Figure 29: Histogram of Ku and S Band Backscattering Coefficient for cycle 41 (dB/100)

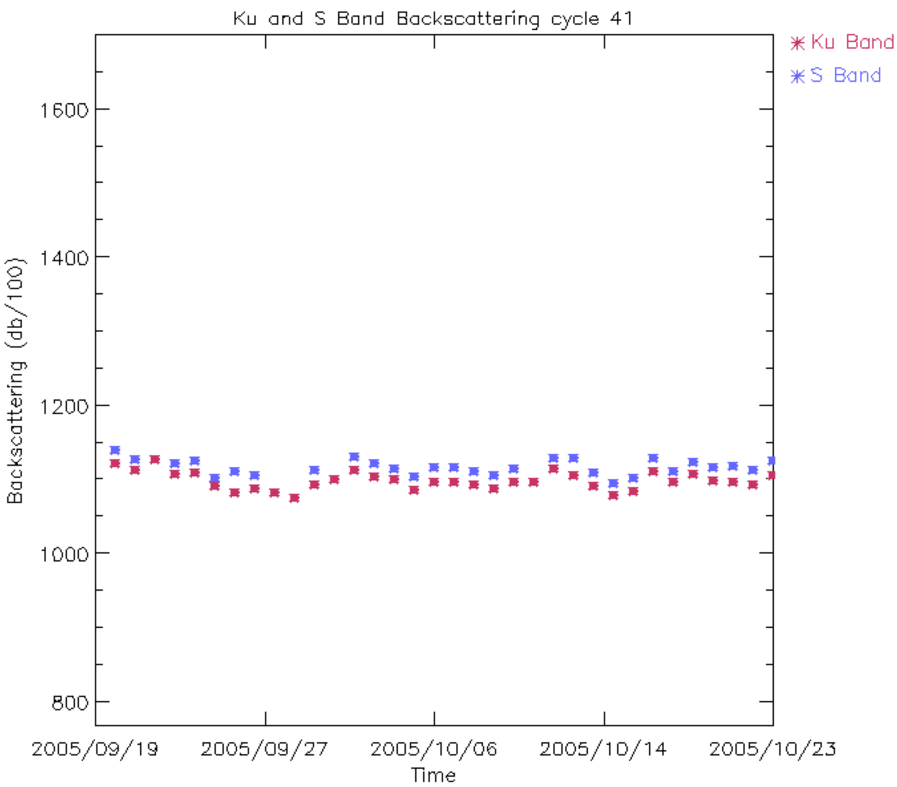

Figure 30: Ku and S Sigma_0 daily average for cycle 41 (dB/100)

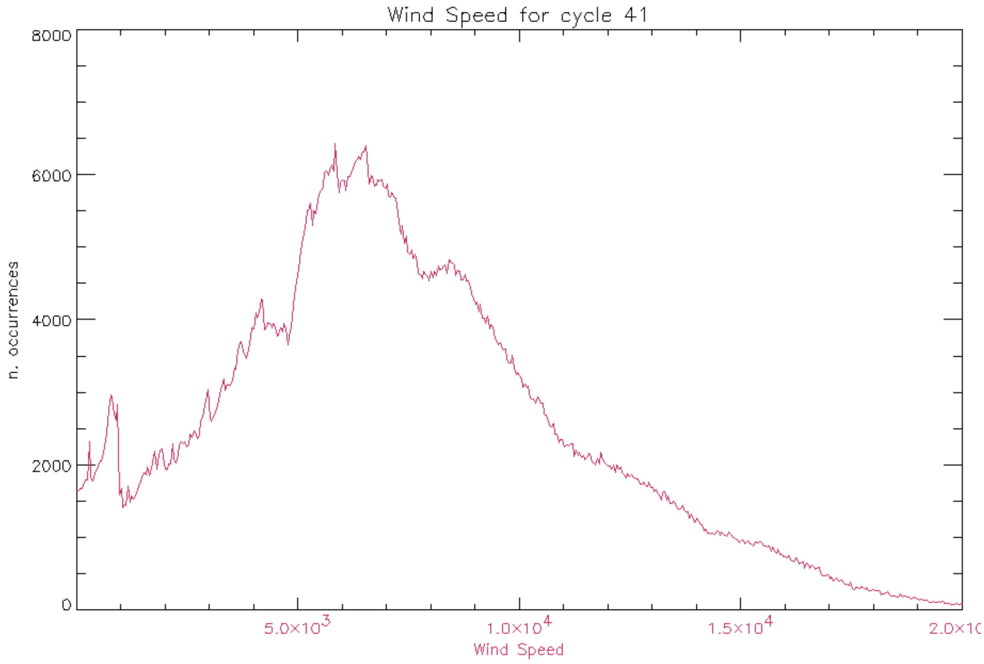

Figure 31: Histogram of Ku Wind Speed for cycle 41 (mm/s)

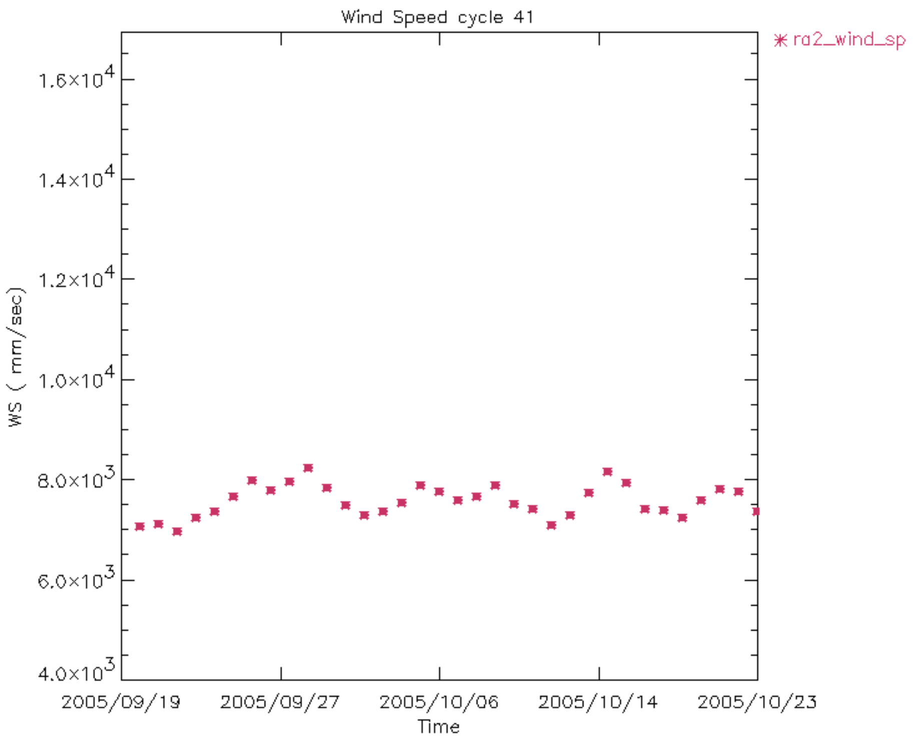

Figure 32: Ku Band Wind Speed daily average for cycle 41 (mm/s)

The Ku-Band Sigma_0 trend, reported hereafter, 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 34.

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.

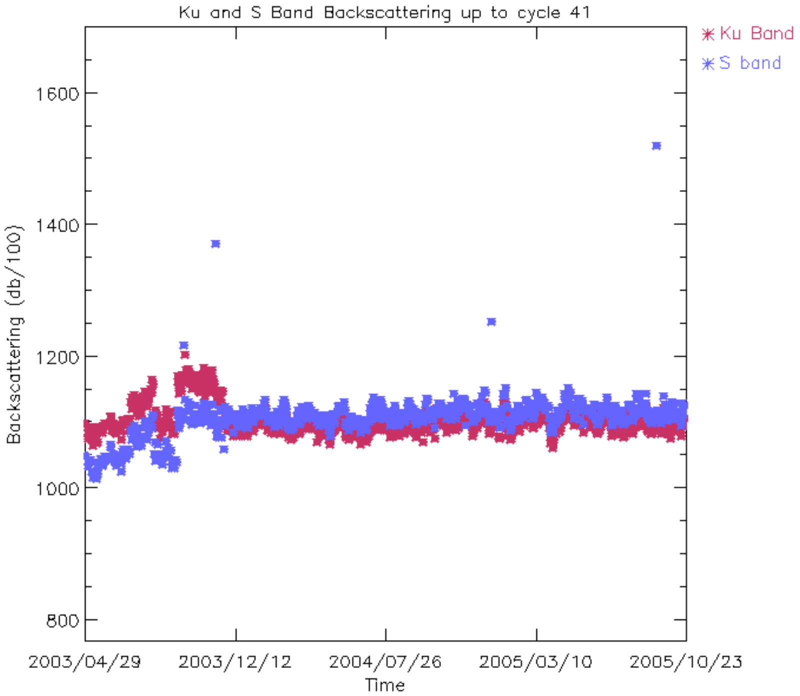

Figure 33: Ku and S band Backscattering daily averages up to cycle 41 (dB/100)

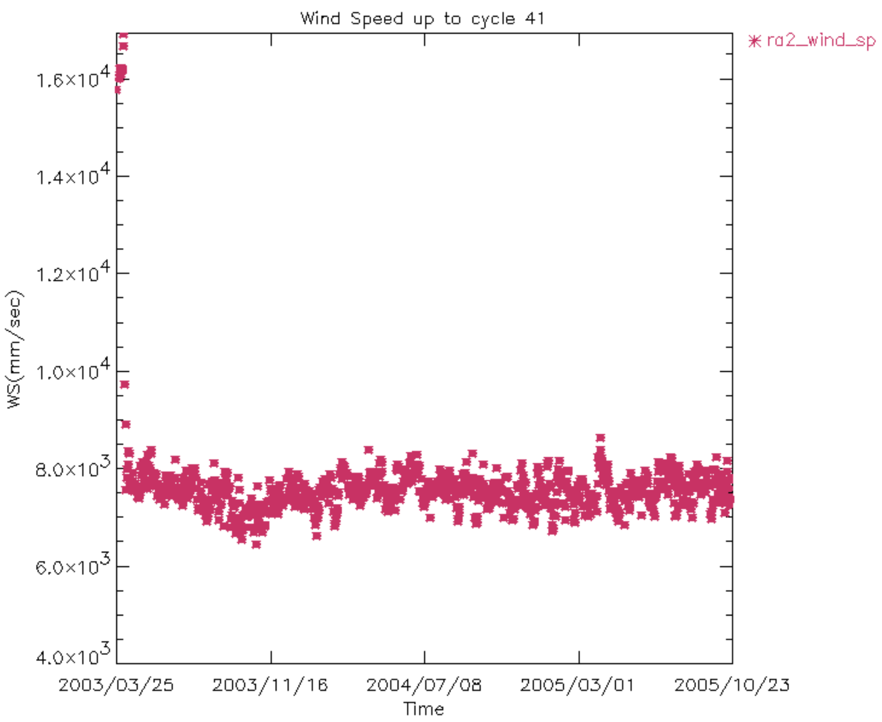

Figure 34: Wind Speed daily averages up to cycle 41 (mm/s)

8 PARTICULAR INVESTIGATIONS

During cycle 41 no special investigation has been performed.

APPENDIX 1: AVAILABILITY

Table 4: RA-2 L0, L1b and L2 FGD Data products availability summary for cycle 41

Start orbit	Stop orbit	Time [sec] instrum. Unavail-ability	Time [sec] L0 gaps	Time [sec] L1b gaps	Time [sec] L2 (FGD) gaps	% instrum. avail.	% L0 avail.	% L1b avail.	% L2 (FGD) avail.
18592	18692	25.635.465	2.150.374	2.137.712	2.166.629	95	95	95	95
18692	18792	77.219.482	1.115.768	1.109.599	1.121.898	87	87	87	87
18792	18892	46.973.932	1.011.992	1.005.901	6.854.223	92	92	92	91
18892	18992	2.067.754	1.904.630	1.888.645	7.697.747	99	99	99	98
18992	19093	2.152.523	16.119.069	16.104.718	16.126.388	99	96	96	96

Table 5: MWR L0 Data products availability summary for cycle 41

Start orbit	Stop orbit	Time [sec] instrum. unavailability	Time [sec] L0 gaps	% instrum. avail.	% L0 avail.
18592	18692	0	1.104	100	99,81
18692	18792	0	264	100	99,96
18792	18892	0	0	100	100
18892	18992	0	984	100	99,83
18992	19093	0	15.025	100	97,51

Table 6: DORIS L0 Data products availability summary for cycle 41

Start orbit	Stop orbit	Time [sec] instrum. unavailability	Time [sec] L0 gaps	% instrum. avail.	% L0 avail.
18592	18692	0	7.080	100	99,41
18692	18792	0	2.356	100	99,77
18792	18892	0	2.674	100	99,76
18892	18992	0	4.720	100	99,61
18992	19093	0	32.132	100	97,34

Table 7: List of gaps for RA-2 L0 cycle 41

Start date	Start time	Stop date	Stop time	Duration [sec]	Start orbit	Stop orbit	Reason
19-SEP-2005	4.15.36	19-SEP-2005	4.16.54	78	18581	18581	PDS_UNKNOWN_FAILURE
19-SEP-2005	15.28.04	19-SEP-2005	15.29.22	78	18588	18588	PDS_UNKNOWN_FAILURE
22-SEP-2005	4.21.24	22-SEP-2005	4.22.42	78	18624	18624	PDS_UNKNOWN_FAILURE
22-SEP-2005	15.33.55	22-SEP-2005	15.35.13	78	18631	18631	PDS_UNKNOWN_FAILURE
23-SEP-2005	5.27.29	23-SEP-2005	5.27.32	3	18639	18639	PDS_UNKNOWN_FAILURE
23-SEP-2005	5.28.55	23-SEP-2005	5.30.13	78	18639	18639	PDS_UNKNOWN_FAILURE
23-SEP-2005	16.42.08	23-SEP-2005	16.43.25	77	18646	18646	PDS_UNKNOWN_FAILURE
24-SEP-2005	4.58.40	24-SEP-2005	4.59.58	78	18653	18653	PDS_UNKNOWN_FAILURE
24-SEP-2005	16.10.23	24-SEP-2005	16.11.41	78	18660	18660	PDS_UNKNOWN_FAILURE
19-SEP-2005	22.14.39	19-SEP-2005	22.19.39	300	18592	18592	PDS_UNKNOWN_FAILURE
20-SEP-2005	5.23.56	20-SEP-2005	5.25.14	78	18596	18596	PDS_UNKNOWN_FAILURE
20-SEP-2005	11.51.33	20-SEP-2005	11.53.25	112	18600	18600	PDS_UNKNOWN_FAILURE
20-SEP-2005	12.19.03	20-SEP-2005	12.19.17	14	18600	18600	PDS_UNKNOWN_FAILURE
20-SEP-2005	18.56.00	20-SEP-2005	18.57.06	66	18604	18604	PDS_UNKNOWN_FAILURE
21-SEP-2005	0.36.36	21-SEP-2005	0.37.39	63	18607	18607	PDS_UNKNOWN_FAILURE
21-SEP-2005	4.53.01	21-SEP-2005	4.54.19	78	18610	18610	PDS_UNKNOWN_FAILURE
21-SEP-2005	16.04.41	21-SEP-2005	16.05.58	77	18617	18617	PDS_UNKNOWN_FAILURE
20-SEP-2005	12.19.17	20-SEP-2005	16.34.21	15304	18600	18603	UNAV_RA2
20-SEP-2005	16.36.43	20-SEP-2005	18.56.00	8357	18603	18604	UNAV_RA2
26-SEP-2005	3.55.04	26-SEP-2005	3.56.21	77	18681	18681	PDS_UNKNOWN_FAILURE

26-SEP-2005	15.07.23	26-SEP-2005	15.08.40	77	18688	18688	PDS_UNKNOWN_FAILURE
30-SEP-2005	5.07.41	30-SEP-2005	5.07.44	3	18739	18739	PDS_UNKNOWN_FAILURE
30-SEP-2005	5.09.54	30-SEP-2005	5.11.12	78	18739	18739	PDS_UNKNOWN_FAILURE
30-SEP-2005	16.22.12	30-SEP-2005	16.23.30	78	18746	18746	PDS_UNKNOWN_FAILURE
01-OCT-2005	4.38.39	01-OCT-2005	4.39.57	78	18753	18753	PDS_UNKNOWN_FAILURE
01-OCT-2005	15.50.42	01-OCT-2005	15.52.00	78	18760	18760	PDS_UNKNOWN_FAILURE
26-SEP-2005	20.15.39	26-SEP-2005	20.25.17	578	18691	18691	PDS_UNKNOWN_FAILURE
27-SEP-2005	5.04.17	27-SEP-2005	5.05.35	78	18696	18696	PDS_UNKNOWN_FAILURE
27-SEP-2005	16.16.18	27-SEP-2005	16.17.35	77	18703	18703	PDS_UNKNOWN_FAILURE
27-SEP-2005	20.52.07	27-SEP-2005	20.55.03	176	18705	18705	PDS_UNKNOWN_FAILURE
28-SEP-2005	4.32.54	28-SEP-2005	4.34.12	78	18710	18710	PDS_UNKNOWN_FAILURE
28-SEP-2005	15.45.06	28-SEP-2005	15.46.24	78	18717	18717	PDS_UNKNOWN_FAILURE
29-SEP-2005	4.00.56	29-SEP-2005	4.02.14	78	18724	18724	PDS_UNKNOWN_FAILURE
29-SEP-2005	15.13.17	29-SEP-2005	15.14.35	78	18731	18731	PDS_UNKNOWN_FAILURE
04-OCT-2005	12.47.26	04-OCT-2005	12.47.33	7	18801	18801	PDS_UNKNOWN_FAILURE
04-OCT-2005	16.35.30	04-OCT-2005	16.36.36	66	18803	18803	PDS_UNKNOWN_FAILURE
08-OCT-2005	15.31.02	08-OCT-2005	15.32.19	77	18860	18860	PDS_UNKNOWN_FAILURE
05-OCT-2005	4.12.40	05-OCT-2005	4.13.58	78	18810	18810	PDS_UNKNOWN_FAILURE
05-OCT-2005	15.22.23	05-OCT-2005	15.22.26	3	18817	18817	PDS_UNKNOWN_FAILURE
05-OCT-2005	15.25.06	05-OCT-2005	15.26.24	78	18817	18817	PDS_UNKNOWN_FAILURE
06-OCT-2005	5.21.08	06-OCT-2005	5.22.25	77	18825	18825	PDS_UNKNOWN_FAILURE
06-OCT-2005	16.34.01	06-OCT-2005	16.35.19	78	18832	18832	PDS_UNKNOWN_FAILURE
07-OCT-2005	4.50.09	07-OCT-2005	4.51.27	78	18839	18839	PDS_UNKNOWN_FAILURE
07-OCT-2005	16.01.53	07-OCT-2005	16.03.11	78	18846	18846	PDS_UNKNOWN_FAILURE
08-OCT-2005	4.18.32	08-OCT-2005	4.19.50	78	18853	18853	PDS_UNKNOWN_FAILURE
04-OCT-2005	12.47.33	04-OCT-2005	15.53.41	11168	18801	18803	UNAV_RA2
04-OCT-2005	15.56.17	04-OCT-2005	16.35.30	2353	18803	18803	UNAV_RA2
10-OCT-2005	4.55.52	10-OCT-2005	4.57.10	78	18882	18882	PDS_UNKNOWN_FAILURE
10-OCT-2005	16.07.29	10-OCT-2005	16.08.47	78	18889	18889	PDS_UNKNOWN_FAILURE
13-OCT-2005	16.13.21	13-OCT-2005	16.14.39	78	18932	18932	PDS_UNKNOWN_FAILURE
14-OCT-2005	4.30.03	14-OCT-2005	4.31.20	77	18939	18939	PDS_UNKNOWN_FAILURE
14-OCT-2005	15.39.20	14-OCT-2005	15.39.23	3	18946	18946	PDS_UNKNOWN_FAILURE
14-OCT-2005	15.42.20	14-OCT-2005	15.43.37	77	18946	18946	PDS_UNKNOWN_FAILURE
15-OCT-2005	3.55.58	15-OCT-2005	3.56.01	3	18953	18953	PDS_UNKNOWN_FAILURE
15-OCT-2005	3.58.01	15-OCT-2005	3.59.19	78	18953	18953	PDS_UNKNOWN_FAILURE
15-OCT-2005	15.10.21	15-OCT-2005	15.11.39	78	18960	18960	PDS_UNKNOWN_FAILURE
10-OCT-2005	22.28.54	10-OCT-2005	22.40.43	709	18892	18893	PDS_UNKNOWN_FAILURE
11-OCT-2005	4.24.17	11-OCT-2005	4.25.35	78	18896	18896	PDS_UNKNOWN_FAILURE
11-OCT-2005	15.33.41	11-OCT-2005	15.33.44	3	18903	18903	PDS_UNKNOWN_FAILURE
11-OCT-2005	15.36.44	11-OCT-2005	15.38.02	78	18903	18903	PDS_UNKNOWN_FAILURE
12-OCT-2005	3.52.08	12-OCT-2005	3.53.26	78	18910	18910	PDS_UNKNOWN_FAILURE
12-OCT-2005	16.44.51	12-OCT-2005	16.46.08	77	18918	18918	PDS_UNKNOWN_FAILURE
12-OCT-2005	20.13.54	12-OCT-2005	20.14.23	29	18920	18920	PDS_UNKNOWN_FAILURE
13-OCT-2005	5.01.29	13-OCT-2005	5.02.47	78	18925	18925	PDS_UNKNOWN_FAILURE

17-OCT-2005	4.32.41	17-OCT-2005	4.32.43	2	18982	18982	PDS_UNKNOWN_FAILURE
17-OCT-2005	4.35.48	17-OCT-2005	4.37.06	78	18982	18982	PDS_UNKNOWN_FAILURE
19-OCT-2005	16.25.11	19-OCT-2005	16.26.29	78	19018	19018	PDS_UNKNOWN_FAILURE
19-OCT-2005	19.52.23	19-OCT-2005	20.56.48	3865	19020	19020	PDS_UNKNOWN_FAILURE
20-OCT-2005	4.41.33	20-OCT-2005	4.42.51	78	19025	19025	PDS_UNKNOWN_FAILURE
20-OCT-2005	15.50.47	20-OCT-2005	15.50.50	3	19032	19032	PDS_UNKNOWN_FAILURE
20-OCT-2005	15.53.31	20-OCT-2005	15.54.49	78	19032	19032	PDS_UNKNOWN_FAILURE
21-OCT-2005	4.09.46	21-OCT-2005	4.11.03	77	19039	19039	PDS_UNKNOWN_FAILURE
21-OCT-2005	15.19.36	21-OCT-2005	15.19.38	2	19046	19046	PDS_UNKNOWN_FAILURE
21-OCT-2005	15.22.11	21-OCT-2005	15.23.29	78	19046	19046	PDS_UNKNOWN_FAILURE
21-OCT-2005	20.30.40	21-OCT-2005	20.31.47	67	19049	19049	PDS_UNKNOWN_FAILURE
21-OCT-2005	23.22.28	22-OCT-2005	2.14.21	10313	19050	19052	PDS_UNKNOWN_FAILURE
17-OCT-2005	15.45.02	17-OCT-2005	15.45.05	3	18989	18989	PDS_UNKNOWN_FAILURE
22-OCT-2005	5.18.21	22-OCT-2005	5.19.39	78	19054	19054	PDS_UNKNOWN_FAILURE
22-OCT-2005	16.31.06	22-OCT-2005	16.32.24	78	19061	19061	PDS_UNKNOWN_FAILURE
23-OCT-2005	4.47.18	23-OCT-2005	4.48.36	78	19068	19068	PDS_UNKNOWN_FAILURE
23-OCT-2005	15.56.33	23-OCT-2005	15.56.35	2	19075	19075	PDS_UNKNOWN_FAILURE
23-OCT-2005	15.59.07	23-OCT-2005	16.00.25	78	19075	19075	PDS_UNKNOWN_FAILURE
17-OCT-2005	15.47.56	17-OCT-2005	15.49.13	77	18989	18989	PDS_UNKNOWN_FAILURE
18-OCT-2005	4.03.53	18-OCT-2005	4.05.11	78	18996	18996	PDS_UNKNOWN_FAILURE
18-OCT-2005	15.16.16	18-OCT-2005	15.17.34	78	19003	19003	PDS_UNKNOWN_FAILURE
18-OCT-2005	18.41.49	18-OCT-2005	18.44.48	179	19005	19005	PDS_UNKNOWN_FAILURE
18-OCT-2005	20.23.13	18-OCT-2005	20.33.08	595	19006	19006	PDS_UNKNOWN_FAILURE
19-OCT-2005	5.10.31	19-OCT-2005	5.10.34	3	19011	19011	PDS_UNKNOWN_FAILURE
19-OCT-2005	5.12.44	19-OCT-2005	5.14.02	78	19011	19011	PDS_UNKNOWN_FAILURE

Table 8: List of gaps for MWR L0 cycle 41

Start date	Start time	Stop date	Stop time	Duration [sec]	Start orbit	Stop orbit	Reason
19-SEP-2005	22.13.39	19-SEP-2005	22.19.15	336	18592	18592	PDS_UNKNOWN_FAILURE
20-SEP-2005	11.50.05	20-SEP-2005	11.50.53	48	18600	18600	PDS_UNKNOWN_FAILURE
21-SEP-2005	0.35.42	21-SEP-2005	0.37.18	96	18607	18607	PDS_UNKNOWN_FAILURE
26-SEP-2005	20.14.43	26-SEP-2005	20.25.07	624	18691	18691	PDS_UNKNOWN_FAILURE
27-SEP-2005	20.51.09	27-SEP-2005	20.54.45	216	18705	18705	PDS_UNKNOWN_FAILURE
29-SEP-2005	7.08.00	29-SEP-2005	7.08.48	48	18726	18726	PDS_UNKNOWN_FAILURE
10-OCT-2005	22.28.02	10-OCT-2005	22.40.26	744	18892	18893	PDS_UNKNOWN_FAILURE
12-OCT-2005	20.12.55	12-OCT-2005	20.14.07	72	18920	18920	PDS_UNKNOWN_FAILURE
13-OCT-2005	19.38.33	13-OCT-2005	19.39.21	48	18934	18934	PDS_UNKNOWN_FAILURE
18-OCT-2005	20.22.20	18-OCT-2005	20.33.08	648	19006	19006	PDS_UNKNOWN_FAILURE
19-OCT-2005	19.51.34	19-OCT-2005	20.56.46	3912	19020	19020	PDS_UNKNOWN_FAILURE
21-OCT-2005	20.29.39	21-OCT-2005	20.31.39	120	19049	19049	PDS_UNKNOWN_FAILURE
21-OCT-2005	23.21.39	22-OCT-2005	2.14.04	10345	19050	19052	PDS_UNKNOWN_FAILURE

Table 9: List of gaps for RA-2 L1b cycle 41

Start date	Start time	Stop date	Stop time	Duration [sec]	Start orbit	Stop orbit	Reason
22-SEP-2005	4.21.24	22-SEP-2005	4.22.42	78	18624	18624	PDS_UNKNOWN_FAILURE
22-SEP-2005	15.33.55	22-SEP-2005	15.35.13	78	18631	18631	PDS_UNKNOWN_FAILURE
23-SEP-2005	5.28.55	23-SEP-2005	5.30.13	78	18639	18639	PDS_UNKNOWN_FAILURE
23-SEP-2005	16.42.08	23-SEP-2005	16.43.25	77	18646	18646	PDS_UNKNOWN_FAILURE
24-SEP-2005	4.58.40	24-SEP-2005	4.59.58	78	18653	18653	PDS_UNKNOWN_FAILURE
24-SEP-2005	16.10.23	24-SEP-2005	16.11.41	78	18660	18660	PDS_UNKNOWN_FAILURE
25-SEP-2005	4.27.09	25-SEP-2005	4.28.27	78	18667	18667	PDS_UNKNOWN_FAILURE
19-SEP-2005	22.14.40	19-SEP-2005	22.19.39	299	18592	18592	PDS_UNKNOWN_FAILURE
20-SEP-2005	5.23.56	20-SEP-2005	5.25.14	78	18596	18596	PDS_UNKNOWN_FAILURE
20-SEP-2005	11.51.34	20-SEP-2005	11.53.25	111	18600	18600	PDS_UNKNOWN_FAILURE
20-SEP-2005	12.19.04	20-SEP-2005	12.19.17	13	18600	18600	PDS_UNKNOWN_FAILURE
20-SEP-2005	18.56.00	20-SEP-2005	18.57.06	66	18604	18604	PDS_UNKNOWN_FAILURE
21-SEP-2005	0.36.37	21-SEP-2005	0.37.39	62	18607	18607	PDS_UNKNOWN_FAILURE
21-SEP-2005	4.53.01	21-SEP-2005	4.54.19	78	18610	18610	PDS_UNKNOWN_FAILURE
21-SEP-2005	16.04.41	21-SEP-2005	16.05.58	77	18617	18617	PDS_UNKNOWN_FAILURE
26-SEP-2005	3.55.04	26-SEP-2005	3.56.21	77	18681	18681	PDS_UNKNOWN_FAILURE
26-SEP-2005	15.07.23	26-SEP-2005	15.08.40	77	18688	18688	PDS_UNKNOWN_FAILURE
30-SEP-2005	5.09.54	30-SEP-2005	5.11.12	78	18739	18739	PDS_UNKNOWN_FAILURE
30-SEP-2005	16.22.12	30-SEP-2005	16.23.30	78	18746	18746	PDS_UNKNOWN_FAILURE
01-OCT-2005	4.38.39	01-OCT-2005	4.39.57	78	18753	18753	PDS_UNKNOWN_FAILURE
01-OCT-2005	15.50.42	01-OCT-2005	15.52.00	78	18760	18760	PDS_UNKNOWN_FAILURE
26-SEP-2005	20.15.40	26-SEP-2005	20.25.17	577	18691	18691	PDS_UNKNOWN_FAILURE
27-SEP-2005	5.04.17	27-SEP-2005	5.05.35	78	18696	18696	PDS_UNKNOWN_FAILURE
27-SEP-2005	16.16.18	27-SEP-2005	16.17.35	77	18703	18703	PDS_UNKNOWN_FAILURE
27-SEP-2005	20.52.08	27-SEP-2005	20.55.03	175	18705	18705	PDS_UNKNOWN_FAILURE
28-SEP-2005	4.32.54	28-SEP-2005	4.34.12	78	18710	18710	PDS_UNKNOWN_FAILURE
28-SEP-2005	15.45.06	28-SEP-2005	15.46.24	78	18717	18717	PDS_UNKNOWN_FAILURE
29-SEP-2005	4.00.56	29-SEP-2005	4.02.14	78	18724	18724	PDS_UNKNOWN_FAILURE
29-SEP-2005	15.13.17	29-SEP-2005	15.14.35	78	18731	18731	PDS_UNKNOWN_FAILURE
04-OCT-2005	12.47.27	04-OCT-2005	12.47.33	6	18801	18801	PDS_UNKNOWN_FAILURE
04-OCT-2005	16.35.30	04-OCT-2005	16.36.36	66	18803	18803	PDS_UNKNOWN_FAILURE
05-OCT-2005	4.12.40	05-OCT-2005	4.13.58	78	18810	18810	PDS_UNKNOWN_FAILURE
05-OCT-2005	15.25.06	05-OCT-2005	15.26.24	78	18817	18817	PDS_UNKNOWN_FAILURE
06-OCT-2005	5.21.08	06-OCT-2005	5.22.25	77	18825	18825	PDS_UNKNOWN_FAILURE
06-OCT-2005	16.34.01	06-OCT-2005	16.35.19	78	18832	18832	PDS_UNKNOWN_FAILURE
07-OCT-2005	4.50.09	07-OCT-2005	4.51.27	78	18839	18839	PDS_UNKNOWN_FAILURE
07-OCT-2005	16.01.53	07-OCT-2005	16.03.11	78	18846	18846	PDS_UNKNOWN_FAILURE
08-OCT-2005	4.18.32	08-OCT-2005	4.19.50	78	18853	18853	PDS_UNKNOWN_FAILURE
08-OCT-2005	15.31.02	08-OCT-2005	15.32.19	77	18860	18860	PDS_UNKNOWN_FAILURE
10-OCT-2005	4.55.52	10-OCT-2005	4.57.10	78	18882	18882	PDS_UNKNOWN_FAILURE
10-OCT-2005	16.07.29	10-OCT-2005	16.08.47	78	18889	18889	PDS_UNKNOWN_FAILURE
14-OCT-2005	4.30.03	14-OCT-2005	4.31.20	77	18939	18939	PDS_UNKNOWN_FAILURE

14-OCT-2005	15.42.20	14-OCT-2005	15.43.37	77	18946	18946	PDS_UNKNOWN_FAILURE
15-OCT-2005	3.58.01	15-OCT-2005	3.59.19	78	18953	18953	PDS_UNKNOWN_FAILURE
15-OCT-2005	15.10.21	15-OCT-2005	15.11.39	78	18960	18960	PDS_UNKNOWN_FAILURE
10-OCT-2005	22.28.55	10-OCT-2005	22.40.43	708	18892	18893	PDS_UNKNOWN_FAILURE
11-OCT-2005	4.24.17	11-OCT-2005	4.25.35	78	18896	18896	PDS_UNKNOWN_FAILURE
11-OCT-2005	15.36.44	11-OCT-2005	15.38.02	78	18903	18903	PDS_UNKNOWN_FAILURE
12-OCT-2005	3.52.08	12-OCT-2005	3.53.26	78	18910	18910	PDS_UNKNOWN_FAILURE
12-OCT-2005	16.44.51	12-OCT-2005	16.46.08	77	18918	18918	PDS_UNKNOWN_FAILURE
12-OCT-2005	20.13.55	12-OCT-2005	20.14.23	28	18920	18920	PDS_UNKNOWN_FAILURE
13-OCT-2005	5.01.29	13-OCT-2005	5.02.47	78	18925	18925	PDS_UNKNOWN_FAILURE
13-OCT-2005	16.13.21	13-OCT-2005	16.14.39	78	18932	18932	PDS_UNKNOWN_FAILURE
17-OCT-2005	4.35.48	17-OCT-2005	4.37.06	78	18982	18982	PDS_UNKNOWN_FAILURE
17-OCT-2005	15.47.56	17-OCT-2005	15.49.13	77	18989	18989	PDS_UNKNOWN_FAILURE
20-OCT-2005	15.50.48	20-OCT-2005	15.50.50	2	19032	19032	PDS_UNKNOWN_FAILURE
20-OCT-2005	15.53.31	20-OCT-2005	15.54.49	78	19032	19032	PDS_UNKNOWN_FAILURE
21-OCT-2005	4.09.46	21-OCT-2005	4.11.03	77	19039	19039	PDS_UNKNOWN_FAILURE
21-OCT-2005	15.22.11	21-OCT-2005	15.23.29	78	19046	19046	PDS_UNKNOWN_FAILURE
21-OCT-2005	20.30.41	21-OCT-2005	20.31.47	66	19049	19049	PDS_UNKNOWN_FAILURE
21-OCT-2005	23.22.29	22-OCT-2005	2.14.21	10312	19050	19052	PDS_UNKNOWN_FAILURE
22-OCT-2005	5.18.21	22-OCT-2005	5.19.39	78	19054	19054	PDS_UNKNOWN_FAILURE
22-OCT-2005	16.31.06	22-OCT-2005	16.32.24	78	19061	19061	PDS_UNKNOWN_FAILURE
23-OCT-2005	4.47.18	23-OCT-2005	4.48.36	78	19068	19068	PDS_UNKNOWN_FAILURE
23-OCT-2005	15.59.07	23-OCT-2005	16.00.25	78	19075	19075	PDS_UNKNOWN_FAILURE
18-OCT-2005	4.03.53	18-OCT-2005	4.05.11	78	18996	18996	PDS_UNKNOWN_FAILURE
18-OCT-2005	15.16.16	18-OCT-2005	15.17.34	78	19003	19003	PDS_UNKNOWN_FAILURE
18-OCT-2005	18.41.50	18-OCT-2005	18.44.48	178	19005	19005	PDS_UNKNOWN_FAILURE
18-OCT-2005	20.23.15	18-OCT-2005	20.33.08	593	19006	19006	PDS_UNKNOWN_FAILURE
19-OCT-2005	5.12.44	19-OCT-2005	5.14.02	78	19011	19011	PDS_UNKNOWN_FAILURE
19-OCT-2005	16.25.11	19-OCT-2005	16.26.29	78	19018	19018	PDS_UNKNOWN_FAILURE
19-OCT-2005	19.52.24	19-OCT-2005	20.56.48	3864	19020	19020	PDS_UNKNOWN_FAILURE
20-OCT-2005	4.41.33	20-OCT-2005	4.42.51	78	19025	19025	PDS_UNKNOWN_FAILURE

APPENDIX 2: AUXILIARY DATA FILES

RA2_CHD_AXVIEC20030402_094243_20030407_000000_20200101_000000
RA2_CON_AXVIEC20020606_164228_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_IFA_AXVIEC20050216_125529_20020101_000000_20200101_000000
RA2_IFB_AXVIEC20050216_125738_20020101_000000_20200101_000000
RA2_IFF_AXVIEC20031208_151817_20030602_215929_20100101_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_AXVIEC20031208_150608_20020101_000000_20200101_000000
RA2_SSB_AXVIEC20031208_150749_20020101_000000_20200101_000000
RA2_TLD_AXVIEC20031208_151137_20020101_000000_20200101_000000
RA2_USO_AXVIEC20020122_162920_20020101_000000_20200101_000000

APPENDIX 3: SIGMA0 ABSOLUTE CALIBRATION

Table 10: Transponder measurement results up to cycle 41

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	0,141
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	1,417	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	0.076
18799	04-Oct-05	Maccarese/208	High	0.85	0.082
18906	11-Oct-05	Perm site Rome / 315	Low	1.46	0.078

APPENDIX 4: S-BAND ANOMALY

Table 11: List of L2 FGD Files affected by S-Band anomaly during cycle 41

File name	Start date	Start time	Stop date	Stop time
RA2_FGD_2PNPDK20050922_104840_000059632041_00037_18628_0791.N1	22-SEP-2005	10.48.40	22-SEP-2005	12.28.04
RA2_FGD_2PNPDK20050922_122631_000059982041_00038_18629_0792.N1	22-SEP-2005	12.26.31	22-SEP-2005	14.06.29
RA2_FGD_2PNPDK20050922_140526_000051282041_00039_18630_0793.N1	22-SEP-2005	14.05.27	22-SEP-2005	15.30.54
RA2_FGD_2PNPDK20050922_140626_000050682041_00039_18630_0801.N1	22-SEP-2005	14.06.27	22-SEP-2005	15.30.54
RA2_FGD_2PNPDK20050928_173112_000060172041_00127_18718_0869.N1	28-SEP-2005	17.31.12	28-SEP-2005	19.11.29
RA2_FGD_2PNPDK20050928_191010_000062182041_00128_18719_0872.N1	28-SEP-2005	19.10.11	28-SEP-2005	20.53.49
RA2_FGD_2PNPDE20050928_205305_000043092041_00129_18720_0667.N1	28-SEP-2005	20.53.06	28-SEP-2005	22.04.55
RA2_FGD_2PNPDE20050928_220355_000062002041_00129_18720_0669.N1	28-SEP-2005	22.03.56	28-SEP-2005	23.47.16
RA2_FGD_2PNPDE20050928_234601_000059952041_00130_18721_0670.N1	28-SEP-2005	23.46.02	29-SEP-2005	1.25.57
RA2_FGD_2PNPDE20050929_012443_000044012041_00131_18722_0671.N1	29-SEP-2005	1.24.44	29-SEP-2005	2.38.05
RA2_FGD_2PNPDE20050929_023729_000048742041_00132_18723_0672.N1	29-SEP-2005	2.37.29	29-SEP-2005	3.58.43
RA2_FGD_2PNPDK20051001_074357_000061662041_00164_18755_0897.N1	01-OCT-2005	7.43.57	01-OCT-2005	9.26.43
RA2_FGD_2PNPDK20051001_092607_000059632041_00165_18756_0898.N1	01-OCT-2005	9.26.07	01-OCT-2005	11.05.31
RA2_FGD_2PNPDK20051001_110335_000061362041_00166_18757_0899.N1	01-OCT-2005	11.03.36	01-OCT-2005	12.45.52
RA2_FGD_2PNPDK20051001_124402_000059952041_00167_18758_0900.N1	01-OCT-2005	12.44.03	01-OCT-2005	14.23.58
RA2_FGD_2PNPDK20051001_142254_000051022041_00168_18759_0901.N1	01-OCT-2005	14.22.55	01-OCT-2005	15.47.57
RA2_FGD_2PNPDK20051009_195955_000000342041_00286_18877_0999.N1	09-OCT-2005	19.59.55	09-OCT-2005	20.00.30
RA2_FGD_2PNPDK20051011_062156_000041872041_00306_18897_1013.N1	11-OCT-2005	6.21.56	11-OCT-2005	7.31.43
RA2_FGD_2PNPDK20051011_073046_000061672041_00307_18898_1014.N1	11-OCT-2005	7.30.47	11-OCT-2005	9.13.34
RA2_FGD_2PNPDK20051011_091250_000060122041_00308_18899_1015.N1	11-OCT-2005	9.12.50	11-OCT-2005	10.53.03
RA2_FGD_2PNPDK20051011_105130_000059572041_00309_18900_1016.N1	11-OCT-2005	10.51.30	11-OCT-2005	12.30.47