ERS-2 SAR Cyclic Report

Cycle 81

13th January 2003 - 15th February 2003

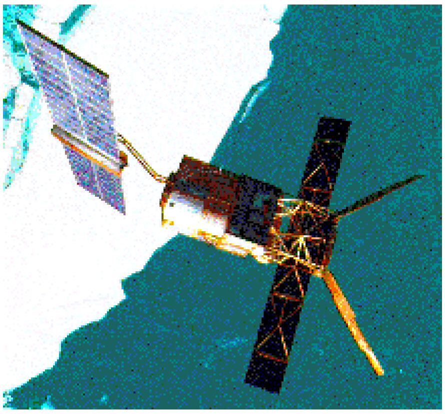

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Table Of Contents

1 DISTRIBUTION LIST

This report is available in PDF format on Internet at: http://earth.esrin.esa.it/pcs/ers/sar/reports

2 INTRODUCTION

This report summarises the results of the investigations made for the SAR instrument related to the cycle 81. The analysis has been made using the QCP files produced at I-PAF (high-rate analysis), UWA and UWAND files produced by the LRDPF processors in Kiruna, Maspalomas, Gatineau and Prince Albert and sent automatically to ESRIN PCS.

Since ERS-2 is in ZGM/YCM[1], a monitoring of the attitude is performed in near real time. This report also provides a summary of the attitude evolution for the reported cycle.

The calibration site is Flevoland (The Netherlands). The transponders have been monitored to control the stability of the ERS systems. VMP PRI products corresponding to Flevoland acquisitions have also been processed and analysed.

2.1 UI16 Analysis

The UI16 headers (UISP) are no longer regularly available since the UI16 product was discontinued from planned production starting January 1999, at the beginning of cycle 39. Analysis of UI16, UIND and UIC has been dependent on occasional and contingent productions until December 1999, when production was finally discontinued.

2.2 UIND Analysis

Noise power level and the Calibration Pulse power level data are no longer available for analysis through the regular High Rate Fast Delivery channel.

The UIND analysis is substituted by the analysis of QCP files, see paragraph 2.6.2

[1] ZGM/YCM: Zero Gyro Mode / Yaw Control Monitoring

2.3 UIC Analysis

The Replica Pulse power data is no longer available for analysis through the regular High Rate Fast Delivery channel.

2.4 UWA Analysis

The percentage of acquisition warnings at Kiruna is less than 20 %, and there was no occurrence of empty products.

2.5 UWAND Analysis

On 4th September 2002 an update of the ERS-2 AMI up-converter gain occurred. For wave mode the gain was increased by 3dB. However from our measurements only a change of about 1dB has been noted. The level of the calibration pulse power grew from 23.5dB to 24.4dB.

Since the gain update, the calibration pulse power decreases with a regular slope of –0.04db/Cycle. For the current cycle its mean value is about 24.2892dB with a standard deviation of 0.77221 dB as shown in Figure 20. Please note that a loss 0.2dB on four days has been monitored on the end of the cycle as shown in Figure 21.

2.6 Internal Calibration Analysis

2.6.1 VMP PRODUCTS ANALYSIS

a) Replica Pulse Power

Since the beginning of the mission, the Replica Pulse Power has lost about 5dB. It decreases with a slope of -0.0683 dB/cycle; for the current cycle it reaches a mean value of 47.326dB. This value and the trend evolution are coherent with the results of the QCP files analysis. Averaged values over 3 months are given in Table 7.

Please see Figure 17 for trend plots.

2.6.2 QCP ANALYSIS

The QCP products give information on internal calibration of High Rate products at the beginning and at the end of the data.

a) Replica Pulse Power

The replica pulse power has a constant level over the product lifetime. For both samples (start / stop) it decreases with a slope of –0.052dB/cycle. For the current cycle it reaches a mean value of 46.87dB with a standard deviation of 0.16dB. Averaged values over 3 months are given in Table 8.

b) Calibration Pulse Power

The calibration pulse power decreases with a slope of –0.050dB/cycle at the start, respectively –0.0389dB/cycle at the end of the acquisition. Its level is now over 40.76dB for the first samples and respectively over 41.65dB for the last calibration pulses
Please note that the last pulses are more instable with a standard deviation of 0.58dB regarding 0.26dB for the samples at the beginning of the product.

c) Noise Pulse Power

The noise power level seems to be constant during the whole mission. It decreases with a low slope of –0.00722dB/cycle at the beginning of the product, respectively –0.00083 dB at the end. During the current cycle it reaches a mean value of 6.67dB for the first samples and respectively 6.37dB for the last calibration pulses.

Please see Figure 18 for trend plots.

2.7 Transponders in Flevoland

The SAR calibration site is in Flevoland (The Netherlands) with 3 transponders having the following coordinates:

Transponder	Latitude	Longitude
1: Pampushout	+52.36651429N	+5.15197438E
2: Lelystad	+52.45806341N	+5.52755628E
3: Minderhout	+52.55502077N	+5.66896505E

Table 1: Flevoland Transponders coordinates

At present transponder 1 is no longer operational, transponders 2 and 3 have not been visible and/or functional since 17 October 2001 for transponder 2, and 22 March 2002 for transponder 3. The unavailability of transponders 2 and 3 is expected to be temporary.

A graph is included showing the calibration constant measured from the transponders starting from the beginning of the mission (see Figure 1).

2.8 Rain Forest analysis

The Amazon Rain Forest presents a well-known and very stable backscattering characteristic. Its homogeneity and isotropic properties provide a stable and constant gamma nought allowing the SAR Antenna Pattern monitoring. Since transponders are currently not available, acquisitions over the rain forest also support the radiometric stability analysis mainly based on transponders up to now.

A number of acquisitions over homogeneous rain forest areas are analysed during each cycle. The analysis results are presented in section 4.2 which contains graphs showing the antenna pattern and the gamma profile and the mean gamma nought values for each scene.

2.9 Doppler/Attitude analysis

The ERS-2 SAR wave mode data is systematically used to derive yaw and pitch information. The process to derive attitude information from wave mode data is not straightforward due to the nature of the wave mode data and to the limitations of the wave mode processor. Attitude pointing is derived using the Doppler frequency at near range estimated by the processor for each imagette and the variation of Doppler frequency between near and far range.

Since the end of cycle 72, the platform attitude is piloted efficiently by the ZGM/YCM mode.

Due to insufficient high rate data the correction of Wave Doppler is not yet available for the current cycle. An update of this report will be made as soon as sufficient high rate data are available. By consequence chapter 5 is not complete.

3 PRODUCTS DEFINITION

3.1 Offline SAR Data Products Format Standards

This includes, for the current purposes, the following product:

- SAR Annotated Raw Data (SAR.RAW)
- SAR Single Look Complex Image (SAR.SLC)
- SAR Precision Image (SAR.PRI)
- SAR Ellipsoid Geocoded Image (SAR.GEC)
- QCP: Quality Control Products

3.1.1 SAR RAW

This product consists of decommutated raw SAR echo data suitable for input to a processor.

3.1.2 SAR SLC

This product presents SAR data following pre-processing, but retains every sample as complex data. A minimum number of correction and interpolation are performed on the data in order to allow the end-user maximum freedom to derive higher level products; complex output data is retained to avoid loss of information. The product is single-look and slant range. It is intended principally for the development of techniques using phase preservation, e.g. SAR interferometry.

3.1.3 SAR PRI

Multi-look, ground range, digital image generated from raw SAR image mode data using up-to-date (at the time of processing) auxiliary parameters and corrected for antenna elevation gain and range spreading loss. SAR PRI has been specified for users wishing to perform application-oriented analysis. It is intended for multi-temporal imaging and to derive radar cross sections. Engineering corrections and relative calibration are applied to compensate for well-understood sources of system variability.

3.1.4 SAR GEC

Geocoded SAR image generated from raw SAR image mode data with the best available instrumental correction applied, precisely located and rectified onto a map projection, but not corrected for terrain distortion. It is a high level product for users interested in imaging radar remote sensing application where the geo-reference is important. Engineering corrections and relative calibration are applied to compensate for well-understood sources of system variability.

3.2 SAR High Rate Quality Control screening

The monitoring of the ERS-SAR High Rate (HR) Fast Delivery (FD) data products is carried out since the beginning of the ERS missions (1991 for ERS-1 and 1995 for ERS-2). Due to the non-Y2K compliance of the Fast Delivery processor, installed at the ESA ground stations, an alternative has been chosen for the monitoring of the SAR HR data processing. For each HR (off-line) data products generated at the Italian Processing and Archiving Facility (I-PAF, Matera), an extract of the telemetry is formatted as an ASCII file and transferred via ftp to the PCS. These new data products, known as Quality Control Products also referred as QCP, substitute the previous UIND (calibration pulses & noise samples) and UIC (Replica pulses) data products generated by the "old" SAR FD processor.

An example of QCP file is given in annex B.

3.3 Fast Delivery Ground Station Products Format Standards

Fast delivery products include all products that are disseminated over an electronic telecommunication link from the Stations or from EECF. This includes, for the purposes of this SAR-Wave document, the following products:

- AMI Image-16 bit (UI16): no more available
- AMI Image Noise Statistic and Drift Calibration (UIND): no more available
- AMI Image Chirp Replica (UIC): no more available
- AMI Wave (UWA)
- AMI Wave Noise Statistic and Drift Calibration (UWAND)

3.3.1 UI16

SAR fast delivery image. No more available

3.3.2 UIND

The product contains mean magnitude and standard deviation of the extracted noise data, and four calibration pulses. (The data for one single product can be extracted either at the beginning or at the end of a measurement sequence). No more available.

3.3.3 UIC

This product contains two chirps, i.e. two sets of samples of the transmitted pulse. For each image scene, one chirp is extracted from the beginning, and one at the end of the auxiliary data to be processed. No more available.

3.3.4 UWA

Power spectrum in polar coordinates. The power spectrum is based on a sample of data covering an area of at least 5 x 5 km. The instrument on the satellite collects data at intervals of approximately 200 to 300 km. The sample patch may be anywhere in the 100-km wide swath in the order of 2-km steps. Input for this product can be OBRC or OGRC data.

3.3.5 UWAND

Mean magnitude and standard deviation of the noise data, as well as four calibration pulses, extracted at the beginning of a measurement sequence (scene), every 15th scene.

4 SAR CALIBRATION

The SAR CAL/VAL plan is expressed relatively to the 35-day repeat cycle and shall be translated periodically for each ERS-2 mission cycle.

4.1 Calibration over Flevoland

During one 35-day cycle, there are 3 ascending passes and 3 descending passes that allow taking a SAR Image over the area containing at least two of the three transponders. The complete list of acquisitions over the area covering the transponders location is given in the table below; no transponder is visible for the current cycle.

Transponder	Passes	Orbit	Date	Visibility

Table 2: Transponders visibility for current cycle

Figure 1 shows the values of Calibration Constant calculated at the three available point targets over the Flevoland area. The legend in the figure reports the full mission average value for each transponder, and relative statistics. Please note that zero value signifies that the transponder was not visible over a specific Flevoland image acquisition. A zero value is simbolic and not included in the statistical calculation.

Figure Not available

Figure 1: Calibration constant values for Transponder 1, 2 and 3 from 16-Jul-1995.

Looking at the full mission it can be noted that transponder 1 was last detected in 2 Feb 1997, and it has been no longer active ever since. Detection of point targets has continued on transponder 2 and 3, with alternating shuts off. Transponder 2 was last visible on 17 Oct 2001, and finally Transponder 3 was last visible on 22 Mar 2002. From this date on there has been no detection of point targets in the designated areas in all subsequent Flevoland images up to date. A full table with values of calibration constants and dates of acquisition is given in annex C.

It can be also said that most of the outliers visible as triangles in the middle of the plot (TR2), were not caused by instability of the instrument but were found to be reconducible to mispointing of the transponder's antennas on ground.

4.2 Calibration over Rain Forest

SAR data in ascending and descending pass shall be acquired over the Amazon Rain-Forest to investigate changes in the antenna pattern. Since transponders are currently not visible, acquisitions over the rain forest also support the radiometric stability analysis mainly based on transponders up to now.

The data will be acquired at the station of Cotopaxi (Ecuador) and Cuiaba (Brazil) and shipped to ESRIN/CPRF for processing.

Four images have been selected over this area for cycle 81. The location of the selected images is shown in Figure 2 and their characteristics are summarised in Table 3.

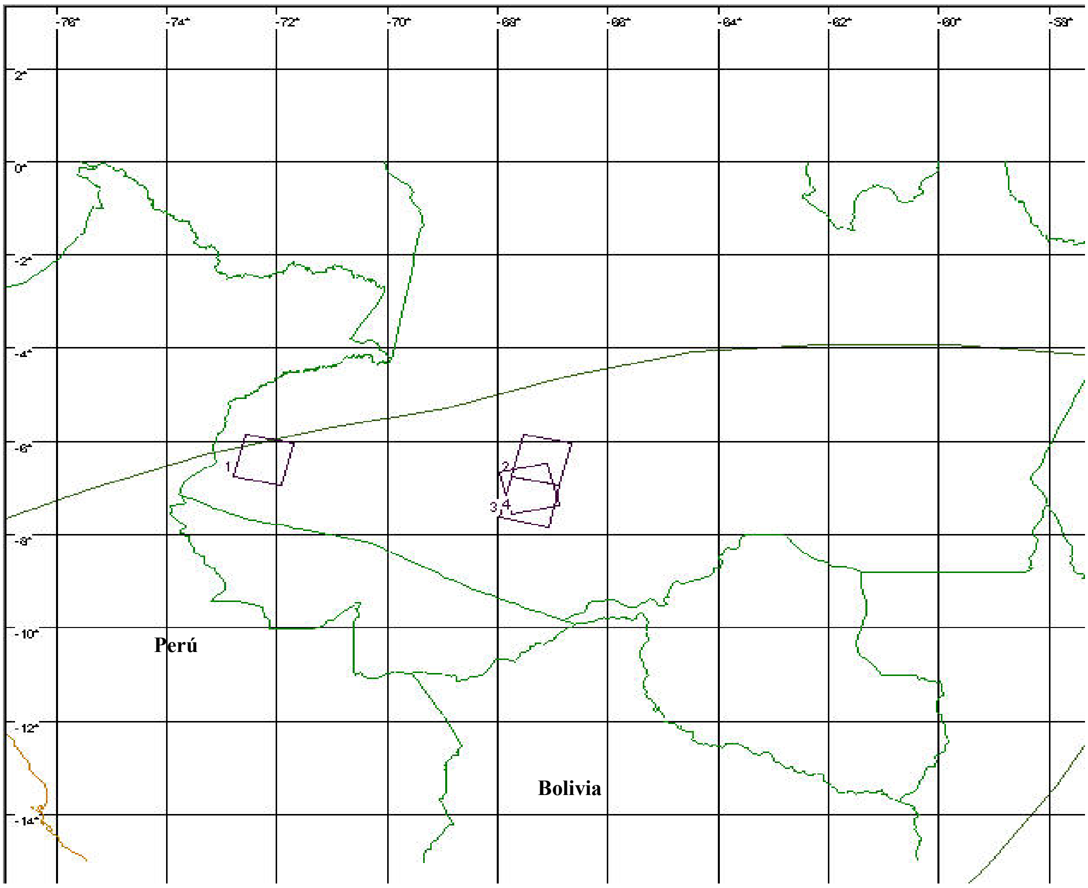

Figure 2: Location of the selected scenes

Scene	Orbit – Frame	Acquisition date	Centre lat/long (deg)	Mean σ_0 (dB)
1	40747 - 3735 (descending)	16-Jan-2003 15:02:55.787	Lat: -6.392 Lon: 287.734	-6.626
2	40574 - 3735 (descending)	23-Jan-2003 14:42:46.675	Lat: -6.415 Lon: 292.753	-6.821
3	40574 – 3753 (descending)	23-Jan-2003 14:43:01.768	Lat: -7.310 Lon: 292.553	-6.869
4	40581 – 7047 (ascending)	24-Jan-2003 03:13:14.800	Lat: -7.0260 Lon: 292.5650	-7.012

Table 3: Selected Rain Forest scenes

Non-uniform regions have been masked in order to perform the antenna pattern monitoring. The results of the analysis over the selected scenes are reported in the figures below.

Figure 3 shows the antenna patterns derived from the selected scenes, in ascending and descending passes, superimposed; results show a small variation in the measured pattern. The pattern obtained combining the one from each scene is shown in Figure 4, with the current VMP antenna pattern. The profiles match each other very closely, as shown by the two patterns (combined and reference) difference, overplotted.

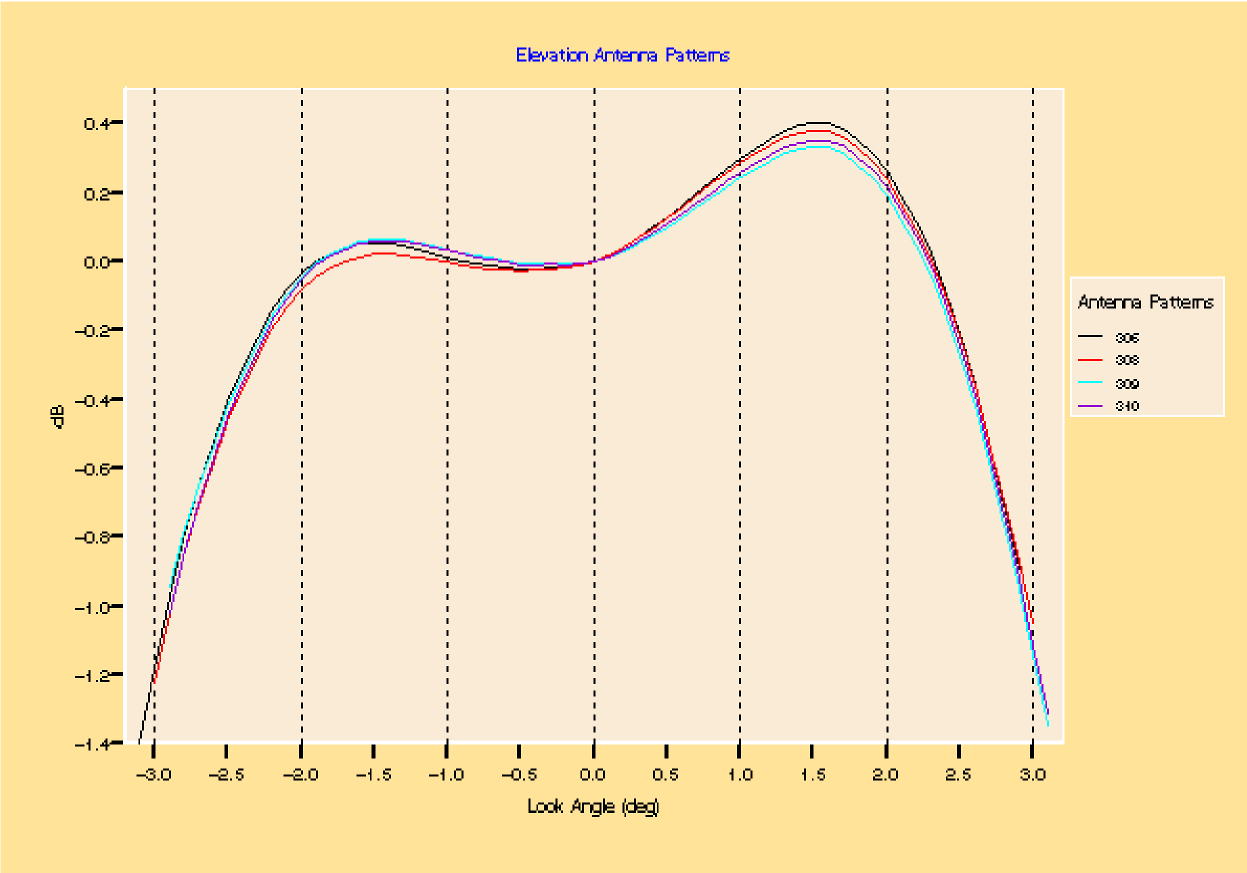

Figure 3: Antenna patterns derived from the selected scenes (id 306 ascending pass, id 308/309/310 descending passes)

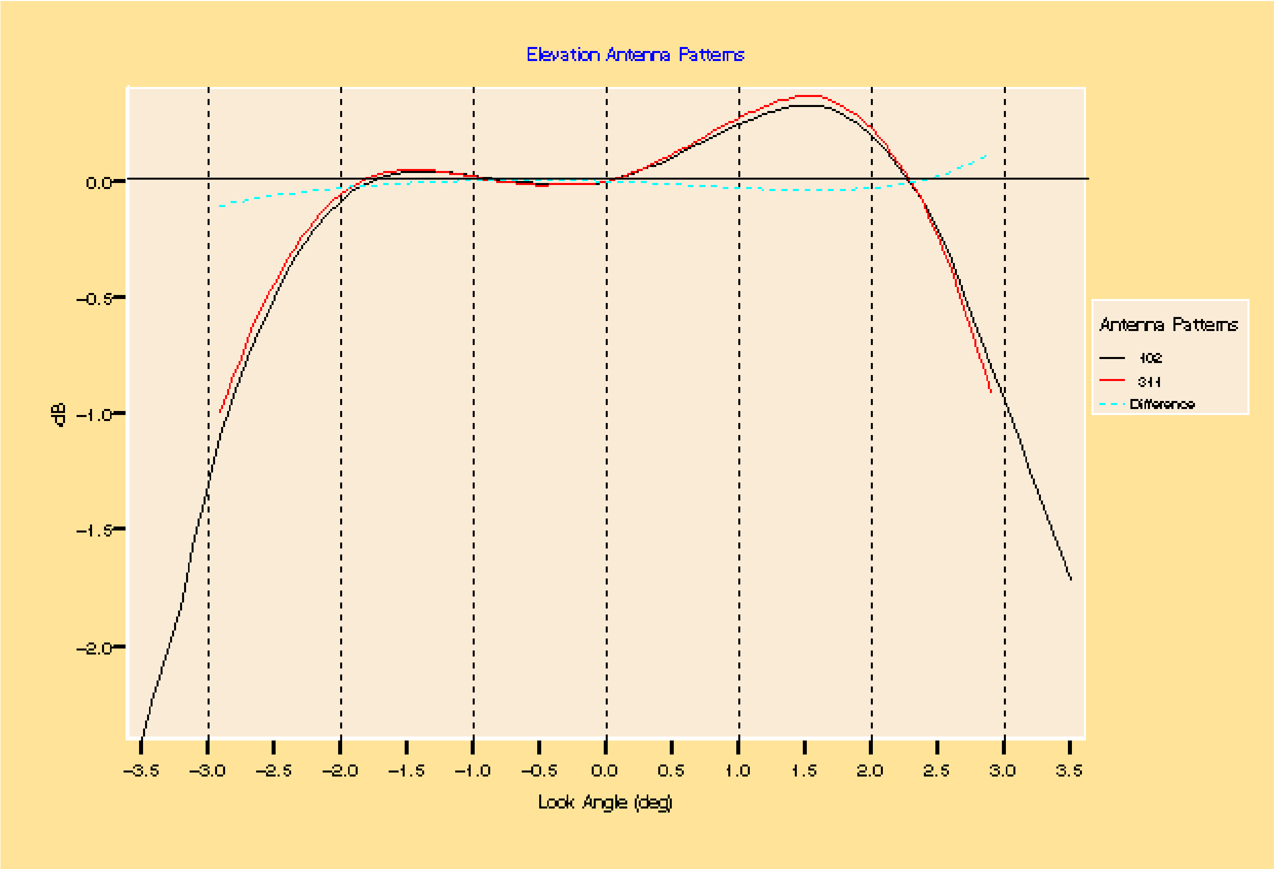

Figure 4: Antenna patterns combination (red curve) plus reference pattern (black curve) plus difference (blue curve)

The gamma profiles for the selected scenes are shown in the figures below. They are flat within 0.1 dB. The absolute calibration has been checked referring the mean gamma value, reported in Table 4. It's quite close to the nominal value (6 dB for this area) for all the examined scenes.

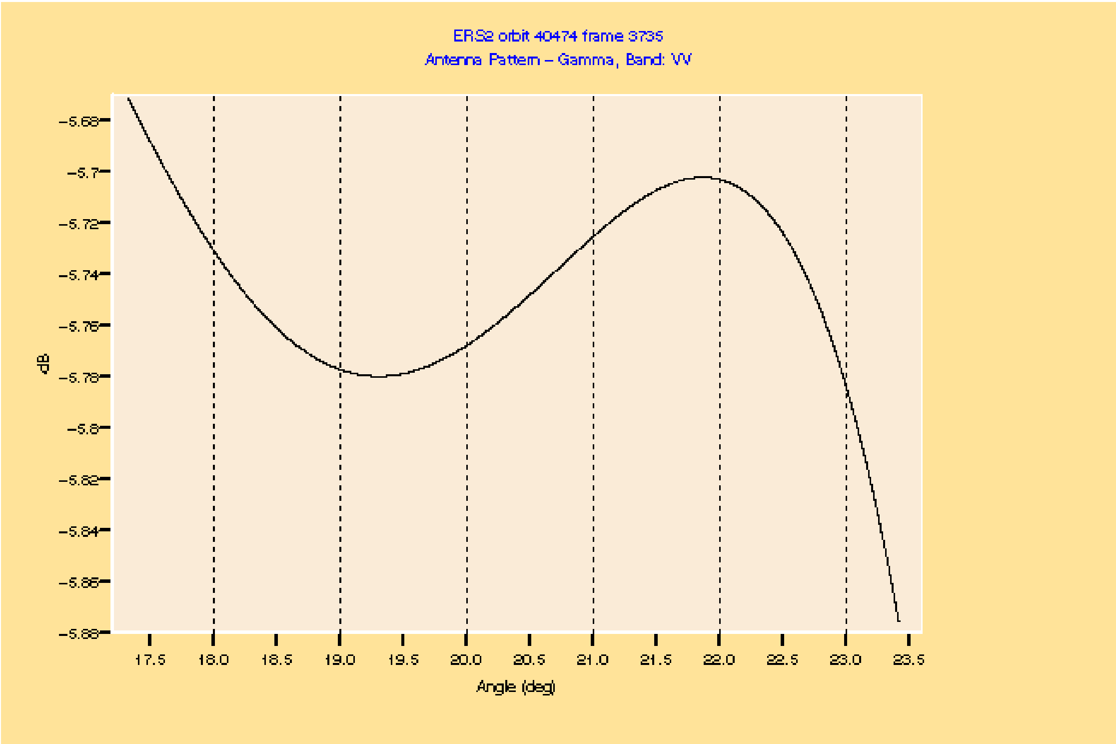

Figure 5: Gamma profile for orb. 40474 fr. 3735

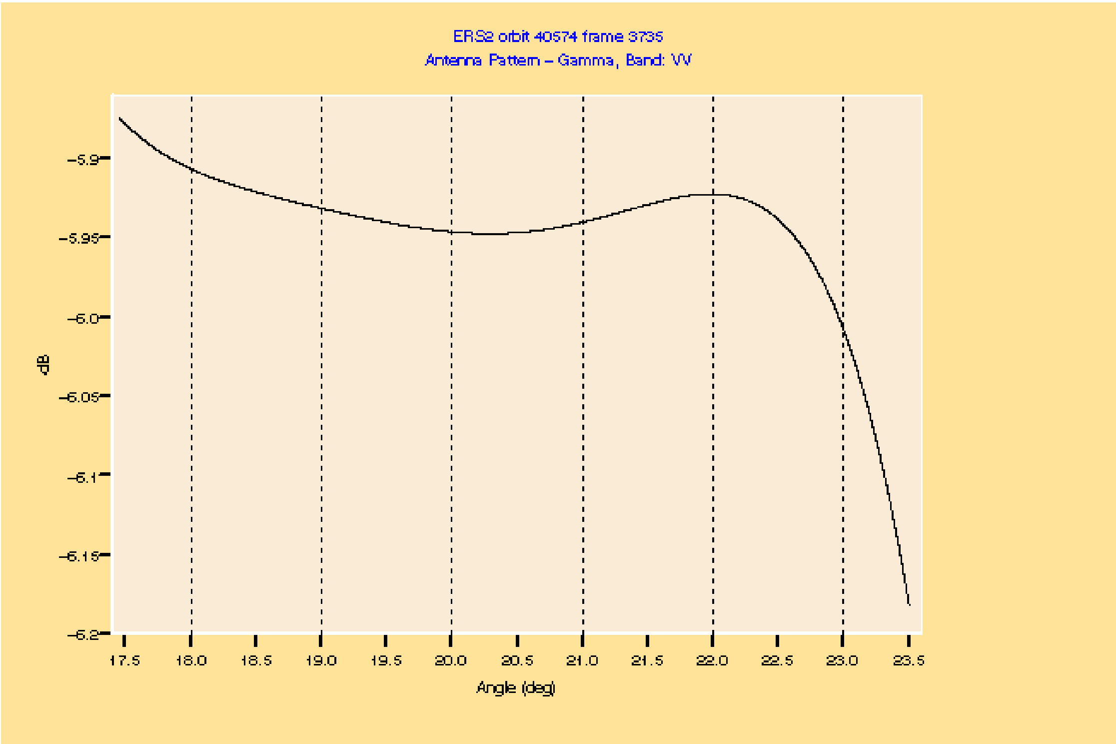

Figure 6: Gamma profile for orb. 49574 fr. 3735

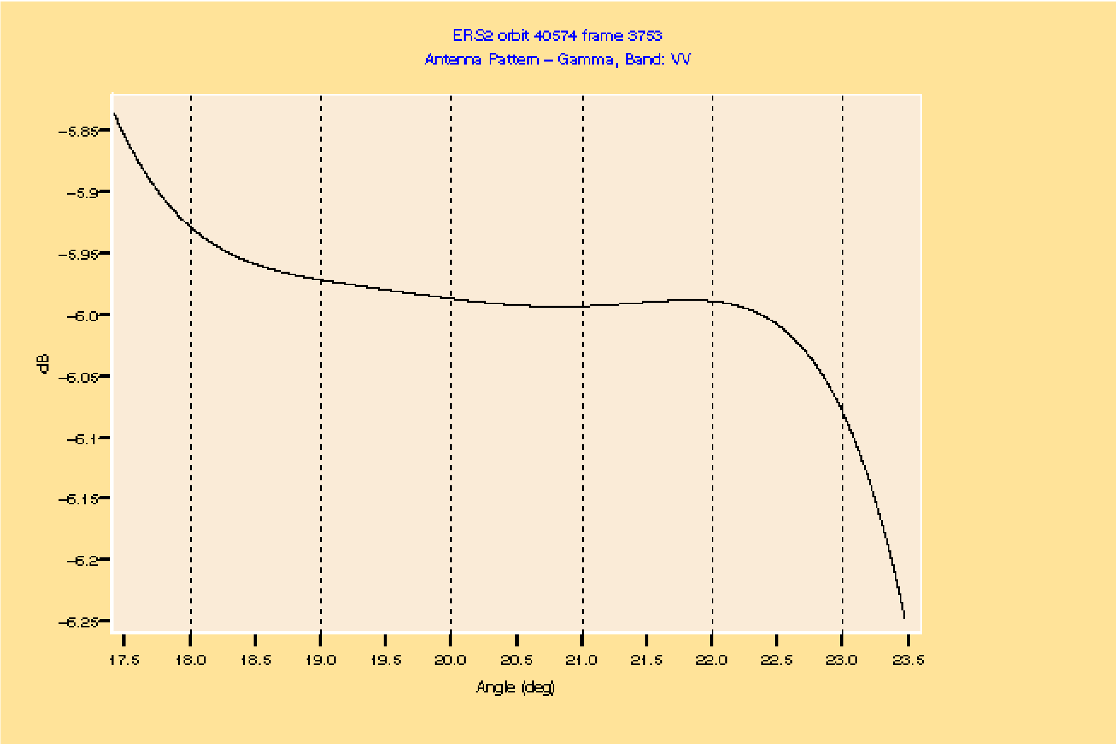

Figure 7: Gamma profile for orb. 40574 fr. 3753

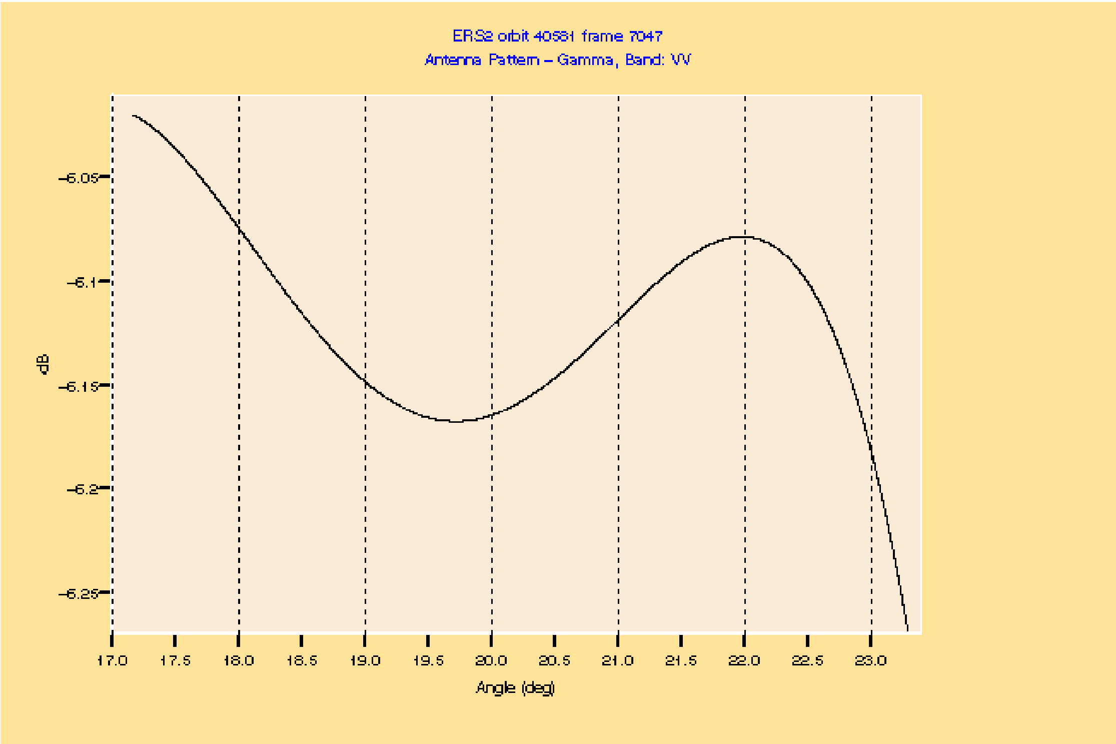

Figure 8: Gamma profile for orb. 40581 fr. 7047

Scene	Orbit – Frame	Mean gamma (dB)
1	40747 - 3735 (descending)	-6.267
2	40574 – 3735 (descending)	-6.458
3	40574 – 3753 (descending)	-6.508
4	40581 – 7047 (ascending)	-6.657

Table 4: Mean gamma value for the selected scenes

5 SAR PERFORMANCE

The instrument performances are assessed monitoring the following parameters:

- Acquisition Percentage: the percentage of products in AMI SAR Image/Wave Mode and for the current cycle and since the beginning of the mission. It is useful to determine the capability of the instrument in performing planned vs. operational meaningful measurements.

- Internal Instrument Parameters for the cycle: it is important to keep track of the status of every subsystem internal to the instrument, try to establish correlation with eventual variations in the measured quantities (e.g. range, sigma_0 and significant wave spectra) and with instrument malfunctioning.

5.1 AMI unavailability

Instrument	From	To	Comment
AMI	25-01-2003 04:48:04	25-01-2003 06:42:36	AMI in STBY/REF owing to an on board anomaly

Table 5: Summary of AMI unavailability

5.1.1 SAR UNAVAILABILITY FOR THERMAL CALIBRATION OF THE AMI

Twice a year, one 24-hour period of operations without any SAR image shall be scheduled around the solstice (+- 10 days) for payload thermal control and calibration purposes. This period shall be selected during working days and shall start at around mid-day. The choice will be coordinated between ESRIN and ESOC in order to minimise the impact on the SAR mission.

5.2 SAR/Wave acquisition

Figure not yet available

Figure 9: SAR Wave acquisitions world map for cycle 81

5.3 *Platform attitude evolution*

Since June 2001, the ERS-2 platform is piloted in ZGM. On January 2002 the procedure YCM has been implemented to pilot the platform in near real time.

Since April 2002 end, the platform is piloted efficiently. Indeed the yaw is well constrain between ±2 degrees and the Doppler[2] between ±4500 Hz, see Figure 11 and Table 6 for trend plots and statistics over this cycle.

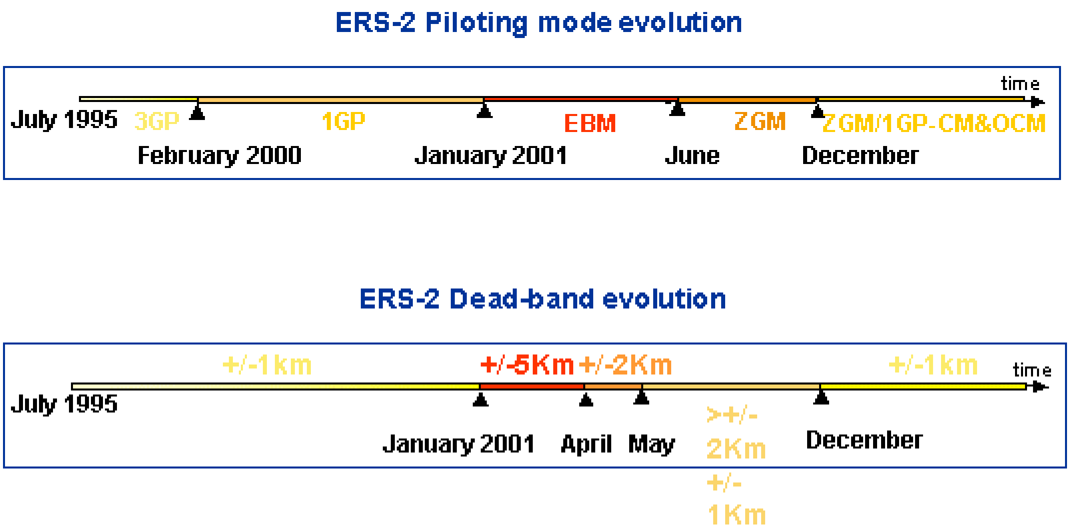

Figure 10: Summary of ERS-2 Piloting Mode

5.3.1 ATTITUDE MONITORING PROCESSING

The wave mode Doppler frequency estimated by the processor is wrapped in the baseband (+/-PRF/2) and shall be unwrapped before deriving any attitude information. In nominal 3-GP operations, the Doppler frequency stays in the baseband for almost the entire orbit and therefore there is no more than 1 PRF error between the wrapped Doppler and the corrected unwrapped Doppler. For the new AOCS configuration, the error can be up to 10 PRF and it is therefore critical to unwrap the Doppler. Difficulties occur during when acquisition gaps appear during the unwrapping. Several levels of correction have been implemented and attitude information is available after each correction step. No correction of the Doppler variation between near and far range is required.

The overall process can be described as follows:

[2] The Doppler 3rd level correction is available online at http://earth.esa.int/pcs/ers/sar/doppler/doppler_query/

1. First level of Doppler unwrapping.

   A simple unwrapping is performed in this first level until a data gap higher than 300 sec. is encountered. Then the Doppler is re-set to the baseband when data becomes available and it is unwrapped taking this baseband Doppler as reference. Therefore, discontinuities are expected for gaps large than 300 sec.

2. Second level of correction.

   The pitch values derived from the wrapped and unwrapped Doppler frequencies differ by several degrees; on the contrary the yaw values are quite similar. As the pitch should be very close to zero, we make the assumption that the pitch obtained from the first level wrapped frequencies is due to the "error" performed in the unwrapping; therefore, using the pitch pattern together with a zero yaw should allow us to recover the Doppler frequency error. The corrected Doppler values are obtained by adding the Doppler error derived from the calculated pitch and the Doppler values from the first level unwrapping.

3. Third level of correction.

   The unwrapped Doppler after the second level is an almost continue Doppler frequency but with an unknown offset due to the fact that the reference for unwrapping in the first/second level is a relative Doppler. The only way (up to now) to correct for this offset is the use of Doppler frequencies derived from HR SAR products, since the HR SAR processor (VMP) provides an absolute Doppler frequency estimation. Several steps are necessary to achieve this 3rd level of correction:

   - HR products are systematically received at ESRIN (2-3 per day) and ingested in a dedicated attitude monitoring database.
   - A first quality analysis of the HR Doppler is performed to verify the correctness of the absolute Doppler annotated in the HR products. The experience shows that the VMP Doppler estimation may be wrong when the Doppler is higher than +/- 5 KHz. The quality analysis of the HR Doppler is now performed automatically. The result is a flag indicating whether the Doppler for each available HR image is or not reliable.
   - HR scenes with reliable Doppler are included in the wave mode Doppler estimation. For orbits where HR scenes are available, the wave mode second level Doppler is offset to match with the HR value. Following/precedent orbits are offset by the same amount until another orbit with HR data is available.
   -

5.3.2 DOPPLER, YAW AND PITCH EVOLUTION

FIGURE NOT AVAILABLE DUE TO INSUFFICIENT HR DATA

Figure 11: Doppler, Yaw and pitch 3rd level correction evolution for cycle 81

	Percentage of good products	Range
Doppler		[-4500,4500] Hz
Yaw angle		[-2, 2] deg.

Table 6: Statistics of 3rd level correction attitude parameters.

FIGURE NOT AVAILABLE DUE TO INSUFFICIENT HR DATA

Figure 12: Doppler difference evolution between cycles 80-81.

FIGURE NOT AVAILABLE DUE TO INSUFFICIENT HR DATA

Figure 13: Yaw difference evolution between cycles 80-81

5.3.3 DOPPLER MAP PLOT

FIGURE NOT AVAILABLE DUE TO INSUFFICIENT HR DATA

Figure 14: Doppler evolution for ascending passes

FIGURE NOT AVAILABLE DUE TO INSUFFICIENT HR DATA

Figure 15: Doppler evolution for descending passes

5.4 SAR high rate Doppler monitoring

To perform the 3rd level correction of the attitude monitoring processing described in section 5.3.1, the leader files of all SAR high rate products produced at ESRIN C-PAF are ingested into a dedicated database. For the current cycle 92.77% of the products ingested in the database have a near range Doppler inside the critical range of [-4500, 4500] as shown in Figure 16.

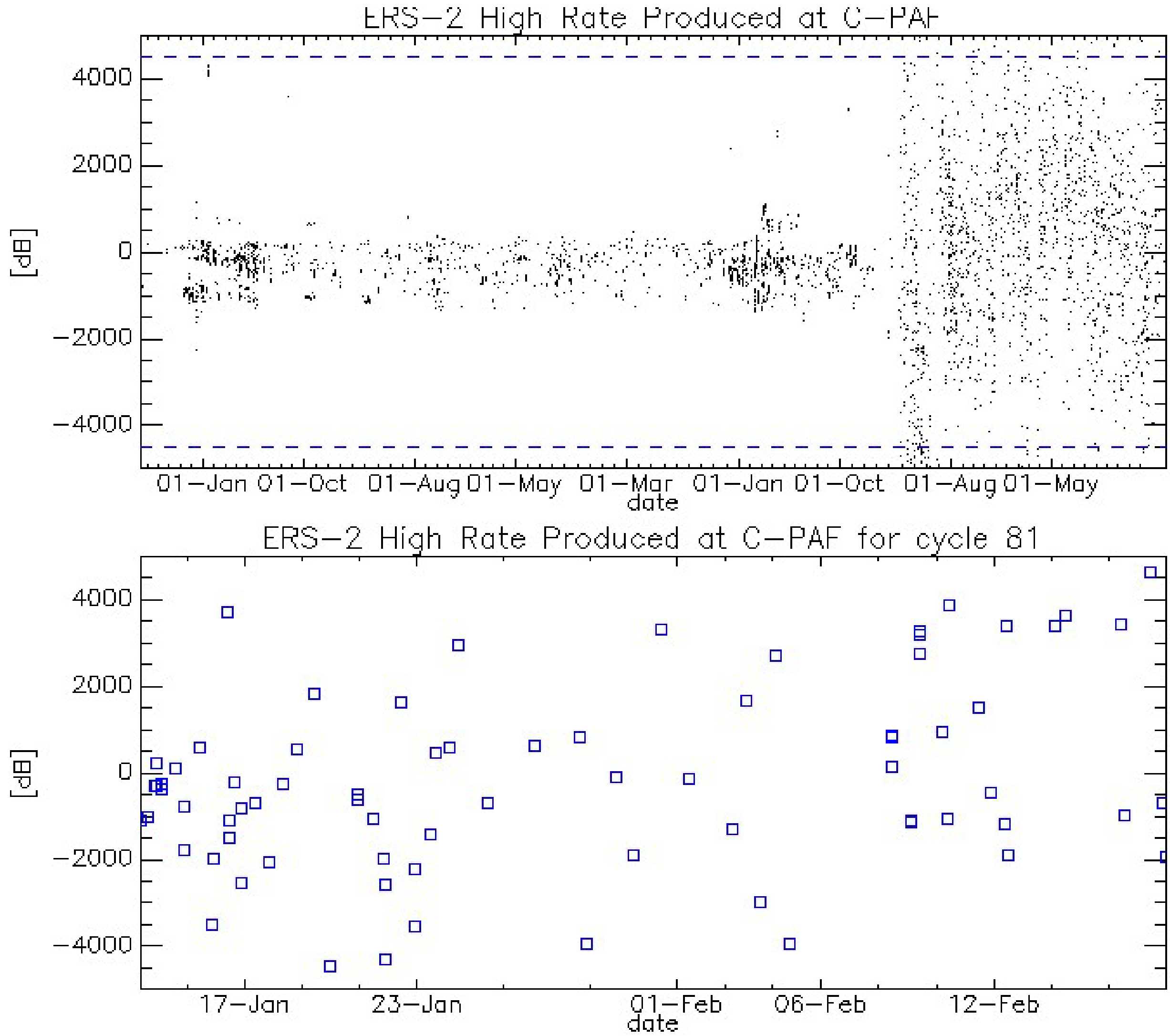

Figure 16: SAR high rate products Doppler evolution

5.5 ERS-2 SAR Wave Mode Operation Cyclic Report

FIGURE NOT AVAILABLE

FIGURE NOT AVAILABLE

6 INTERNAL CALIBRATION ANALYSIS

6.1 High rate analysis

For the high rate products, only the Replica Pulse power could be monitored. As shown in the following plot, the Replica Pulse Power has lost about 5Db since the beginning of the mission. With a slope of -0.0683 dB/Cycle, it reaches for the reported cycle a mean value of 47.326dB. This value and the trend evolution are coherent with the results of the QCP files analysis. Averaged values over 3 months are given in Table 7.

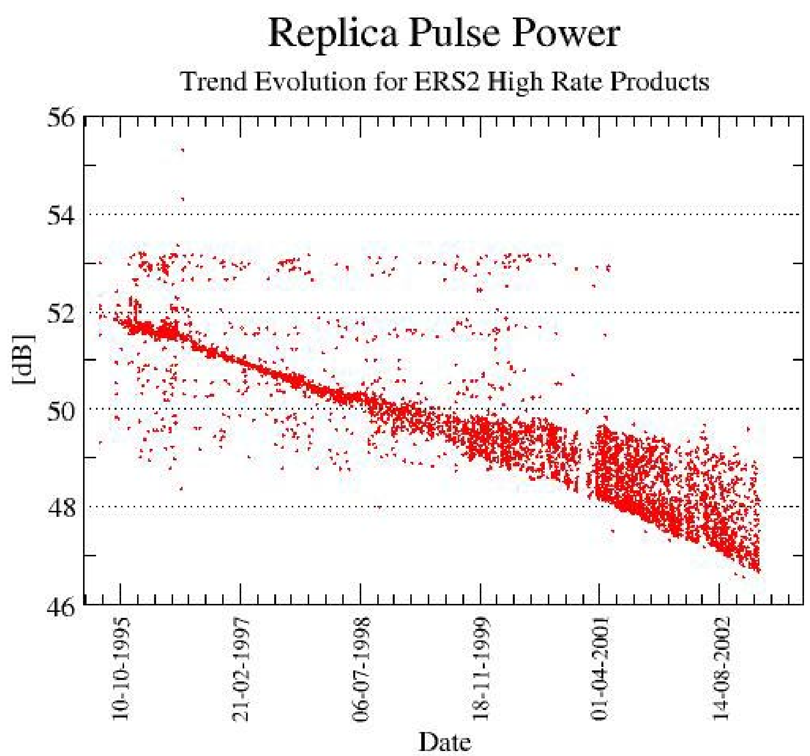

Figure 17: Evolution of Replica pulse power for High Rate products

Year	Jan-Feb-Mar	Apr-May-Jun	Jul-Aug-Sep	Oct-Nov-Dec
1995	Not Available	Not Available	51.731	51.755
1996	51.644	51.599	51.466	51.140
1997	51.081	50.866	50.808	50.729
1998	50.346	50.396	50.266	50.092
1999	49.955	49.839	50.027	49.696
2000	49.714	49.814	49.465	49.194
2001	49.158	48.976	48.449	48.375
2002	48.018	48.1835	47.731	47.722
2003	Not Available	Not Available	Not Available	Not Available

Table 7: Evolution of Replica Pulse Power.

6.2 QCP analysis

From the QCP files only information relative to the internal calibration such like replica pulse, calibration and noise pulse power is monitored. The Figure 18 shows the trend evolution of those parameters for the whole mission. An example of QCP file is presented on annex B.

Both replica and calibration pulses have the same behaviour since the beginning of the mission. Their level decreases with regular slope of –0.052dB/cycle for the replica pulses and –0.050 dB/cycle for the calibration pulses. On the contrary the noise pulse power seems to be very stable. Table 8 gives values averaged every 3 months for the Replica Pulse Power for QCP files.

Year	Jan-Feb-Mar	Apr-May-Jun	Jul-Aug-Sep	Oct-Nov-Dec
1995	Not available	51.843	51.996	51.769
1996	51.729	51.581	Not available	51.155
1997	51.073	Not available	50.707	Not available
1998	50.382	50.275	50.077	49.872
1999	49.817	49.558	Not available	49.238
2000	49.056	48.884	48.864	48.69
2001	48.525	48.335	48.104	47.916
2002	47.684	47.462	47.344	47.05
2003	46.863	Not available	Not available	Not available

Table 8: Evolution of Replica Pulse Power for QCP files

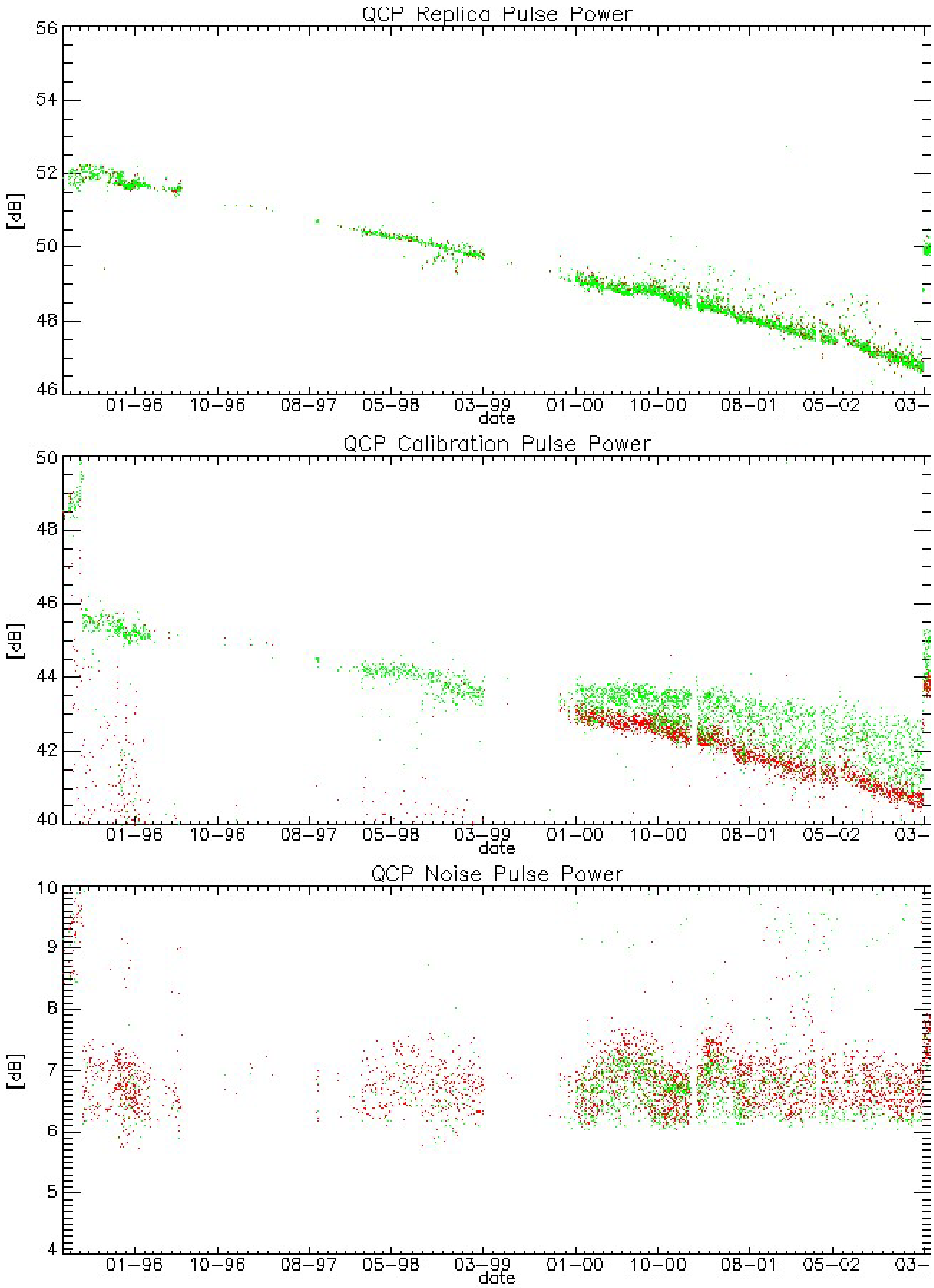

Figure 18: Evolution of Replica, calibration and noise pulses from QCP files. Red points are for the pulses at the beginning of the product, while green are for pulses at the end of the product

The Figure 19 shows the joint evolution between replica and calibration pulses. As expected there is clearly a relationship of linearity between them.

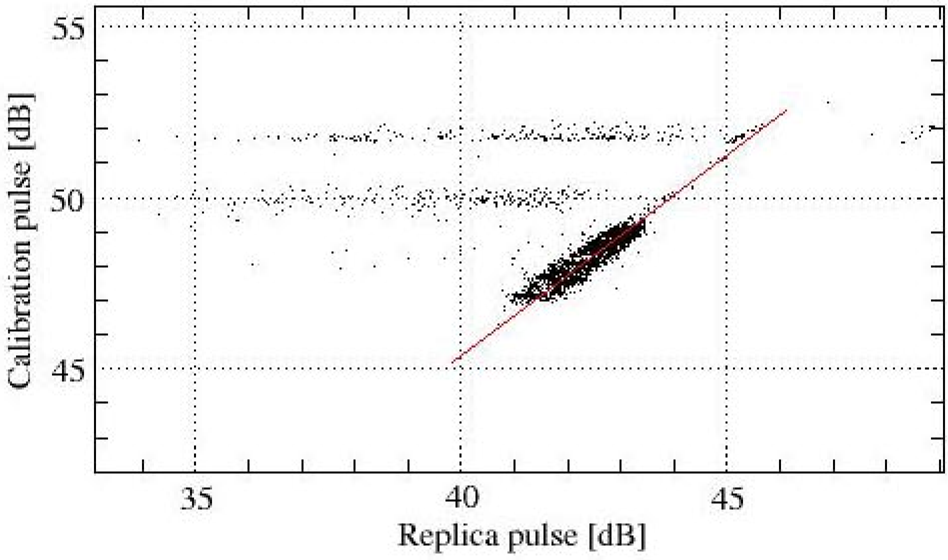

Figure 19: Joint evolution of Replica and calibration pulses

7 WAVE CALIBRATION PULSE TRENDS

7.1 UWAND analysis

Noise power density, scaled and unscaled calibration pulse power can be calculated extracting the following parameters from UWAND products:

- σ_I the standard deviation of I part noise data on SPH
- σ_Q the standard deviation of Q part noise data on SPH
- I and Q part of the 4 DSR

7.1.1 NOISE POWER DENSITY

The noise power density is defined as follows:

$$npd = \sigma_i^2 + \sigma_q^2$$

7.1.2 CALIBRATION PULSE POWER

For each of the four DSRs, we search the maximum of the intensity of the calibration pulses. In order to take into only the energy of the main lobe of the calibration pulses only 16 samples are used around the peak. If p is the position of the peak the calibration pulse power for one DSR is defined as follows:

$$powerDSR = \frac{1}{16} \sum_{n=p-8}^{p+7} I_n^2 + Q_n^2$$

The Calibration Pulse Power is obtained by averaging the ones calculated for each DSR:

$$CalibrationPulsePower = \frac{1}{4} \sum_{j=1}^{4} powerDSR(j)$$

a) Unscaled calibration pulse power
The unscaled calibration power is identical as the previous formula:

$$UnscaledCalibrationPulsePower = CalibrationPulsePower = \frac{1}{4} \sum_{j=1}^{4} powerDSR(j)$$

b) Scaled calibration pulse power
The scaled calibration pulse power is defined as follows:

$$scaledCalibrationPulsePower = CalibrationPulsePower - 16 * npd = \left[\frac{1}{4}\sum_{j=1}^{4} powerDSR(j)\right] - 16 * npd$$

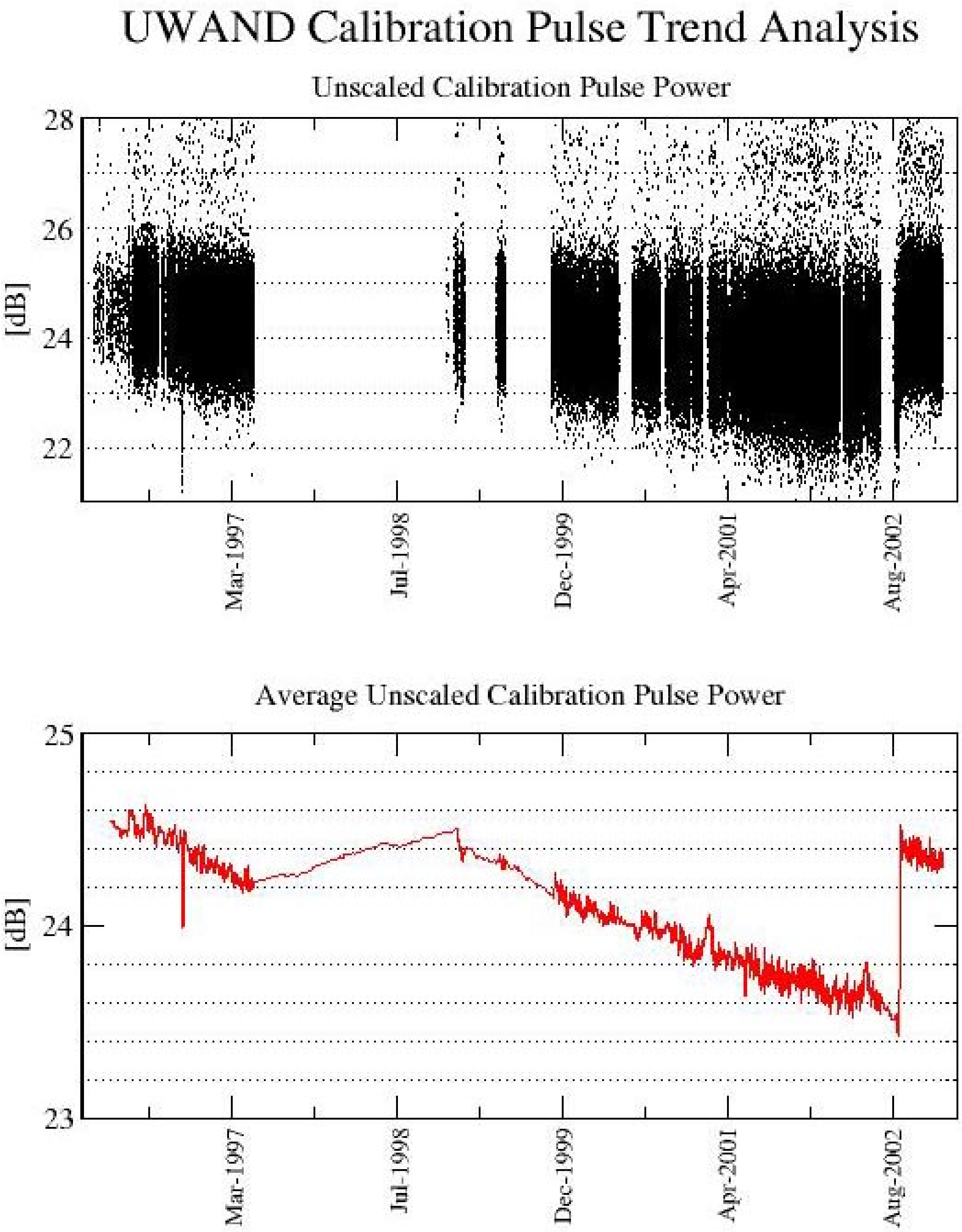

Figure 20: Evolution of Mean Calibration Pulse Power

On 4th September 2002 an update of the ERS-2 AMI up-converter gain occurred. For wave mode the gain was increased by 3dB. However, as shown in the previous plot, only a change of about 1dB has been noted. The level of the calibration pulse power has grown from 23.5dB to 24.4dB. After this, it has decreased with a slope of –0.04dB/cycle to the current level of 24.2892dB with a standard deviation of 0.77221 dB (see Figure 21).

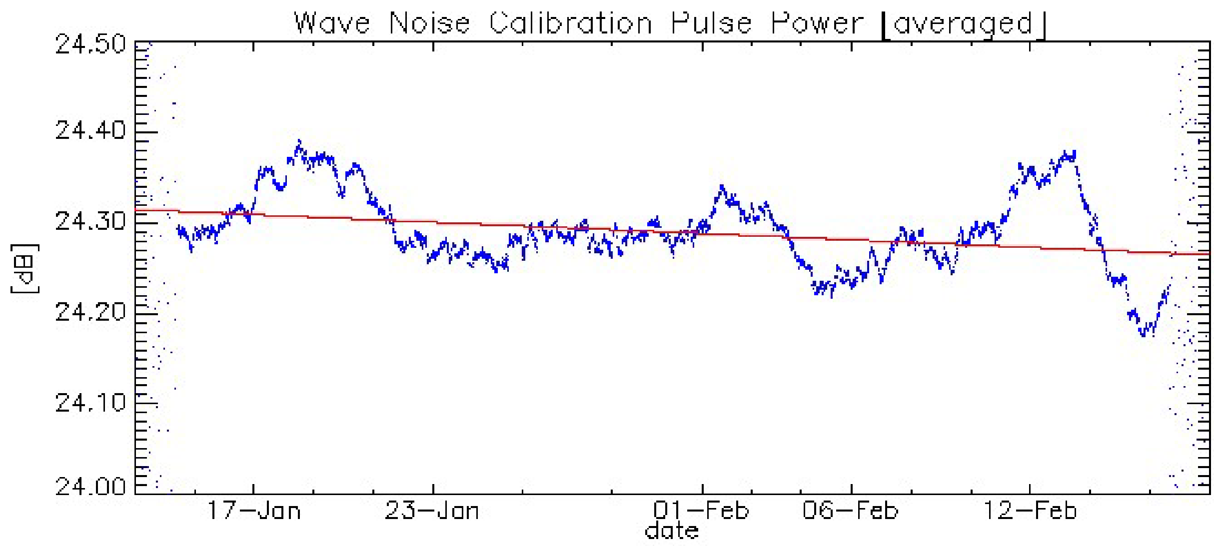

Figure 21: Evolution of Mean Calibration Pulse Power for cycle 81 (blue) and its linear regression (red).

ANNEX A: PRODUCTS QUALITY ANALYSIS

This activity is principally dedicated to the user support. The two main types of activities are:

- Verification of products with a high Doppler value (rejected products)
- Product quality/format anomalies

Summary of rejected products during the cycle

Rejected products are those having Doppler Centroid frequencies outside the interval [-4500,4500] Hz. In this case VMP ambiguity estimation is not reliable so the product's focusing has to be checked. The table below reports the rejected products for the current cycle corresponding quality assessment:

Rejected products number	Accepted rejections	Refused rejections
2	2	0

Table 9: Rejected products summary

Summary of product quality anomalies

Products quality anomalies are detected internally or via the users complaints. The action is to analyse the faulty products and report the analysis results.

Complaints number	Complaints description
2	Corrupted data analysis
	Shifted frame reprocessing

Table 10: Users complaints summary

ANNEX B: EXAMPLE OF QCP FILE

```
Processing - ERS_2_$QCP200_027387.$EXCHANGE

Filename                        = ERS_2_$QCP200_027387.$EXCHANGE
File size in bytes              = 3551
Time of last access             = 01-NOV-2002 19:33:37.000
Time of last data modification  = 27-JUL-2000 09:38:23.000
Time of last file status change = 27-JUL-2000 09:38:23.000

[QCP200Header]
Filename                        = ERS_2_$QCP200_027387.$EXCHANGE
ArrivalTime                     = 2000-07-27 09:38:23
Platform Id                     = 2
NumOfPasses                     = 1
PassId                          = 1
NumOfImagingSeqs                = 1

[ImageSeqId_1]
NumberOfValidNoisePulsesStart        = 3
NumberOfValidCalibPulsesStart        = 4
NumberOfValidRepPulsesStart          = 8
MeanPowerOfValidRepStart             = 78166.750000
MeanPowerOfValidRepFlagStart         = 0.000000
IndexOfFirstValidRepSampleWindowStart  = 29
FirstValidReplicaSampleWindowFlagStart = 1
RangeCompressionNormFactorStart      = 77990.000000
RangeCompressionNormFactorFlagStart  = 0
MeanPowerOfValidCalibStart           = 18861.839990
MeanPowerOfValidCalibFlagStart       = 0
MeanPowerOfValidNoiseStart           = 5.681800
MeanPowerOfValidNoiseFlagStart       = 1
NumberOfValidNoisePulsesEnd          = 6
NumberOfValidCalibPulsesEnd          = 4
NumberOfValidRepPulsesEnd            = 8
MeanPowerOfValidReplicaEnd           = 77995.250000
MeanPowerOfValidReplicaFlagEnd       = 0
IndexOfFirstValidReplicaSampleWindowEnd = 28
FirstValidReplicaSampleWindowFlagEnd = 1
RangeCompressionNormFactorEnd        = 77890.000000
RangeCompressionNormFactorFlagEnd    = 0
MeanPowerOfValidCalibEnd             = 18015.237350
MeanPowerOfValidCalibFlagEnd         = 0
MeanPowerOfValidNoiseEnd             = 5.276930
MeanPowerOfValidNoiseFlagEnd         = 1
MeanReplicaPulsePowerUpperThreshold  = 255000.000000
MeanReplicaPulsePowerLowerThreshold  = 85000.000000
MeanNoiseSignalPowerUpperThreshold   = 7.500000
MeanNoiseSignalPowerLowerThreshold   = 2.500000
MeanCalibSignalPowerUpperThreshold   = 3750.000000
MeanCalibSignalPowerLowerThreshold   = 1250.000000
RangeCompressNormFactorUpperThreshold  = 255000.000000
RangeCompressNormFactorLowerThreshold  = 85000.000000
```

ANNEX C: PRI VMP CALIBRATION CONSTANT VALUES