

ASAR LEVEL 0 PRODUCT ANALYSIS FOR ALTERNATING POLARISATION AND GLOBAL MONITORING MODE

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1 INTRODUCTION

ENVISAT / ASAR data for all five operational ASAR modes (image, wave, alternating polarization, wide-swath and global monitoring) are archived in raw format as level 0 products. These products consist mainly of the ASAR instrument source packets (ISPs) and are accompanied with a minimum set of characterizing annotation parameters. The generation of any ASAR level 1 user product starts from the level 0 product as input.

The integrity of the long-term ASAR level 0 data archive has to be assured, i.e. the level 0 products have to be in line with their specification [1] and they should not show any systematic deficiencies. This is the major task of the level 0 product validation activity.

The level 0 product analysis results for the image, wide-swath and wave mode have been presented at the ENVISAT Calibration Review, see [2]. This paper supplements them with the alternating polarization mode AP and the global monitoring mode GM.

2 ANALYSIS METHODOLOGY AND TOOLS

Two different methodologies described in more detail in [2] are used for the level 0 product analysis:

- systematic and automatic evaluation of the level 1 product annotation parameters related to raw data quality
- interactive level 0 analysis using the SAR Product Control Software SARCON [3]

Since the tool to perform the automatic and systematic evaluation of ASAR annotation parameters is still not available in the ENVISAT Payload Data Segment PDS, the performed systematic product analysis is completely based on parameters provided by an off-line tool developed and operated at ESTEC. For details see [4].

3 DATA SET OVERVIEW

The results reported in this paper are based on the following data sets:

Alternating Polarisation

- selection of annotation parameters from 57 medium resolution APM and 49 precision images APP products from beams IS 1 ... IS 7 in HV, HH, HH HV and VV VH polarization
- level 0 product over the ASAR transponders, beam IS 6, H/H and H/V polarization
ASA_APH_0PNPDK20021106_094707_00000892011_00022_03583_0043.N1

Global Monitoring

- one level 0 product
ASA_GM_0PNPDK20021114_071147_000001062011_00135_03696_0211 in VV polarization

4 DOWNLINK DATA QUALITY IN ALTERNATING POLARISATION MODE

Missing range lines are reported in 3 of the 106 level 1 products: 7 missing lines in one product, 1 missing line each in two other products. The one product with the 7 missing lines shows 2 corrupted auxiliary codes, all others none at all. Missing only 7 in a total of 6392012 lines confirms the good downlink data quality already observed in [2] for other ASAR modes.

5 ECHO DATA STATISTICS IN ALTERNATING POLARISATION MODE

The echo data statistic results retrieved from the level 1 product annotations reveal no anomalies and no suspicious outliers. Fig.1 shows the I and Q channel bias values for beams IS 1 and IS 7. The plots of the Q channel standard deviation against the I channel standard deviation confirms the expected linear behaviour, see IS 7 as example in Fig. 2.

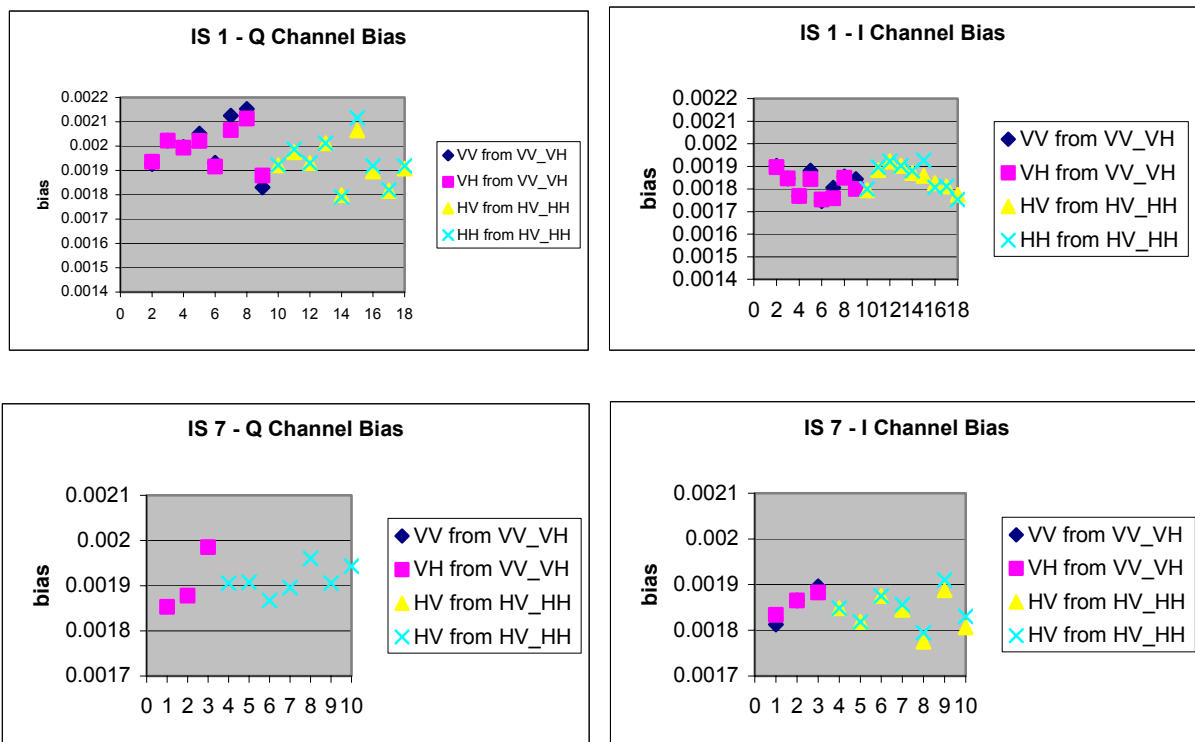


Fig. 1. Alternating Polarisation Mode Level 1 Product Set: I and Q Channel Bias

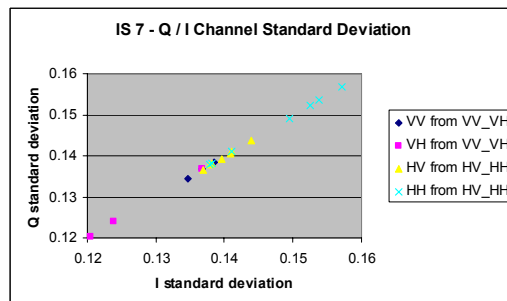


Fig. 2. Alternating Polarisation Mode Level 1 IS 7 Product Set: Q Channel Standard Deviation / I Channel Standard

6 DETAILED ANALYSIS OF AN ALTERNATING POLARISATION MODE PRODUCT

Product: ASA_APH_0PNPDK20021106_094707_000000892011_00022_03583_0043.N1
 over Netherlands calibration site with transponders
 H/V and H/H polarization, beam IS 6

6.1 Downlink Data Quality

The data set shows an excellent downlink data quality: No missing / erroneous source packets, no missing range lines and no errors in the analysed SAR header (auxiliary codes) are found.

6.2 Timeline Analysis

The timeline found is according to the expectation: 8 initial noise lines in HV and 8 noise lines in HH polarisation, 97 initial calibration pulses in HV and 97 initial calibration pulses in HH polarization. The periodic cycle shows the pre-flight observed anomaly as described by ESA in [5]. This anomaly is correctly handled by PF_ASAR and SARCON.

In AP mode, the echo data are acquired using a burst technique in which a burst of echo lines acquired in polarisation A is followed by a burst of echo lines acquired in polarization I (HV in our case) and then again followed by a burst of echo lines acquired in polarisation II (HH in our case), and so on. All bursts consist of an equal number of echo lines. An AP periodic cycle consists of 2 subcycles with 4 bursts each. In the first subcycle, the last echo of the first burst is replaced by a calibration source packet (polarization I), in the second subcycle, the last echo of the second burst is replaced by a calibration source packet (polarisation II). In contradiction to the specification, the first subcycle shows the following anomaly: The second and third burst (following the one with the calibration source packet) have only (M-1) echo source packets instead of the expected burst length M. Tab. 1 illustrates this anomaly for the AP product under investigation (burst length = 238 echo lines):

<i>specified periodic timeline</i>	<i>observed periodic timeline</i>
.....
237 echo + 1 cal in HV	237 echo + 1 cal in HV
238 echo in HH	237 echo in HH
238 echo in HV	237 echo in HV
238 echo in HH	238 echo in HH
238 in HV	238 in HV
237 echo + 1 cal in HH	237 echo + 1 cal in HH
238 echo in HV	238 echo in HV
238 echo in HH	238 echo in HH
237 echo + 1 cal in HV	237 echo + 1 cal in HV
238 echo in HH	237 echo in HH
238 echo in HV	237 echo in HV
238 echo in HH	238 echo in HH
.....

Tab. 1. Alternating Polarisation Mode Periodic Cycle Anomaly

The evaluation of the on-board time in the SAR auxiliary data confirms, that the echo source packets are really missing, i.e. a constant burst length and thus a consistent burst timing are maintained although the mode packet counter does not reveal this situation.

6.3 Echo Data Analysis

As for the other ASAR modes (see [2]) the echo data histogram analysis shows, that there is no echo data saturation. Only a portion of the available dynamic range is used and this portion is actually quite small for the HV channel, see Fig. 3. The non-optimal use of the dynamic range is a consequence of the fact, that only one instrument gain setting is

available for both the echo data and calibration pulses. Changing the gain in favour of the echo data dynamic range causes saturation of the periodic internal calibration pulses [6].

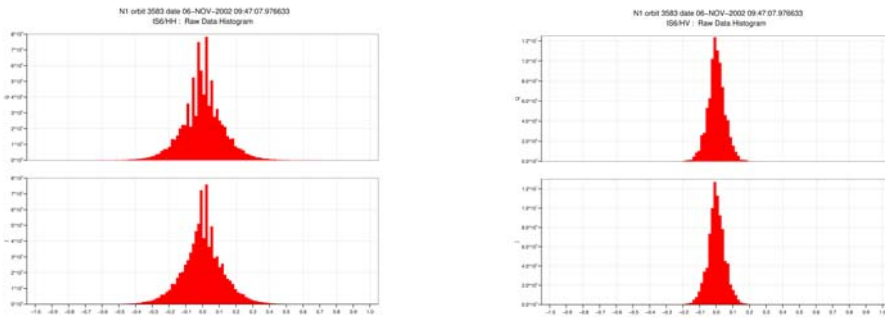


Fig. 3. Echo Data Histograms: HH (left) and HV (right) polarisations (Q channel at top, I channel at bottom)

The detailed echo data statistics results are found in Tab. 2:

	<i>HH polarization</i>	<i>HV polarisation</i>
<i>I channel bias</i>	0.001765	0.001730
<i>Q channel bias</i>	0.001854	0.001793
<i>I channel standard deviation</i>	0.1220002	0.051607
<i>Q channel standard deviation</i>	0.121865	0.051510
<i>I/Q gain imbalance</i>	1.001119	1.001875

Tab. 2. Echo Data Statistics Results

The visual echo and range-compressed data inspection including range and azimuth power spectra shows no problem. See Fig. 4, 5 and 6. Note, that for analysis purposes, the inter-burst regions between two successive bursts in one polarisation have been filled with zero lines.

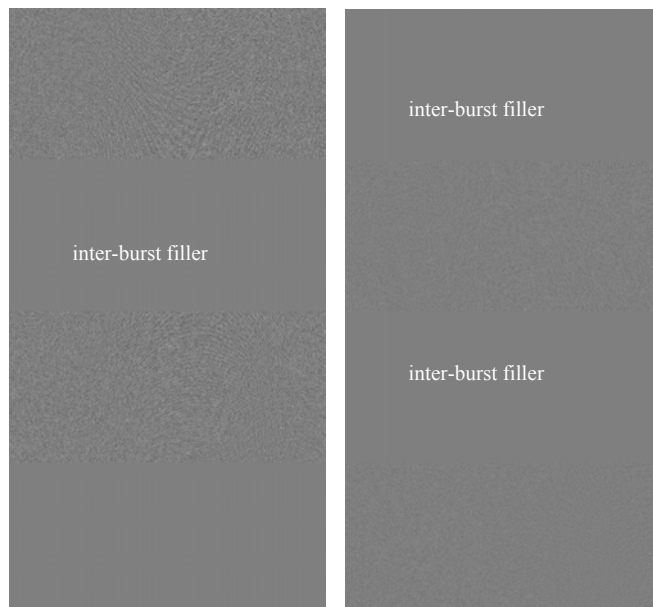


Fig. 4. Real Part of Extracted Echo Data: HH (left) and HV (right) channel

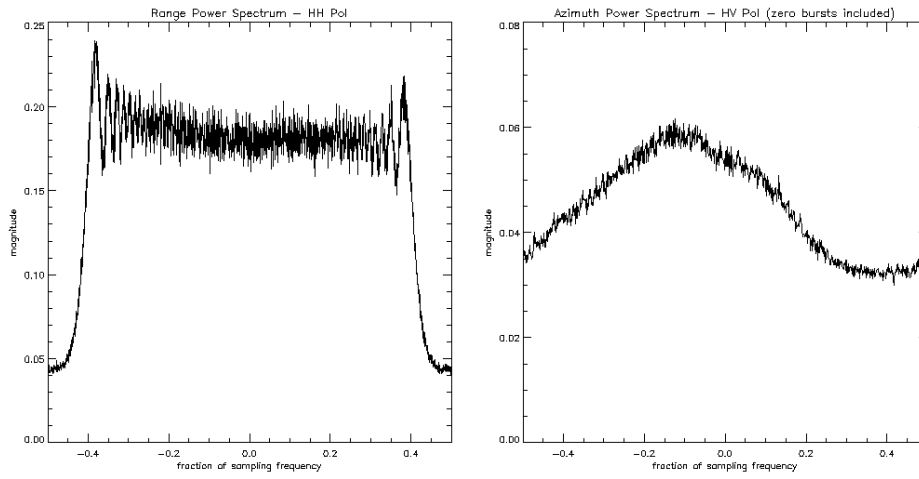


Fig. 5. HH Range and HV Azimuth Power Spectrum of Echo Data

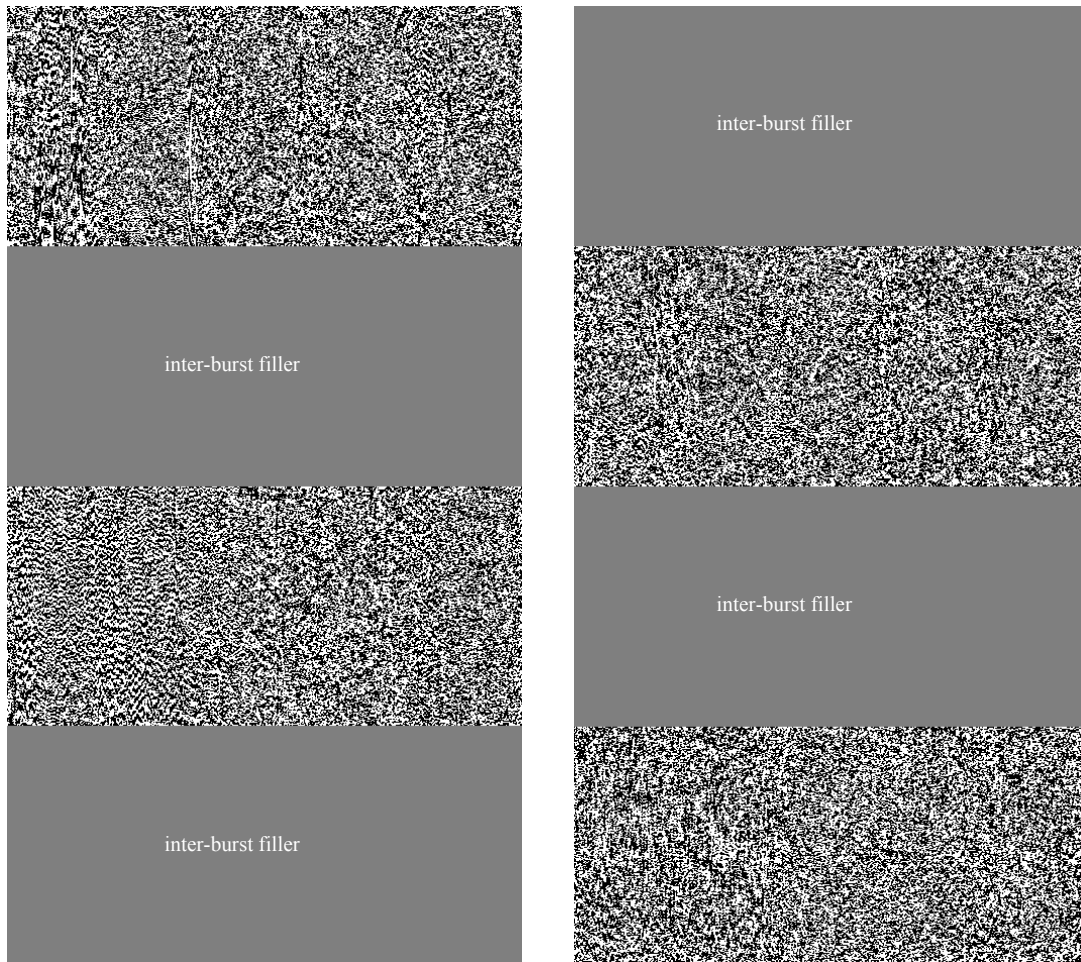


Fig. 6. Real Part of Range-Compressed Data: HH (left) and HV (right) channel

7 DETAILED ANALYSIS OF THE GLOBAL MONITORING MODE PRODUCT

Product: ASA_GM_0PNPDK20021114_071147_000001062011_00135_03696_0211
 over region in the north of Russia
 VV polarization

7.1 Downlink Data Quality

The data set shows a good downlink data quality: No missing / erroneous source packets, no missing range lines and no errors in the analyzed SAR header (auxiliary codes) are found.

7.2 Observed Anomalies

The resampling (subsampling) factors in the operationally used instrument characterisation file ASA_INS_AXVIEC20021030_125454_20021030_110000_20021231_235959 are offset by 1 for beams SS 2, SS 3, SS 4 and SS 5, an anomaly detected at ESA side during GM testing. Therefore a corrected INS file (with the resampling factors 16, 24, 29, 32, 35) had to be delivered for the SARCON GM product analysis to enable a correct echo data extraction.

Using the corrected INS file, SARCON provides correctly extracted echo data sets for beams SS1, SS4 and SS5, but still has problems with beams SS 2 and SS 3. Since PF_ASAR can process this scene without problems, it is assumed that the SARCON analysis tool itself has a problem. Further investigations are necessary.

Also an anomaly with respect to the periodic calibration pulses has been reported in [7] when comparing the P1 amplitude histories for 4 complete periodic calibration cycles in dependence of the antenna row number among each other. A certain pattern for rows 1 to 16 in one periodic cycle seems to be recognizable for rows 17 to 32 in a following periodic cycle. This has to be further investigated.

7.3 Echo Data Analysis

The echo data analysis is restricted to beams SS 1, SS 4 and SS 5 due to the problems described in 7.2. Fig. 7 shows the echo data histograms confirming the well-known results: no echo data saturation, small portion of dynamic range used only.

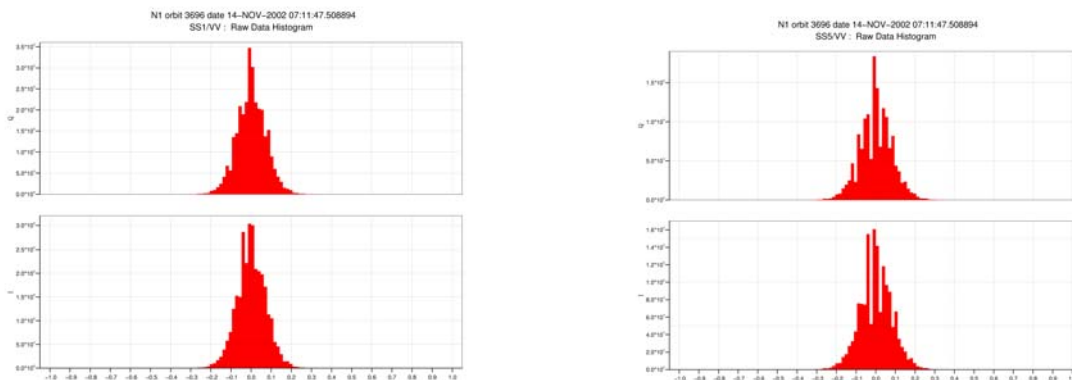


Fig. 7. Echo Data Histograms for swath SS1 (left) and SS5 (right) (Q channel at top, I channel at bottom)

Some detailed echo data statistics results are found in Tab. 3:

	SS 1	SS 5
<i>I channel bias</i>	0.001516	0.001495
<i>Q channel bias</i>	0.001479	0.001429
<i>I channel standard deviation</i>	0.070892	0.080410

<i>Q</i> channel standard deviation	0.070799	0.080333
<i>I/Q</i> gain imbalance	1.001307	1.000956

Tab. 3. Echo Data Statistics Results

The visual echo and range-compressed data inspection including the range and azimuth power spectra reveals no problem, see Fig. 8 and 9. Note the characteristic GM range spectrum with its low range time-bandwidth product.

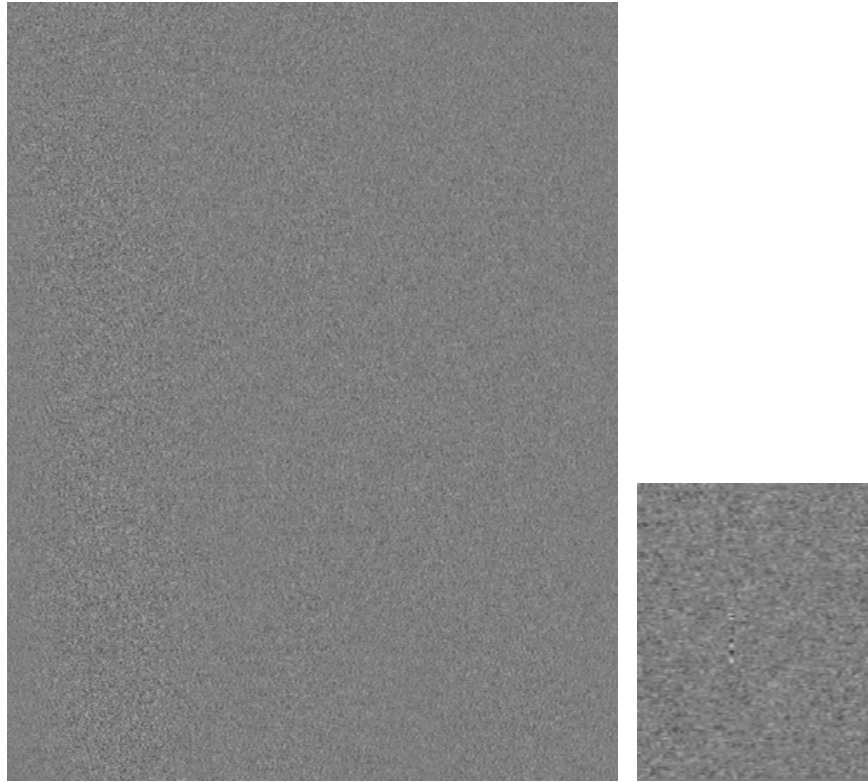


Fig. 8. Real Part of Echo Data (left) and Range-Compressed Data (right, smaller data part) in Swath SS 1

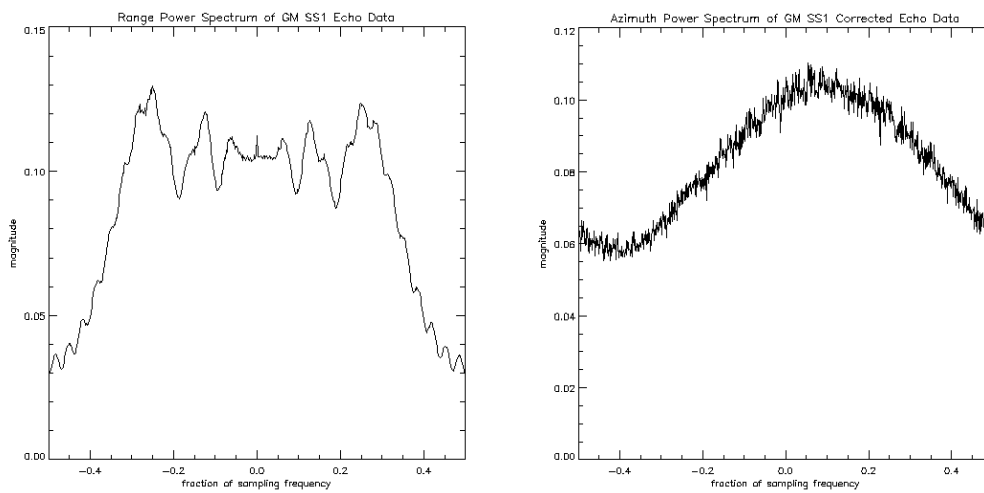


Fig. 9. Range and Azimuth Power Spectrum for Swath SS 1

8 SUMMARY, CONCLUSIONS AND OUTLOOK

The analysed alternating polarisation mode products show a good level 0 product quality confirming the overall analysis results already found for image, wide swath and wave mode. This concludes the detailed off-line level 0 product validation for these modes. Only suspicious level 0 products will be analysed in detail in the following pre-operational phase.

The availability of one and only one global monitoring product restricts any quality statement to this specific product only. A further detailed analysis based on a larger variety of GM products is still necessary and will be done in the following pre-operational phase.

During the operational phase, a systematic level 0 parameter monitoring has to be performed to get an indication for possible anomalies as soon as possible and to further characterise the overall level 0 product quality.

9 ACKNOWLEDGEMENTS

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- Chris Buck for providing all the material necessary for a systematic level 0 quality assessment.

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10 REFERENCES

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- [7] M. Zink, *Early Analysis of Global Monitoring Mode*, ENVISAT Validation Workshop, ESRIN, December 2002