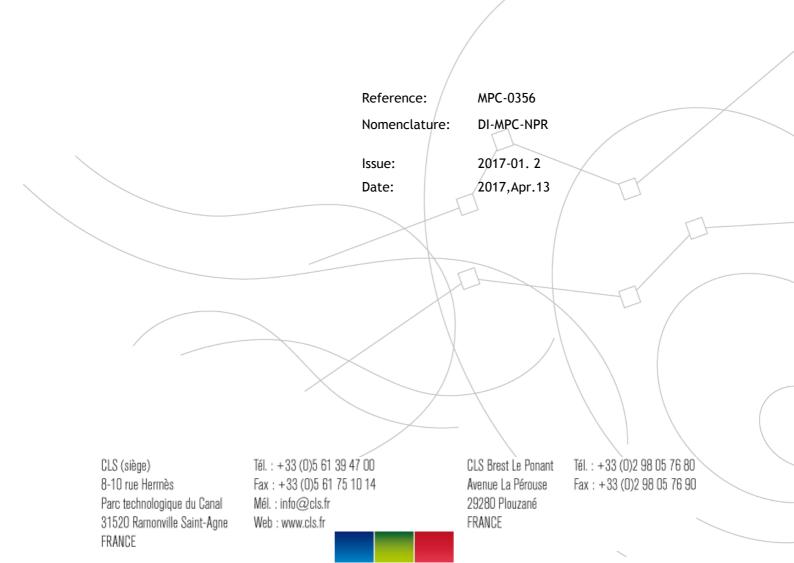


S-1 MPC

S1-B N-Cyclic Performance Report - 2017-02 Cycles 31 to 34 (09-Feb-2017 to 29-Mar-2017)



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Chronology Issues:

Issue:	Date:	Reason for change:
2017-02	13.04.17	First Issue : reporting period 09-Feb-2017 to 29-Mar-2017

People involved in this issue:

Written by (*):	Peter Meadows	Date + Initials:(visa or ref)
Checked by (*):	K.Cordier	Date + Initial:(visa ou ref) K.Cordier
Approved by (*):	G.Hajduch	Date + Initial:(visa ou ref) G.Hajduch
Application authorized by (*):		Date + Initial:(visa ou ref)

*In the opposite box: Last and First name of the person + company if different from CLS

Index Sheet:

Context:	Sentinel-1 Mission Performance Centre	
Keywords:	Sentinel-1, Mission Performance Centre, N-Cyclic Report	
Hyperlink:		

Distribution:

Company	Means of distribution	Names
ESA	Notification	N.Miranda

Applicable documents

Nomenclature	Title	Edition Number	Revision Number
[S1-AD-14]	S1 RS-MDA-52-7441 Sentinel-1 Product Specification	3	2
[S1-AD-15]	S1-RS-MDA-57-7440 Sentinel-1 Product Definition	2	7

Reference documents

None

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1. Introduction

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1.1. Purpose of the document

The purpose of this document is to provide a status on the S-1B sensor and product performance for orbit repeat cycle 31 from 9th February to 21st February 2017, cycle 32 from 21st February to 5th March 2017, cycle 33 from 5th March to 17th March 2017 and cycle 34 from 17th March to 29th March 2017.

1.2. Structure of the document

- Chapter 1 : This introduction
- Chapter 2 : Executive Summary
- Chapter 3 : Instrument Status
- Chapter 4 : IPF and Auxiliary Date File Status
- Chapter 5 : Manoeuvres
- Chapter 6 : Products Status

The following appendices are also provided:

- Appendix A : List of Acronyms
- Appendix B : S1-B Transmit Receive Module Failures
- Appendix C : S1-B Instrument Unavailability
- Appendix D : S1-B Auxiliary Data Files

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2. Executive Summary

The main change during S1-B cycles 31 to 34 (9th February to 29th March 2017) was an update the Instrument Processing Facility (IPF v2.82) - see Section 4.1 for further details.

A summary of the instrument and product status is provided in following sections of the document.

The list of Quality Disclaimers on the Sentinel-1B products performances and the list of the IPF Auxiliary Data Files can be accessed on the QC Web Server at following address:

https://qc.sentinel1.eo.esa.int/

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3. Instrument Status

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Here the status of the S1-B instrument during the reporting period is provided.

3.1. Antenna Status

There were no new S1-B antenna transmit/receive module failures during the reporting period.

TRM	Description	Date of Failure

Table 1 S1-B Antenna Transmit/Receive Module Failures

A full list of all TRM failures since S1-B launch is given in Appendix B.

3.2. Instrument Unavailability

Table 2 gives when the S1-B instrument was unavailable during the reporting period:

Start Date/Time	End Date/Time	MPC Reference	Summary
21/03/2017 16:23	22/03/2017 11:53	SOB-702	Sentinel-1B SAR issue from 21/03/2017 to 22/03/2017

Table 2 S1-B Instrument Unavailabilities

A full list of all instrument unavailabilities since the S1-B launch is given in Appendix C.

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4. IPF and Auxiliary Date File Status

4.1. Level 1 Processor Issues

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There was an update to the Instrument Processing Facility (IPF) during the reporting period - IPF v2.82 became operational on the 28th March 2017.

The main updates introduced by this IPF version are:

- Fine processor radiometric normalization for IW and EW modes data
- Fixed azimuth radiometric artefacts due to bad usage of Doppler Centroid estimations
- Update of different terrain height information in L1 products to have consistent values.

4.2. Auxiliary Data File Updates

There were no updates to S1-B Auxiliary Data Files (ADFs) during the reporting period. A full list of currently applicable ADF files is given in Appendix D.

Instrument ADF (AUX_INS)

ADF	Update Reason
S1B_AUX_PP1_V20160422T000000_G20170328T093014.SAFE	Update of processing gains for IW and EW modes to implement the outcome of recalibration #2 activity performed in preparation to IPF V282 deployment. Related to RDB#1.

Table 3 AUX_INS Updates

Calibration ADF (AUX_CAL)

ADF	Update Reason
S1B_AUX_CAL_V20160422T000000_G20170328T092822.SAFE	Update of noise calibration factors in S1B_AUX_CAL to implement the outcome of recalibration #2 activity performed in preparation to IPF V282 deployment. Related to RDB#1.

Table 4 AUX_CAL Updates

L1 Processor Parameters ADF (AUX_PP1)

ADF	Update Reason

Table 5 AUX_PP1 Updates

L2 Processor Parameters ADF (AUX_PP2)

ADF	Update Reason

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Table 6 AUX_PP2 Updates

Simulated Cross Spectra ADF (AUX_SCS)

ADF	Update Reason

Table 7 AUX_SCS Updates

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5. Manoeuvres

Table 8 gives a list of the S1-B orbit manoeuvres that occurred during the reporting period¹:

Start Date	Start Time	Stop Date	Stop Time	Comment
16/02/2017	00:15:59.515	16/02/2017	00:16:03.515	
01/03/2017	21:49:30.942	01/03/2017	21:50:10.692	
01/03/2017	23:49:06.182	01/03/2017	23:49:13.557	
08/03/2017	23:31:50.576	08/03/2017	23:31:54.701	
22/03/2017	23:41:17.489	22/03/2017	23:41:19.614	
23/03/2017	00:30:45.249	23/03/2017	00:30:49.749	

Table 8 S1-B Orbit Manoeuvres

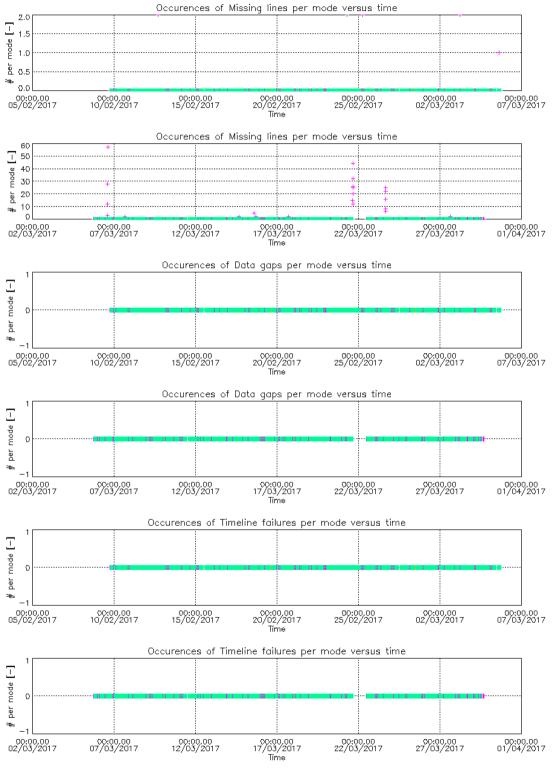
¹ This table is extracted from the DBL file of the SAFE product containing the list of thruster event by applying : awk 'NR>1 {if (\$3=1) start=\$1 ; getline; print start";"\$1}'



6. Products Status

6.1. Level 0 Products

Figure 1 show missing lines, data gaps, and timeline failures derived from L1 annotation products (purple for IW, blue for EW and green for WV):-



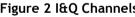


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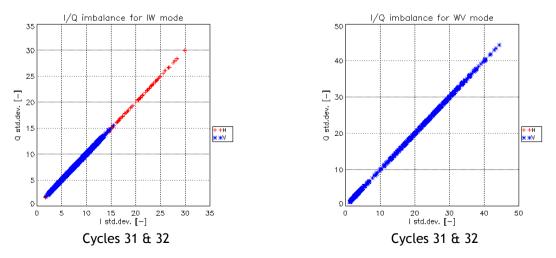
The above plots indicate no problems with missing lines and data gaps plus a small number of timeline failures.

I and Q trends for IW mode 0.40 1 0.30 +++iH ¥¥IV ++-ΩH ¥¥QV 0.25 mean 0.20 ġ 0.10 0.05 00:00.00 05/02/2017 00:00.00 00:00.00 15/02/2017 00:00,00 20/02/2017 Tíme 00:00.00 00:00.00 02/03/2017 00:00.00 I and Q trends for IW mode 0.40 mean [-] 0.30 +++1H ¥¥IV ++-ΩH ¥¥QV 0.20 ğ 0.10 0.05 0.00 00:00.00 17/03/2017 Tíme 00:00.00 02/03/2017 00:00.00 07/03/2017 00:00.00 12/03/2017 00:00.00 22/03/2017 00:00.00 27/03/2017 00:00.00 01/04/2017 I and Q trends for WV mode 0.40 0.35 0.30 Ξ 0.30 ++1H ¥¥IV ++ΩH ¥¥QV mean *** ğ 0.10 0.05 00:00.00 05/02/2017 00:00.00 00:00.00 00:00.00 20/02/2017 00:00.00 25/02/2017 00:00.00 02/03/2017 00:00.00 07/03/2017 Tíme I and Q trends for WV mode 0.4 0.3 mean [-] +++IH ¥¥IV +++QH ¥¥QV 0.2 0.1 ã 0.0 -0.1 00:00,00 17/03/2017 Tíme 00:00.00 02/03/2017 00:00.00 22/03/2017 00:00.00 27/03/2017 00:00.00 07/03/2017 00:00.00 12/03/2017 00:00.00 01/04/2017

Figure 2 and Figure 3 show I and Q trends and imbalance for IW and WV modes:



The jumps that may be noticed on the above time-series are related to instrument switch on/off, and correspond to a normal behaviour, that is compensated at processing level. It therefore has no impact on data quality.





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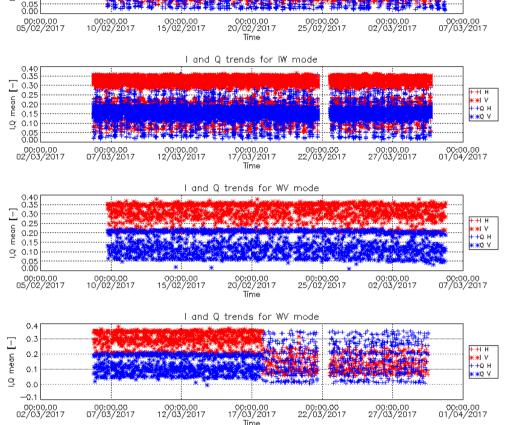


Figure 2 I&Q Channels

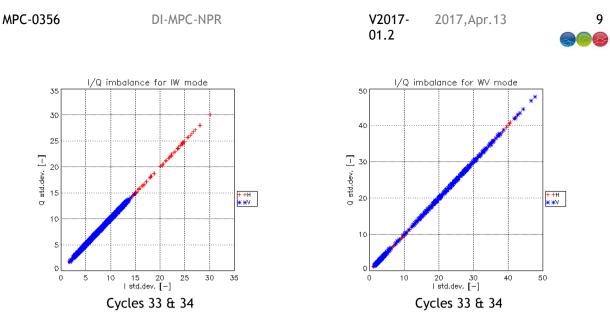


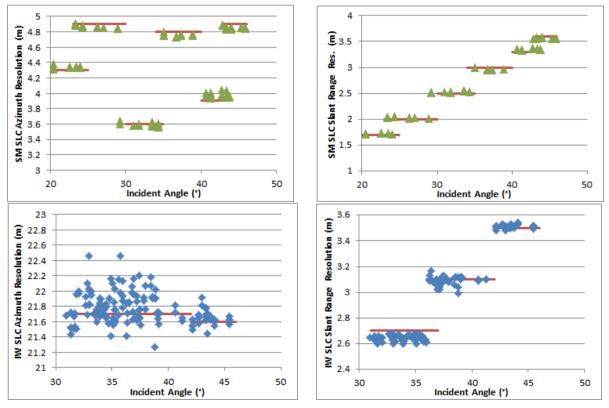
Figure 3 WV I&Q Channel Imbalance

The I & Q imbalance plots in the figure above (*left*: IW mode, *right*: WV mode) indicate that the Rx I and Q channels are perfectly balanced.

6.2. Level 1 Products

6.2.1. Image Quality

Figure 4 and Table 9 give the azimuth and range spatial resolution using the Australian corner reflector array, the BAE corner reflector and the DLR transponders & corner reflectors derived from SM & IW imagery acquired during the reporting period. The spatial resolution has been derived from SLC data. Table 10 gives the impulse response function (IRF) sidelobe ratios. These indicate a nominal IRF performance.





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Mode/Swath	Azimuth Spatial Resolution (m)	Slant Range Spatial Resolution (m)
S1	4.34±0.02	1.72±0.01
S2	4.87±0.02	2.03±0.01
\$3	3.59±0.02	2.53±0.01
S4	4.76±0.02	2.97±0.02
S5	3.98±0.03	3.35±0.01
S6	4.85±0.02	3.57±0.01
IW1	21.80±0.22	2.64±0.02
IW2	21.80±0.20	3.09±0.03
IW3	21.65±0.09	3.51±0.02

Table 9 IW & EW Azimuth and Slant Range Spatial I	Resolutions
---	-------------

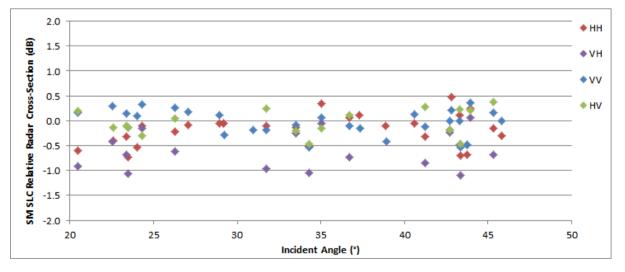
Mode/Swath	Integrated Sidelobe Ratio (dB)	Peak Sidelobe Ratio (dB)	Spurious Sidelobe Ratio (dB)
SM	-13.21±0.52	-20.62±0.61	-26.80±0.98
IW	-11.87±3.31	-19.78±1.28	-23.09±3.50

Table 10 SM & IW Sidelobe Ratios

No Equivalent Number of Looks/Radiometric Resolution and Ambiguity measurements were made during the reporting period.

6.2.2. Radiometric Calibration

Figure 5 and Table 11 give the relative radar cross-section using the Australian corner reflector array, the BAE corner reflector and the DLR transponders & corner reflectors derived from SM & IW imagery acquired during the reporting period. The relative radar cross-section has been derived from SLC data. These indicate a nominal radiometric calibration performance (where there is sufficient number of measurements per sub-swath).





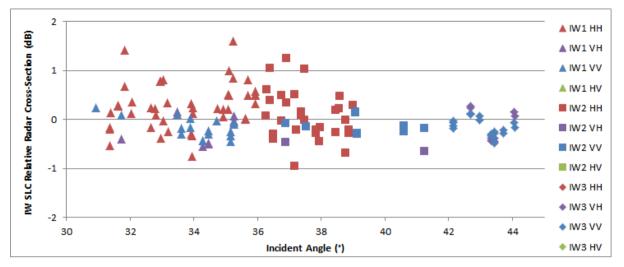


Figure 5 SM & IW Relative Radar Cross-Section

Mode/Swath	Relative Radar Cross-Section (dB)				
	All	НН	VH	VV	HV
S1	-0.31±0.43	-0.57±0.14	-0.80±0.35	0.11±0.18	-0.02±0.19
\$2	-0.10±0.29	-0.15±0.11	-0.48±0.29	0.21±0.09	-0.12±0.18
\$3	-0.30±0.34	-0.17±0.20	-0.76±0.43	-0.25±0.17	-0.14±0.36
S4	-0.08±0.28	0.11±0.19	-0.40±0.47	-0.15±0.19	-0.02±0.19
S5	-0.35±0.36	-0.39±0.29	-0.72±0.44	-0.25±0.29	-0.13±0.37
\$6	0.05±0.32	0.07±0.31	-0.37±0.38	0.14±0.16	0.27±0.08
IW1	0.12±0.46	0.28±0.47	-0.25±0.30	-0.15±0.20	
IW2	0.00±0.46	0.08±0.49	-0.56±0.13	-0.12±0.17	
IW3	-0.20±0.24		-0.23±0.35	-0.18±0.17	

Table 11 IW Relative Radar Cross-Section

Figure 6 shows the IW long-term relative radar cross-section of the BAE corner reflector since the start of the Sentinel-1B routine phase (September 2016). The mean relative radar cross-section is -0.19 ± 0.19 dB (all the measurements are for VV polarisation).

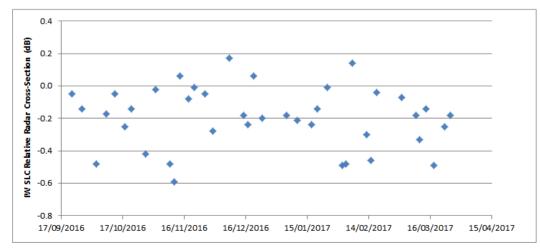
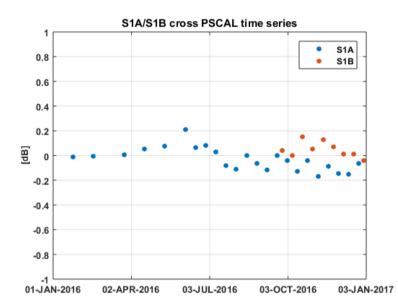


Figure 6 IW Long-Term Relative Radar Cross-Section

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The following figure shows a recent IW VV Permanent Scatter Calibration series over Paris. The series covers the whole 2016 and includes both S1A and S1B acquisitions, in order to perform a cross-calibration between the sensors. The blue dots (S1A) show, after the tile 11 issue (June 2016), a small reduction of the calibration constant (about 0.1 dB). The red dots show that the calibration constant for S1B is around 0.05 dB. The S1B calibration constant is well aligned with S1A values before tile 11 issue. After the issue a very small radiometric imbalance can be observed (around 0.15 dB).





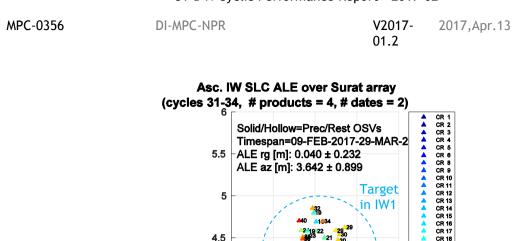
6.2.3. Geometric Calibration

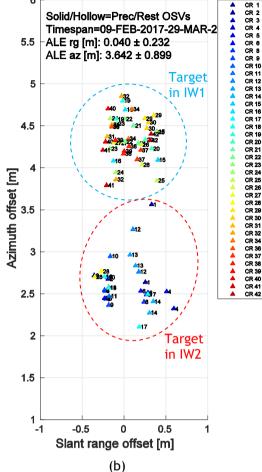
Figure 8 shows the absolute location error (ALE) based on four SLC products from the IW acquisition mode acquired during the current reporting period (two pairs of azimuth-adjacent products). The points have been colour-coded and labelled to reflect the numerical labels assigned to them by Geoscience Australia. The products were analysed using both precise and near-real-time restituted orbit files, depending on their availability at the time of reporting. Atmospheric path delay (PD) and azimuth timing errors (residual error from the bistatic correction made by the IPF) have also been mitigated. Note that PD correction depends on the local incident angle, which is considered here for the individual corner reflectors spanning the over-100km wide array.

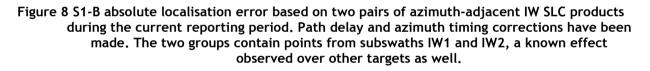
The points can be observed to cluster into two distinct groups, a feature of these analyses that has already been well-established for other test sites, for both S1-A and S1-B. It is the result of the way the data are processed, and has been under investigation for some time with currently only a partial explanation available.

In spite of the known biases, the IW mode ALE plots indicate a nominal localisation performance; the range and azimuth ALE mean and standard deviations are annotated in the upper left corner of the figure subplot. The standard deviations are better than the specified 1-sigma ALE for IW mode products (3.33m, i.e. 10m at 3 sigma; see section 5.5.2.2 of the "GMES Sentinel-1 System Requirements Document," Ref. S1-RS-ESA-SY-0001, Iss. 3, Rev. 3).

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6.2.4. Polarimetric Calibration

Table 12 gives the co-registration between the two polarisations of dual-polarisation products acquired during the reporting period (based in DLR transponder measurements). No channel distortion measurements were made during the reporting period.

Mode/Swath	Range Co-registration Accuracy (m)	Azimuth Co- registration Accuracy (m)	Channel Distortion (dB)
SM	0.01±0.05	0.02±0.09	
IW	0.00±0.00	0.09±0.40	

Table 12 Polarimetric Calibration Measurements

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6.2.5. Elevation Antenna Patterns

No Elevation Antenna Pattern (EAP) updates were updated during the reporting period.

6.2.6. Azimuth Antenna Patterns

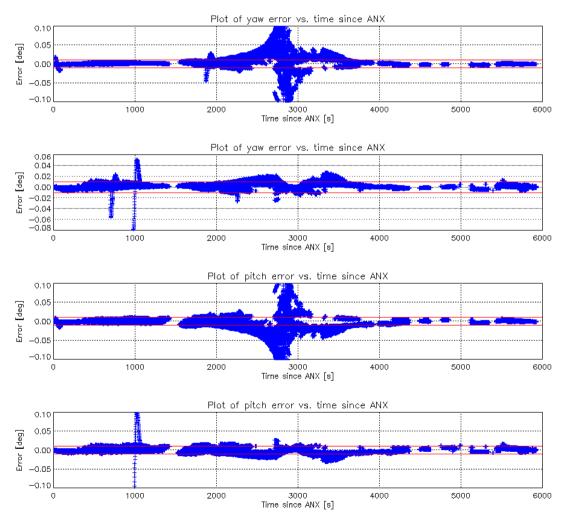
No Azimuth Antenna Patterns (AAPs) were updated during the reporting period.

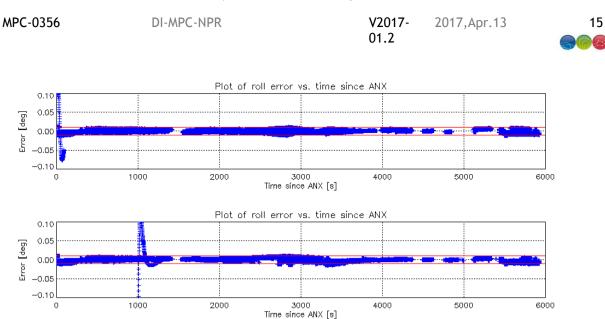
6.2.7. Noise Equivalent Radar Cross-section

No Noise Equivalent Sigma0 Zero (NESZ) measurements were made during the reporting period.

6.2.8. Antenna Pointing

Figure 9 shows yaw, pitch and roll errors calculated for the reporting period against ascending node crossing time (ANX). The red horizontal lines show the nominal $\pm 0.01^{\circ}$ bounds for these attitude errors - points outside these bounds are normally due to orbit manoeuvres. The recent increase in calculated yaw around ANX of 3000 is not an issue with Sentinel1-B itself but with how the yaw is calculated on-ground. Consequently there is no impact of the quality of products.





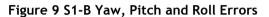
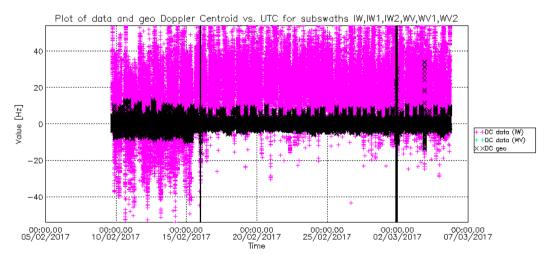


Figure 10 shows the Doppler Centroid frequency as a function of date and ANX. The data has been derived from IW & WV data and from geometry. Note that it is expected that the Doppler estimation from WV mode data will have a higher standard deviation than from IW mode due to the Doppler estimation over the ocean will be noisier than over land. Table 13 gives the statistics based on Doppler Centroid derived from IW and WV data (note that the larger than expected min/max Doppler values for Cycles 33 and 34 are likely due to a problem WV product). A more detailed plot of Doppler Centroid frequency derived over land from SM, IW and EW products is shown in Figure 11. Note that there was a small increase of the average DC from 8 Hz to about 20 Hz due to a change in the STT configuration on the 15th February 2017.





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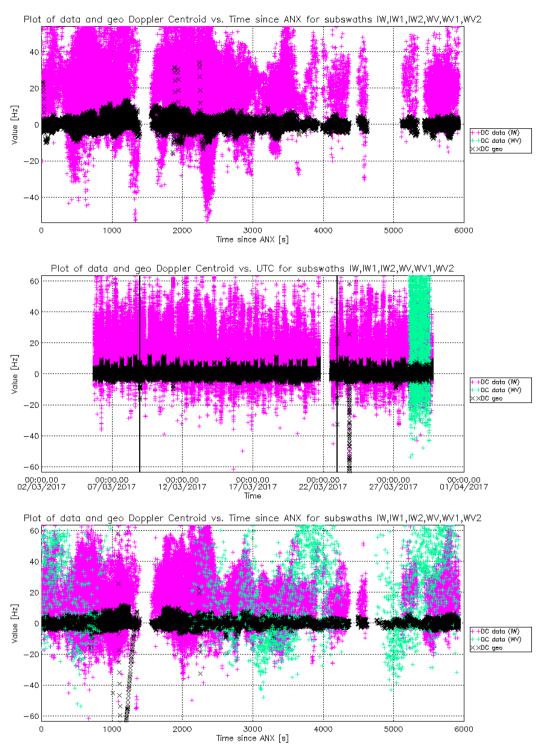


Figure 10 S1-B Doppler Centroid

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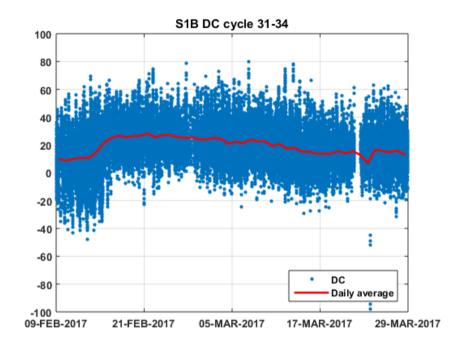


Figure 11 S1-B Doppler Centroid

	Min (Hz)	Mean (Hz)	Max (Hz)
Cycles 31 & 32	-57.41	20.52±14.84	118.46
Cycles 33 & 34	-1679.0	14.77±17.03	1062.8

Table 13 Doppler Centroid Statistics

6.2.9. Summary of Anomalies

There were no anomalies during the reporting period.

6.2.10. Quality Disclaimers

One L1 product quality disclaimers was updated during the reporting period: this related to an incorrect Cycle Number in S1-A Products acquired between 12/01/2017 and 24/01/2017 (see Appendix E for a list of issued and prepared quality disclaimers). A full list of issued quality disclaimers can also be found on the <u>QC Web site</u>.

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Appendix A - List of Acronyms

Azimuth Antenna Pattern
Applicable Document
Auxiliary Data File
Absolute Localisation Accuracy Error
Ascending Node Crossing Time
Elevation Antenna Pattern
Extra Wide Swath
Instrument Processing Facility
Impulse Response Function
Interferometric Wide Swath
Noise Equivalent Sigma0 Zero
Path Delay
Permanent Scatter Calibration
Reference Document
Radar Data Base
Receive
Stripmap
To be confirmed
To be defined
Transmit Receive Module
Transmit
Wave Mode

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Appendix B - S1-B Transmit Receive Module Failures

The following S1-B antenna TRM have failed since the S1-B launch:

TRM	Description	Date of Failure
Tile 5, Row 7	Tx, H & V - Rx V	22-April-2016
Tile 5, Row 8	Tx, H & V	22-April-2016
Tile 5, Row 8	Rx, V	17-June-2016
Tile 5, Row 8 Rx, H		16-January-2017

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Appendix C - S1-B Instrument Unavailability

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The S1-B instrument has been unavailable during the following periods since S-1B launch:

Start Date/Time	End Date/Time	MPC Reference	Summary
16/06/2016 00:00	16/06/2016 08:17	SOB-446	Sentinel-1B Unavailability on 16/06/2016
28/06/2016 19:41	29/06/2016 10:32	SOB-461	Sentinel-1B Unavailability from 28/06/2016 to 29/06/2016
04/07/2016 03:28	04/07/2016 10:42	SOB-477	Sentinel-1B Unavailability on 04/07/2016
12/10/2016 07:00	13/10/2016 15:34	SOB-572	Sentinel-1B SAR issue from 12/10/2016 to 13/10/2016
21/03/2017 16:23	22/03/2017 11:53	SOB-702	Sentinel-1B SAR issue from 21/03/2017 to 22/03/2017

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Appendix D - S1-B Auxiliary Data Files

The following is a full list of currently applicable ADF updates:

Instrument ADF (AUX_INS)

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ADF Update Reason	
S1B_AUX_INS_V20160422T000000_G20160922T094114.SAFE	First applicable auxiliary file for user released products. Related to RDB#1.

Calibration ADF (AUX_CAL)

ADF	Update Reason Update of noise calibration factors in S1B_AUX_CAL to implement the outcome of recalibration #2 activity performed in preparation to IPF V282 deployment. Related to RDB#1.		
S1B_AUX_CAL_V20160422T000000_G20170328T092822.SAFE			
S1B_AUX_CAL_V20160422T000000_G20170116T134142.SAFE	Updated S1-B noise vectors for IW and EW modes. Related to RDB#1.		

L1 Processor Parameters ADF (AUX_PP1)

ADF	Update Reason	
S1B_AUX_PP1_V20160422T000000_G20170328T093014.SAFE	Update of processing gains for IW and EW modes to implement the outcome of recalibration #2 activity performed in preparation to IPF V282 deployment. Related to RDB#1.	
S1B_AUX_PP1_V20160422T000000_G20170116T134234.SAFE	S1B QL scaling LUT updated for SM, IW and EW modes (to be similar to S-1A). Related to RDB#1.	

L2 Processor Parameters ADF (AUX_PP2)

ADF	Update Reason
S1B_AUX_PP2_V20160422T000000_G20160420T135034.SAFE	First applicable auxiliary file for user released products. Related to RDB#1.

Simulated Cross Spectra ADF (AUX_SCS)

ADF	Update Reason
S1AUX_SCS_V20140402T000000_G20160413T103855.SAFE	First applicable auxiliary file for user released products. Related to RDB#1.

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Appendix E - S-1B Quality Disclaimers

The following Quality Disclaimers have been prepared since the S1-B launch:

Number	Description	Start Validity Date	End Validity Date	Issue Status
19	S1B Denoising vectors not qualified	2016-08-20 00:00:00	ongoing	Issued
20	S-1B Dual Polarisation Timing De- synchronisation & Single H polarisation Localisation Error	2016-10-12 08:31:00	2016-10-13 15:36:00	Issued
23	Invalid annotation of SSPPDU in the manifest of S-1B products	2016-08-20 00:00:00	ongoing	Issued
25	Incorrect Cycle Number in S1-B Products acquired between 12/01/2017 and 24/01/2017	2017-01-12 07:48:29	2017-01-24 07:14:46	Issued