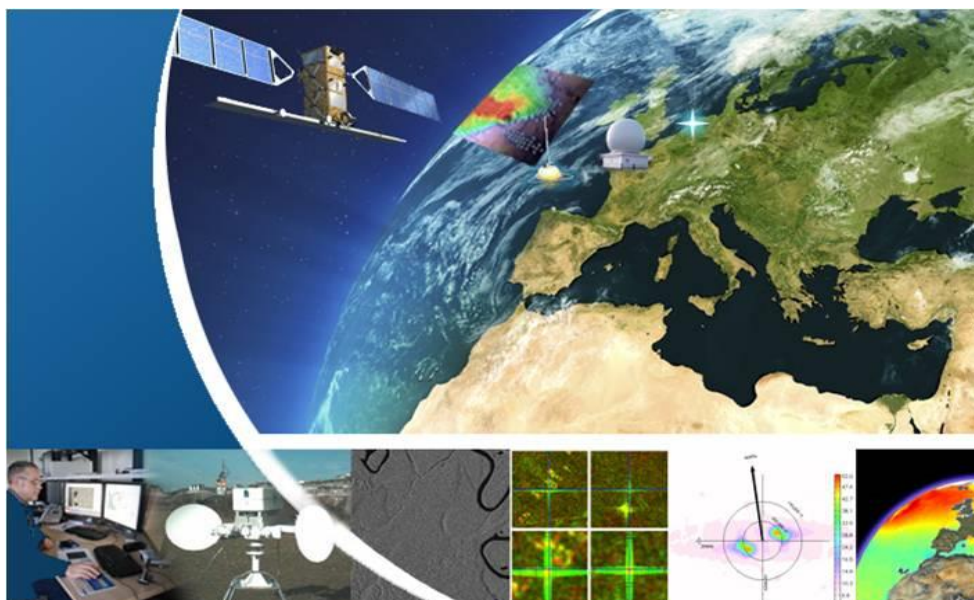


S-1 MPC



S1-B N-Cyclic Performance Report - 2019-03 Cycles 99 to 102 (06-May-2019 to 23-June-2019)

Reference: MPC-0356
Nomenclature: DI-MPC-NPR
Issue: 2019-02. 3
Date: 2019, Jul. 10



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Chronology Issues:

Issue:	Date:	Reason for change:
2019-03.1	10.07.19	First Issue : reporting period 06-May to 23-June 2019

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	5
[S1-AD-15]	S1-RS-MDA-57-7440 Sentinel-1 Product Definition	2	7

Reference documents



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1. Introduction

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 99 from 6th May to 18th May 2019, cycle 100 from 18th May to 30th May 2019, cycle 101 from 30th May to 11th June 2019 and cycle 102 from 11th June to 23rd June 2019.

1.2. Structure of the document

- Chapter 1 : This introduction
- Chapter 2 : Executive Summary
- Chapter 3 : Instrument Status
- Chapter 4 : IPF and Auxiliary Data 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



2. Executive Summary

There were no particular issues for S1-B during cycles 99 to 102 (6th May to 23rd June 2019).

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/>



3. Instrument Status

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
14/05/2019 08:58	14/05/2019 09:15	SOB-1045	Sentinel-1B Planned Unavailability on 14/05/2019
28/05/2019 08:43	28/05/2019 08:56	SOB-1046	Sentinel-1B Planned Unavailability on 28/05/2019

Table 2 S1-B Instrument Unavailabilities

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



4. IPF and Auxiliary Data File Status

4.1. Level 1 Processor Issues

There were no updates to the Instrument Processing Facility during the reporting period.

4.2. Auxiliary Data File Updates

There were no updates to S1-B Auxiliary Data Files (ADFs) during the reporting period.

Instrument ADF (AUX_INS)

ADF	Update Reason

Table 3 AUX_INS Updates

Calibration ADF (AUX_CAL)

ADF	Update Reason

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

Table 6 AUX_PP2 Updates

Simulated Cross Spectra ADF (AUX_SCS)

ADF	Update Reason

Table 7 AUX_SCS Updates



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
09/05/2019	20:50:43.876	09/05/2019	20:54:05.876	
09/05/2019	23:20:22.317	09/05/2019	23:20:50.692	
15/05/2019	22:39:26.487	15/05/2019	22:39:29.362	
29/05/2019	21:22:47.847	29/05/2019	21:27:51.097	
29/05/2019	22:20:17.968	29/05/2019	22:20:51.718	
06/06/2019	22:47:28.752	06/06/2019	22:47:31.627	
12/06/2019	22:02:28.624	12/06/2019	22:02:34.124	
19/06/2019	22:38:44.551	19/06/2019	22:40:09.301	
19/06/2019	23:30:00.044	19/06/2019	23:30:07.169	

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):-

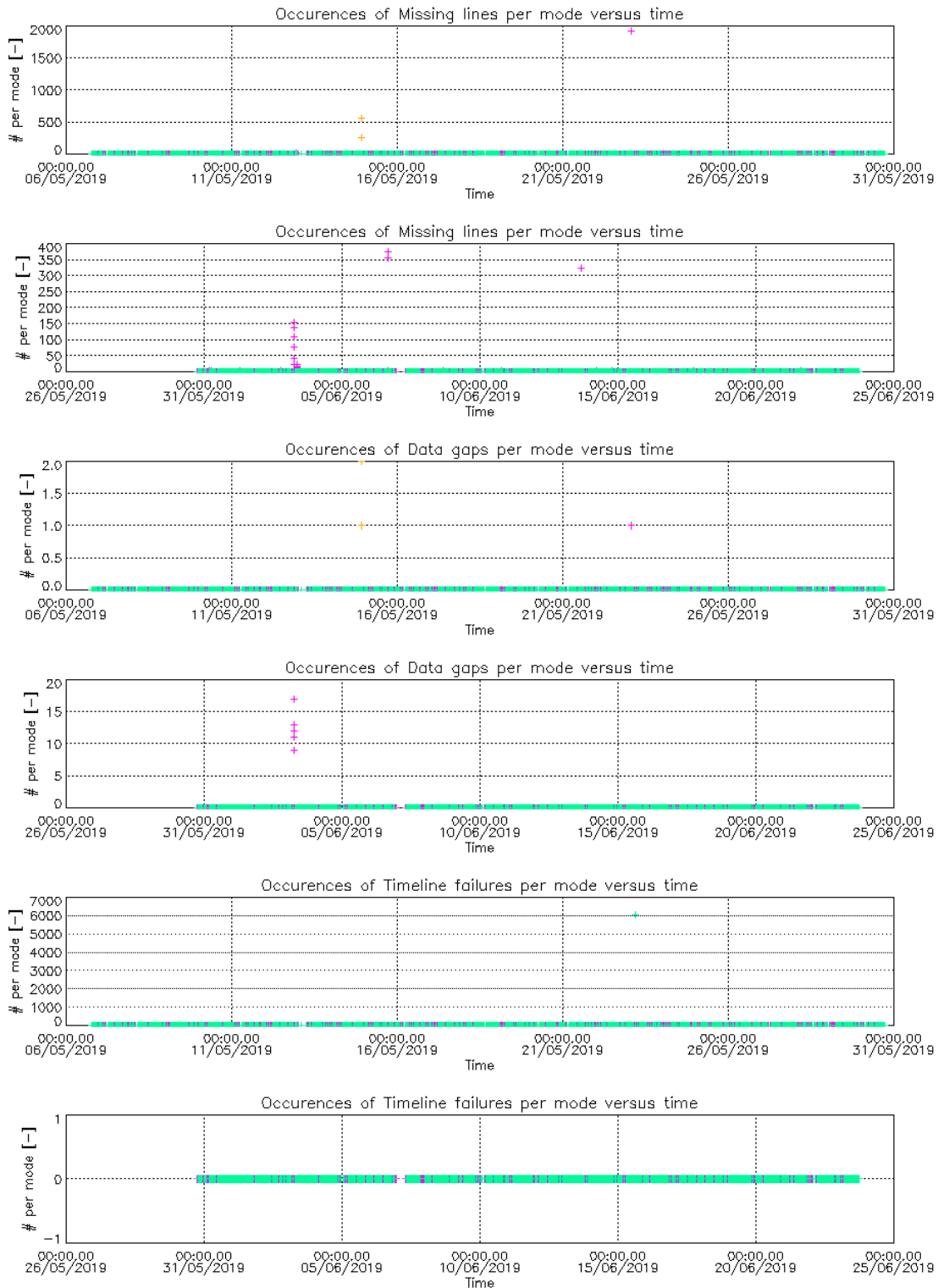


Figure 1 Missing Lines, Data Gaps and Timeline Failures.



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

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

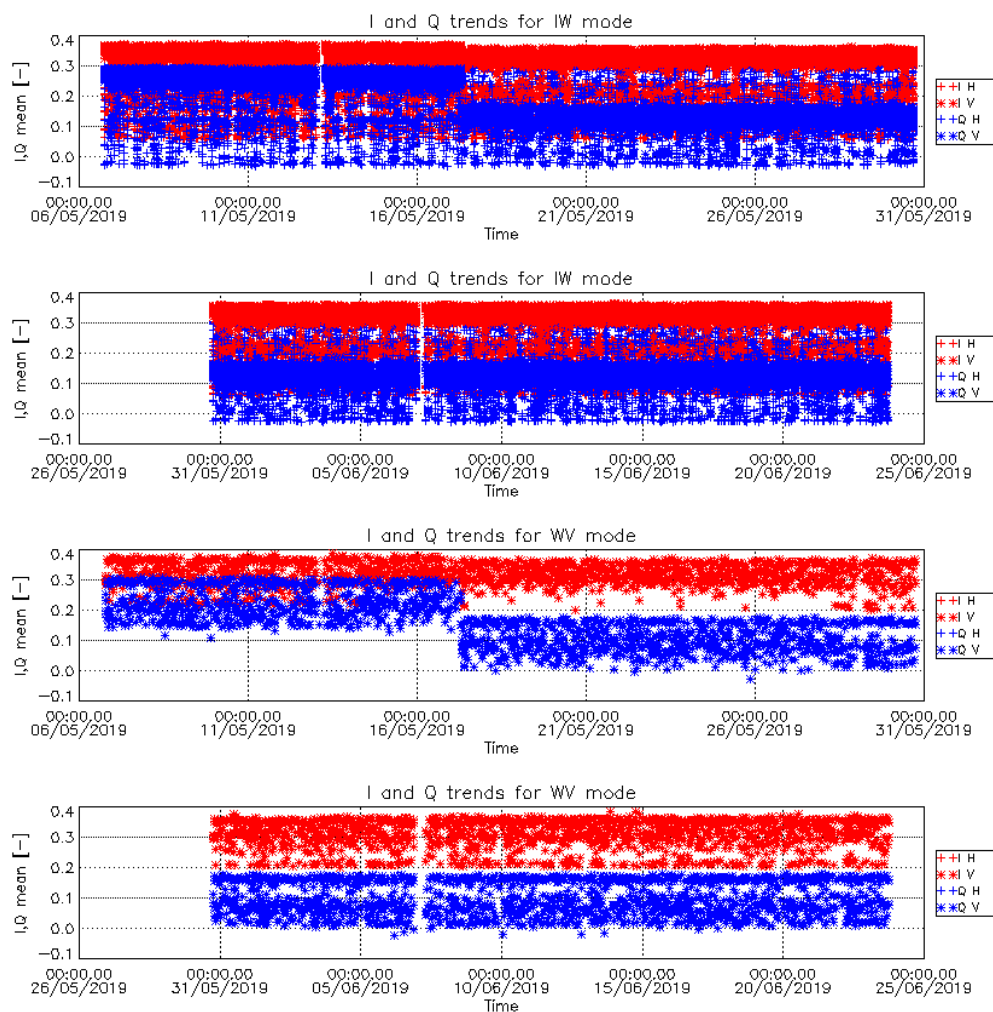
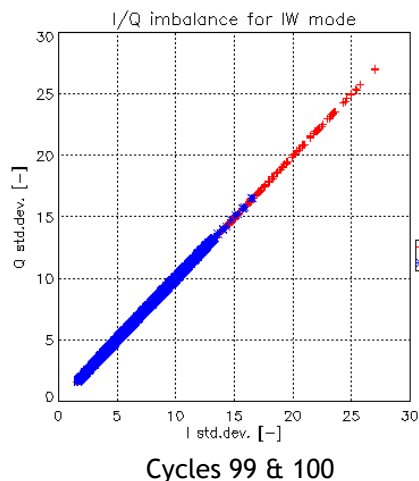
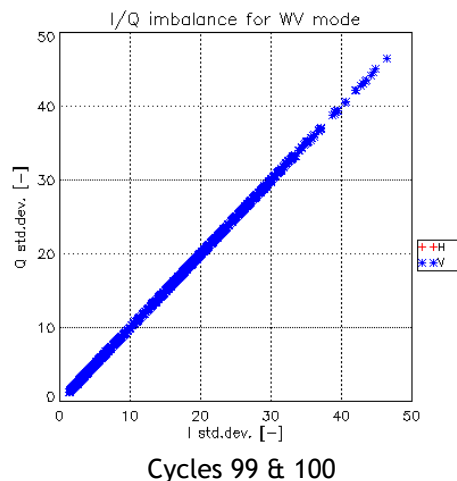


Figure 2 I&Q Channels

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.



Cycles 99 & 100



Cycles 99 & 100

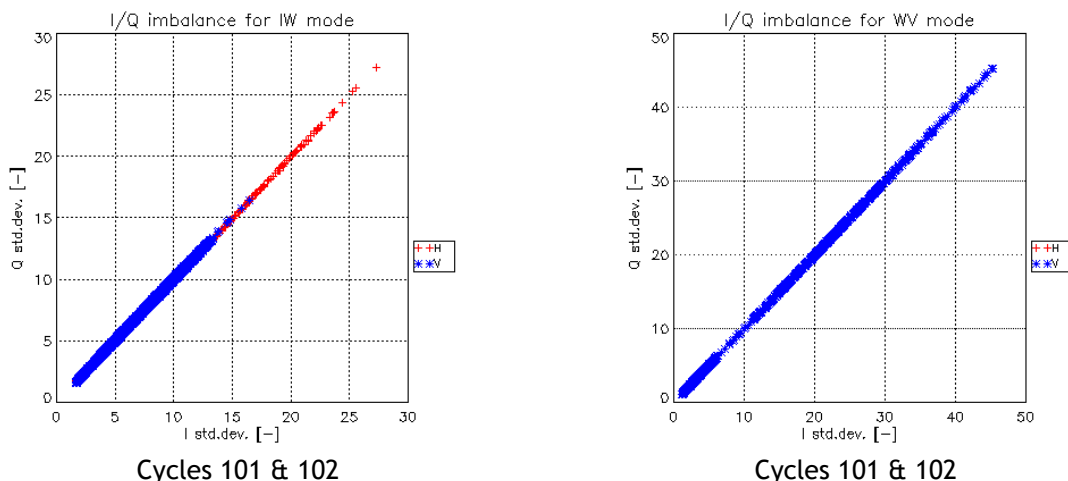


Figure 3 WV I&Q Channel Imbalance

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 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.

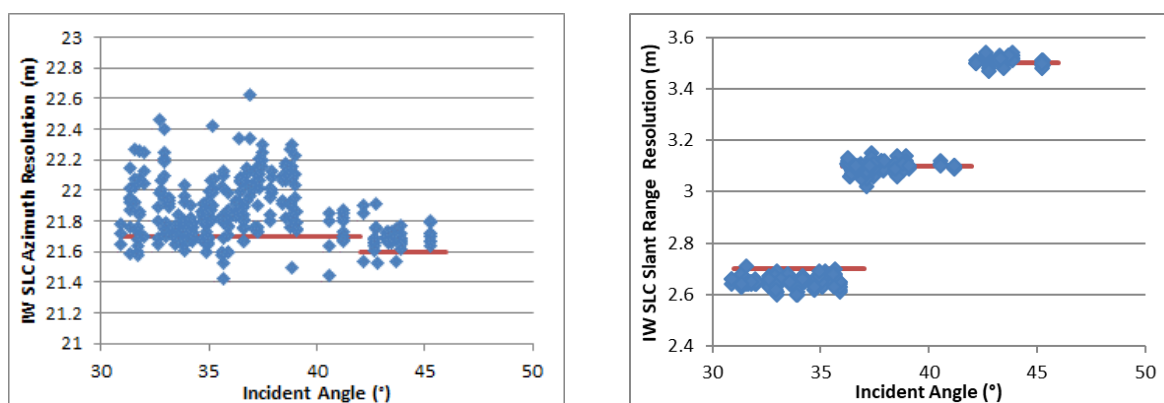


Figure 4 IW Azimuth and Slant Range Spatial Resolutions

Mode/Swath	Azimuth Spatial Resolution (m)	Slant Range Spatial Resolution (m)
IW1	21.84±0.19	2.65±0.02
IW2	21.95±0.20	3.10±0.02
IW3	21.70±0.08	3.51±0.02

Table 9 IW Azimuth and Slant Range Spatial Resolutions



Mode/Swath	Integrated Sidelobe Ratio (dB)	Peak Sidelobe Ratio (dB)	Spurious Sidelobe Ratio (dB)
IW	-12.02±3.14	-19.99±1.01	-23.40±3.38

Table 10 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 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).

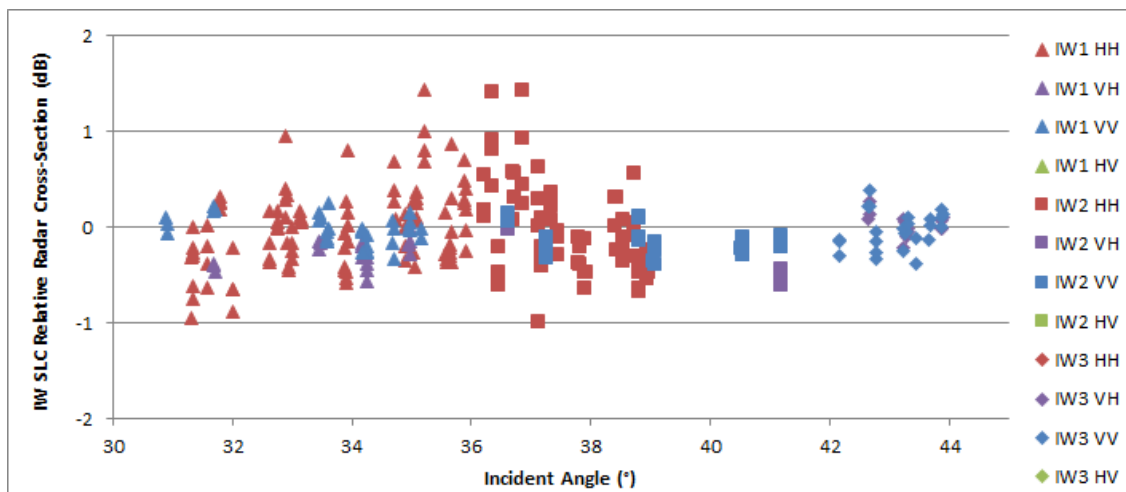


Figure 5 IW Relative Radar Cross-Section

Mode/Swath	Relative Radar Cross-Section (dB)				
	All	HH	VH	VV	HV
IW1	-0.04±0.36	-0.01±0.43	-0.28±0.14	-0.03±0.15	
IW2	-0.06±0.42	0.00±0.48	-0.26±0.28	-0.14±0.15	
IW3	-0.07±0.21		-0.10±0.27	-0.05±0.18	

Table 11 IW Relative Radar Cross-Section

Figure 6 shows the IW long-term relative radar cross-section of the DLR transponders since March 2017 (the green triangles are the average radar cross-section per product) - the relative radar cross-section is -0.12 ± 0.22 dB. Also shown in the IW long-term relative radar cross-section of the BAE corner reflector since the start of the Sentinel-1B routine phase (September 2016) where the mean relative radar cross-section is -0.22 ± 0.19 dB (the majority of the measurements are for VV polarisation).

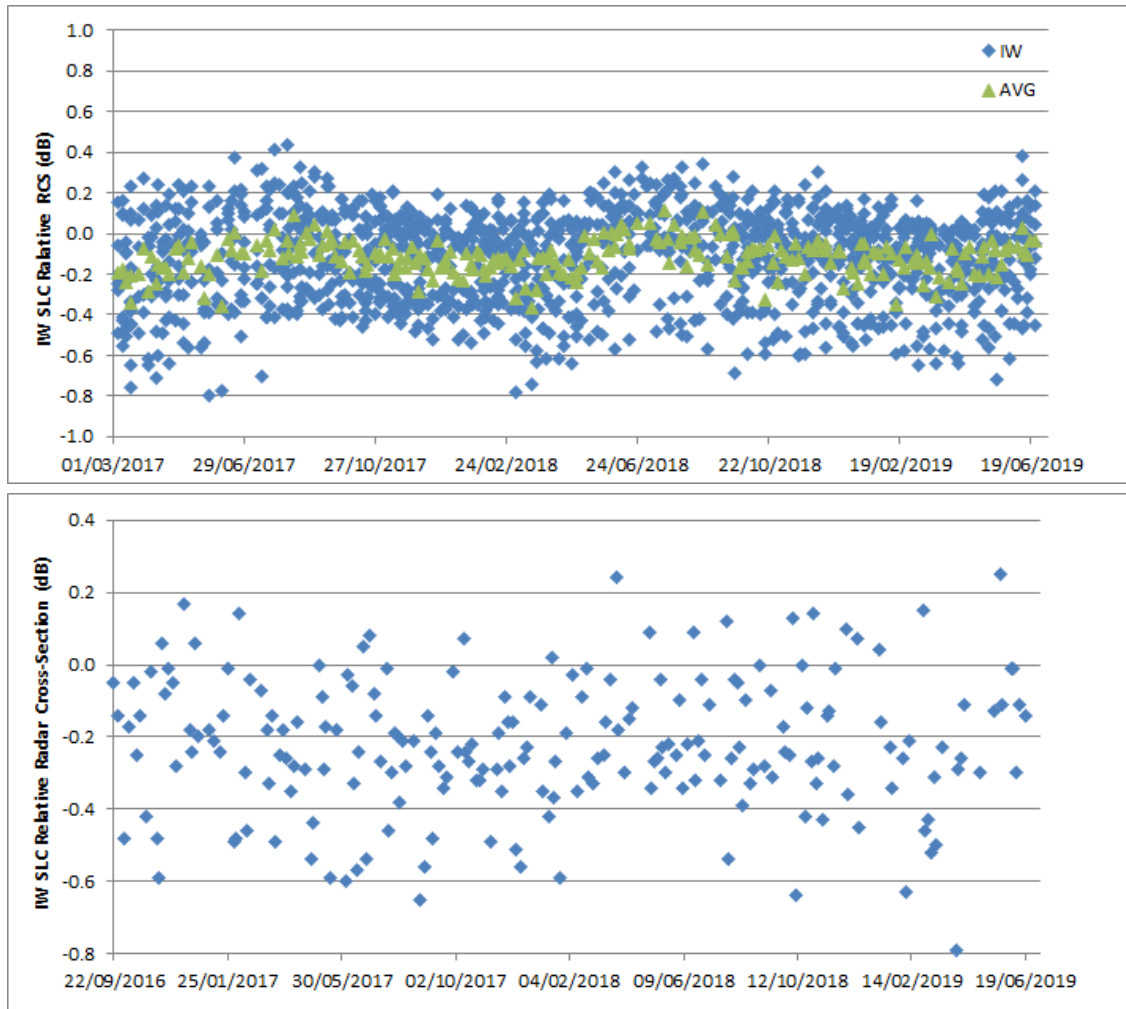


Figure 6 IW Long-Term Relative Radar Cross-Section

The following figure shows a recent IW VV Permanent Scatter Calibration series over Paris. The series covers the period from September 2016 to end of 2017. The S1B PS calibration constant time series is stable during the whole monitored period.

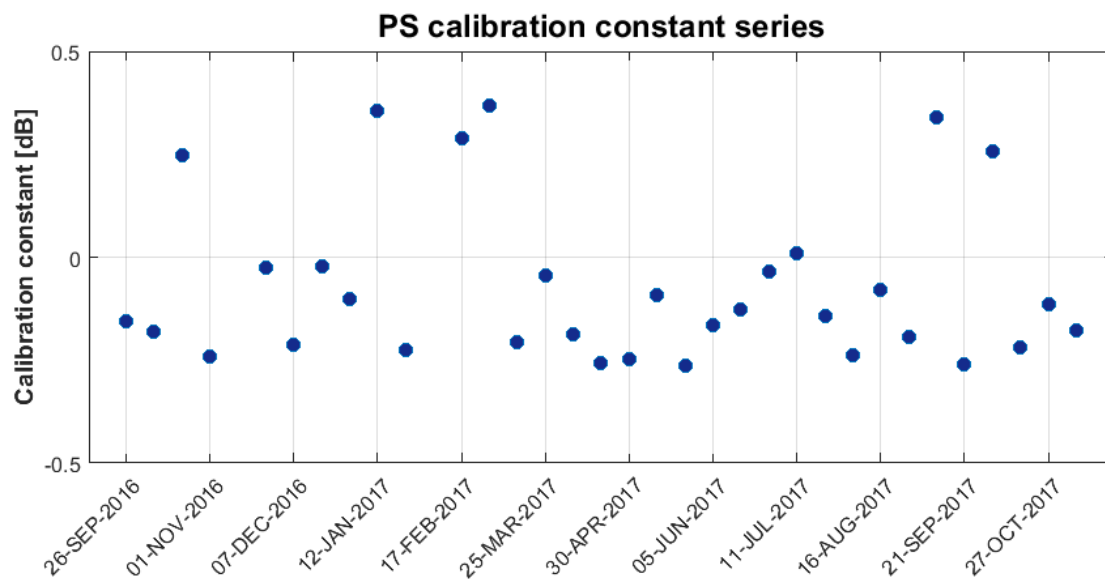


Figure 7 PSCAL time series for IW DV acquisitions over Paris.



6.2.3. Geometric Calibration

Figure 8 shows the absolute location error (ALE) based on eight S1-B SLC products from the IW acquisition mode acquired during the current reporting period (four azimuth-adjacent product pairs acquired on four separate dates). The products were analysed using both precise and near-real-time restituted orbit files, depending on their availability at the time of reporting. Data point sizes have been increased since the previous report to permit better visibility of the orbit quality (hollow=restituted, solid=precise). The points have been colour-coded according to the subswath the targets were visible in. Corrections described in previous reports were made, including the atmospheric path delay (PD), the “intra-burst-dependent” range correction, the “bulk bistatic correction,” a residual azimuth timing offset (the “bistatic residual” correction) and a topography-dependent Doppler centroid correction. Note that PD correction depends on the off nadir angle, which is considered here for the individual corner reflectors spanning the over-100km wide array.

Figure 8 shows the ALE scatter after the effects listed above were corrected during post-processing. The range and azimuth ALE mean and standard deviations are annotated in the upper left corners of the figure. A residual range bias is apparent, which may represent a residual constant timing bias indicating the need for an updated calibration constant; the current calibration constant was determined before recent improvements were made to the geolocation estimation procedure.

The IW mode ALE plots indicate a localisation performance well within the requirements. The ALE is within the specified 1-sigma 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).

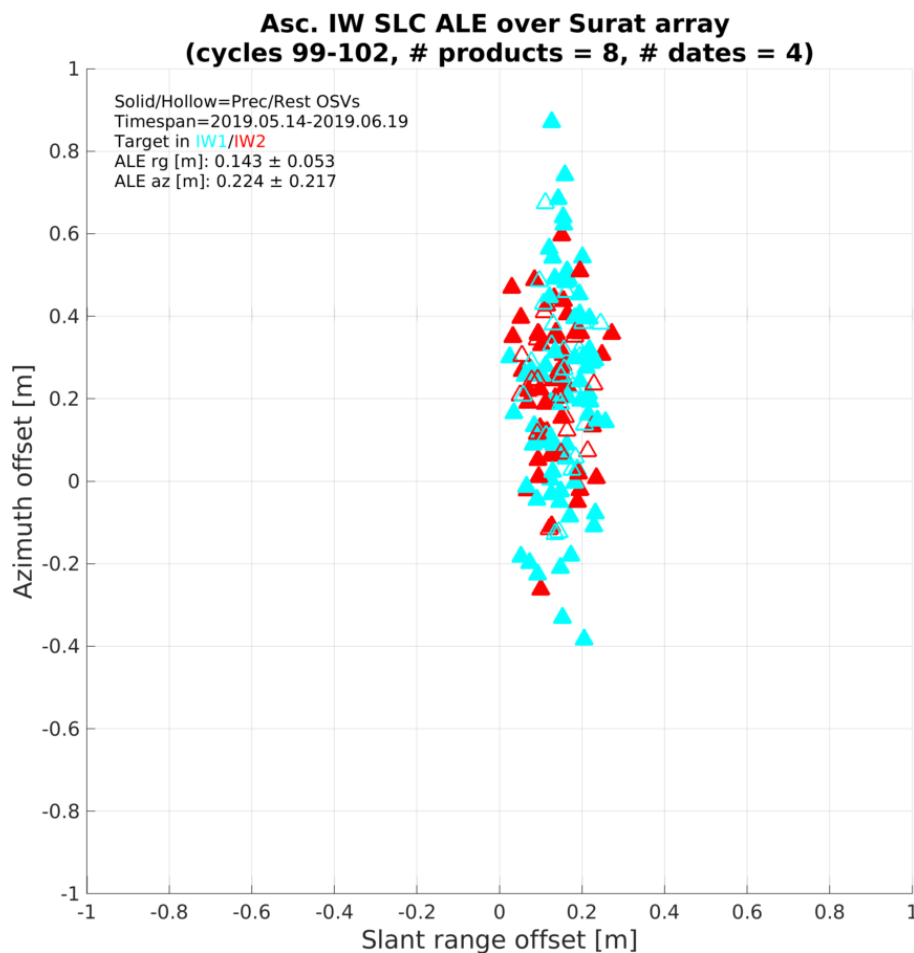


Figure 8 S1-B absolute localisation error based on IW SLC products acquired over the test site during the current reporting period.



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)
IW	0.01±0.06	0.04±0.26	

Table 12 Polarimetric Calibration Measurements

6.2.5. Elevation Antenna Patterns

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

6.2.6. Azimuth Antenna Patterns

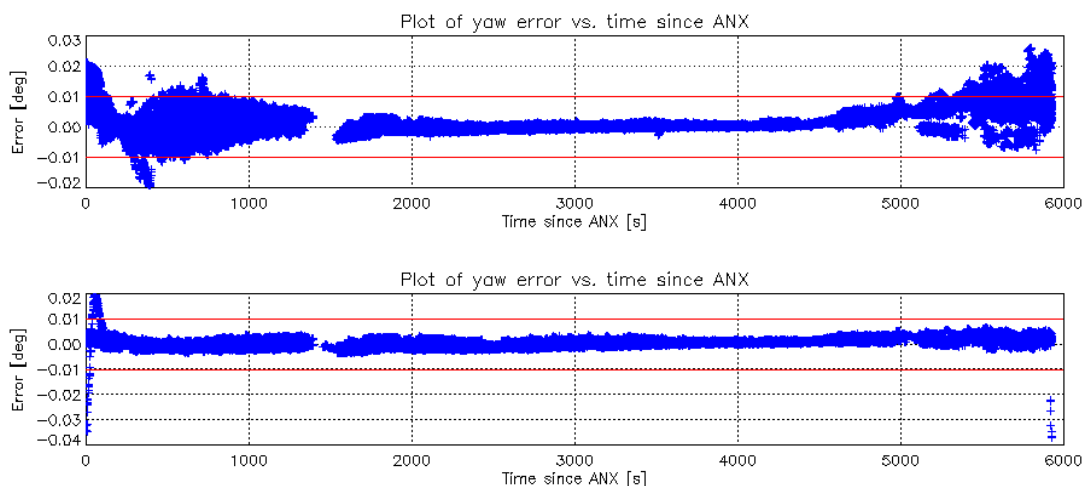
No Azimuth Antenna Patterns (AAPs) were updated during the reporting period.

6.2.7. Noise Equivalent Radar Cross-section

No 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.



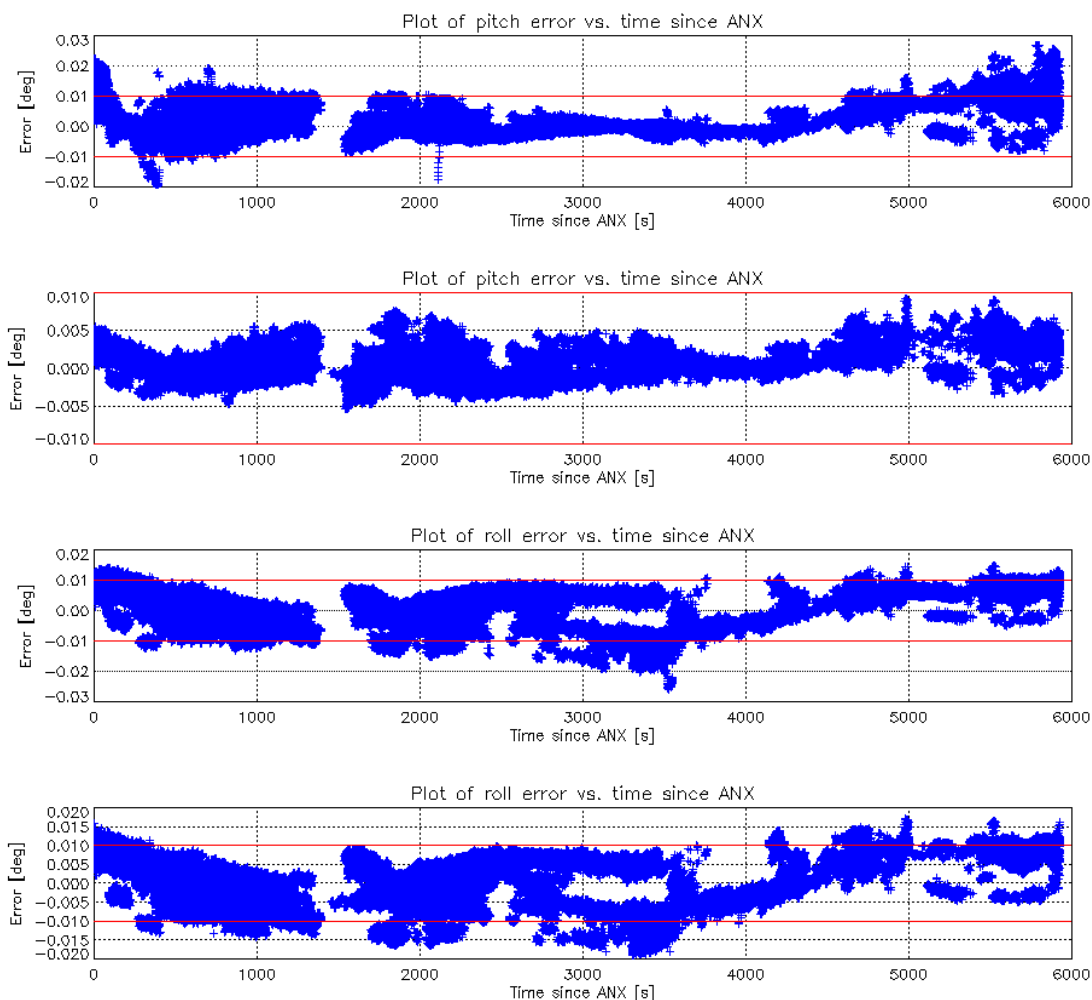
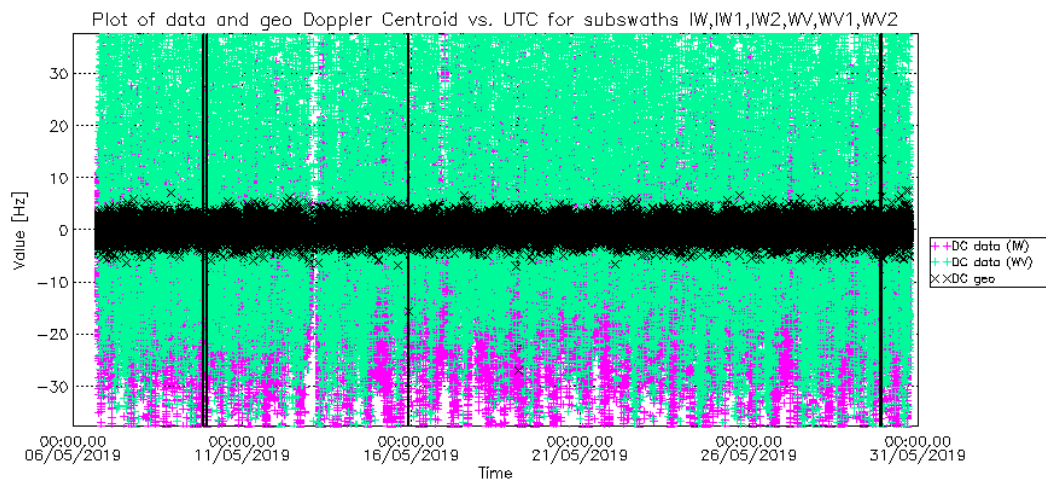


Figure 9 S1-B Yaw, Pitch and Roll Errors

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. A more detailed plot of Doppler Centroid frequency derived over land from SM, IW and EW products is shown in Figure 11. The gap in the plot is related to missing data in the DC database.



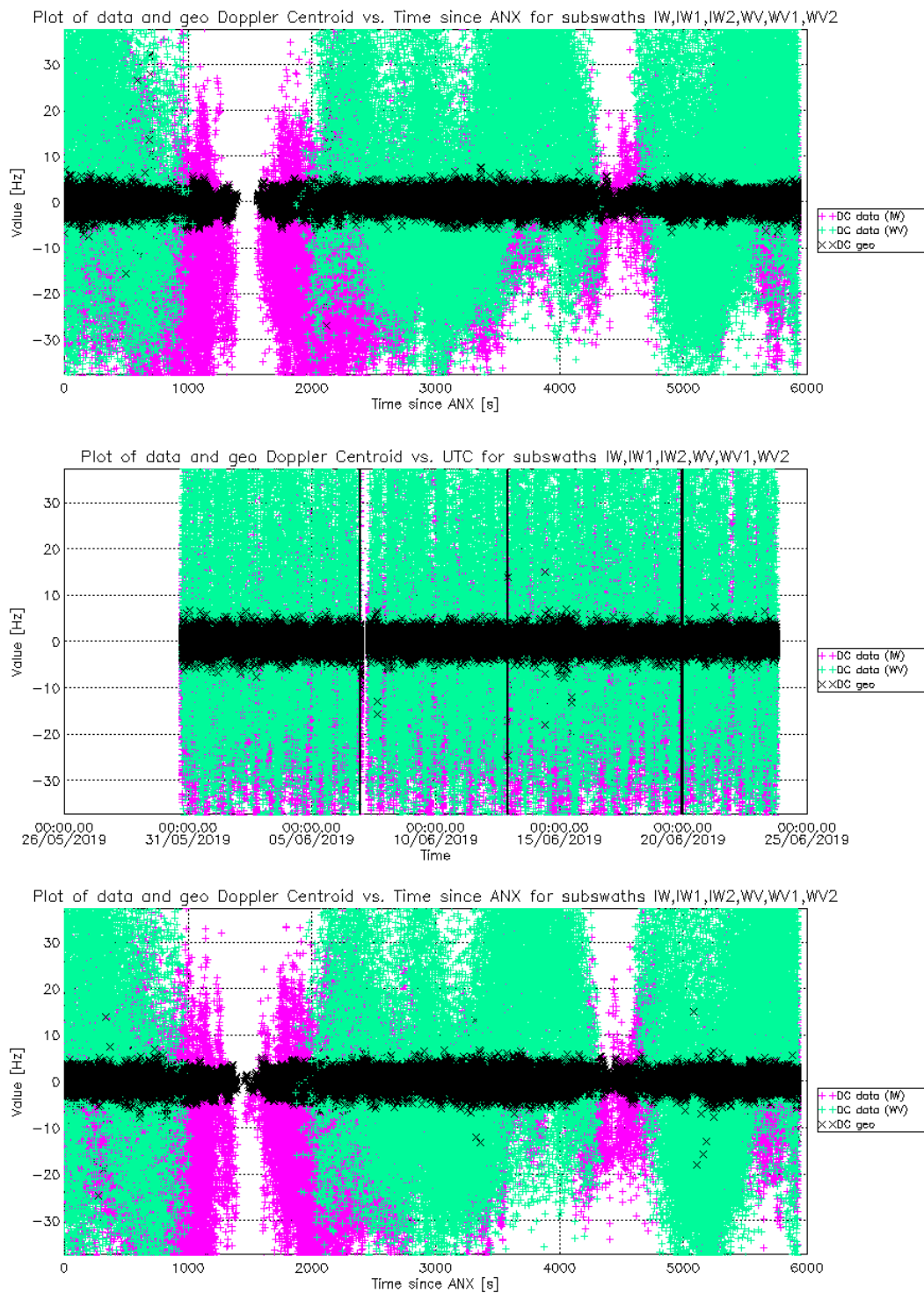


Figure 10 S1-B Doppler Centroid

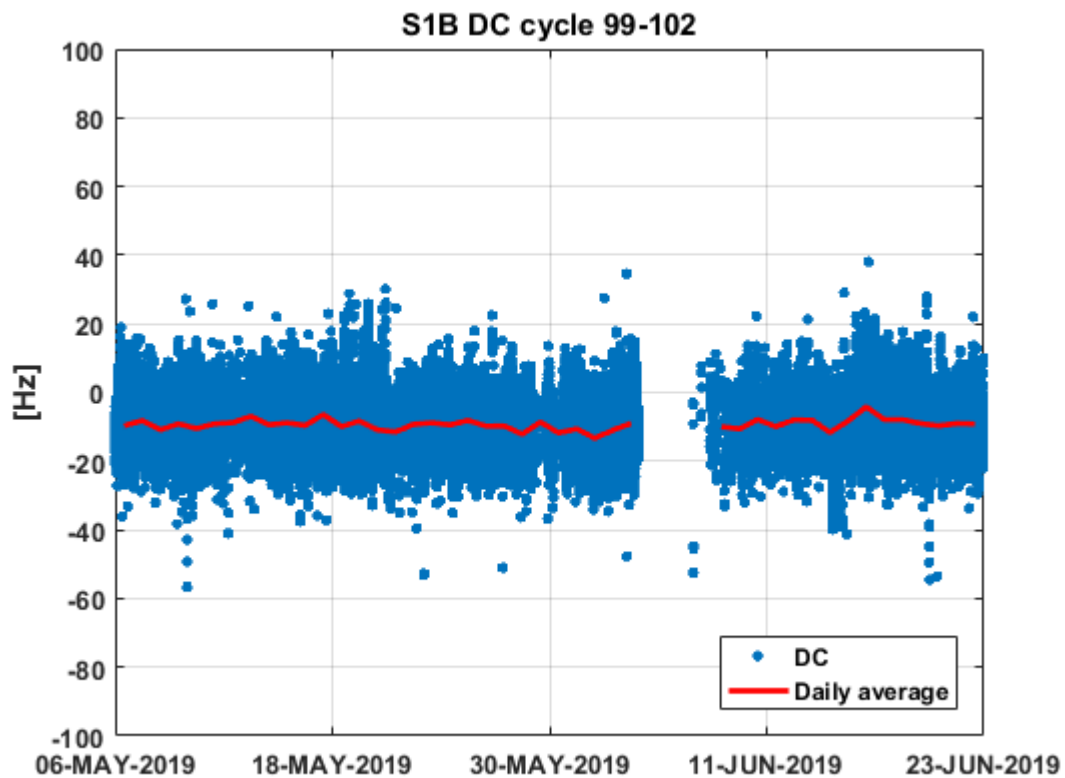


Figure 11 S1-B Doppler Centroid detail

	Min (Hz)	Mean (Hz)	Max (Hz)
Cycles 99 & 100	-751.41	-8.59±15.30	734.37
Cycles 101 & 102	-437.11	-8.73±15.13	364.14

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 new quality disclaimer was updated during the reporting period: QD-23 on Invalid annotation of SSPPDU in the manifest files of S-1B and one new quality disclaimer was issued during the reporting period for the new S-1B antenna configuration aiming improvement of WV2 performances (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 [QC Web site](#).



Appendix A - List of Acronyms

AAP	Azimuth Antenna Pattern
AD	Applicable Document
ADF	Auxiliary Data File
ALE	Absolute Localisation Accuracy Error
ANX	Ascending Node Crossing Time
EAP	Elevation Antenna Pattern
EW	Extra Wide Swath
IPF	Instrument Processing Facility
IRF	Impulse Response Function
IW	Interferometric Wide Swath
NESZ	Noise Equivalent Sigma0 Zero
PD	Path Delay
PSCAL	Permanent Scatter Calibration
RD	Reference Document
RDB	Radar Data Base
Rx	Receive
SM	Stripmap
TBC	To be confirmed
TBD	To be defined
TRM	Transmit Receive Module
Tx	Transmit
WV	Wave Mode

**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



Appendix C - S1-B Instrument Unavailability

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
13/04/2017 15:38	14/04/2017 09:35	SOB-727	Sentinel-1B Unavailability from 13/04/2017 to 14/04/2017
20/04/2017 20:43	21/04/2017 11:32	SOB-729	Sentinel-1B Unavailability from 20/04/2017 to 21/04/2017
12/05/2017 09:03	12/05/2017 10:46	SOB-738	Sentinel-1B Unavailability on 12/05/2017
08/07/2017 05:21	08/07/2017 10:15	SOB-759	Sentinel-1B Unavailability on 08/07/2017
02/08/2017 14:21	02/08/2017 17:32	SOB-779	Sentinel-1B Unavailability on 02/08/2017
25/08/2017 23:29	26/08/2017 09:18	SOB-781	Sentinel-1B Unavailability between 25/08/2017 and 26/08/2017
18/11/2017 20:48	19/11/2017 10:02	SOB-825	Sentinel-1B Unavailability between 18/11/2017 and 19/11/2017
22/03/2018 10:22	22/03/2018 13:41	SOB-889	Sentinel-1B Unavailability on 22/03/2018
13/05/2018 11:29	13/05/2018 13:08	SOB-891	Sentinel-1B Unavailability on 13/05/2018
22/05/2018 17:37	22/05/2018 18:22	SOB-896	Sentinel-1B Unavailability on 22/05/2018
25/11/2018 09:58	26/11/2018 11:43	SOB-952	Sentinel-1B Unavailability between 25/11/2018 and 26/11/2018
06/02/2019 23:51	07/02/2019 09:02	SOB-985	Sentinel-1B Unavailability between 06/02/2019 and 07/02/2019
23/02/2019 12:00	23/02/2019 15:07	SOB-996	Sentinel-1B Unavailability on 23/02/2019
27/02/2019 23:31	28/02/2019 15:12	SOB-995	Sentinel-1B Unavailability between 27/02/2019 and 28/02/2019

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17/04/2019 23:55	18/04/2019 15:50	SOB-1031	Sentinel-1B Unavailability between 17/04/2019 and 18/04/2019
14/05/2019 08:58	14/05/2019 09:15	SOB-1045	Sentinel-1B Planned Unavailability on 14/05/2019
28/05/2019 08:43	28/05/2019 08:56	SOB-1046	Sentinel-1B Planned Unavailability on 28/05/2019



Appendix D - S1-B Auxiliary Data Files

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

Instrument ADF (AUX_INS)

ADF	Update Reason
S1B_AUX_INS_V20160422T000000_G20190130T102942.SAFE	S1B PGModel updated in order to keep into account observed fluctuations and changes in the PG value monitoring. Related to RDB#1.

Calibration ADF (AUX_CAL)

ADF	Update Reason
S1B_AUX_CAL_V20160422T000000_G20180622T074003.SAFE	Revised SM Noise Calibration Factors. Related to RDB#1.

L1 Processor Parameters ADF (AUX_PP1)

ADF	Update Reason
S1B_AUX_PP1_V20160422T000000_G20190221T152250.SAFE	WV gains tuned after latest re-calibration activity and to have radiometric agreement in the whole product family (both L1 and L2). 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
S1_AUX_SCS_V20171017T080000_G20171016T150910.SAFE	Update of ADF to be compliant with S1-A RDB#6.



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	2018-06-21 18:55:47	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	2019-04-17 07:06:51	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
27	S-1B products processed with invalid Restituted Orbit Files (AUX_RESORB) between 2017-09-06 and 2017-09-07	2017-09-06 18:07:43	2017-09-07 07:17:41	Issued
29	S-1B L2 OCN products provide reverse OSW wind direction respect to the specification	2016-09-26 00:00:00	ongoing	Issued
31	Issue on the noise vector annotation of S-1B products generated from LON with updated content	2018-03-13 02:43:05	2018-03-15 15:19:30	Issued
34	S-1B products processed without Restituted Orbit Files (AUX_RESORB) between 2018-03-21 and 2018- 03-22	2018-03-21 20:52:26	2018-03-22 07:51:34	Issued
36	S-1B products processed without Restituted Orbit Files (AUX_RESORB) between 2018-04-09 and 2018- 04-11	2018-04-09 07:25:04	2018-04-11 05:06:24	Issued
39	S-1B products processed without Restituted Orbit Files (AUX_RESORB) between 2018-07-07 and 2018-07-09	2018-07-07 11:26:13	2018-07-09 06:03:52	Issued
41	S-1B products processed without Restituted Orbit Files (AUX_RESORB) on 2018-09-20	2018-09-20 10:47:10	2018-09-20 16:05:58	Issued
44	S-1B Products generated without AUX_RESORB between 10 April 14:00 UTC to 11 April 07:00 UTC 2019	2019-04-10 11:41:33	2019-04-11 05:26:00	Issued

45	Test of the new S-1B antenna configuration, aiming improvement of WV2 performances	2019-05-14 09:15:00	2019-05-28 09:00:00	Issued
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