

## S-1 MPC

# S1-B N-Cyclic Performance Report - 2017-03 Cycles 35 to 38 (29-Mar-2017 to 16-May-2017)

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2017-02	25.05.17	First Issue : reporting period 29-Mar-2017 to 16-May-2017

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### Index Sheet:

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Hyperlink:	

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## Applicable documents

<b>Nomenclature</b>	<b>Title</b>	<b>Edition Number</b>	<b>Revision Number</b>
[S1-AD-14]	S1 RS-MDA-52-7441 Sentinel-1 Product Specification	3	3
[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

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The purpose of this document is to provide a status on the S-1B sensor and product performance for orbit repeat cycle 35 from 29th March to 10th April 2017, cycle 36 from 10th April to 22nd April 2017, cycle 37 from 22nd April to 4th May 2017 and cycle 38 from 4th May to 16th May 2017.

### 1.2. Structure of the document

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- 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 35 to 38 (29th March to 16th May 2017).

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
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

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 (IPF) 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. A full list of currently applicable ADF files is given in Appendix D.

#### 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 period<sup>1</sup>:

Start Date	Start Time	Stop Date	Stop Time	Comment
30/03/2017	00:41:40.594	30/03/2017	00:41:46.219	
05/04/2017	23:35:15.837	05/04/2017	23:38:13.712	
06/04/2017	00:31:23.727	06/04/2017	00:31:43.102	
13/04/2017	00:20:14.297	13/04/2017	00:20:22.172	
27/04/2017	00:04:59.979	27/04/2017	00:05:11.104	
03/05/2017	23:01:50.942	03/05/2017	23:05:50.317	
03/05/2017	23:56:09.584	03/05/2017	23:56:31.084	
10/05/2017	23:48:30.874	10/05/2017	23:48:38.124	

**Table 8 S1-B Orbit Manoeuvres**

<sup>1</sup> 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):-

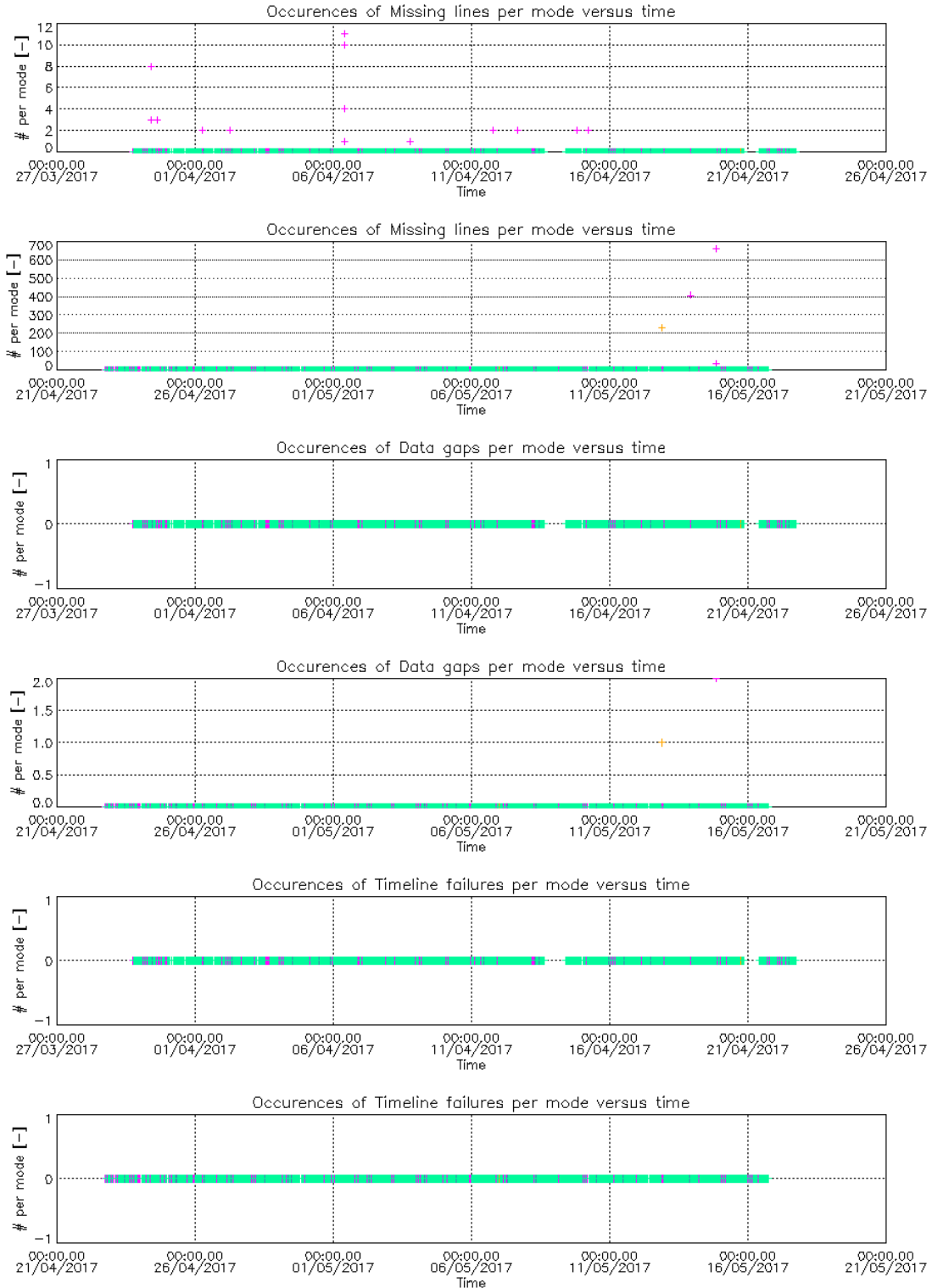


Figure 1 Missing Lines, Data Gaps and Timeline Failures.

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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:

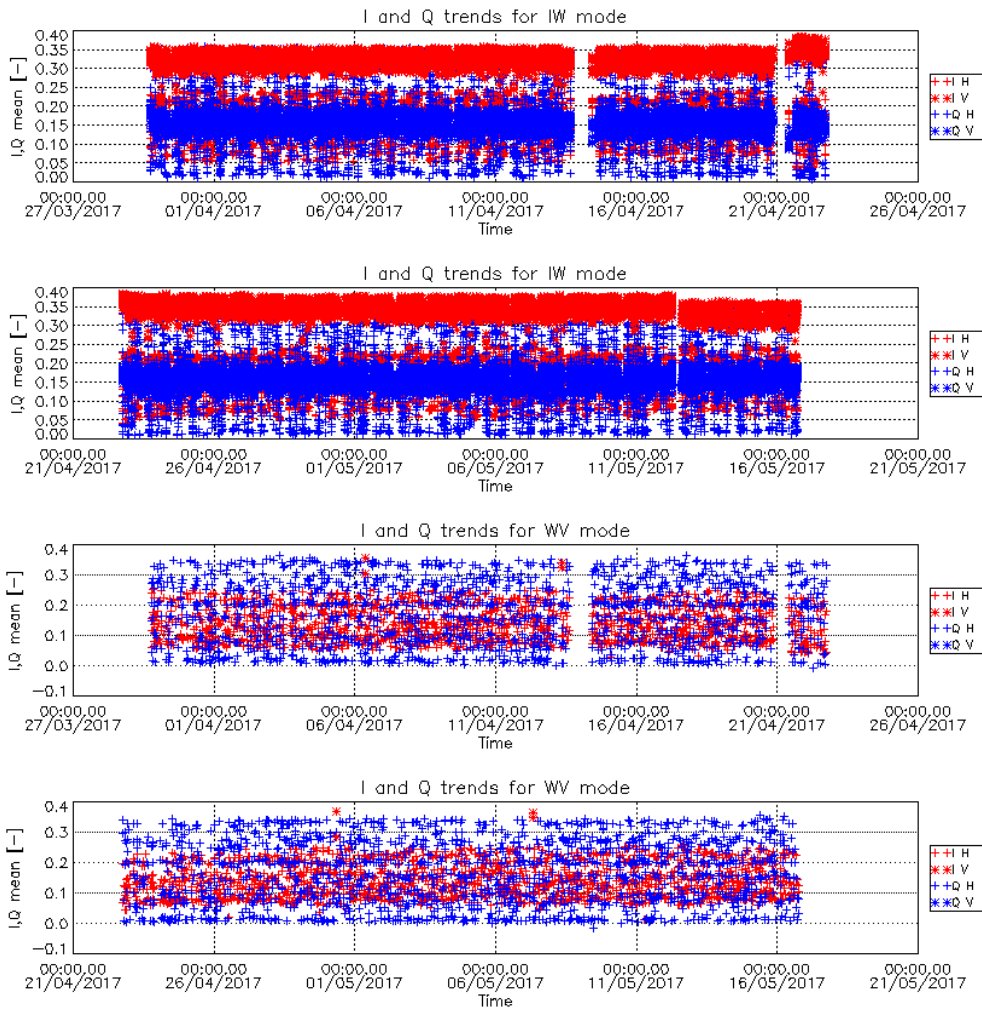
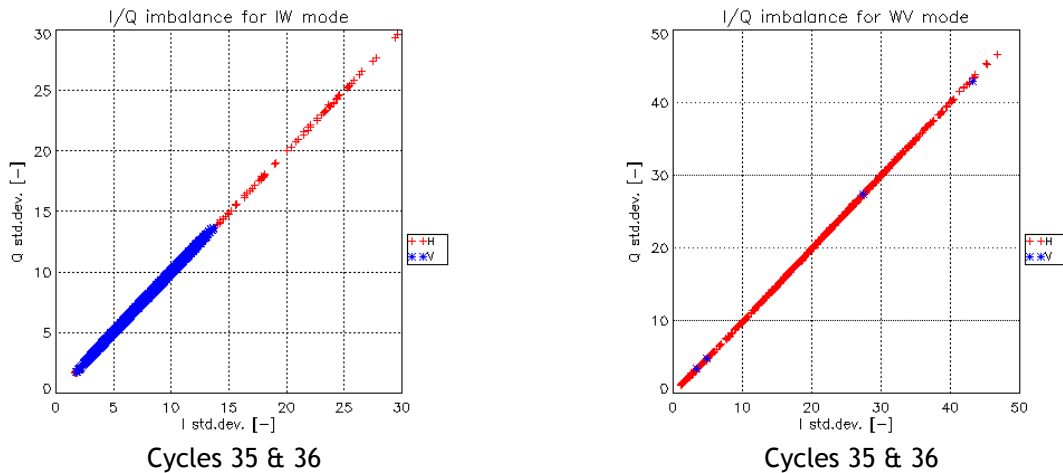


Figure 2 I&Q Channels

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.



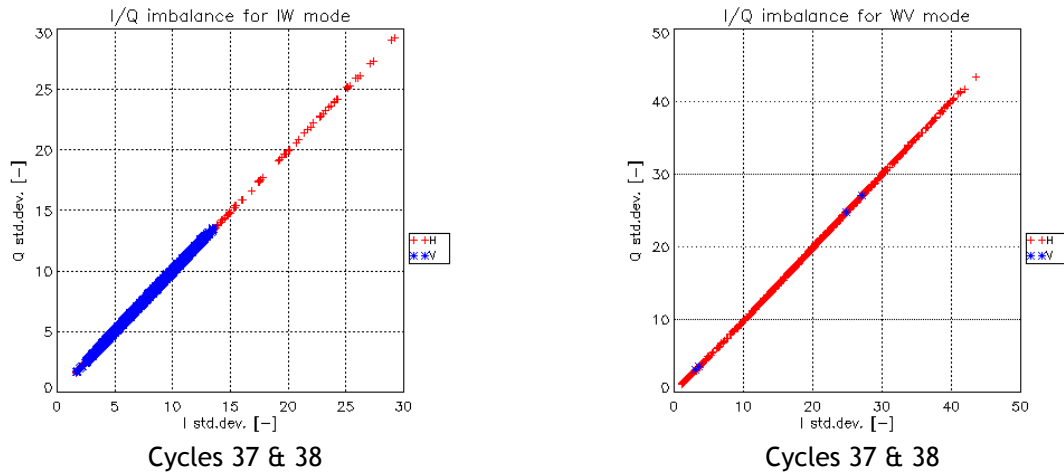


Figure 3 WV I&Q Channel Imbalance

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.

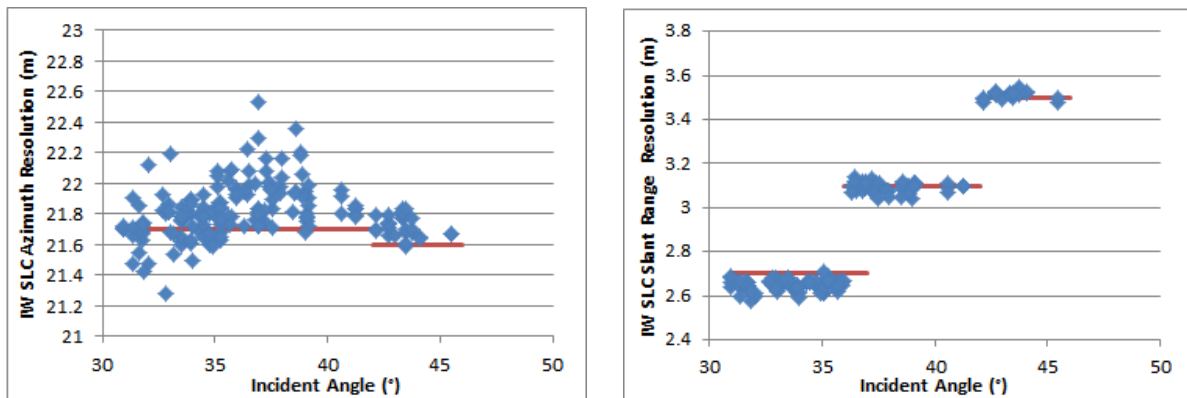


Figure 4 IW Azimuth and Slant Range Spatial Resolutions

Mode/Swath	Azimuth Spatial Resolution (m)	Slant Range Spatial Resolution (m)
IW1	21.77±0.15	2.65±0.02
IW2	21.92±0.18	3.09±0.02
IW3	21.72±0.07	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	-12.34±2.50	-19.96±1.21	-23.83±3.31

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).

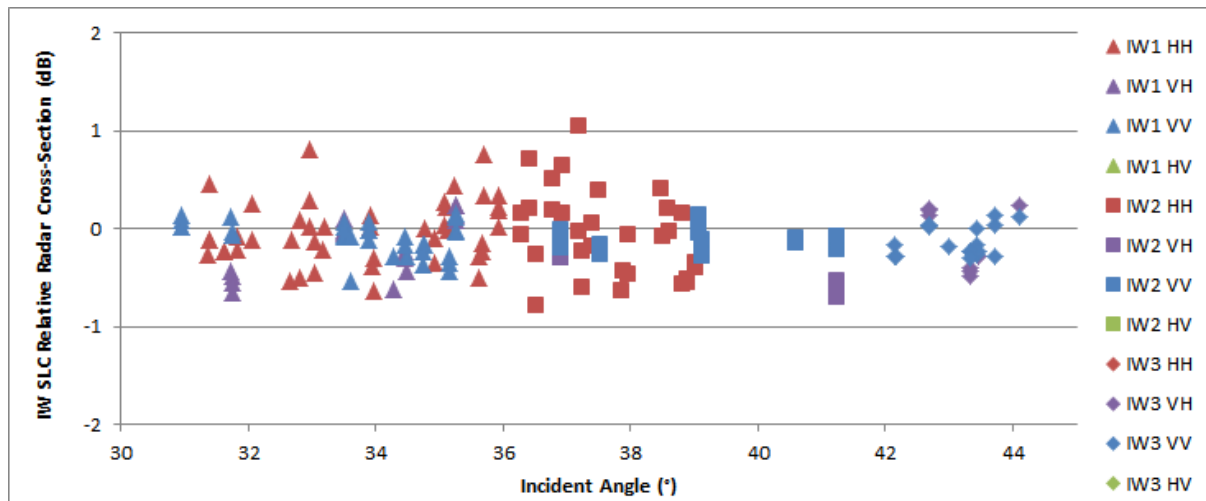


Figure 5 IW Relative Radar Cross-Section

Mode/Swath	Relative Radar Cross-Section (dB)				
	All	HH	VH	VV	HV
IW1	-0.08±0.28	-0.03±0.32	-0.19±0.31	-0.10±0.17	
IW2	-0.12±0.35	-0.05±0.44	-0.42±0.20	-0.12±0.11	
IW3	-0.14±0.23		-0.16±0.35	-0.13±0.15	

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 -0.21±0.18 dB (all the measurements are for VV polarisation).

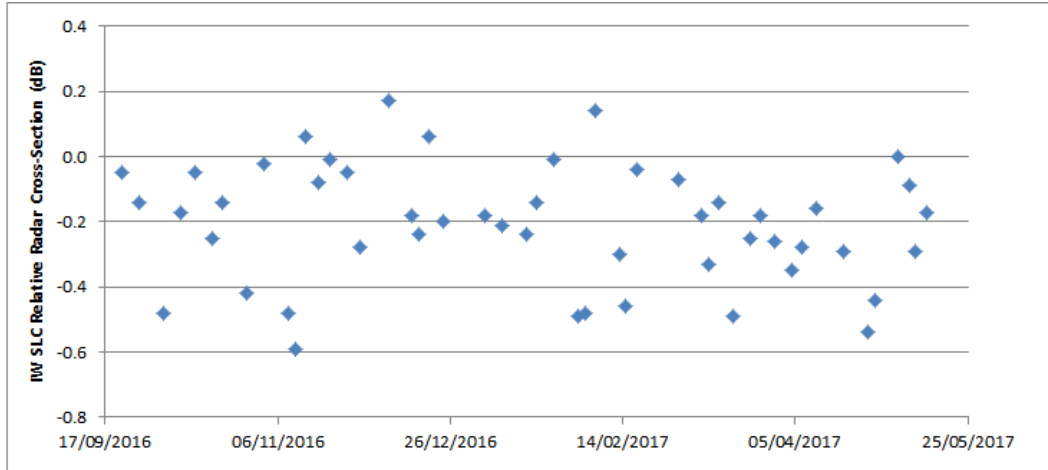


Figure 6 IW Long-Term Relative Radar Cross-Section

The following figure shows a recent IW VV Permanent Scatter Calibration series over Paris. The series covers the 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).

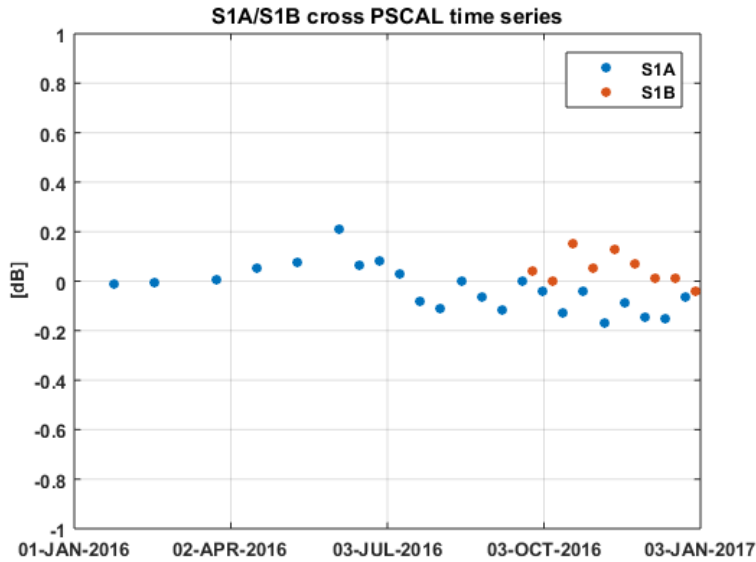


Figure 7 PSCAL time series for IW DV acquisitions over Paris. The colour represents the sensor.

### 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 precise and near-real-time restituted orbit files, depending on their availability at the time of reporting. Atmospheric path delay (PD) and

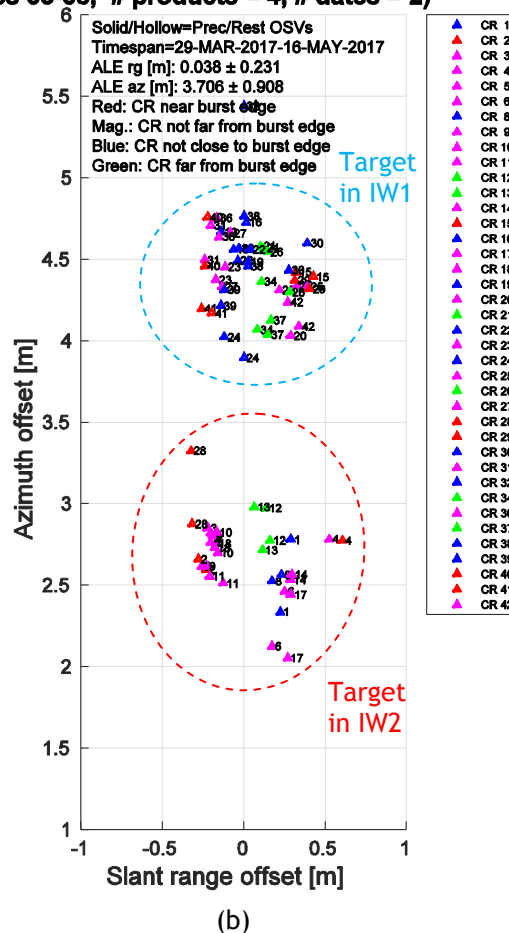


azimuth timing errors (residual error from the bistatic correction made by the IPF) have also been mitigated. Note that PD correction depends on the local incident angle, which is considered here for the individual corner reflectors spanning the over-100km wide array.

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).

**Asc. IW SLC ALE over Surat array  
(cycles 35-38, # products = 4, # dates = 2)**



**Figure 8 S1-B absolute localisation error based on two pairs of azimuth-adjacent IW SLC products during the current reporting period. Path delay and azimuth timing corrections have been made. The two groups contain points from subswaths IW1 and IW2, a known effect observed over other targets as well.**

**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.

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Mode/Swath	Range Co-registration Accuracy (m)	Azimuth Co-registration Accuracy (m)	Channel Distortion (dB)
IW	0.00±0.00	0.22±0.58	

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

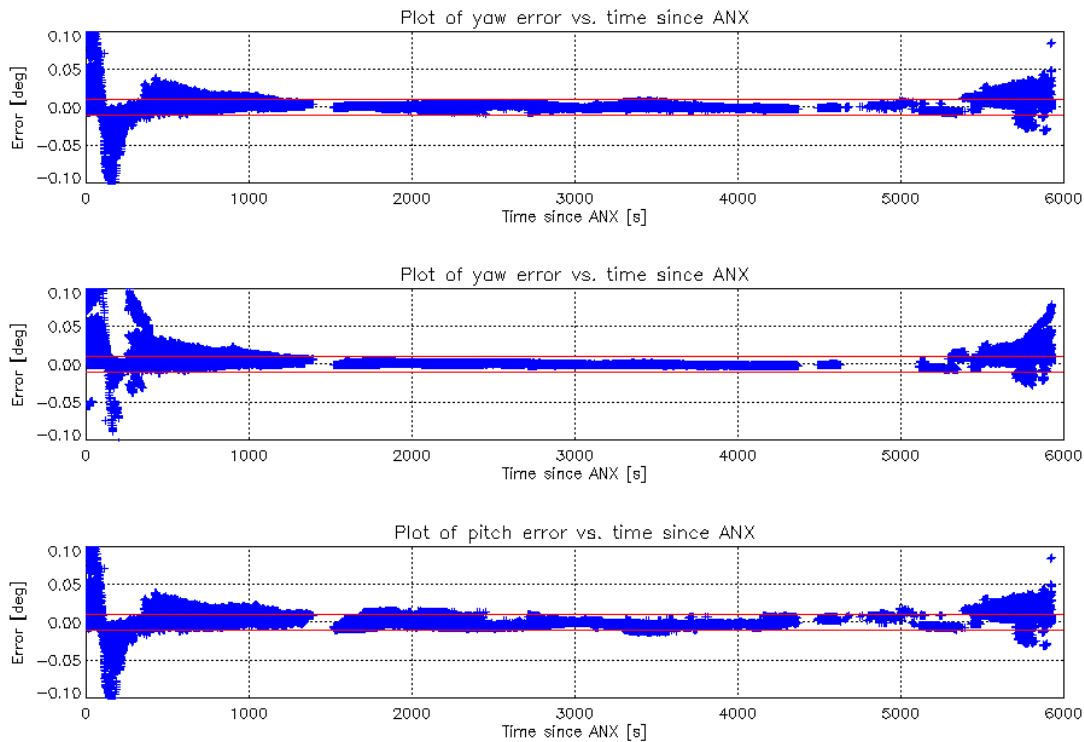
No Azimuth Antenna Patterns (AAPs) were updated during the reporting period.

### 6.2.7. Noise Equivalent Radar Cross-section

No 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.





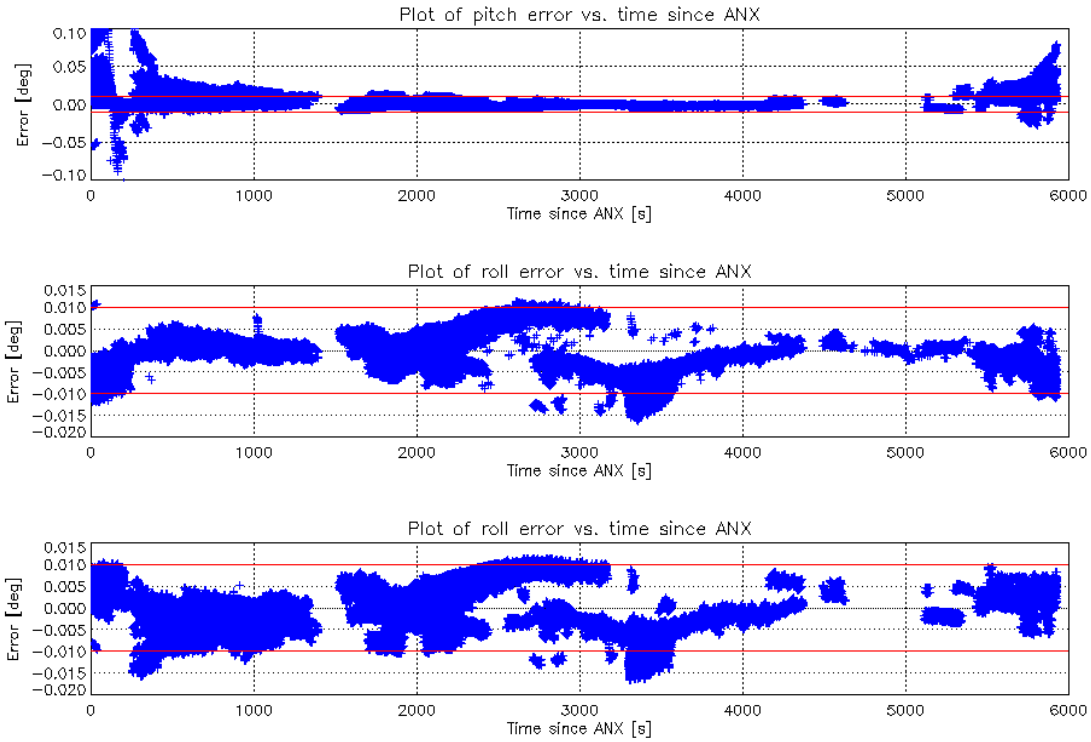
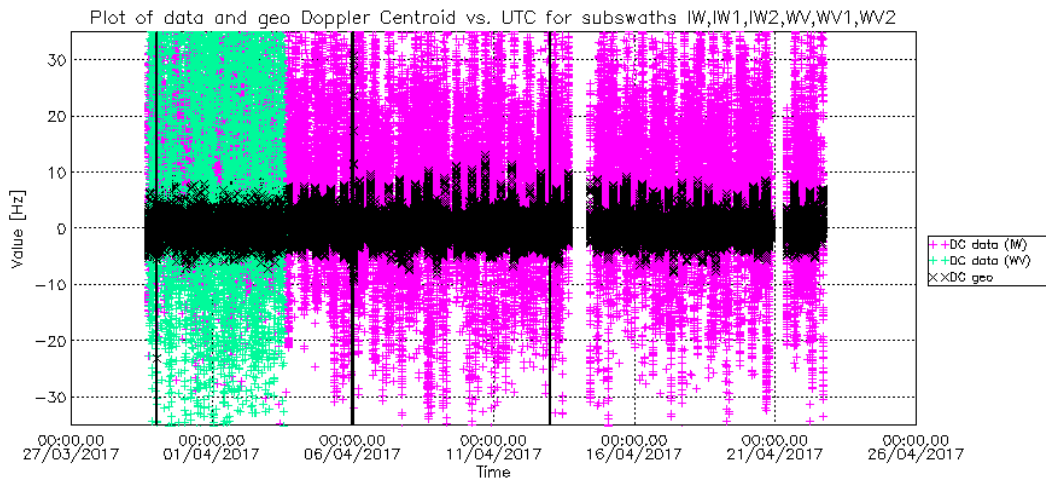


Figure 9 S1-B Yaw, Pitch and Roll Errors

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 (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.



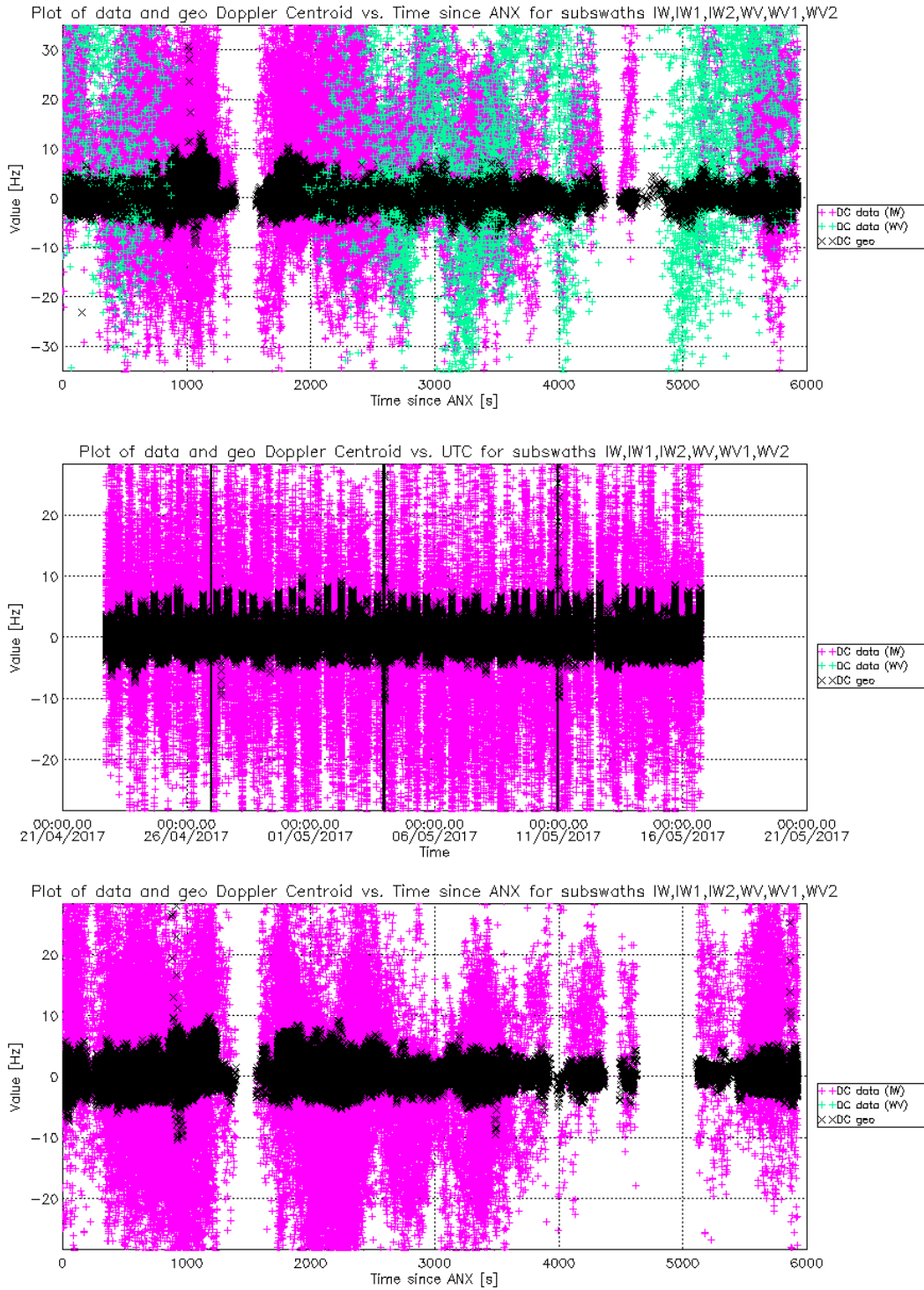


Figure 10 S1-B Doppler Centroid

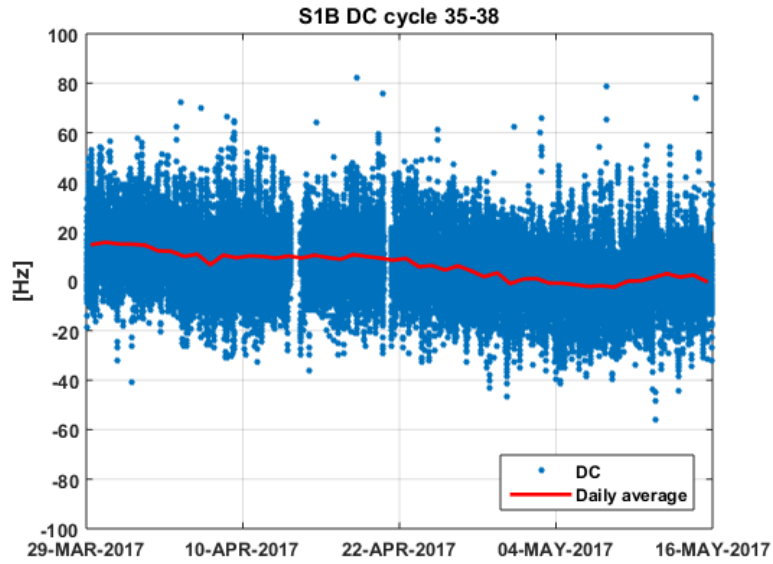


Figure 11 S1-B Doppler Centroid

	Min (Hz)	Mean (Hz)	Max (Hz)
Cycles 35 & 36	-559.75	9.14±13.57	466.24
Cycles 37 & 38	-87.09	-0.66±13.20	78.64

Table 13 Doppler Centroid Statistics

**6.2.9. Summary of Anomalies**

There were no anomalies during the reporting period.

**6.2.10. Quality Disclaimers**

No L1 product quality disclaimers were updated during the reporting period - 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



## 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_G20160922T094114.SAFE	First applicable auxiliary file for user released products. Related to RDB#1.

### 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.
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
S1__AUX_SCS_V20140402T000000_G20160413T103855.SAFE	First applicable auxiliary file for user released products. Related to RDB#1.



## Appendix E - S-1B Quality Disclaimers

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

<b>Number</b>	<b>Description</b>	<b>Start Validity Date</b>	<b>End Validity Date</b>	<b>Issue Status</b>
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