S-1 MPC

S1-B N-Cyclic Performance Report - 2016-01
Cycles 21 to 22 (12-Oct-2016 to 05-Nov-2016)

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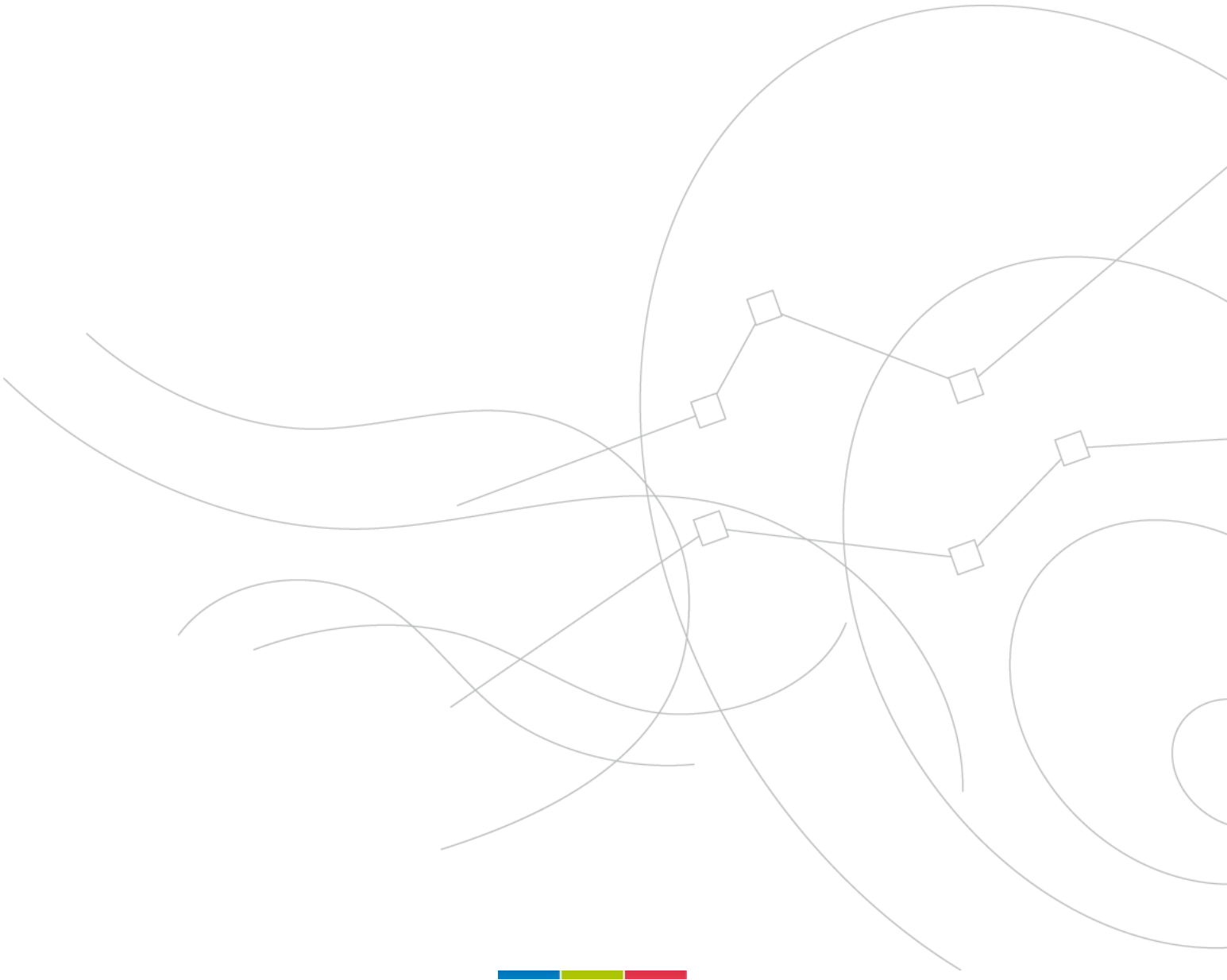
Applicable documents

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

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 21 from 12th October to 24th October 2016 and cycle 22 from 24th October to 5th November 2016.

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

2. Executive Summary

There only issues during S1-B cycles 21 and 22 (12th October to 5th November 2016) was a dual polarisation timing de-synchronisation and single H polarisation localisation rrror that occurred on the 12th and 13th October 2016. In particular, a timing problem occurred whereby H polarisation raw data had a 1 second timing delay. This resulted in (i) the failure to process dual polarisation data due to a 1 second de-synchronisation between the two polarisations and (ii) a 1 second azimuth localisation error (~ 7km further in azimuth than expected) for processed single H polarisation data.

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
12/10/2016 07:00	13/10/2016 15:34	SOB-572	Sentinel-1B SAR issue from 12/10/2016 to 13/10/2016

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 Date File Status

4.1. Level 1 Processor Issues

There were no updates to the Instrument Processing Facility (IPF) during the reporting period. The operational IPF is v2.72 (since the start of the S1-B routine phase).

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[1]:

Start Date	Start Time	Stop Date	Stop Time	Comment
12/10/2016	23:43:52.648	12/10/2016	23:46:12.773	
13/10/2016	01:23:47.289	13/10/2016	01:24:02.414	
20/10/2016	01:15:33.498	20/10/2016	01:15:36.123	
20/10/2016	02:17:52.935	20/10/2016	02:18:02.435	
02/11/2016	21:03:50.078	02/11/2016	21:03:54.703	

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):-

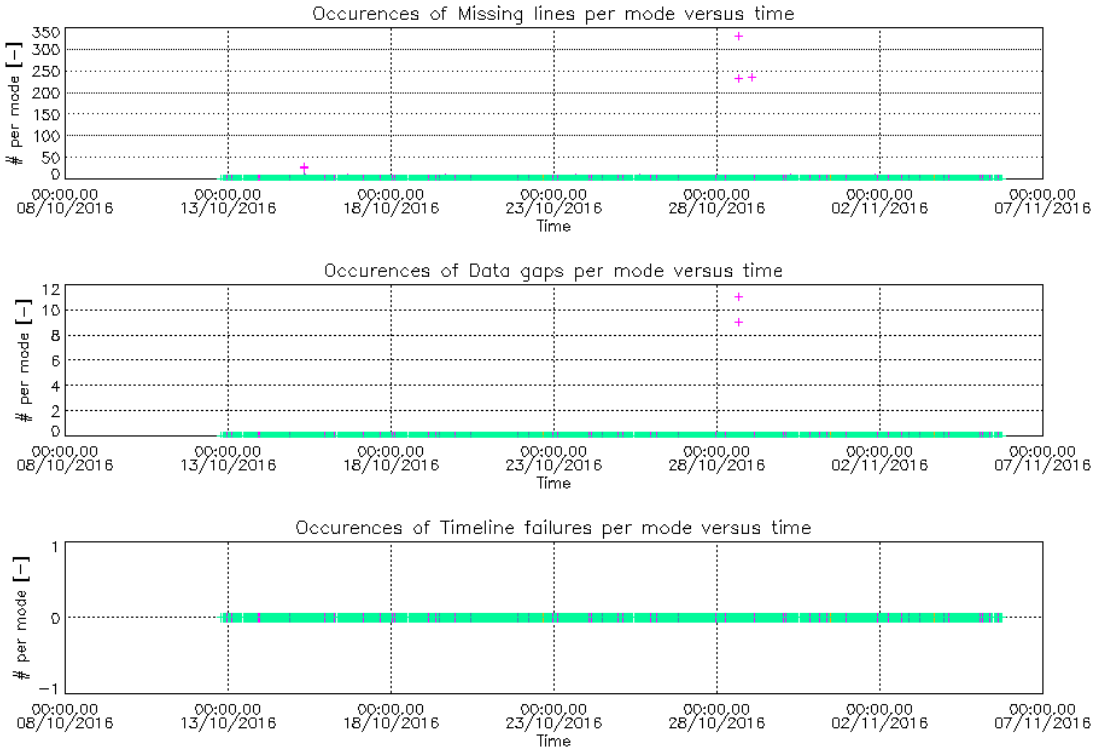


Figure 1 Missing Lines, Data Gaps and Timeline Failures.

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:

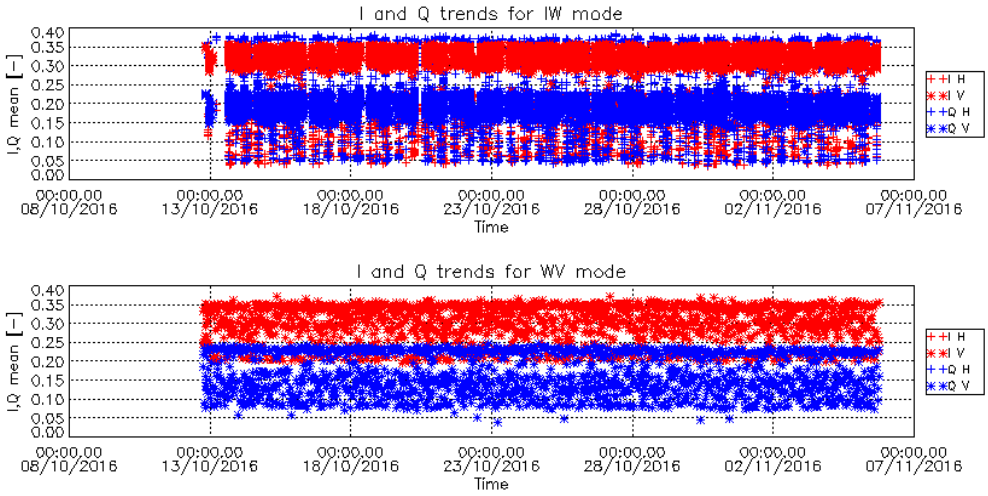
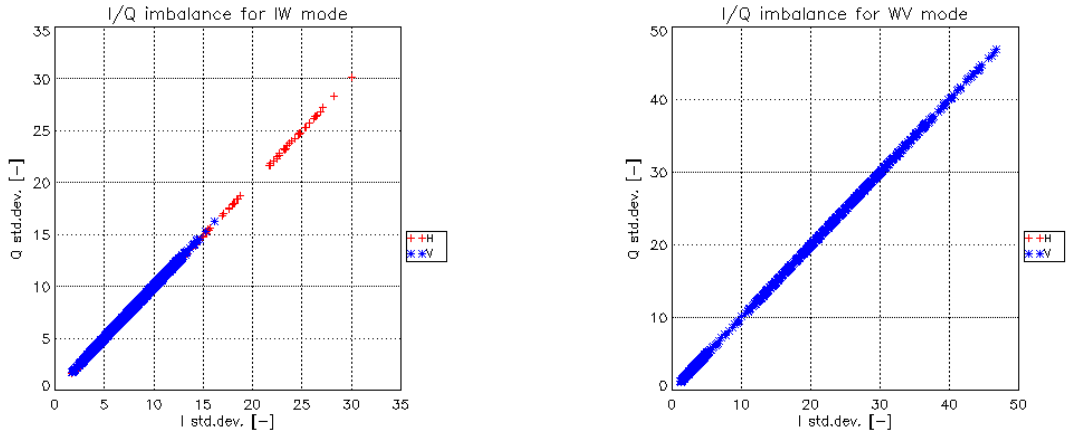


Figure 2 I&Q Channels

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 21 & 22 Cycles 21 & 22

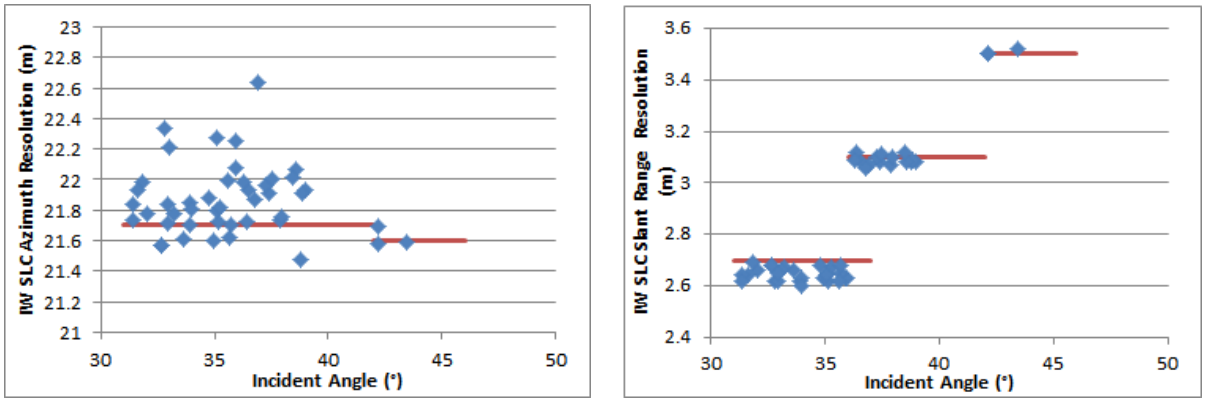
Figure 3 WV I&Q Channel Imbalance

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 & EW 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.



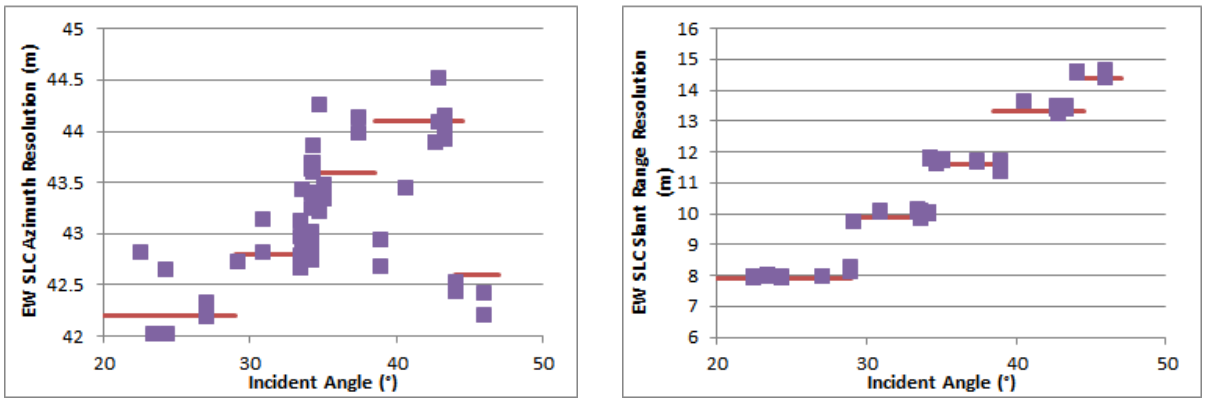


Figure 4 IW & EW Azimuth and Slant Range Spatial Resolutions

Mode/Swath	Azimuth Spatial Resolution (m)	Slant Range Spatial Resolution (m)
IW1	21.85±0.22	2.65±0.02
IW2	21.93±0.25	3.09±0.02
IW3	21.62±0.06	3.51±0.01
EW1	41.95±0.36	7.98±0.08
EW2	42.92±0.21	10.01±0.11
EW3	43.53±0.39	11.71±0.10
EW4	44.01±0.26	13.41±0.10
EW5	42.42±0.11	14.56±0.09

Table 9 IW & EW Azimuth and Slant Range Spatial Resolutions

Mode/Swath	Integrated Sidelobe Ratio (dB)	Peak Sidelobe Ratio (dB)	Spurious Sidelobe Ratio (dB)
IW	-10.99±3.58	-19.30±1.06	-21.02±2.39
EW	-12.95±4.20	-21.15±3.56	-24.03±5.44

Table 10 IW & EW Sidelobe Ratios

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

6.2.2. Radiometric Calibration

Erreur ! Source du renvoi introuvable. and **Erreur ! Source du renvoi introuvable.** 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 & EW 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).

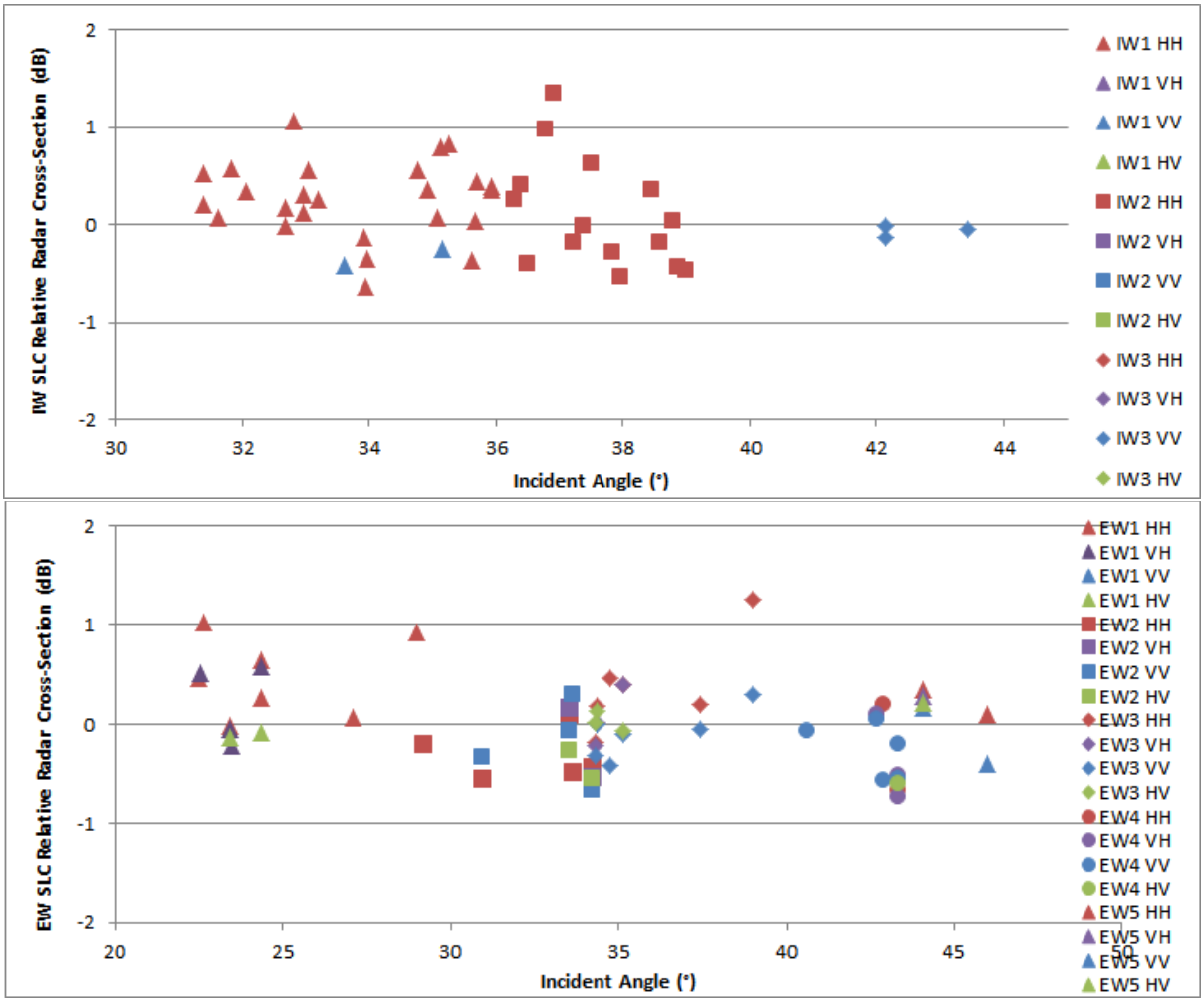


Figure 5 IW & EW Relative Radar Cross-Section

Mode/Swath	Relative Radar Cross-Section (dB)				
	All	HH	VH	VV	HV
IW1	0.22±0.41	0.26±0.39		-0.34±0.12	
IW2	0.10±0.56	0.10±0.56			
IW3	-0.07±0.06			-0.07±0.06	
EW1	0.36±0.37	0.48±0.41	0.20±0.40	0.49±0.24	-0.12±0.04
EW2	-0.27±0.31	-0.32±0.26	-0.18±0.49	-0.20±0.41	-0.41±0.20
EW3	0.11±0.38	0.39±0.48	0.06±0.31	-0.10±0.25	0.02±0.10
EW4	-0.33±0.34	-0.24±0.62	-0.39±0.44	-0.27±0.28	-0.60
EW5	0.11±0.27	0.22±0.18	0.27	-0.12±0.40	0.21

Table 11 IW Relative Radar Cross-Section

Erreur ! Source du renvoi introuvable. 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±0.16 dB (all the measurements are for VV polarisation).

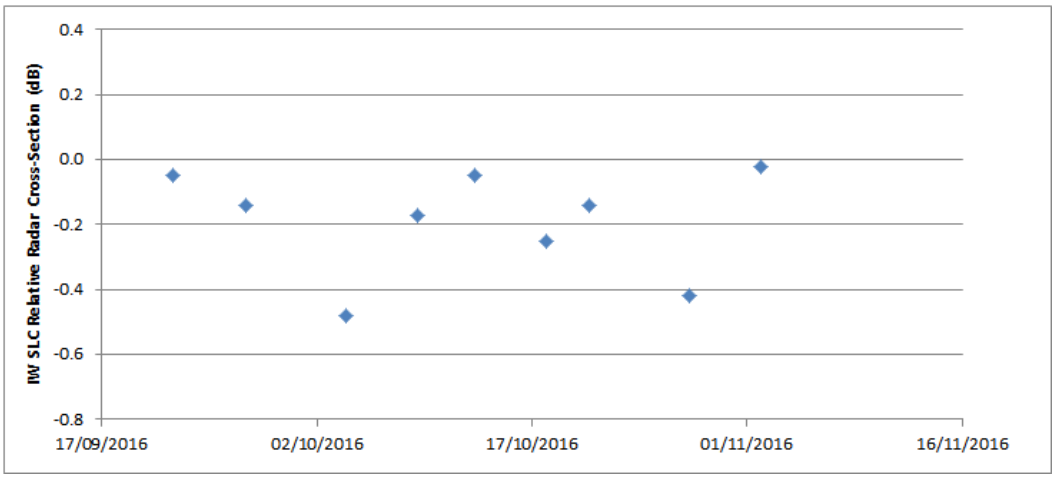


Figure 6 IW Long-Term Relative Radar Cross-Section

6.2.3. Geometric Calibration

Figure 7 shows the absolute localisation error (ALE) based on the azimuth-adjacent SLC products from the IW acquisition mode acquired during the reporting period. The points have been colour-coded and labelled to reflect the numerical labels assigned to them by Geoscience Australia. The products were analysed using near-real-time restituted orbit files. 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 corner reflector survey consistency is known from previous investigations using S1A to be strongly correlated to survey dates. However, recently Geoscience Australia discovered that for a subset of these points, the download of RTK-connection data between the survey marks and corner reflectors (CRs) may have been caused position errors. Updated CR positions have been made available, but these are not yet accounted for in the current analysis. Future reports will be based on the updated coordinates, and a discussion of the observed changes will be included.

In spite of the limitations imposed mainly by the survey quality, 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).

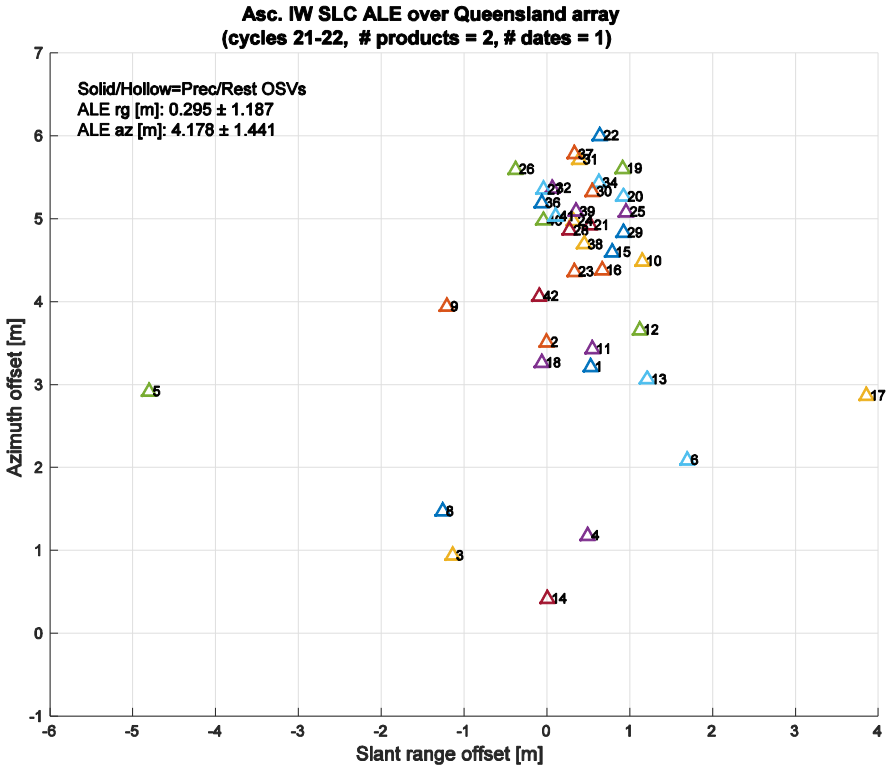


Figure 7 S1-B Absolute localisation error based on one pair of azimuth-adjacent IW SLC products during the reporting period. Path delay and azimuth timing corrections have been made.

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)
EW	0.00±0.00	0.11±0.51	

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 8 shows yaw, pitch and roll errors calculated for the reporting period against ascending node crossing time (ANX). The red horizontal lines show the nominal ±0.01° 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.

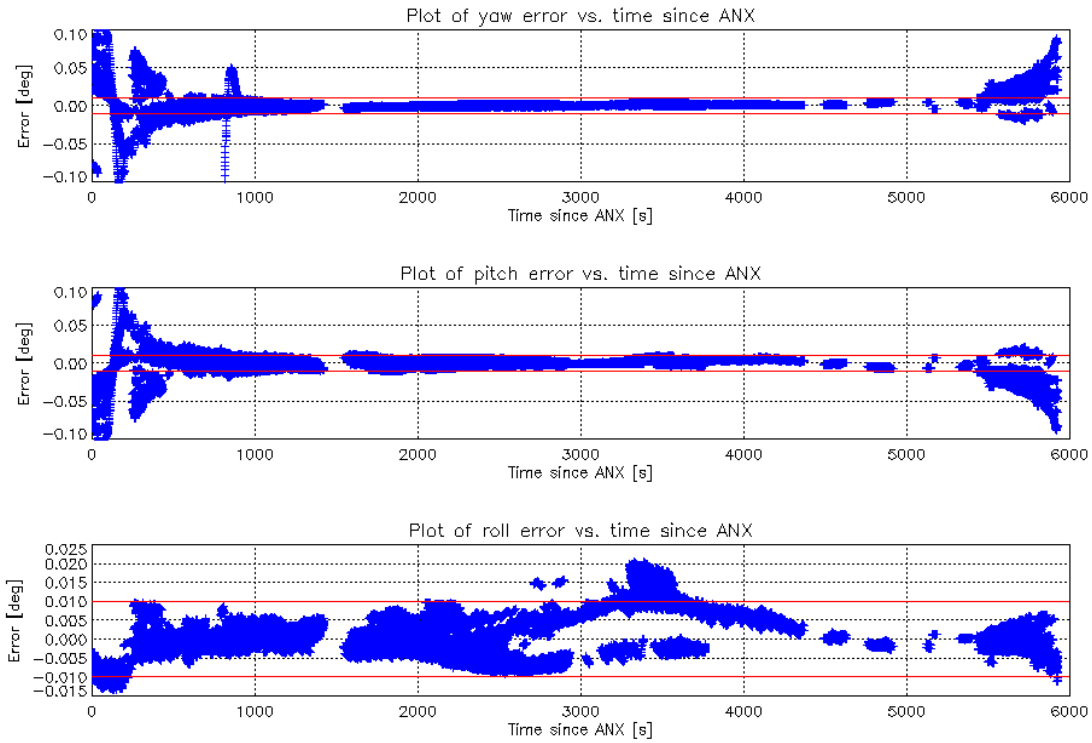
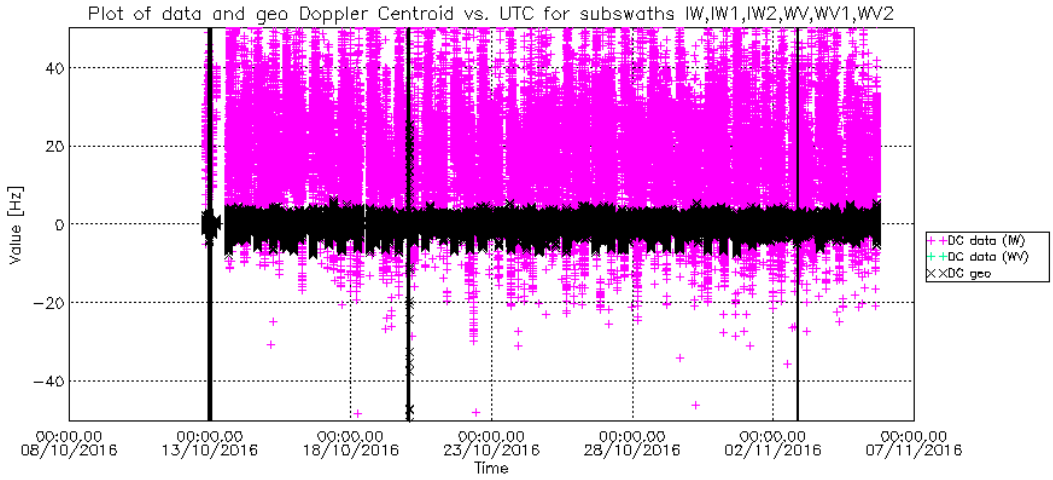


Figure 8 S1-B Yaw, Pitch and Roll Errors

Figure 9 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 10. The average DC is stable around 20 Hz since the STT calibration performed on the 8th September 2016 at the end of the Commissioning Phase.



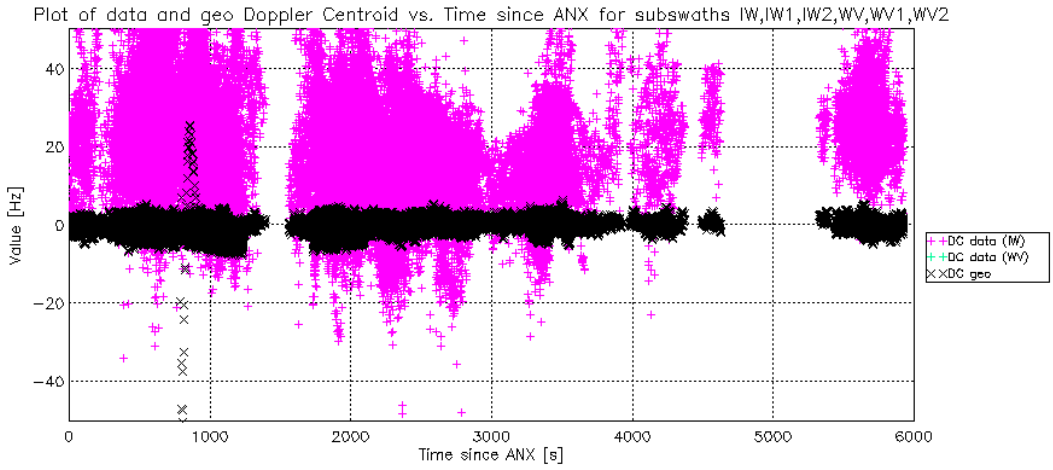


Figure 9 S1-B Doppler Centroid

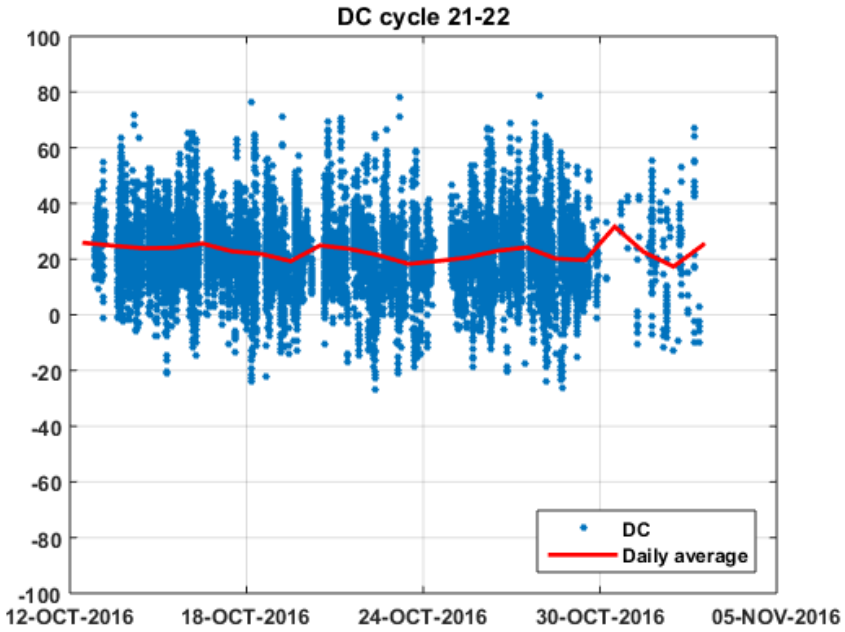


Figure 10 S1-B Doppler Centroid

	Min (Hz)	Mean (Hz)	Max (Hz)
Cycles 21 & 22	-69.32	19.59±13.16	76.11

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 issued during the reporting period: the S-1B dual polarisation timing de-synchronisation and single H polarisation localisation error (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 - Rx H & V	13-May-2016
Tile 5, Row 8	Tx & Rx, H	13-May-2016
Tile 5, Row 8	Rx, V	17-June-2016

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
17/06/2016 14:02	02/08/2016 09:05	SOB-446	Sentinel-1B Unavailability on 16/06/2016
29/06/2016 15:59	02/08/2016 09:06	SOB-461	Sentinel-1B Unavailability from 28/06/2016 to 29/06/2016
06/07/2016 16:39	02/08/2016 09:05	SOB-477	Sentinel-1B Unavailability on 04/07/2016
14/10/2016 10:04	14/10/2016 10:04	SOB-572	Sentinel-1B SAR issue from 12/10/2016 to 13/10/2016

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_G20160922T094442.SAFE	First applicable auxiliary file for user released products. Related to RDB#1.

L1 Processor Parameters ADF (AUX_PP1)

ADF	Update Reason
S1B_AUX_PP1_V20160422T000000_G20160922T094703.SAFE	First applicable auxiliary file for user released products. 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:

Number	Description	Start Validity Date	End Validity Date	Issue Status
19	S1B Denoising vectors not qualified	2016-08-20 00:00:00	2030-01-01 00:00:00	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
	Invalid annotation of SSPPDU in the manifest of S-1B products	2016-08-20 00:00:00	ongoing	In preparation