**S-1 MPC**

# S1-B N-Cyclic Performance Report - 2017-05
## Cycles 43 to 46 (03-July-2017 to 20-August-2017)

| | |
|---|---|
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| Nomenclature: | DI-MPC-NPR |
| Issue: | 2017-03. 5 |
| Date: | 2017,Sep.01 |


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## Chronology Issues:

| Issue: | Date: | Reason for change: |
|---|---|---|
| 2017-05 | 01.09.17 | First Issue : reporting period 03-July-2017 to 20-August-2017 |
| | | |
| | | |
| | | |
| | | |
| | | |

## People involved in this issue:

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## Index Sheet:

| | |
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| Context: | Sentinel-1 Mission Performance Centre |
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## Distribution:

| Company | Means of distribution | Names |
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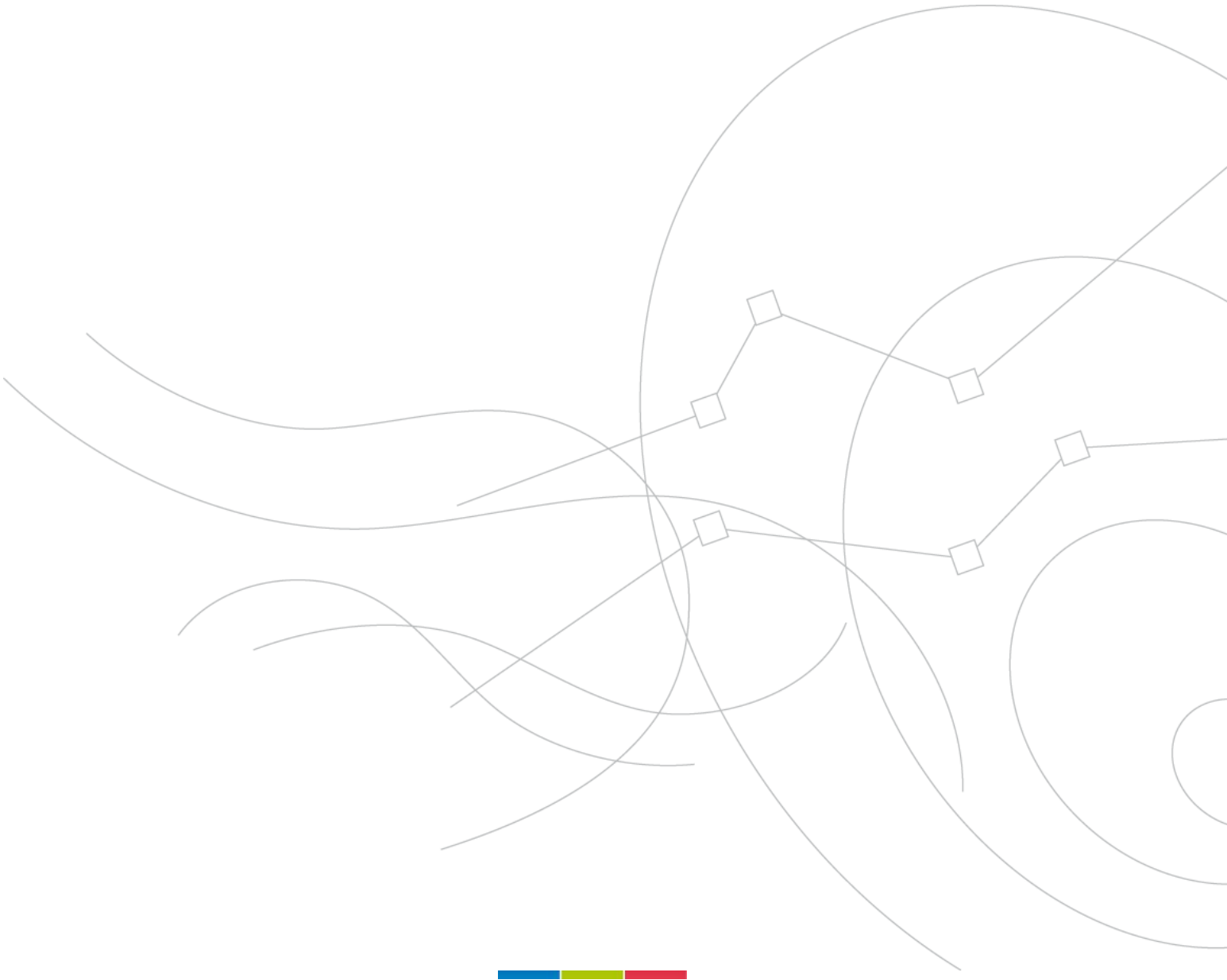
## Applicable documents

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

## Reference documents

None



List of Contents

# 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 43 from 3rd July to 15th July 2017, cycle 44 from 15th July to 27th July 2017, cycle 45 from 27th July to 8th August 2017 and cycle 46 from 8th August to 20th August 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

## 2. Executive Summary

There were no particular issues for S1-B during cycles 43 to 46 (3rd July to 20th August 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 |
|---|---|---|---|
| 02/08/2017 14:21 | 02/08/2017 17:32 | SOB-779 | Sentinel-1B Unavailability on 02/08/2017 |
| 08/07/2017 05:21 | 08/07/2017 10:15 | SOB-759 | Sentinel-1B Unavailability on 08/07/2017 |

**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 Date 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[1]:

| Start Date | Start Time | Stop Date | Stop Time | Comment |
|---|---|---|---|---|
| 06/07/2017 | 00:21:28.315 | 06/07/2017 | 00:21:37.565 | |
| 20/07/2017 | 00:01:53.824 | 20/07/2017 | 00:02:16.574 | |
| 20/07/2017 | 00:51:34.265 | 20/07/2017 | 00:51:51.015 | |
| 26/07/2017 | 22:12:23.559 | 26/07/2017 | 22:16:50.934 | |
| 26/07/2017 | 23:55:39.000 | 26/07/2017 | 23:55:49.250 | |
| 27/07/2017 | 00:45:07.153 | 27/07/2017 | 00:45:15.903 | |
| 02/08/2017 | 23:54:54.581 | 02/08/2017 | 23:54:59.581 | |
| 16/08/2017 | 21:54:28.066 | 16/08/2017 | 21:54:35.691 | |

**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):-

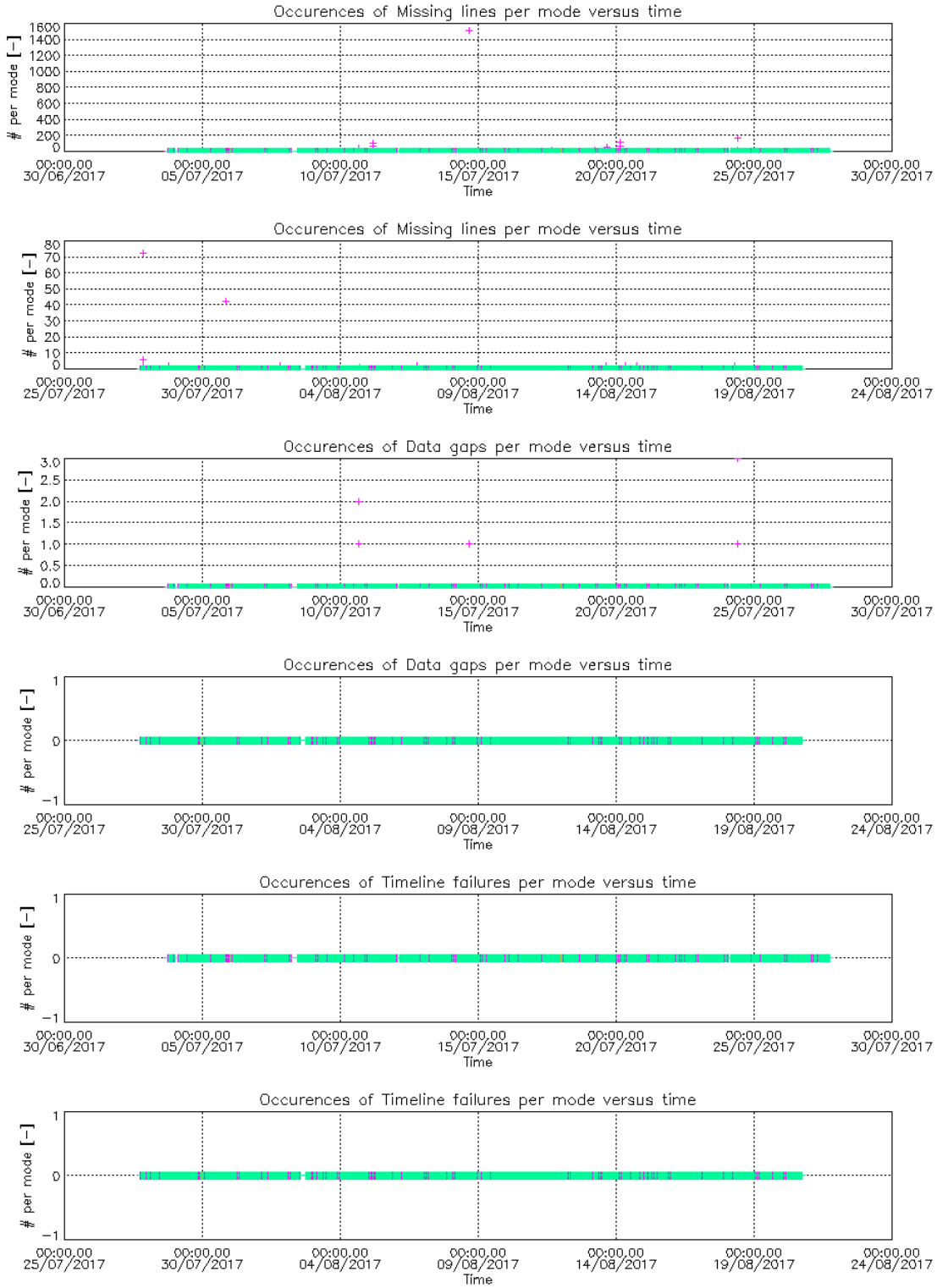



**Figure 1 Missing Lines, Data Gaps and Timeline Failures.**

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:

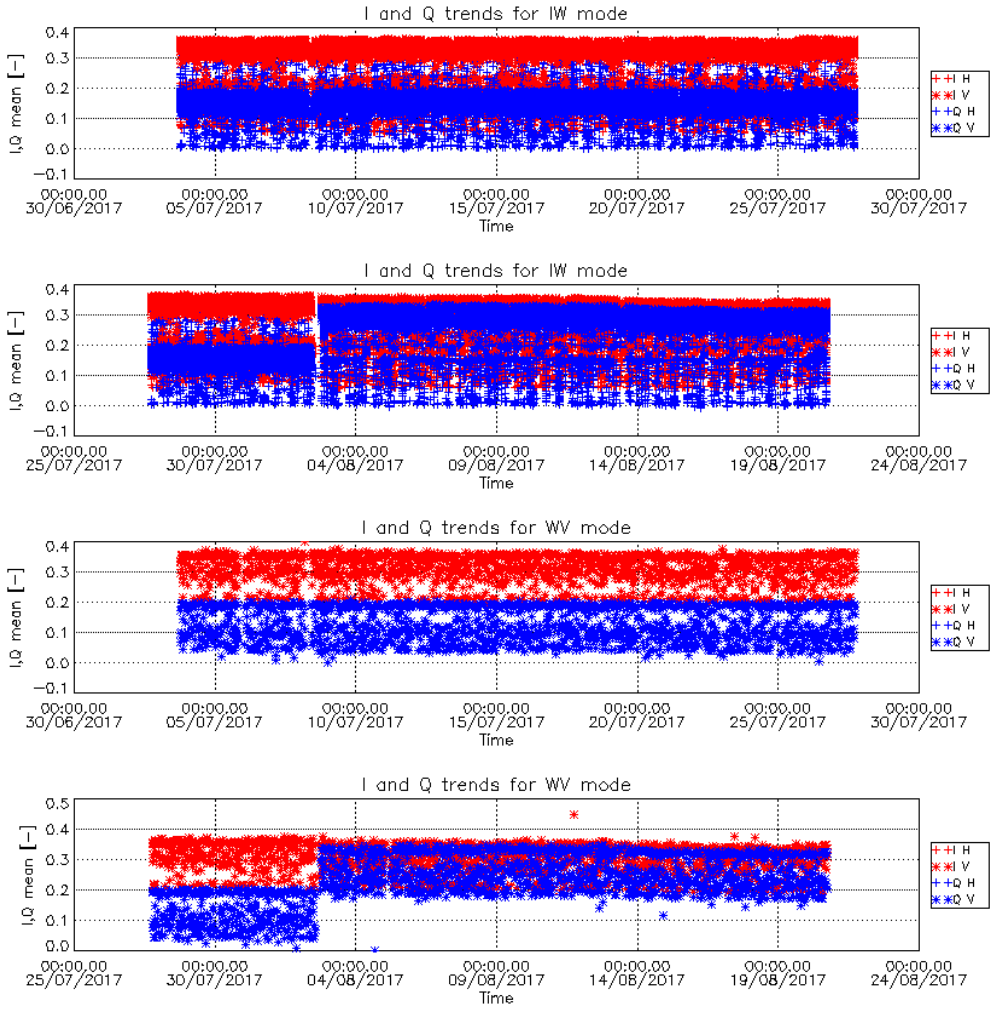
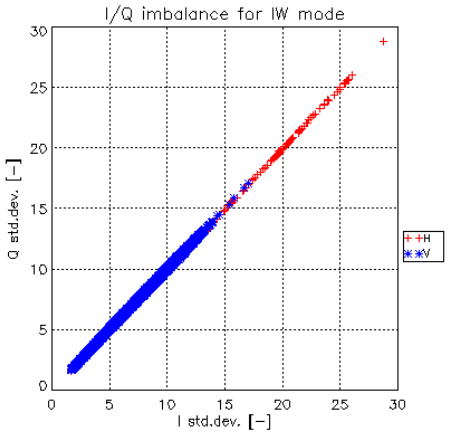
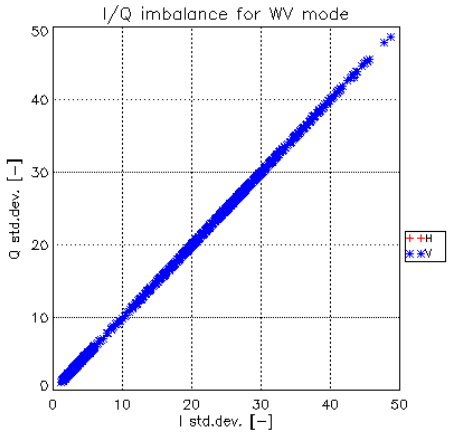



**Figure 2 I&Q Channels**

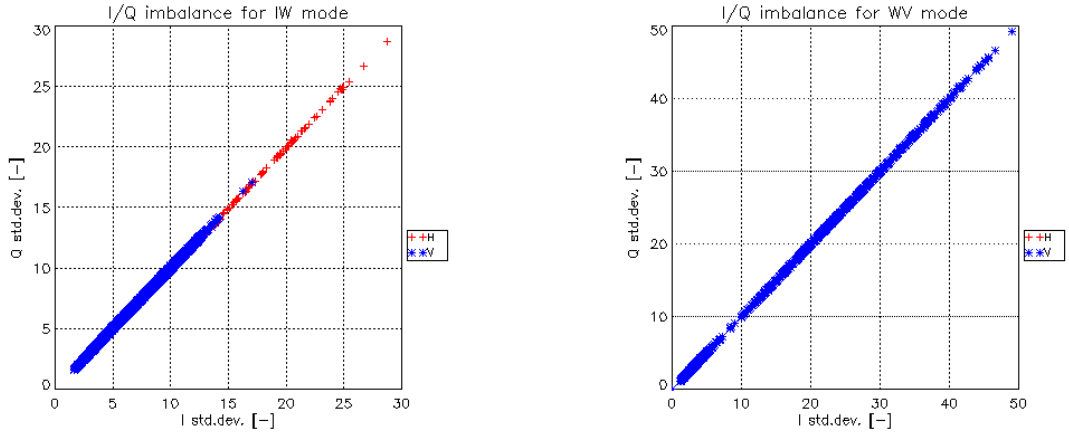
The jumps that may be noticed on the above time-series are related to instrument switch on/off, and correspond to a normal behaviour, that is compensated at processing level. It therefore has no impact on data quality.




Cycles 43 & 44




Cycles 43 & 44




Cycles 45 & 46 Cycles 45 & 46

**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.

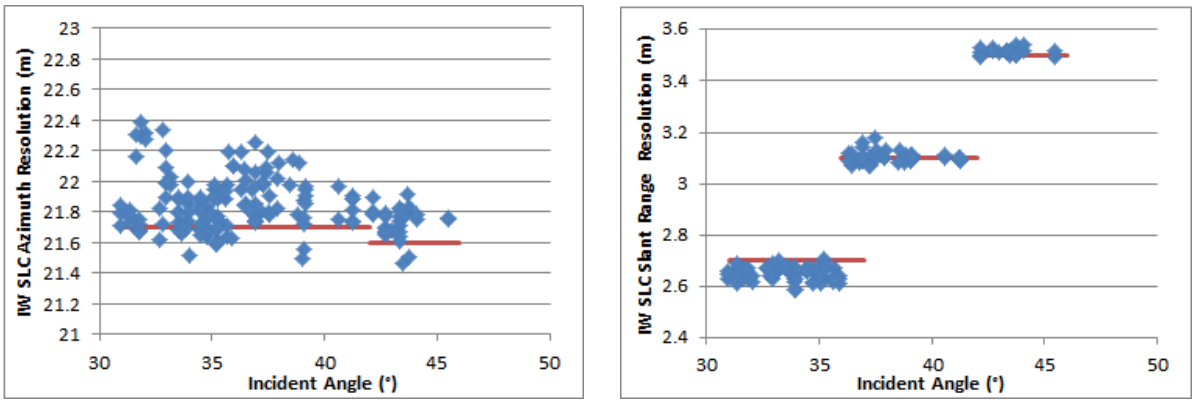



**Figure 4 IW Azimuth and Slant Range Spatial Resolutions**

| Mode/Swath | Azimuth Spatial Resolution (m) | Slant Range Spatial Resolution (m) |
|---|---|---|
| IW1 | 21.85±0.19 | 2.65±0.02 |
| IW2 | 21.89±0.16 | 3.10±0.02 |
| IW3 | 21.74±0.10 | 3.52±0.01 |

**Table 9 IW Azimuth and Slant Range Spatial Resolutions**

| Mode/Swath | Integrated Sidelobe Ratio (dB) | Peak Sidelobe Ratio (dB) | Spurious Sidelobe Ratio (dB) |
|---|---|---|---|
| IW | -12.45±2.91 | -20.21±0.99 | -23.87±3.35 |

**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).

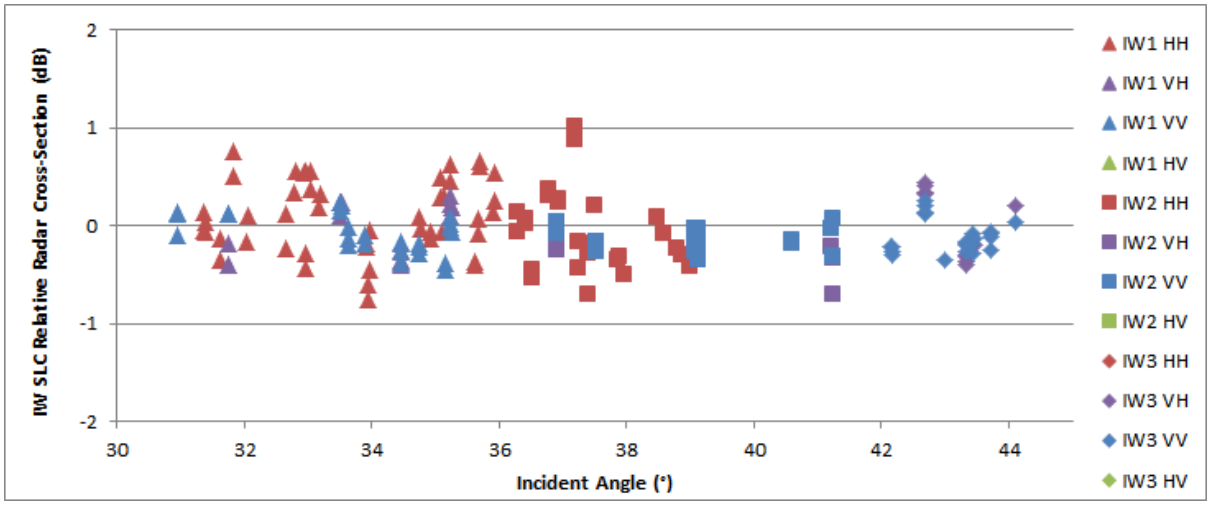



**Figure 5 IW Relative Radar Cross-Section**

| Mode/Swath | Relative Radar Cross-Section (dB) | | | | |
|---|---|---|---|---|---|
| | All | HH | VH | VV | HV |
| IW1 | 0.02±0.32 | 0.09±0.37 | -0.07±0.29 | -0.07±0.19 | |
| IW2 | -0.11±0.31 | -0.06±0.41 | -0.25±0.23 | -0.13±0.12 | |
| IW3 | -0.09±0.24 | | -0.03±0.36 | -0.12±0.16 | |

**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 -0.22±0.19 dB (all the measurements are for VV polarisation).

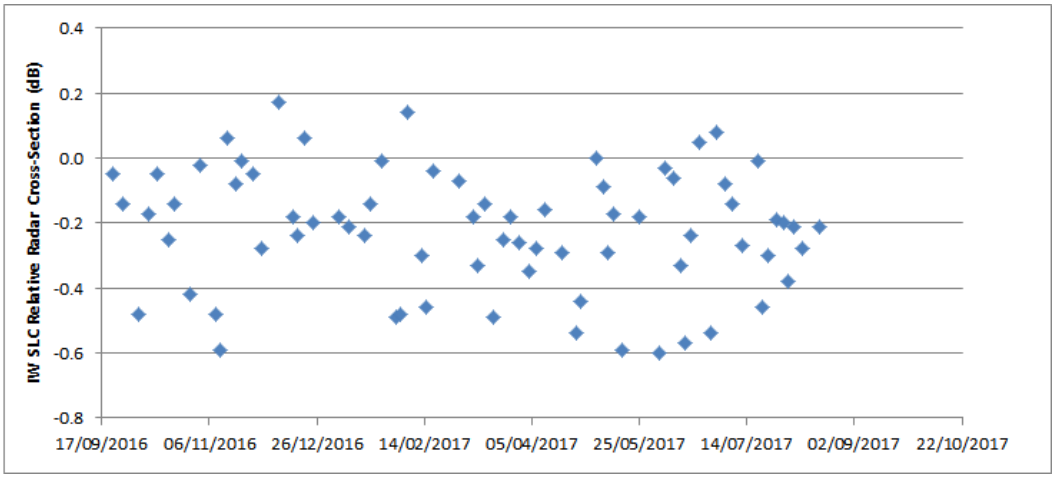



**Figure 6 IW Long-Term Relative Radar Cross-Section**

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).

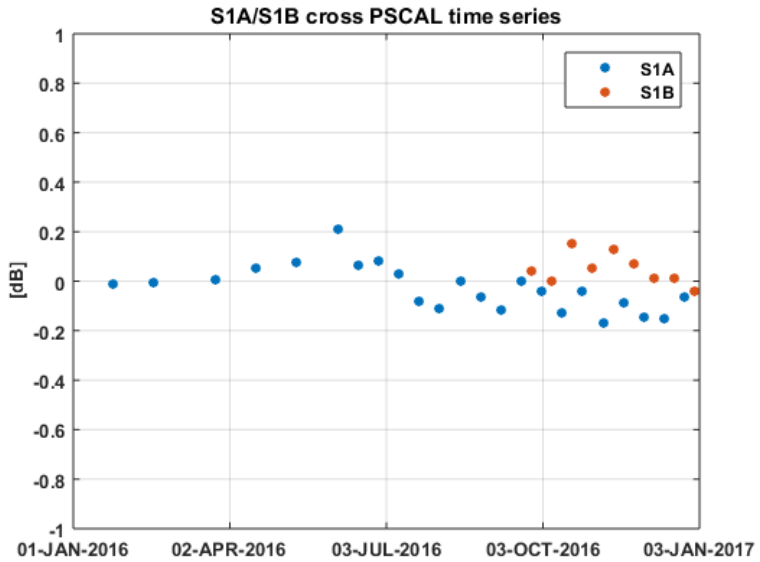



**Figure 7 PSCAL time series for IW DV acquisitions over Paris. The colour represents the sensor.**

## 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. As of the previous report, a small range bias present in TOPS mode (IW and EW) products is also taken into account during geolocation estimation.

The points can additionally 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).

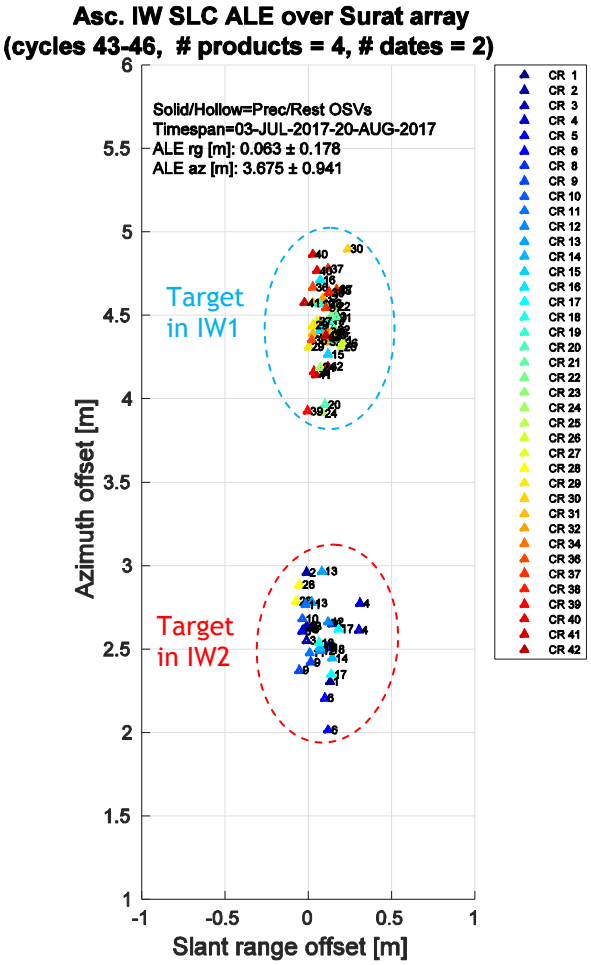



**Figure 8 S1-B absolute localisation error based on two pairs of azimuth-adjacent IW SLC products during the current reporting period. A new range bias inherent to TOPS products (described in the previous report) has also been corrected. Path delay and azimuth timing corrections have been made. The circled groups contain points from subswaths IW1 and IW2, a known azimuth separation 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.

| Mode/Swath | Range Co-registration Accuracy (m) | Azimuth Co-registration Accuracy (m) | Channel Distortion (dB) |
|---|---|---|---|
| IW | 0.00±0.00 | 0.05±0.30 | |

**Table 12 Polarimetric Calibration Measurements**

### 6.2.5. Elevation Antenna Patterns

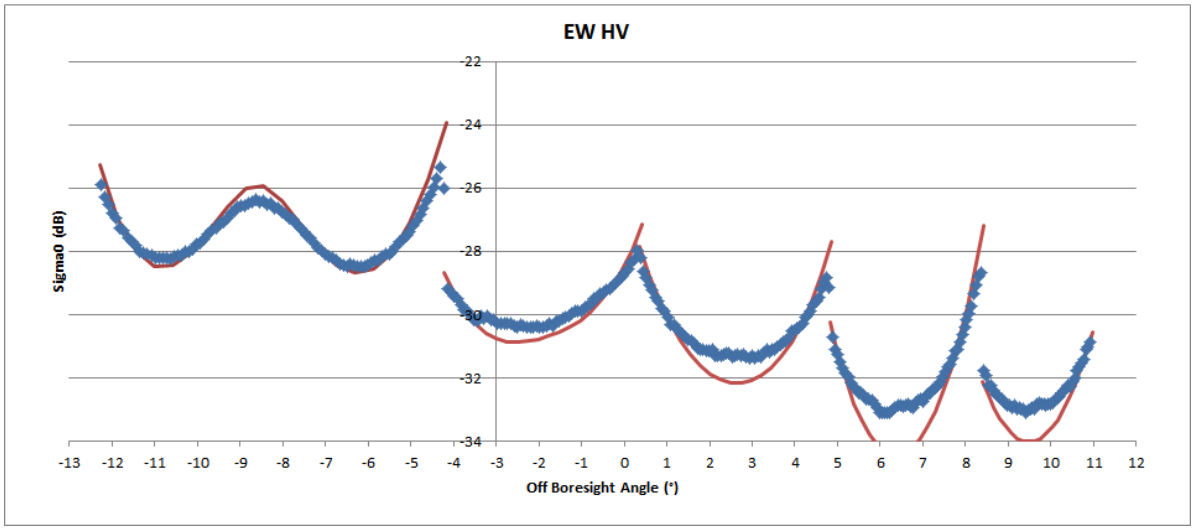
No Elevation Antenna Pattern (EAP) updates were updated during the reporting period.

### 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

The following Noise Equivalent Sigma0 Zero (NESZ) measurements were made during the reporting period.




S1B_EW_GRDH_1SDH_20170819T005101_20170819T005205_007002_00C560_59FF.SAFE

**Figure 9 NESZ measures for EW. Blue is the measured NESZ and the red lines are the predicted NESZ at minimum orbital altitude.**

### 6.2.8. Antenna Pointing

Figure 10 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.

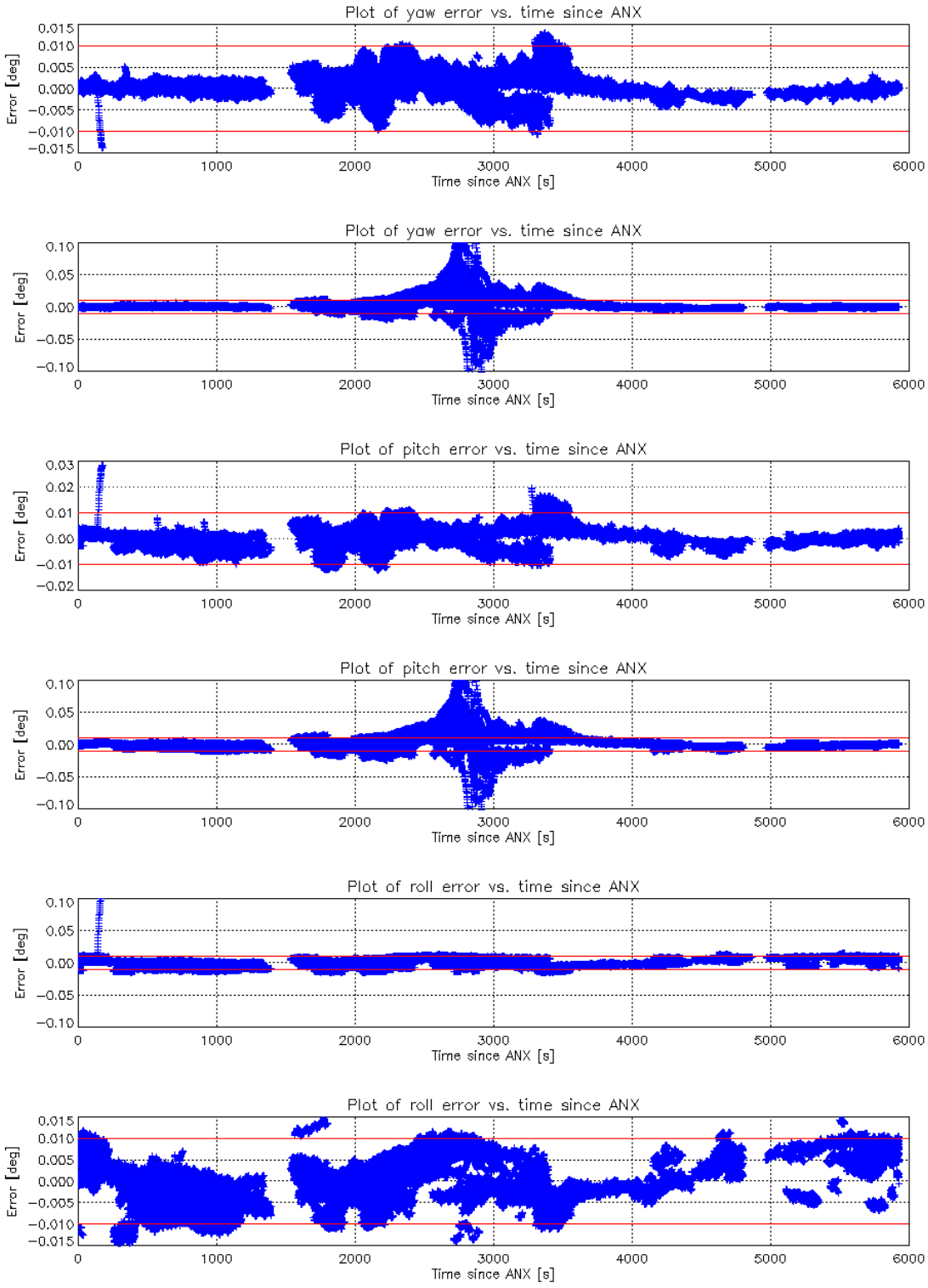
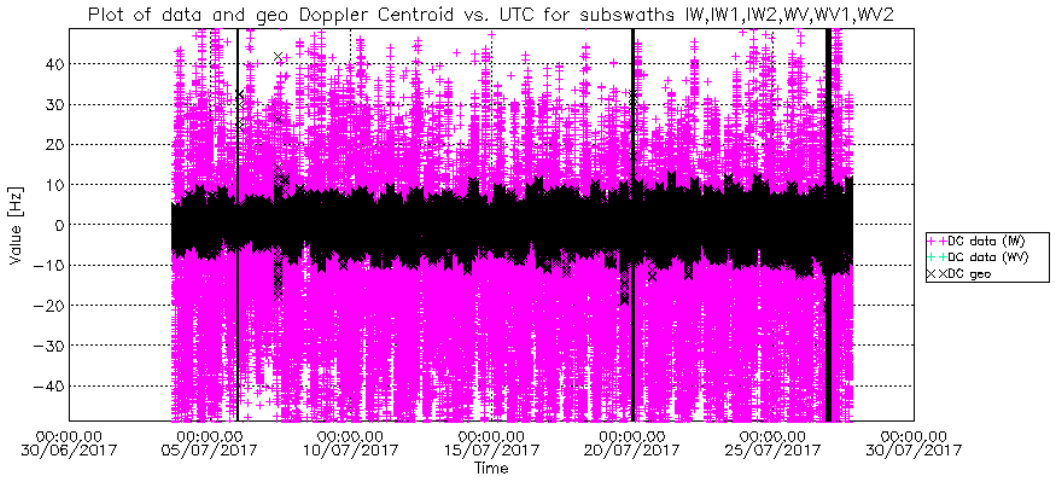
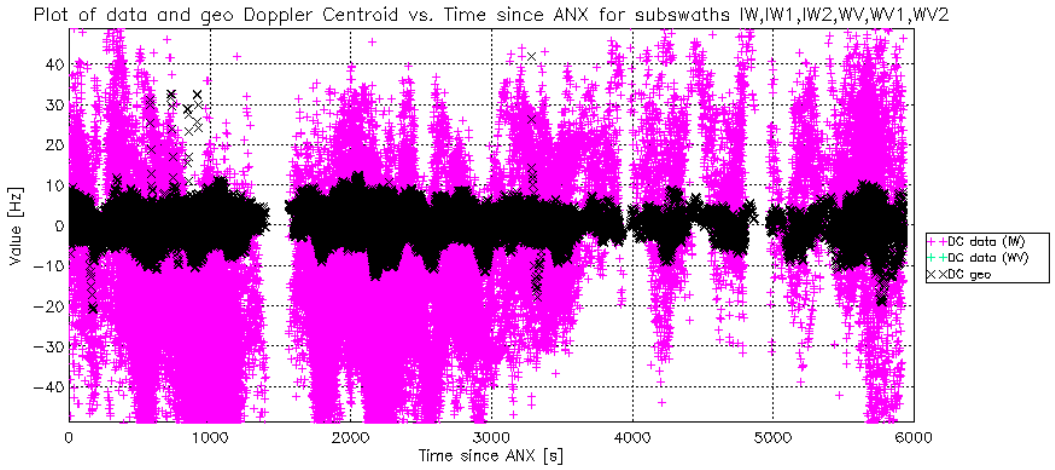
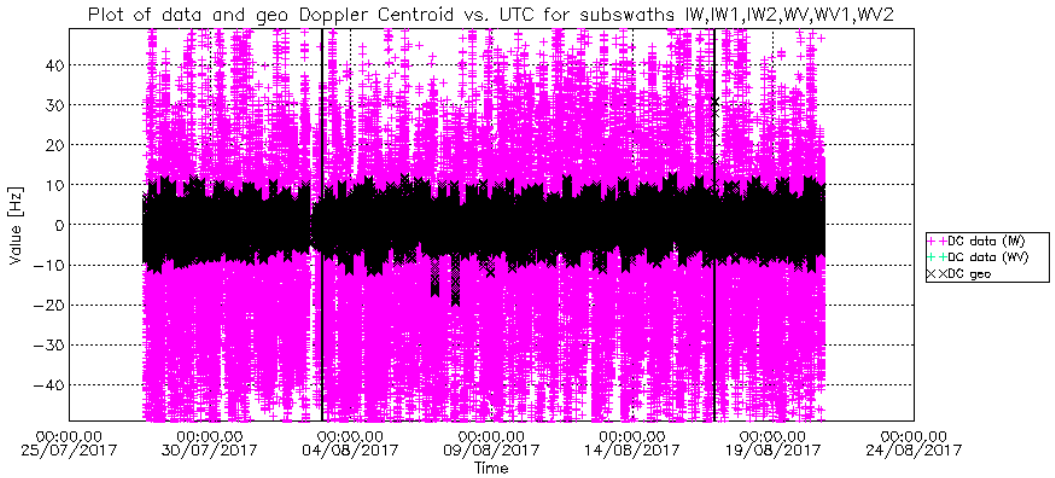



**Figure 10 S1-B Yaw, Pitch and Roll Errors**

Figure 11 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 12.



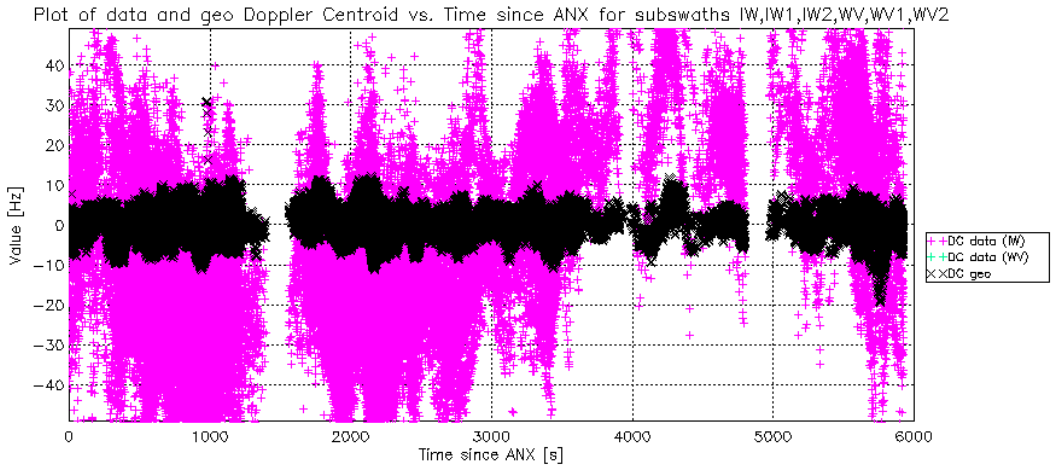



**Figure 11 S1-B Doppler Centroid**

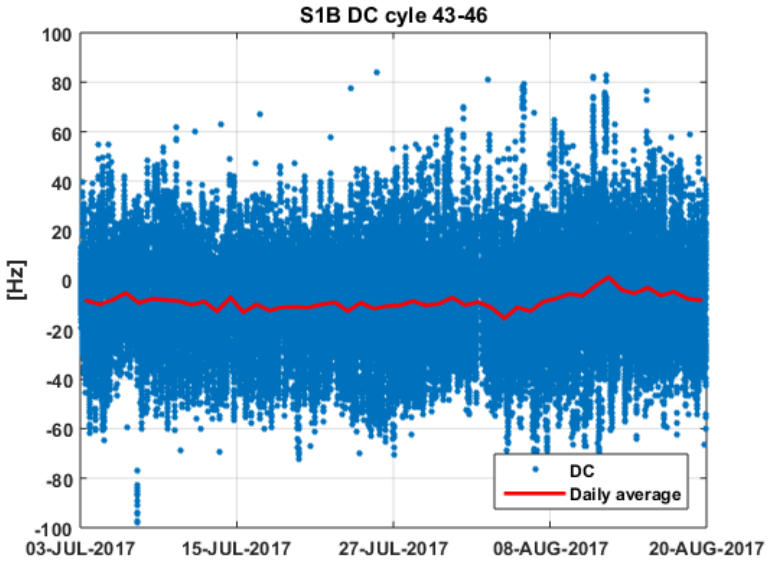



**Figure 12 S1-B Doppler Centroid detail**

| | Min (Hz) | Mean (Hz) | Max (Hz) |
|---|---|---|---|
| Cycles 43 & 44 | -534.86 | -12.51±18.99 | 140.92 |
| Cycles 45 & 46 | -92.29 | -10.37±20.43 | 104.79 |

**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 |
| 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 |

## 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:

| 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 |