PREPARATION AND OPERATIONS OF THE MISSION PERFORMANCE CENTRE (MPC) FOR THE COPERNICUS SENTINEL-3 MISSION

<b>S3-A</b>	S3-B
Cycle No. 058	Cycle No. 039
Start date: 02/05/2020	Start date: 12/05/2020
End date: 29/05/2020	End date: 08/06/2020



Mission Performance Centre

SENTINEL 3



Ref.: S3MPC.RAL.PR.02-058-039 Issue: 1.0 Date: 15/06/2020 Contract: 4000111836/14/I-LG

Customer:	ESA	Document Ref.:	S3MPC.RAL.PR.02-058-039
Contract No.:	4000111836/14/I-LG	Date:	15/06/2020
		Issue:	1.0

Project:	PREPARATION AND OPERATIONS OF THE MISSION PERFORMANCE CENTRE (MPC) FOR THE COPERNICUS SENTINEL-3 MISSION								
Title:	53 SLSTR Cyclic Performance Report								
Author(s):	SLSTR ESLs								
Approved by:	D. Smith, SLSTR ESL Authorized by Frédéric Rouffi, OPT Tech Coordinator Performance Manager								
Distribution:	ESA, EUMETSAT, S3MPC conso	rtium							
Accepted by ESA	S. Dransfeld, MPC Deputy TO for OPT P. Féménias, MPC TO								
Filename	S3MPC.RAL.PR.02-058-039 - i1	r0 - SLSTR Cyclic Repo	ort 058-039.docx						

#### Disclaimer

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# **Changes Log**

Version	Date	Changes
1.0	15/06/2020	First Version

# List of Changes

Version	Section	Answers to RID	Changes



S3A Cycle No. 058 – S3B Cycle No. 039

 Ref.:
 S3MPC.RAL.PR.02-058-039

 Issue:
 1.0

 Date:
 15/06/2020

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# **1** Processing Baseline Version

IPF	IPF / Processing Baseline version	Date of deployment
	S3A	
SL1	06.17 / 2.59	CGS: 15/01/2020 11:36 UTC
		PAC: 15/01/2020 11:36 UTC
SL2	06.16 / 2.61	PAC: 15/01/2020 11:36 UTC

IPF	IPF / Processing Baseline version	Date of deployment
	S3B	
SL1	06.17 / 1.31	PAC: 15/01/2020 11:36 UTC
SL2	06.16 / 1.33	PAC: 15/01/2020 11:36 UTC

Note that more details of the processing baseline version can be found in the SLSTR Product Notice.



# 2 Instrument monitoring

### 2.1 Instrument temperatures

As a thermal infrared instrument, thermal stability and uniformity of the optical mechanical enclosure (OME) is critical to the radiometric calibration. Figure 1 and Figure 2 show the orbital average temperature of the OME and instrument baffles for SLSTR-A and SLSTR-B during the cycle. The temperatures were stable (on top of a daily variation cycle). The gap between 13<sup>th</sup> and 19<sup>th</sup> May for SLSTR-A is due to the anomaly and decontamination described in Section 6.1.

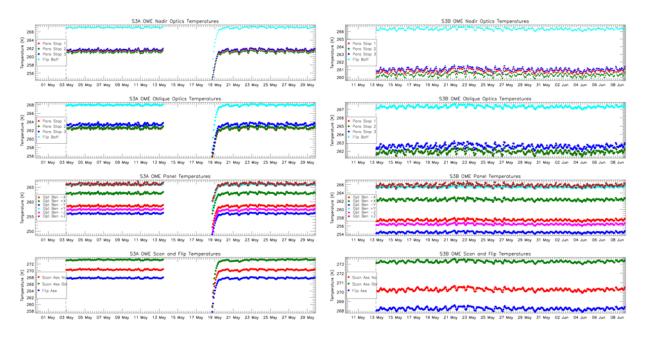
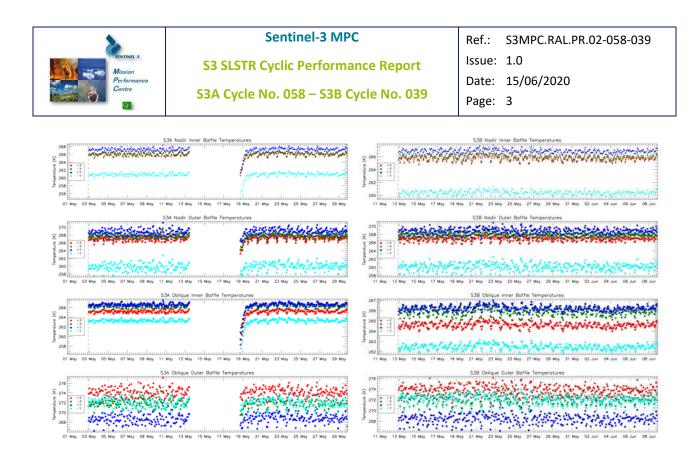


Figure 1: OME temperature trends for SLSTR-A Cycle 058 (left) and SLSTR-B Cycle 039 (right) showing the paraboloid stops and flip baffle (top two plots) and optical bench and scanner and flip assembly (lower two plots). The vertical dashed lines indicate the start and end of the cycle. Each dot represents the average temperature in one orbit.



*Figure 2: Baffle temperature trends for SLSTR-A Cycle 058 (left) and SLSTR-B Cycle 039 (right). The vertical dashed lines indicate the start and end of the cycle. Each dot represents the average temperature in one orbit.* 



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## **2.2** Detector temperatures

The detector temperatures for both SLSTR-A and SLSTR-B were stable at their expected values following the latest decontamination phases. Decontamination was performed for SLSTR-A in Cycle 054 between 3<sup>rd</sup> and 11<sup>th</sup> February 2020, and in Cycle 058 following the instrument anomaly on 13th May 2020 (see Section 6.1). Decontamination was performed for SLSTR-B in Cycle 030 from 19<sup>th</sup> to 25<sup>th</sup> September 2019. Decontamination involves warming up the infrared focal plane assembly (FPA) in order to remove water ice contamination from the cold surfaces. Figure 3 and Figure 4 show the SLSTR-A and SLSTR-B detector temperatures for the past year. The decontaminations are clearly visible as a rise in detector temperature.

A few orbits (Cycle 49 for SLSTR-A and Cycle 29 for SLSTR-B) show slightly lower average SLSTR-A detector temperatures due to instrument tests that were performed on those days.

In Cycle 37 for SLSTR-B, the cooler cold tip temperature was adjusted on 30<sup>th</sup> March. This has the effect of increasing the detector temperatures for the SWIR and TIR channels, and appears as a step in Figure 4.

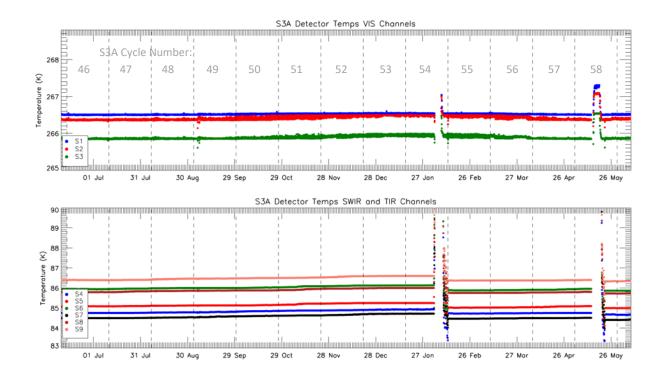


Figure 3: SLSTR-A detector temperatures for each channel for the last year of operations. Discontinuities occur for the infrared channels where the FPA was heated for decontamination. The vertical dashed lines indicate the start and end of each cycle. Each dot represents the average temperature in one orbit. The different colours indicate different detectors.

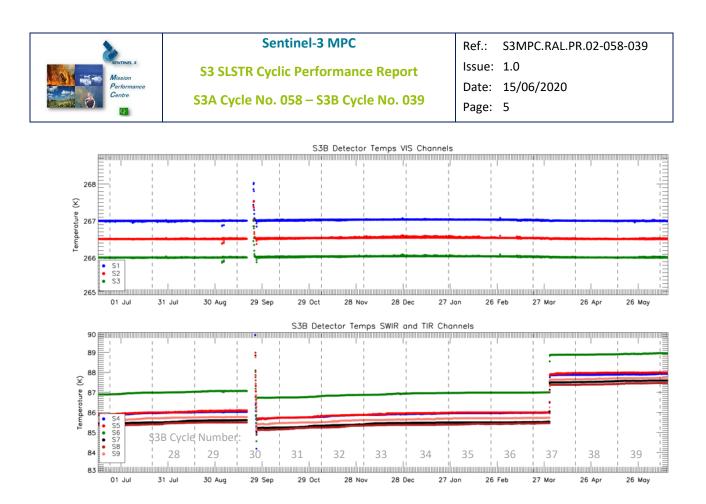


Figure 4: SLSTR-B detector temperatures for each channel for the last year of operations. Discontinuities occur for the infrared channels where the FPA was heated for decontamination. The vertical dashed lines indicate the start and end of each cycle. Each dot represents the average temperature in one orbit. The different colours indicate different detectors.



## 2.3 Scanner performance

Scanner performance has been consistent with previous operations and within required limits for SLSTR-A and Figure 5 shows the trends in Cycle 058. The gap between 13<sup>th</sup> and 19<sup>th</sup> May is due to the anomaly and decontamination.

Figure 6 shows the trend for SLSTR-B in Cycle 039. Although the values are generally within the required limits, the scan and flip mirror deviations have larger variations than for SLSTR-A. This should be monitored carefully to make sure the jitter statistics do not get worse in the longer term.

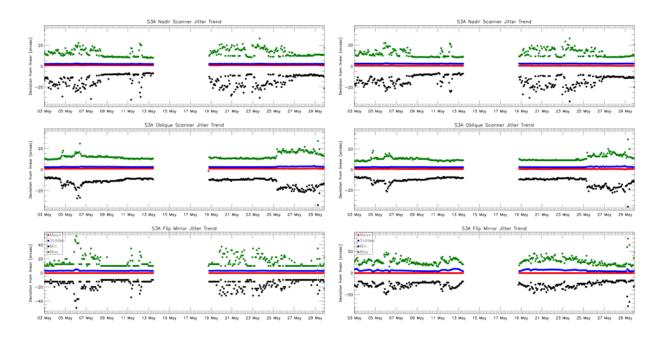


Figure 5: SLSTR-A scanner and flip jitter for Cycle 058, showing mean, stddev and max/min difference from expected position per orbit (red, blue, green and black respectively) for the nadir view (left) and oblique view (right). The plots show the nadir scanner (top), oblique scanner (middle) and flip mirror (bottom).

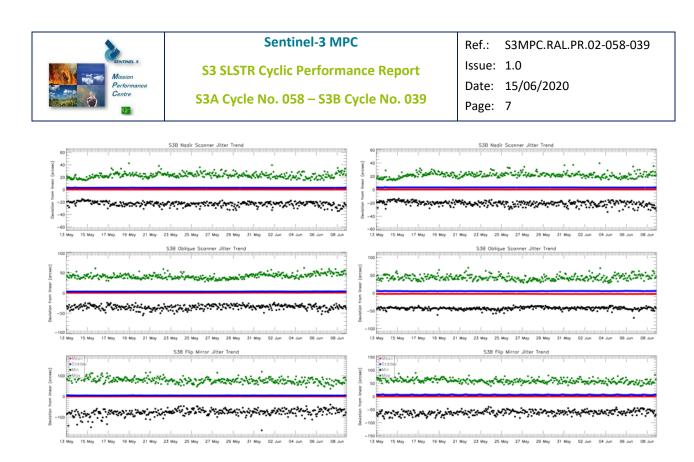


Figure 6: SLSTR-B scanner and flip jitter long term in Cycle 039, showing mean, stddev and max/min difference from expected position per orbit (red, blue, green and black respectively) for the nadir view (left) and oblique view (right). The plots show the nadir scanner (top), oblique scanner (middle) and flip mirror (bottom).



## 2.4 Black-Bodies

The orbital average blackbody temperatures for SLSTR-A are shown in Figure 7, and SLSTR-B are shown in Figure 9. The temperatures were stable on top of a daily variation cycle. There are also longer term cycle-to-cycle trends which show a yearly variation, with temperatures rising as the Earth approaches perihelion at the beginning of January (see Figure 8 and Table 5). Figure 7 and Figure 9 show the gradients across the blackbody baseplate (i.e. each PRT sensor reading relative to the mean). The gradients are stable and within their expected range of  $\pm 20$ mK, except for the +YBB for SLSTR-B which has a higher gradient. This higher gradient is expected and consistent with measurements made before launch. Note that the gap between 13<sup>th</sup> and 19<sup>th</sup> May for SLSTR-A is due to the anomaly and decontamination.

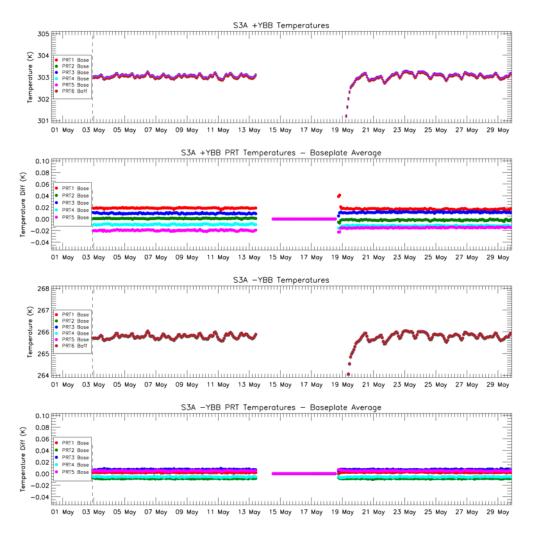


Figure 7: SLSTR-A blackbody temperature and baseplate gradient trends during Cycle 058. The vertical dashed lines indicate the start and end of the cycle. Each dot represents the average temperature in one orbit.



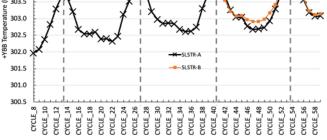


Figure 8: SLSTR-A and SLSTR-B long term trends in average +YBB temperature, showing yearly variation. The vertical dashed lines approximately indicate the 1<sup>st</sup> January 2017, 2018, 2019 and 2020.

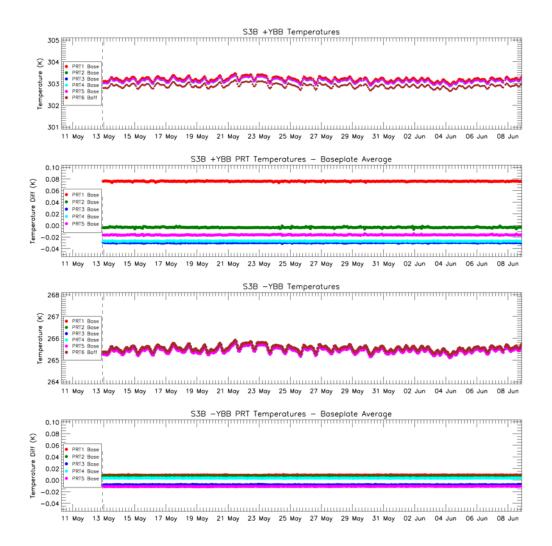


Figure 9: SLSTR-B blackbody temperature and baseplate gradient trends during Cycle 039. The vertical dashed lines indicate the start and end of the cycle. Each dot represents the average temperature in one orbit.



## **2.5** Detector noise levels

#### 2.5.1 SLSTR-A VIS and SWIR channel signal-to-noise

The VIS and SWIR channel noise for SLSTR-A in Cycle 058 was stable and consistent with previous operations - the signal-to-noise ratio of the measured VISCAL signal over the past year is plotted in Figure 10. Table 1 and Table 2 give the average signal-to-noise in each cycle (excluding the instrument decontaminations). These values average over the significant detector-detector dispersion for the SWIR channels that is shown in Figure 10.

 Table 1: Average SLSTR-A reflectance factor, and signal-to-noise ratio of the measured VISCAL signal for the last

 11 cycles, averaged over all detectors for the nadir view.

	Average		Nadir Signal-to-noise ratio									
	Reflectance Factor	Cycle 048	Cycle 049	Cycle 050	Cycle 051	Cycle 052	Cycle 053	Cycle 054	Cycle 055	Cycle 056	Cycle 057	Cycle 058
<b>S1</b>	0.187	244	242	244	248	242	242	248	240	243	240	238
<b>S2</b>	0.194	242	247	247	246	247	250	250	246	245	245	243
<b>S</b> 3	0.190	234	231	234	238	240	237	235	235	230	233	232
<b>S4</b>	0.191	164	166	168	170	170	171	172	175	172	170	166
S5	0.193	280	283	285	286	286	288	293	291	285	283	279
<b>S6</b>	0.175	176	179	180	182	183	184	186	185	182	179	176

Table 2: Average SLSTR-A reflectance factor, and signal-to-noise ratio of the measured VISCAL signal for the last
11 cycles, averaged over all detectors for the oblique view.

	Average					Oblique S	ignal-to-n	oise ratio				
	Reflectance Factor	Cycle 048	Cycle 049	Cycle 050	Cycle 051	Cycle 052	Cycle 053	Cycle 054	Cycle 055	Cycle 056	Cycle 057	Cycle 058
<b>S1</b>	0.166	260	261	260	271	270	266	269	263	268	257	252
<b>S2</b>	0.170	257	264	269	268	270	274	273	267	267	266	258
<b>S3</b>	0.168	243	240	242	250	256	254	245	244	239	238	237
<b>S4</b>	0.166	138	139	140	141	141	141	141	140	139	138	136
<b>S</b> 5	0.166	214	216	216	217	218	214	210	211	215	214	214
<b>S6</b>	0.155	133	134	134	136	136	136	134	133	134	132	131



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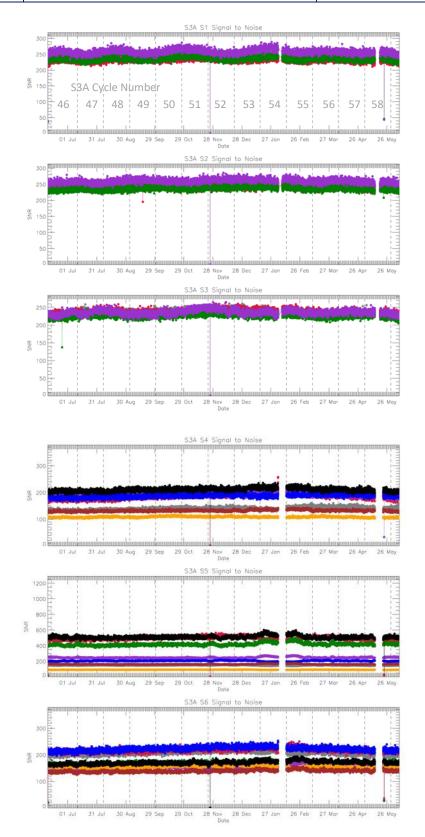


Figure 10: VIS and SWIR channel signal-to-noise of the measured VISCAL signal in each orbit for the last year of operations for SLSTR-A. Different colours indicate different detectors. The vertical dashed lines indicate the start and end of each cycle.



#### 2.5.2 SLSTR-B VIS and SWIR channel signal-to-noise

The average VIS and SWIR channel signal-to-noise ratios for SLSTR-B in Cycle 039 are shown in Table 3 and Table 4. These values average over a significant detector-detector dispersion for the SWIR channels.

 Table 3: Average SLSTR-B reflectance factor, and signal-to-noise ratio of the measured VISCAL signal for the last

 11 cycles, averaged over all detectors for the nadir view.

	Average Nadir Signal-to-noise ratio											
	Reflectance Factor	Cycle 029	Cycle 030	Cycle 031	Cycle 032	Cycle 033	Cycle 034	Cycle 035	Cycle 036	Cycle 037	Cycle 038	Cycle 039
<b>S1</b>	0.177	228	229	231	233	235	240	239	231	232	226	224
<b>S2</b>	0.192	218	220	221	224	224	225	229	221	223	216	217
<b>S3</b>	0.194	233	232	236	231	239	234	241	232	230	229	219
<b>S4</b>	0.186	129	130	132	132	133	133	134	132	130	129	129
S5	0.184	241	241	244	245	245	245	247	245	243	241	241
<b>S6</b>	0.162	160	158	161	164	163	167	169	165	162	161	160

Table 4: Average SLSTR-B reflectance factor, and signal-to-noise ratio of the measured VISCAL signal for the last
11 cycles, averaged over all detectors for the oblique view.

	Average				<u>.</u>	Oblique Signal-to-noise ratio						
	Reflectance Factor	Cycle 029	Cycle 030	Cycle 031	Cycle 032	Cycle 033	Cycle 034	Cycle 035	Cycle 036	Cycle 037	Cycle 038	Cycle 039
<b>S1</b>	0.157	220	224	228	228	230	230	229	225	223	221	215
S2	0.168	251	257	259	262	264	263	265	258	259	250	247
<b>S3</b>	0.172	264	263	270	268	276	269	272	263	266	257	251
<b>S4</b>	0.168	130	128	130	131	131	132	131	128	128	127	126
<b>S</b> 5	0.172	251	250	251	253	255	253	253	252	247	243	242
<b>S6</b>	0.152	186	184	185	189	189	189	187	187	184	182	179



#### 2.5.3 SLSTR-A TIR channel NEDT

The thermal channel NEDT values for SLSTR-A in Cycle 058 are consistent with previous operations and within the requirements. NEDT trends calculated from the hot and cold blackbody signals are shown in Figure 11. NEDT values for each cycle, averaged over all detectors and both Earth views, are shown in Table 5. Note that the gap between 13<sup>th</sup> and 22<sup>nd</sup> May is due to the anomaly and decontamination.

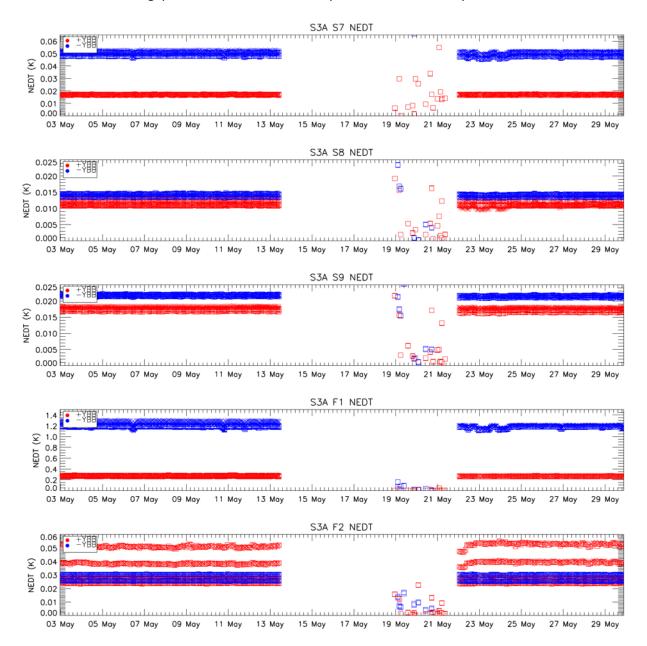


Figure 11: SLSTR-A NEDT trend for the thermal channels in Cycle 058. Blue points were calculated from the cold blackbody signal and red points from the hot blackbody. The square symbols show results calculated from the nadir view and crosses show results from the oblique view. Results are plotted for all detectors and integrators, which is why there are several different levels within the same colour points (particularly for S8 and F2).



# Table 5: NEDT for SLSTR-A in the last 11 cycles averaged over all detectors for both Earth views towards the hot+YBB (top) and the cold -YBB (bottom).

SLSTR-A		Cycle 048	Cycle 049	Cycle 050	Cycle 051	Cycle 052	Cycle 053	Cycle 054	Cycle 055	Cycle 056	Cycle 057	Cycle 058
+YBB temp (K)		302.732	302.931	303.284	303.775	304.059	304.206	304.073	303.560	303.181	303.067	303.078
	S7	17.6	18.0	17.2	17.1	16.8	16.8	16.8	17.2	17.1	17.2	17.2
	<b>S8</b>	11.5	11.5	11.4	11.4	11.2	11.2	11.4	11.2	11.4	11.4	11.2
NEDT (mK)	<b>S</b> 9	17.8	17.9	17.8	17.9	17.8	17.9	17.8	17.4	17.5	17.6	17.3
(1110)	F1	281	296	273	271	266	265	261	271	274	276	268
	F2	33.9	33.6	33.8	35.2	35.5	35.7	34.9	35.8	36.0	35.3	35.3
SLSTR-A		Cycle 048	Cycle 049	Cycle 050	Cycle 051	Cycle 052	Cycle 053	Cycle 054	Cycle 055	Cycle 056	Cycle 057	Cycle 058
-YBB temp (K)		265.226	265.427	265.814	266.475	266.863	266.941	266.707	266.088	265.669	265.675	265.797
	<b>S7</b>	49.8	48.5	49.3	48.2	47.0	46.6	48.4	48.8	49.9	50.0	50.4
	<b>S8</b>	14.1	14.0	14.1	14.1	14.0	14.0	14.1	14.0	14.1	14.1	14.1

21.9

1134

28.1

21.9

1121

28.1

22.0

1141

28.0

21.5

1176

27.8

21.7

1232

28.0

21.7

1231

28.0

21.5

1196

27.8

NEDT

(mK)

**S9** 

F1

F2

21.8

1234

28.0

21.7

1192

28.2

21.9

1212

28.1

21.9

1171

28.0



#### 2.5.4 SLSTR-B TIR channel NEDT

The thermal channel NEDT values for SLSTR-B in Cycle 039, calculated from the hot and cold blackbody signals are shown in Figure 12 and Table 6.

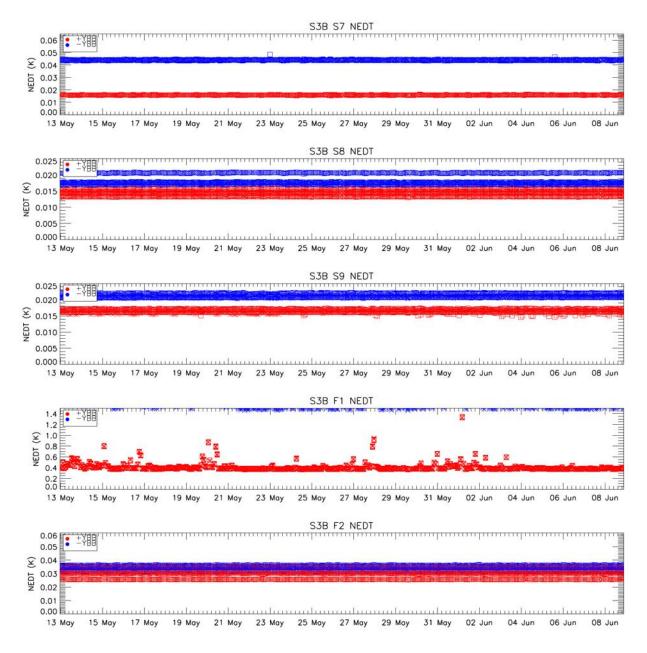
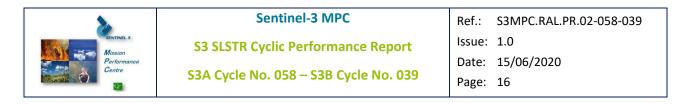


Figure 12: SLSTR-B NEDT trend for the thermal channels in Cycle 039. Blue points were calculated from the cold blackbody signal and red points from the hot blackbody. The square symbols show results calculated from the nadir view and crosses show results from the oblique view. Results are plotted for all detectors and integrators, which is why there are several different levels within the same colour points (particularly for S8 and F2).



# Table 6: NEDT for SLSTR-B in the last 11 cycles averaged over all detectors for both Earth views towards the hot+YBB (top) and the cold -YBB (bottom).

SLSTR-B		Cycle 029	Cycle 030	Cycle 031	Cycle 032	Cycle 033	Cycle 034	Cycle 035	Cycle 036	Cycle 037	Cycle 038	Cycle 039	
+YBB temp (K)		302.974	303.171	303.412	303.962	304.326	304.334	303.991	303.566	303.220	303.115	303.145	
	S7	16.8	16.0	16.0	15.9	15.7	15.7	15.9	16.1	16.0	16.0	16.0	
NEDT	<b>S8</b>	13.3	12.9	12.8	12.9	12.9	12.9	13.0	13.1	13.9	14.3	14.4	
NEDT (mK)	<b>S9</b>	14.9	14.3	14.1	14.2	14.3	14.5	14.6	14.7	15.7	16.4	16.5	
(	F1	403	376	372	370	364	357	369	412	414	395	413	
	F2	29.8	29.9	30.0	30.2	30.2	30.1	30.0	29.9	30.2	30.4	30.5	

SLSTR-B		Cycle 029	Cycle 030	Cycle 031	Cycle 032	Cycle 033	Cycle 034	Cycle 035	Cycle 036	Cycle 037	Cycle 038	Cycle 039
-YBB temp (K)		264.918	265.109	265.510	266.245	266.679	266.613	266.112	265.579	265.263	265.293	265.443
	S7	43.5	44.4	44.0	42.8	42.4	42.4	42.7	44.0	43.9	43.9	44.1
NEDT	<b>S8</b>	16.9	16.8	16.7	16.7	16.7	16.8	16.8	16.9	17.6	18.2	18.2
NEDT (mK)	<b>S</b> 9	18.8	18.3	18.1	18.2	18.3	18.4	18.6	18.8	20.2	21.1	21.2
(1110)	F1	1584	1618	1573	1538	1513	1481	1520	1762	1774	1669	1756
	F2	31.1	30.7	30.5	30.5	30.6	30.7	30.9	31.0	32.5	33.5	33.6



# **2.6 Calibration factors**

#### 2.6.1 VIS and SWIR radiometric response

The visible channels show oscillations in their radiometric response due to the build-up of ice on the optical path within the focal plane assembly (FPA). Similar oscillations were observed for the corresponding channels on ATSR-2 and AATSR. As described in Section 2.2, periodic decontamination of the infrared FPA is necessary to remove the water ice contamination.

The radiometric responses of the SWIR channels appear to be more stable and not affected by the buildup of water ice contamination, although there is a seasonal cycle of the response that could be caused by variations in the solar zenith angle on the diffuser or partial vignetting of the Sun's disc by the VISCAL baffle.

It should be noted that the data from the VISCAL unit and blackbodies calibrates the signal and counteracts the degradation of the optics and other variations in signal.

Figure 13 and Figure 14 show the variation of the radiometric gain derived from the VISCAL signals for SLSTR-A over the past year, and Figure 15 and Figure 16 show the variation of the radiometric gain for SLSTR-B since the start of the S3B mission. Note that the period of the oscillations depends on the rate of build up of the ice layer, which is faster for SLSTR-B because it has had less time to decontaminate.

Note that decontaminations for SLSTR-A were performed in Cycles 45 and 54 and 58. For SLSTR-B, a decontamination was performed during Cycle 24 and Cycle 30.

There is a step in the SWIR channel radiometric response for SLSTR-B in Cycle 37 on 30<sup>th</sup> March 2020 due to the change in temperature of the detectors caused by the cooler set point change.

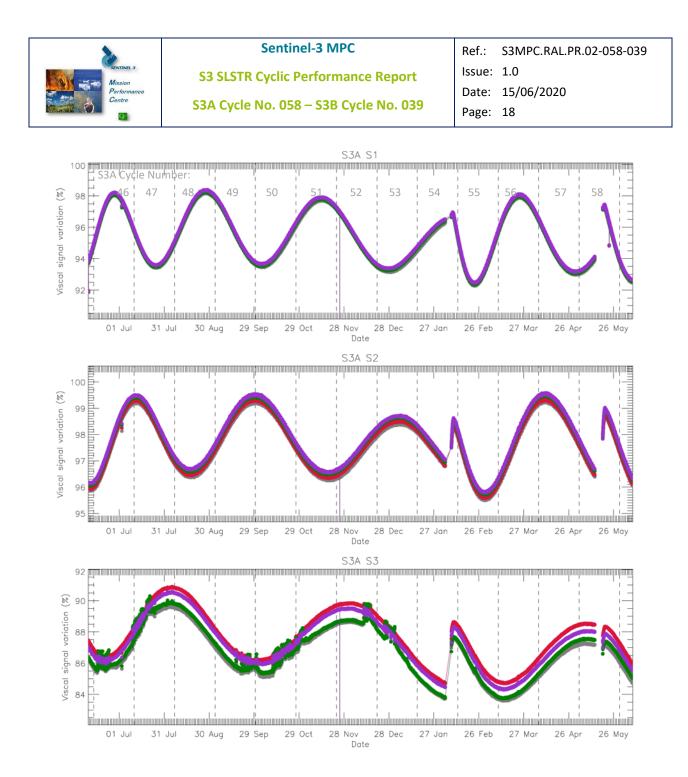


Figure 13: Variation of the radiometric gain derived from the VISCAL signals for SLSTR-A VIS channels for the last year of operations (nadir view). Different colours represent different detectors. The vertical dashed lines indicate the start and end of each cycle.

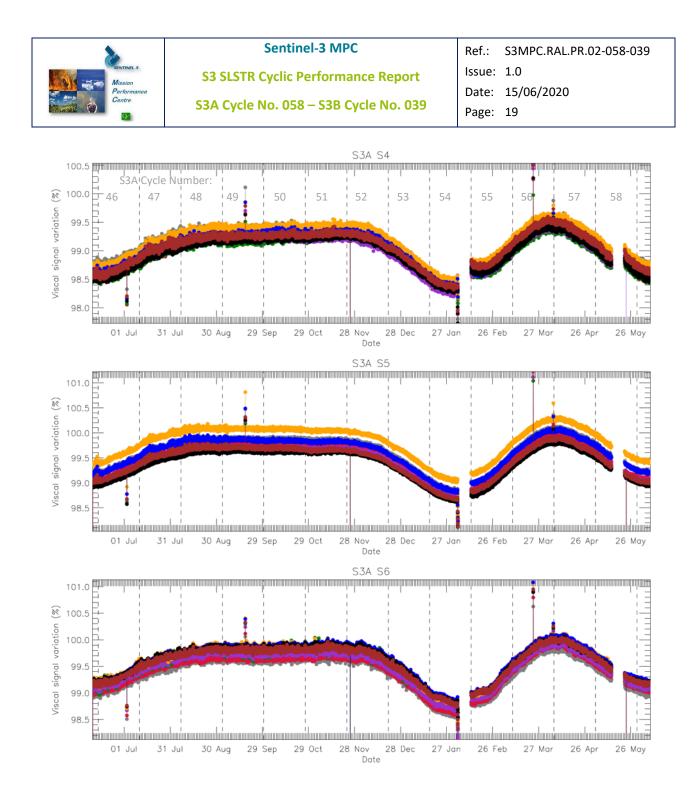


Figure 14: Variation of the radiometric gain derived from the VISCAL signals for SLSTR-A SWIR channels for the last year of operations (nadir view). Different colours represent different detectors. The vertical dashed lines indicate the start and end of each cycle. Note that the spikes in cycle 56 correspond to orbits where there were missing data (Section 6.1).

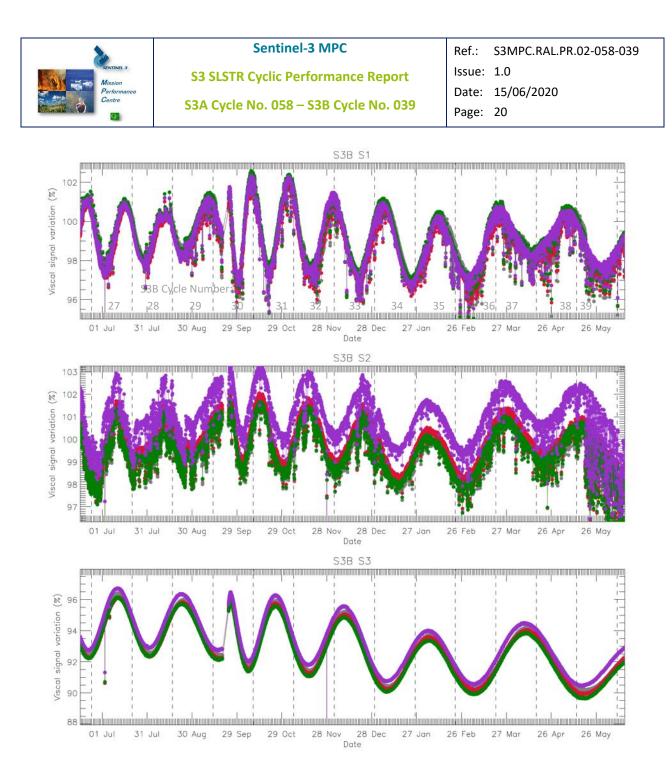


Figure 15: Variation of the radiometric gain derived from the VISCAL signals for SLSTR-B VIS channels for the past year (nadir view). Different colours represent different detectors. The vertical dashed lines indicate the start and end of each cycle.

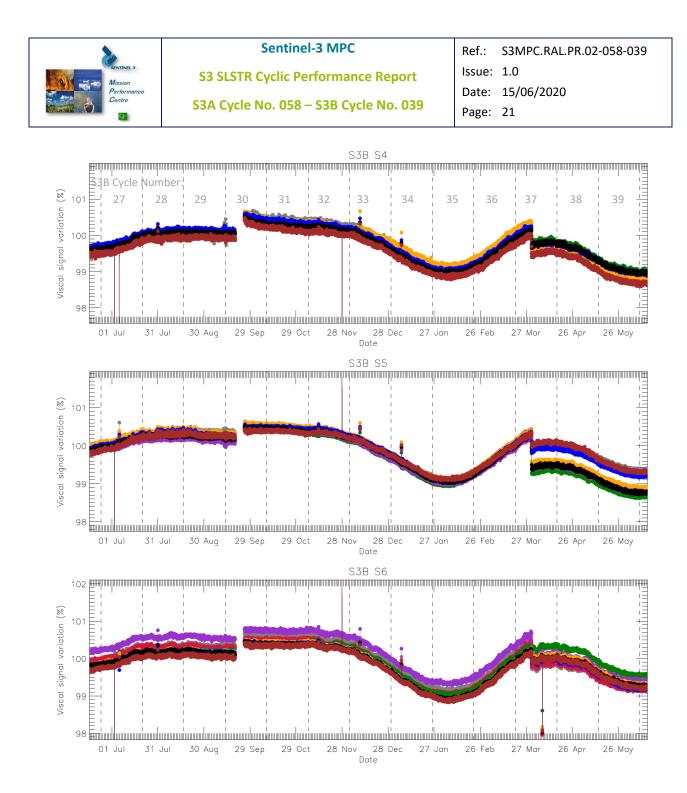


Figure 16: Variation of the radiometric gain derived from the VISCAL signals for SLSTR-B SWIR channels for the past year (nadir view). Different colours represent different detectors. The vertical dashed lines indicate the start and end of each cycle.



# 3 Level-1 product validation

## 3.1 Geometric calibration/validation

Regular monitoring using the GeoCal Tool implemented at the MPC is being carried out. This monitors the geolocation performance in Level-1 images by correlation with ground control point (GCP) imagettes. Each Level-1 granule typically contains several hundred GCPs, which are filtered based on signal-to-noise to obtain a daily average in the across and along track directions. The results are plotted in Figure 17 for SLSTR-A in Cycle 058 and Figure 18 for SLSTR-B in Cycle 039, giving the average positional offsets in kilometres for Nadir and Oblique views.

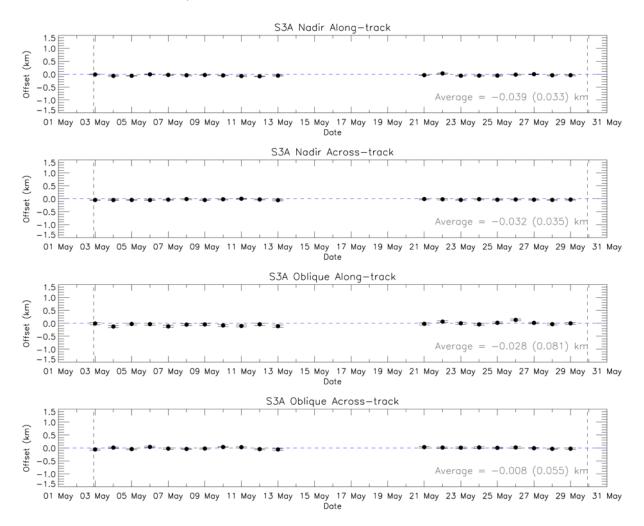


Figure 17: SLSTR-A daily offset results in km from the GeoCal Tool analysis for Nadir along- and across-track (top two plots) and Oblique along- and across-track (bottom two plots) for Cycle 058. The error bars show the standard deviation.

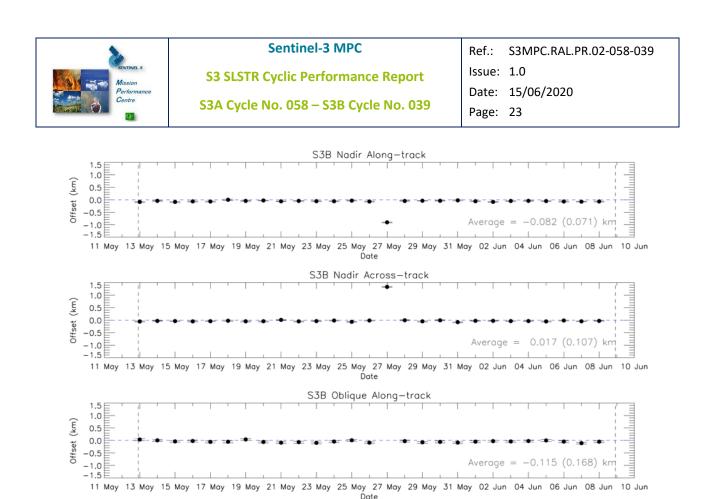


Figure 18: SLSTR-B daily offset results in km from the GeoCal Tool analysis for Nadir along- and across-track (top two plots) and Oblique along- and across-track (bottom two plots) for Cycle 039. The error bars show the standard deviation.

S3B Oblique Across-track

13 May 15 May 17 May 19 May 21 May 23 May 25 May 27 May 29 May 31 May 02 Jun 04 Jun 06 Jun 08 Jun

Ďate

Average =

0.025 (0.135)

10 Jun

0.0 ftset (km) 0.0 0.0 0.5 - 0.5

-1.0 -1.5

11 May

The gap between 14<sup>th</sup> and 20<sup>th</sup> May for SLSTR-A is due to the anomaly and decontamination – see Section 6.1. The large offsets for SLSTR-B on 27th May are due to the in-plane manoevre performed on that day – see Section 6.2. Note that the Oblique offsets are just off scale in the plot (-2.1 km and 1.6 km).



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# **3.2** Radiometric validation

The radiometric calibration of the visible and SWIR channels is monitored using the S3ETRAC service. The S3ETRAC service extracts OLCI and SLSTR Level-1 data and computes associated statistics over 49 sites corresponding to different surface types (desert, snow, ocean maximising Rayleigh signal, and ocean maximising sunglint scattering). These S3ETRAC products are used for the assessment and monitoring of the VIS and SWIR radiometry by the ESL.

Details of the S3ETRAC/SLSTR statistics are provided on the S3ETRAC website <u>http://s3etrac.acri.fr/index.php?action=generalstatistics#pageSLSTR</u>

- Number of SLSTR products processed by the S3ETRAC service
- Statistics per type of target (DESERT, SNOW, RAYLEIGH, SUNGLINT)
- Statistics per site
- Statistics on the number of records

Figure 19 and Figure 20 show the results of the inter-comparison analysis of SLSTR-A with OLCI-A and SLSTR-B with OLCI-B over desert sites. Figure 21 and Figure 22 show the results of an inter-comparison analysis of SLSTR-A and SLSTR-B with AATSR. Average ratios in each case are given in the figures.

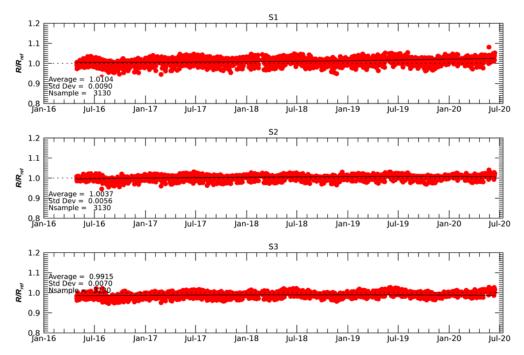


Figure 19: Ratio of SLSTR-A and OLCI-A radiances for the visible channels in Nadir view using combined results for all desert sites.

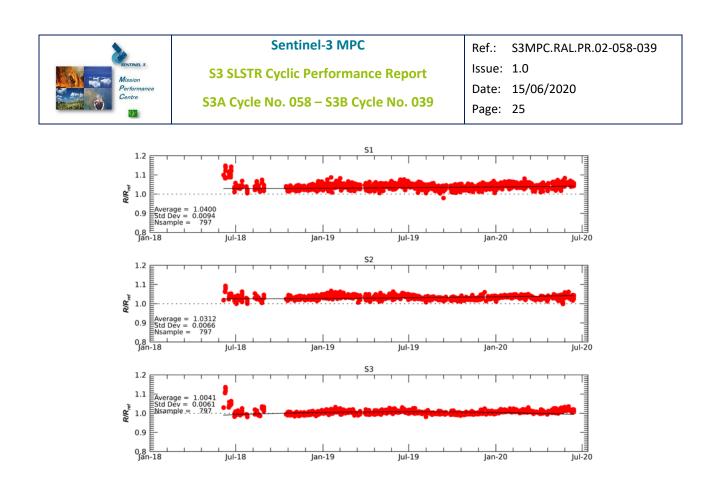


Figure 20: Ratio of SLSTR-B and OLCI-B radiances for the visible channels in Nadir view using combined results for all desert sites.



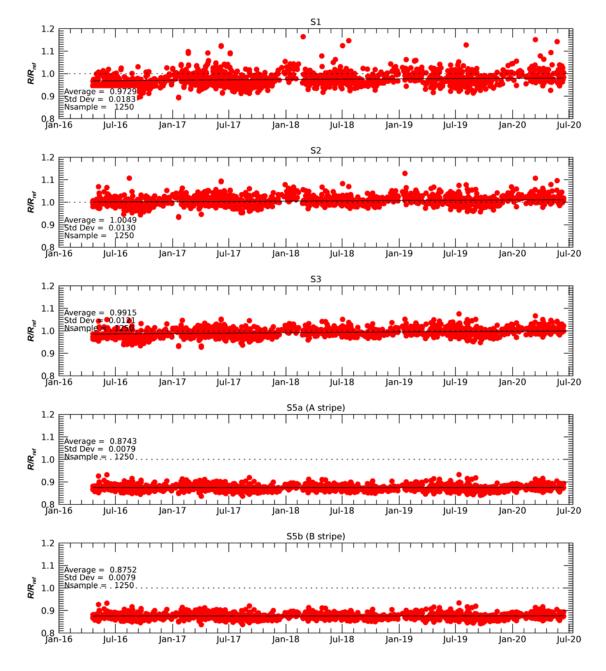


Figure 21: Ratio of SLSTR-A and AATSR radiances in Nadir view using combined results for all desert sites.



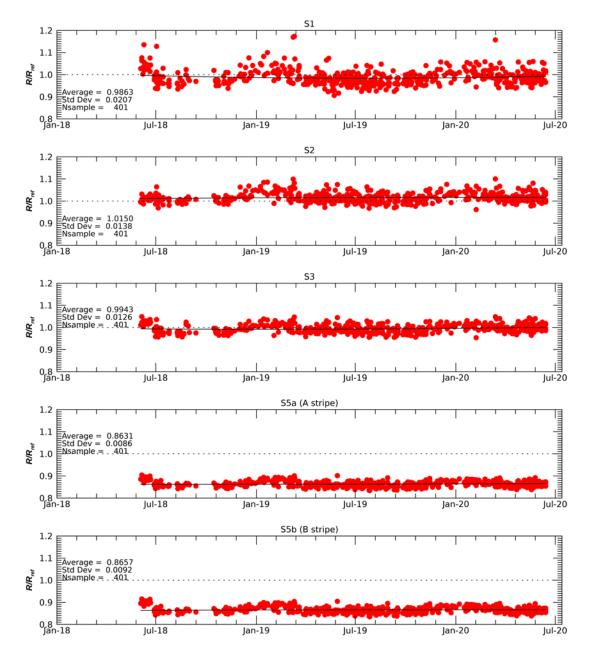
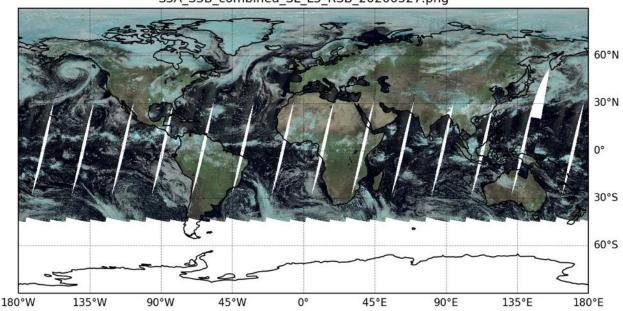


Figure 22: Ratio of SLSTR-B and AATSR radiances in Nadir view using combined results for all desert sites.



## 3.3 Image quality

The Level-1 image quality is assessed when data are available at the MPC. For example by combining all granules over one day into a single combined image. The S3A and S3B satellites are configured to be 140 degrees out of phase in order to observe complimentary portions of the earth. Figure 23 shows an example combined SLSTR-A/SLSTR-B image for the visible channels from 27<sup>th</sup> May 2020 (daytime only).



S3A\_S3B\_combined\_SL\_L3\_RSB\_20200527.png

*Figure 23: Daytime combined SLSTR-A and SLSTR-B Level-1 image for visible channels on 27<sup>th</sup> May 2020.* 



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# 4 Level-2 SST validation

Level-2 SST validation is under the responsibility of EUMETSAT.



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## 5 Level-2 LST validation

Level 2 Land Surface Temperature products have been validated against *in situ* observations (Category-A validation) from twelve "Gold Standard" Stations, and intercompared (Category-C validation) with respect to an independent operational reference product (SEVIRI from LSA SAF). In all cases it is the NTC products that are validated, and the Probabilistic cloud masking implementation is used for all cloud masking. Level-3C products for the full Cycles 058 for SLSTR-A and 039 for SLSTR-B are evaluated for identifying any gross problems. Both S3A and S3B L2 products are produced with the updated LST coefficients following the operational release on 25<sup>th</sup> February 2019. In each case the latest temporal interpolation for the probabilistic cloud mask is applied following the L1 operational release on 15<sup>th</sup> January 2020. **The S3A cycle includes a decontamination period (13<sup>th</sup> May to 21<sup>st</sup> May 2020) following an instrument anomaly.** 

## 5.1 Category-A validation

Category-A validation uses a comparison of satellite-retrieved LST with *in situ* measurements collected from radiometers sited at a number of stations spread across the Earth, for which the highest-quality validation can be achieved. Here we concentrate on twelve "Gold Standard" stations which are installed with well-calibrated instrumentation: seven from the SURFRAD network (Bondville, Illinois; Desert Rock, Nevada; Fort Peck, Montana; Goodwin Creek, Mississippi; Penn State University, Pennsylvania; Sioux Fall, South Dakota; Table Mountain, Colorado); two from the ARM network (Southern Great Plains, Oklahoma; Barrow, Alaska); and three from the USCRN network (Williams, Arizona; Des Moines, Iowa; Manhatten, Kansas). The results can be summarised as follows:

Satellite	Average absolute accuracy vs. Gold Standard (K)			
Satemite	Day	Night		
S3A	1.4	0.9		
S3B	1.2	0.7		

For both SLSTR-A and SLSTR-B both the daytime and night-time accuracies are within or close to the mission requirement of 1K, even though they are impacted to some extent by very small number of matchups for some stations in the cycle due to actual cloud, or over-masking – or in the case of S3A decontamination. The number of matchups across most stations for daytime are very low particularly during the day, and have impacted the biases to an extent. This may be a case of the cloud coefficients ADF not being optimum following the introduction of the temporal interpolation to the probabilistic cloud mask.



#### Sentinel-3 MPC

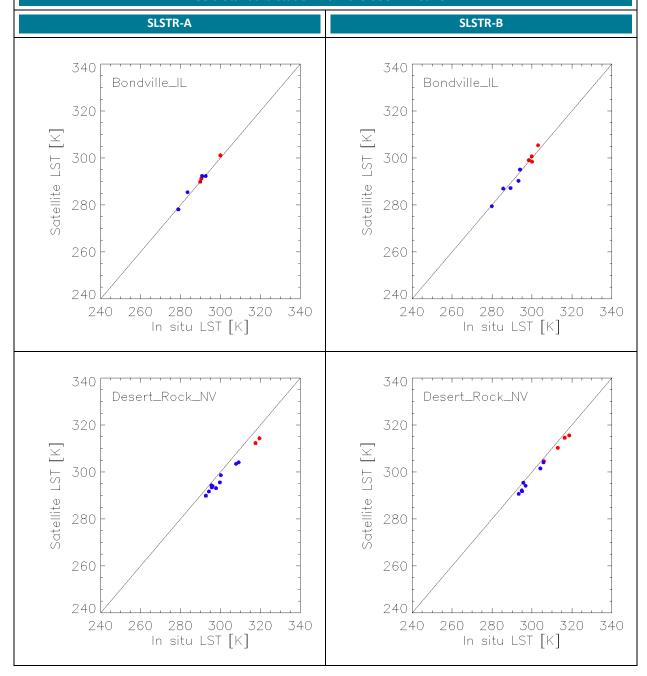
**S3 SLSTR Cyclic Performance Report** 

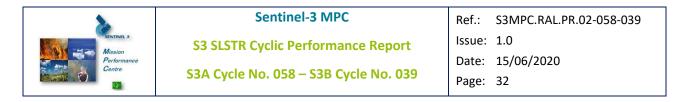
Ref.: S3MPC.RAL.PR.02-058-039 Issue: 1.0 Date: 15/06/2020

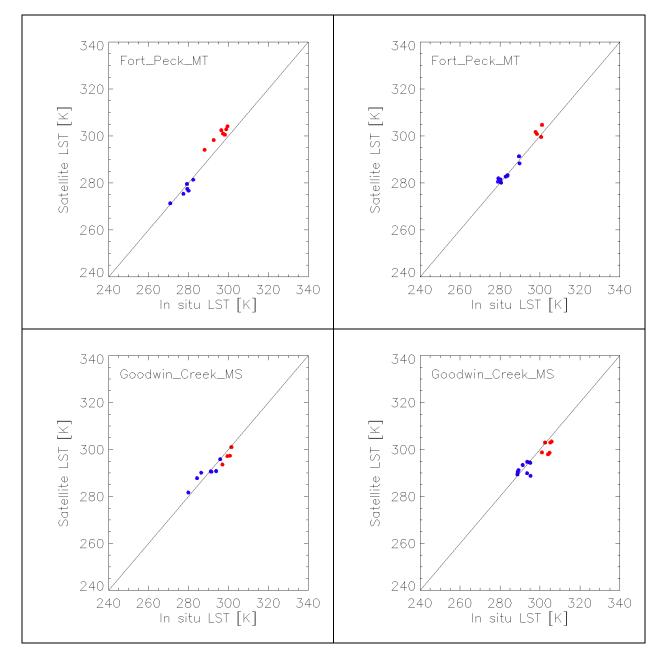
S3A Cycle No. 058 – S3B Cycle No. 039

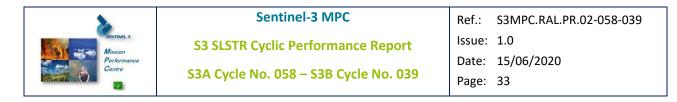
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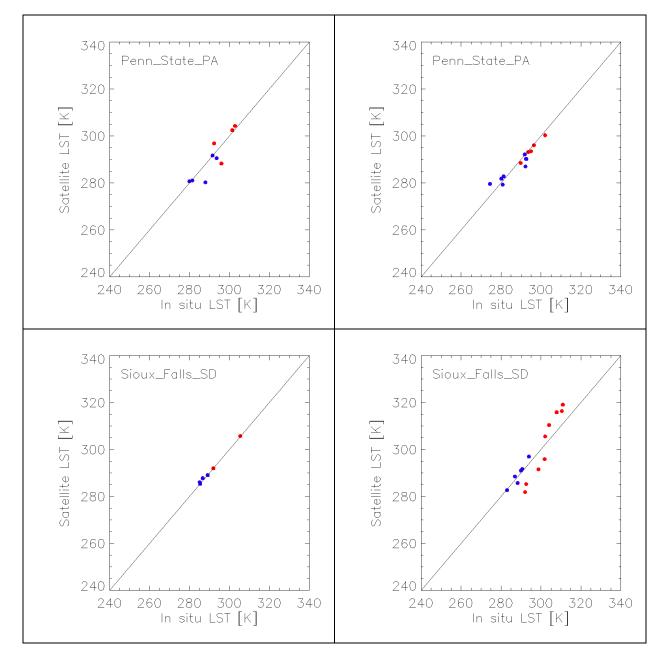
Validation of the SL\_2\_LST product over Cycle 058 (SLSTR-A) and Cycle 039 (SLSTR-B) at seven Gold Standard in situ stations of the SURFRAD network plus two Gold Standard station from the ARM network, and two Gold Standard station from the USCRN network

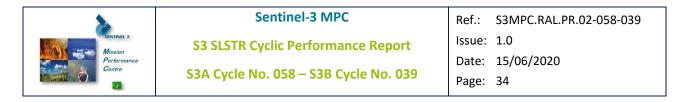


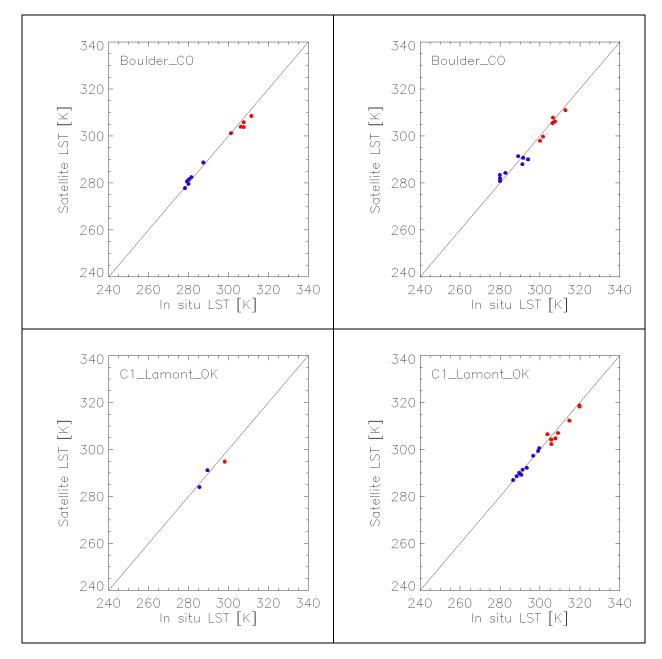


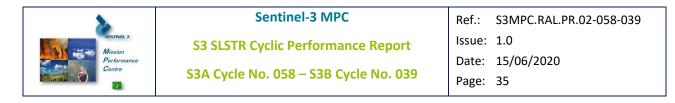


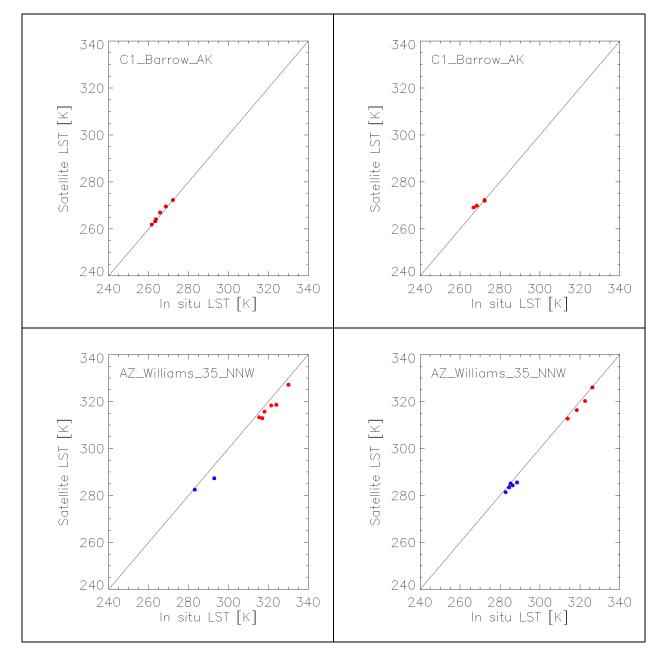


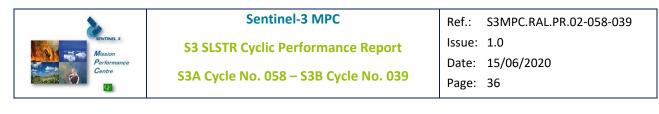


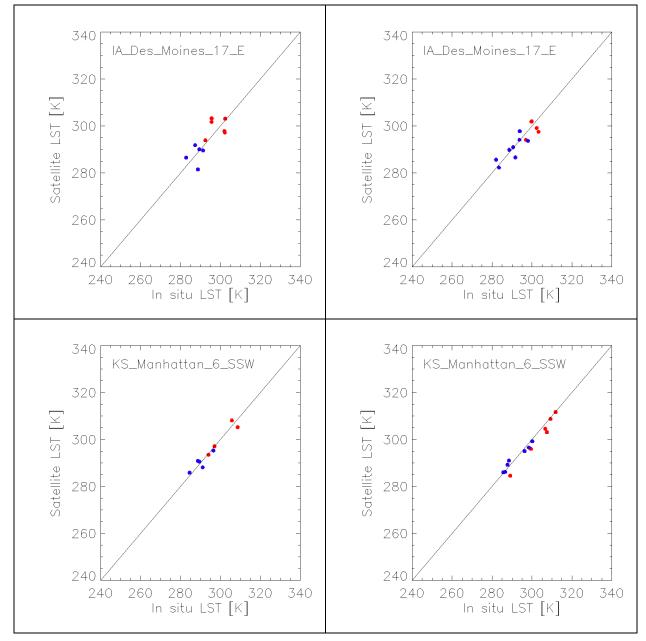












As with past cycles cloud has reduced the number of matchups per station to single figures for most stations during day or night, with some missing statistics entirely. It is therefore challenging to determine robust statistics. Nonetheless, it can be seen that overall the matchups are in general close to the 1:1 line with very few outliers. No systematic bias is evident from these matchups.



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## 5.2 Category-C validation

Category-C validation uses inter-comparisons with similar LST products from other sources such as other satellite sensors, which give important quality information with respect to spatial patterns in LST deviations. Here we compare the SL\_2\_LST product from both SLSTR-A and SLSTR-B with the operational SEVIRI L2 product available from the LSA SAF. The results can be summarised:

Continent	Median differences in K from the intercomparison of the SL_2_LST product with respect to the operational LSA SAF SEVIRI LST product for the period of Cycle 058 (SLSTR-A) and Cycle 039 (SLSTR-B)			
	SLSTR-A		SLSTR-B	
	Day	Night	Day	Night
Africa	-0.1	0.2	0.1	0.3
Europe	1.8	0.6	1.8	0.7

For both Africa and Europe, the differences across the continent for both SLSTR-A and SLSTR-B are relatively small, with very few locations with larger differences. This is the same for both SLSTR-A and SLSTR-B and is primarily driven by differences in viewing geometry between the SLSTR instruments and SEVIRI and is expected. Eastern matchups (such as over the Arabian Peninsula) are towards the edge of the SEVIRI disk and therefore represent large viewing angles. At these extreme viewing angles it is expected that SLSTR LST would be increasingly higher than SEVIRI LST. For both daytime and night-time the differences are mainly < 1K for Africa for both SLSTR-A and SLSTR-B. During daytime differences are over 1K for Europe as a result of increasing differences due to geometry as days get warmer. Differences are not the same as previous cycles for both Europe and Africa which may indicate responses due to changing seasons.

Other analysis can be summarised as follows:

- Differences with respect to biomes tend to be larger during the day for surfaces with more heterogeneity and/or higher solar insolation
- Differences increase for both day and night towards the edge of the SEVIRI disk as the SEVIRI zenith angles become larger

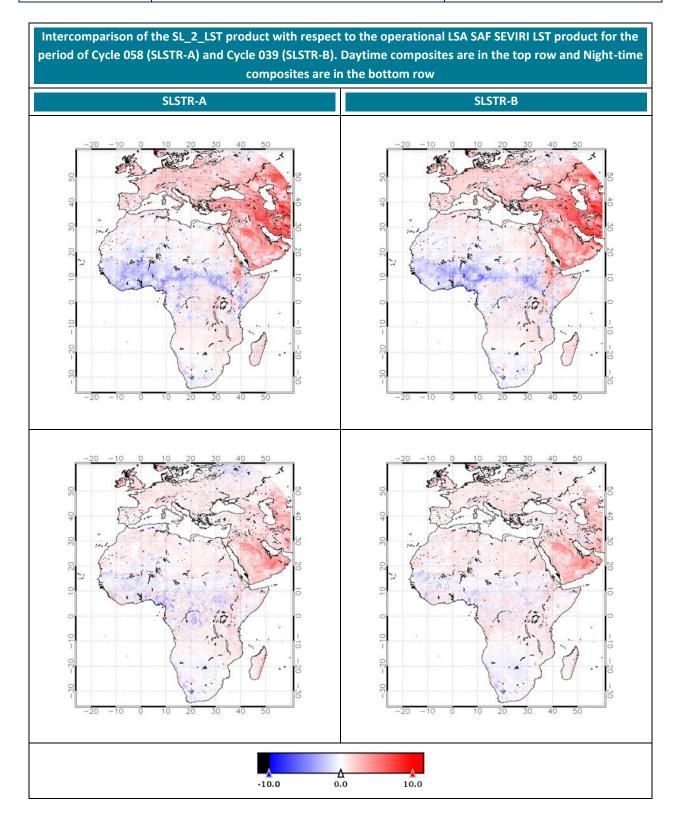


#### Sentinel-3 MPC

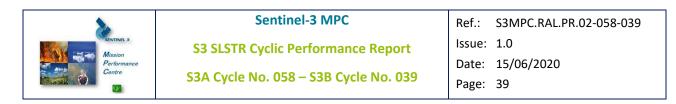
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S3A Cycle No. 058 – S3B Cycle No. 039



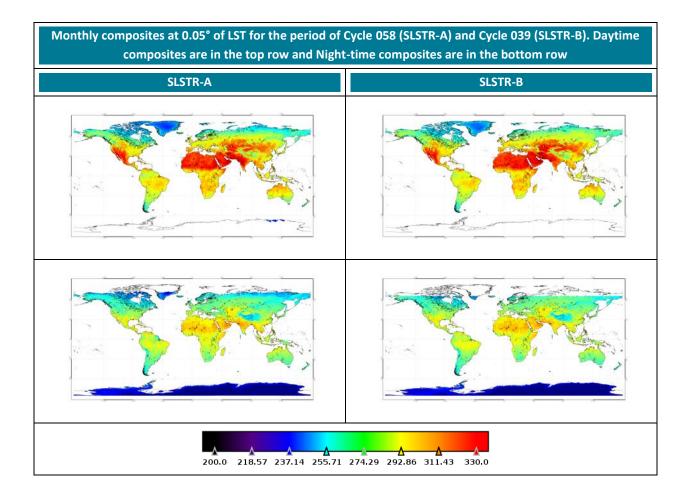
While some of these differences are > 1 K they are all within the corresponding uncertainty of SEVIRI at the pixel-scale (> 2K), and so the **two products can be assessed as being consistent**. It should also be noted that there are no significant differences between the two products in terms of biome-dependency - the differences are consistent across biomes. Some residual cloud contamination is evident from the large differences at the edge of cloud cleared features. While the cloud contamination is seen for both



SLSTR (strong negative differences) and SEVIRI (strong positive differences), compared with cycles where the basic cloud mask was used the contamination for SLSTR is lower indicating improved masking with the Probabilistic Cloud Mask. However, less matchups are evident which suggests the cloud masking could be slightly over conservative in some biomes. This will be monitored over the following Cycles to identify whether an optimisation to the cloud coefficients should be considered for some biomes.

### 5.3 Level-3C Assessment

To better understand the global product and identify any gross issues Level-3 evaluation is also performed. Here we generate monthly daytime and night-time 0.05° composites of the LST field and corresponding sampling ratios. The sampling ratios are derived as clear\_pixels / (clear\_pixels + cloudy\_pixels).



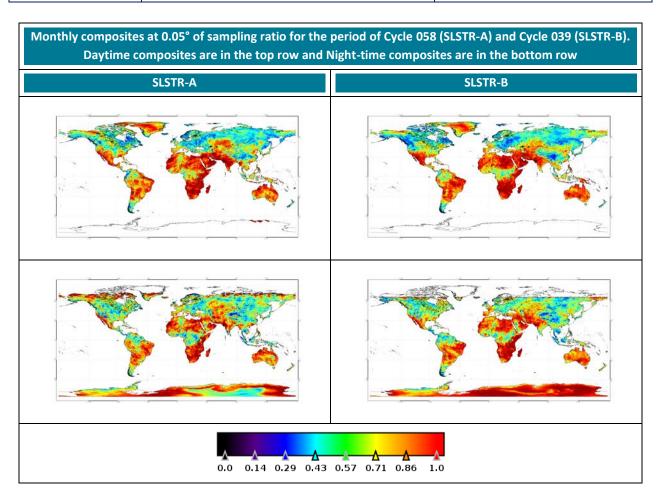


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The LST fields indicate the SL\_2\_LST product is producing values in line with expectations for both SLSTR-A and SLSTR-B. There are no distinct issues or non-physical values evident. The sampling ratio is now closer to what would be expected across the globe following the implementation of the temporal interpolation for the probabilistic cloud mask on 15<sup>th</sup> January 2020. Cloud contamination appears to be low, although there appears to be some excessive cloud clearing in some regions and undermasking in other, indicating the cloud coefficients ADF will need tuning for both instruments now the issue regarding the temporal interpolation has been resolved. The update to the ADF is under development.



S3A Cycle No. 058 – S3B Cycle No. 039

## 6 Events

### 6.1 SLSTR-A

SLSTR-A was switched on and operating nominally during the cycle, with SUE scanning and autonomous switching between day and night modes, except for the following events:

13<sup>th</sup> May 2020, 11:19 – critical event over SAA caused instrument to switch off

An anomaly occurred in SLSTR-A on 13<sup>th</sup> May which caused the instrument to switch off at 11:19. In order to recover from the anomaly and switch-off, a decontamination was scheduled on 14<sup>th</sup> May. This involved heating up the focal plane assembly to evaporate water ice from the cold surfaces, and then subsequently cooling down the instrument back to its normal operating temperatures. The timeline of decontamination and cooldown activities is shown in Table 7 and indicated in Figure 24.

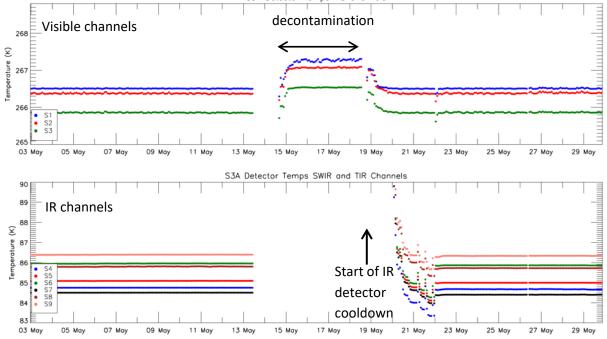
11:19, 13 <sup>th</sup> May 2020	Critical event over SAA caused instrument to
	switch off.
12:04, 14 <sup>th</sup> May 2020	Warm up phase for decontamination begun.
13:40, 18 <sup>th</sup> May 2020	Instrument put into standby mode.
13:41, 18 <sup>th</sup> May 2020	Cooler sticktion test performed (results OK).
17:00, 18 <sup>th</sup> May 2020	Cooling of IR channels started. Visible channels
	switched on.
02:02, 22 <sup>nd</sup> May 2020	Instrument switched to ON_DUTY mode and IR
	channels switched on.

#### Table 7: Timeline of decontamination/cooldown

Note that although the visible channels were switched on from 14th May, the visible data calibration and pointing accuracy may be degraded until the instrument cooldown finished on 22nd May.

The behaviour of the instrument recovered as expected after the cooldown with the IR detectors achieving a slightly lower temperature than beforehand – see Figure 24.





*Figure 24: Detector temperatures for SLSTR-A up to and following the anomaly and decontamination 13<sup>th</sup>-22<sup>nd</sup> May 2020.* 

23<sup>rd</sup> May 2020, 00:26-00:35 –data gaps due to radio frequency interference.

### 6.2 SLSTR-B

SLSTR-B was switched on and operating nominally during the cycle, with SUE scanning and autonomous switching between day and night modes, except for the following events:

- 27<sup>th</sup> May 2020, 06:58-07:07 possible pointing errors due to in-plane manoeuvre.
- 1<sup>st</sup> June 2020, 03:09-03:12 possible data gaps (cause not identified).
- 3<sup>rd</sup> June 2020, 16:03-16:09 and 17:26-17:09 possible data gaps (cause not identified).



# 7 Appendix A

Other reports related to the Optical mission are:

 S3 OLCI Cyclic Performance Report, S3A Cycle No. 058, S3B Cycle No. 039 (ref. S3MPC.ACR.PR.01-058-039)

All Cyclic Performance Reports are available on MPC pages in Sentinel Online website, at: <u>https://sentinel.esa.int</u>

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