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

S3 SLSTR Cyclic Performance Report

S3-A

Cycle No. 068

Start date: 28/01/2021

End date: 24/02/2021

S3-B

Cycle No. 049

Start date: 06/02/2021

End date: 05/03/2021



Mission
Performance
Centre

SENTINEL 3



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Author(s):	SLSTR ESLs	SLSTR ESLs									
Approved by:	D. Smith, SLSTR ESL Coordinator	Authorized by	Frédéric Rouffi, OPT Technical Performance Manager								
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Changes Log

Version	Date	Changes
1.0	12/03/2021	First Version

List of Changes

Version	Section	Answers to RID	Changes



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1 Processing Baseline Version

IPF	IPF / Processing Baseline version	Date of deployment
	S3A	
SL1	06.17 / 2.73	CGS: 12/11/2020 10:50 UTC
		PAC: 12/11/2020 10:50 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 / 1.50	PAC: 12/11/2020 10:50 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.

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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).

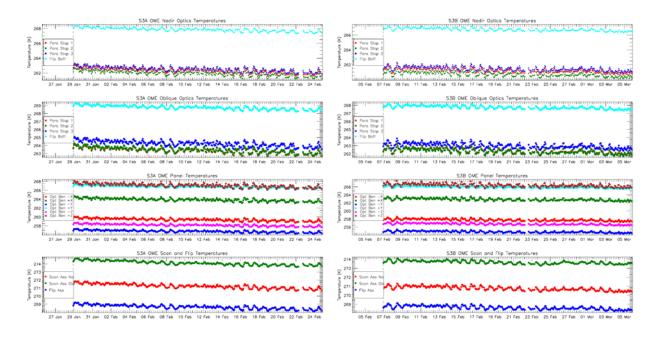


Figure 1: OME temperature trends for SLSTR-A Cycle 068 (left) and SLSTR-B Cycle 049 (right) showing the paraboloid stops and flip baffle (top two plots) and optical bench and scanner and flip assembly (lower two plots). The vertical dashed lines indicate the start and end of the cycle. Each dot represents the average temperature in one orbit.

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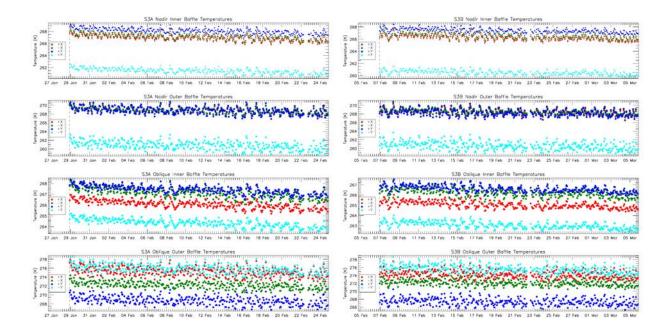


Figure 2: Baffle temperature trends for SLSTR-A Cycle 068 (left) and SLSTR-B Cycle 049 (right). The vertical dashed lines indicate the start and end of the cycle. Each dot represents the average temperature in one orbit.



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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 last performed for SLSTR-A in Cycle 058 following the instrument anomaly on 13th May 2020. Decontamination was last performed for SLSTR-B in Cycle 45 from 11th to 13th November 2020. 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 (e.g. Cycles 60, 63 and 67 for SLSTR-A) show slightly lower average visible channel detector temperatures due to instrument operations that were performed on those days.

The cooler cold tip temperature was adjusted for SLSTR-A on 14th October 2020 in Cycle 64. A similar adjustment was made for SLSTR-B in Cycle 37 on 30th March. This has the effect of increasing the detector temperatures for the SWIR and TIR channels, and appears as a step in Figure 3 and Figure 4. The lower limit of the dynamic range for SLSTR-A channel S8 was adjusted on 26th January to compensate for the change in detector temperatures carried out in October 2020 (see Section 6.1).

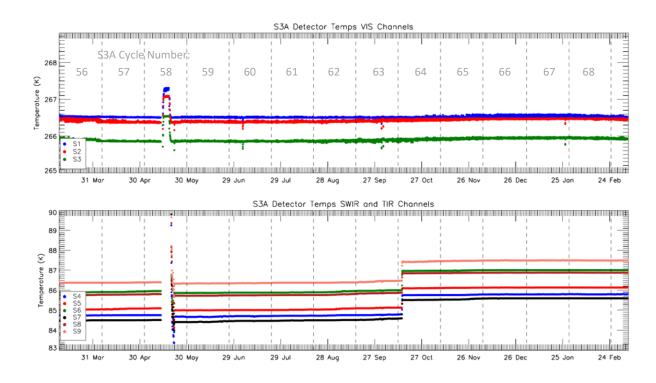


Figure 3: SLSTR-A detector temperatures for each channel for the last year of operations. Discontinuities occur for the infrared channels where the FPA was heated for decontamination. The vertical dashed lines indicate the start and end of each cycle. Each dot represents the average temperature in one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

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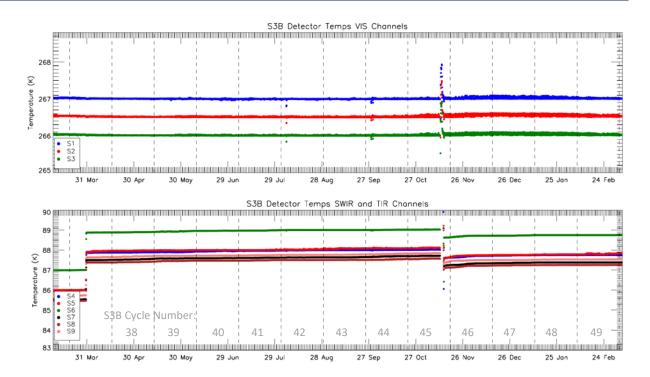


Figure 4: SLSTR-B detector temperatures for each channel for the last year of operations. Discontinuities occur for the infrared channels where the FPA was heated for decontamination. The vertical dashed lines indicate the start and end of each cycle. Each dot represents the average temperature in one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



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2.3 Scanner performance

The actual position of the scan and flip mirrors is measured by the instrument, and Figure 5 shows the statistics of the difference from the expected linear control law for each mirror in each view during SLSTR-A Cycle 068. Figure 6 shows the equivalent trends for SLSTR-B in Cycle 049. The performance has been consistent with previous operations and does not appear to be degrading. For reference, one arcsecond corresponds to roughly 4m on the ground.

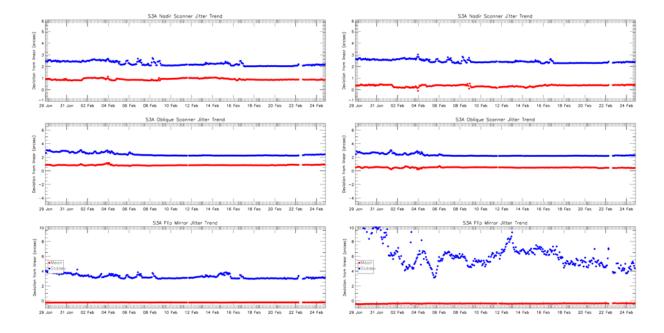


Figure 5: SLSTR-A scanner and flip jitter for Cycle 068, showing mean and stddev from expected position per orbit (red and blue respectively) for the nadir view (left) and oblique view (right). The plots show the nadir scanner (top), oblique scanner (middle) and flip mirror (bottom).

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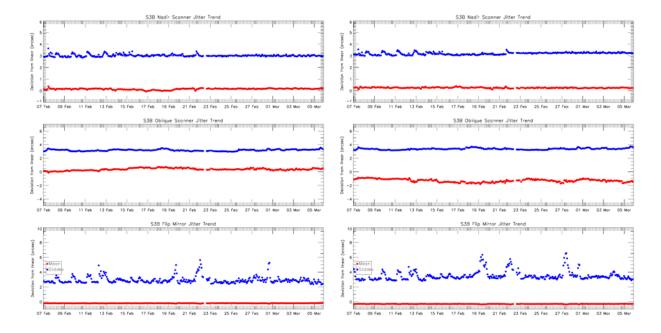


Figure 6: SLSTR-B scanner and flip jitter long term in Cycle 049, showing mean and stddev difference from expected position per orbit (red and blue respectively) for the nadir view (left) and oblique view (right). The plots show the nadir scanner (top), oblique scanner (middle) and flip mirror (bottom).



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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 ± 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.

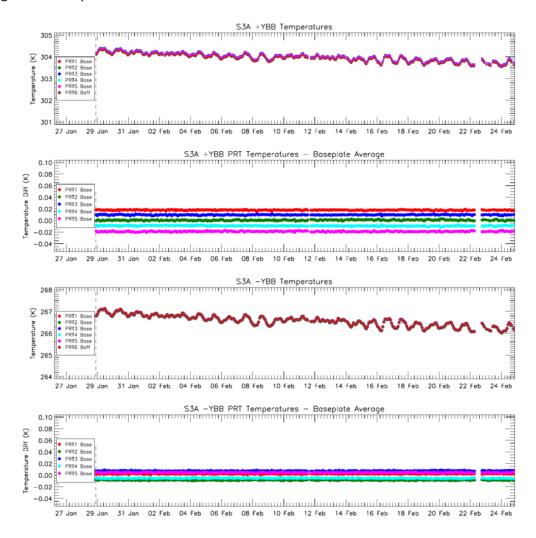


Figure 7: SLSTR-A blackbody temperature and baseplate gradient trends during Cycle 068. The vertical dashed lines indicate the start and end of the cycle. Each dot represents the average temperature in one orbit.

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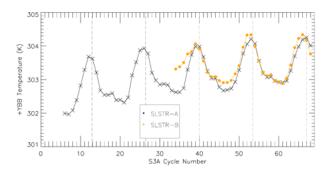


Figure 8: SLSTR-A and SLSTR-B long term trends in average +YBB temperature, showing yearly variation. The vertical dashed lines approximately indicate the 1st January 2017, 2018, 2019, 2020 and 2021.

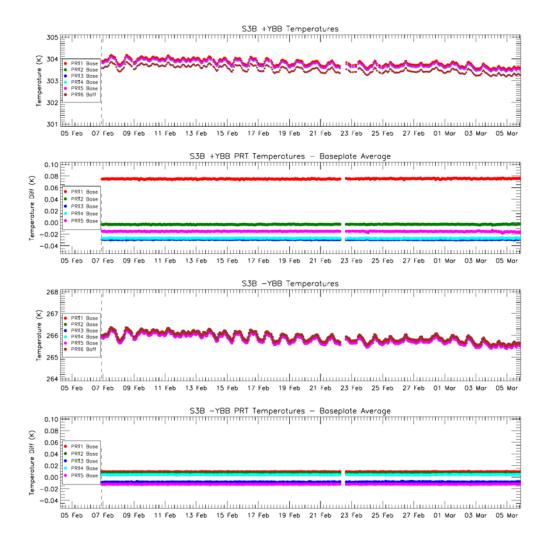


Figure 9: SLSTR-B blackbody temperature and baseplate gradient trends during Cycle 049. The vertical dashed lines indicate the start and end of the cycle. Each dot represents the average temperature in one orbit.



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2.5 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 068 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 058	Cycle 059	Cycle 060	Cycle 061	Cycle 062	Cycle 063	Cycle 064	Cycle 065	Cycle 066	Cycle 067	Cycle 068
S1	0.187	238	236	242	239	238	246	246	241	241	246	244
S2	0.194	243	239	240	243	242	243	246	250	246	246	246
S3	0.190	232	225	225	229	231	231	232	230	231	234	236
S4	0.191	166	165	164	166	169	170	175	176	176	177	176
S5	0.193	279	281	279	279	282	284	287	288	288	292	291
S6	0.175	176	177	178	178	181	184	186	188	189	190	188

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.

	11 cycles, averaged over an acceptors for the oblique view.											
	Average Oblique Signal-to-noise ratio											
	Reflectance Factor	Cycle 058	Cycle 059	Cycle 060	Cycle 061	Cycle 062	Cycle 063	Cycle 064	Cycle 065	Cycle 066	Cycle 067	Cycle 068
S1	0.166	252	245	258	255	253	262	268	265	264	269	269
S2	0.170	258	249	256	261	261	260	265	272	273	269	264
S3	0.168	237	226	227	233	241	241	241	240	241	241	243
S4	0.166	136	133	135	137	138	139	140	141	142	141	139
S5	0.166	214	210	213	211	216	214	215	218	215	210	209
S6	0.155	131	130	130	131	133	133	135	137	136	134	131

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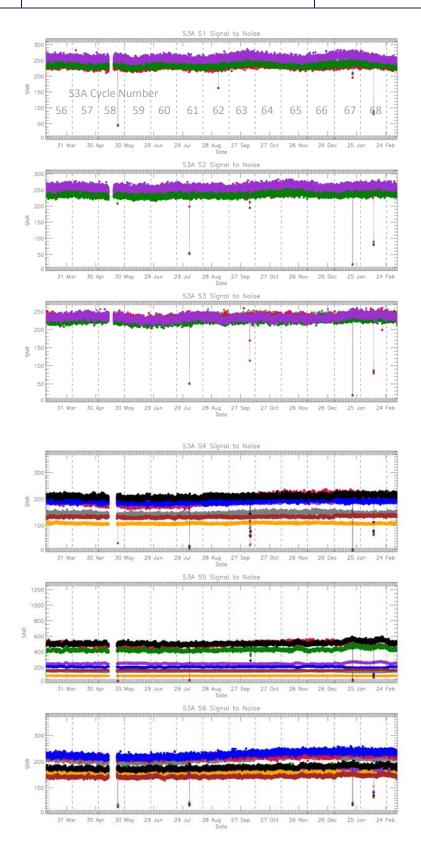


Figure 10: VIS and SWIR channel signal-to-noise of the measured VISCAL signal in each orbit for the last year of operations for SLSTR-A. Different colours indicate different detectors. The vertical dashed lines indicate the start and end of each cycle.



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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 049 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 Sig	gnal-to-no	ise ratio				
	Reflectance Factor	Cycle 039	Cycle 040	Cycle 041	Cycle 042	Cycle 043	Cycle 044	Cycle 045	Cycle 046	Cycle 047	Cycle 048	Cycle 049
S1	0.177	224	224	224	228	228	230	233	232	232	236	231
S2	0.192	217	214	218	219	219	222	221	222	223	224	224
S3	0.194	219	223	225	221	227	233	228	229	233	234	227
S4	0.186	129	129	129	130	131	131	130	132	132	131	130
S5	0.184	241	240	239	241	241	241	244	246	246	244	244
S6	0.162	160	159	159	162	160	159	162	165	166	167	165

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 Oblique Signal-to-noise ratio								0					
	Reflectance Factor	Cycle 039	Cycle 040	Cycle 041	Cycle 042	Cycle 043	Cycle 044	Cycle 045	Cycle 046	Cycle 047	Cycle 048	Cycle 049	
S1	0.157	215	216	216	218	220	223	224	229	227	227	225	
S2	0.168	247	241	247	246	251	255	255	260	260	260	258	
S3	0.172	251	254	250	251	259	257	259	262	269	260	257	
S4	0.168	126	125	127	127	127	128	128	130	132	129	128	
S5	0.172	242	242	242	242	242	241	244	248	249	247	247	
S6	0.152	179	178	179	181	183	184	185	188	188	186	185	



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2.5.3 SLSTR-A TIR channel NEDT

The thermal channel NEDT values for SLSTR-A in Cycle 068 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.

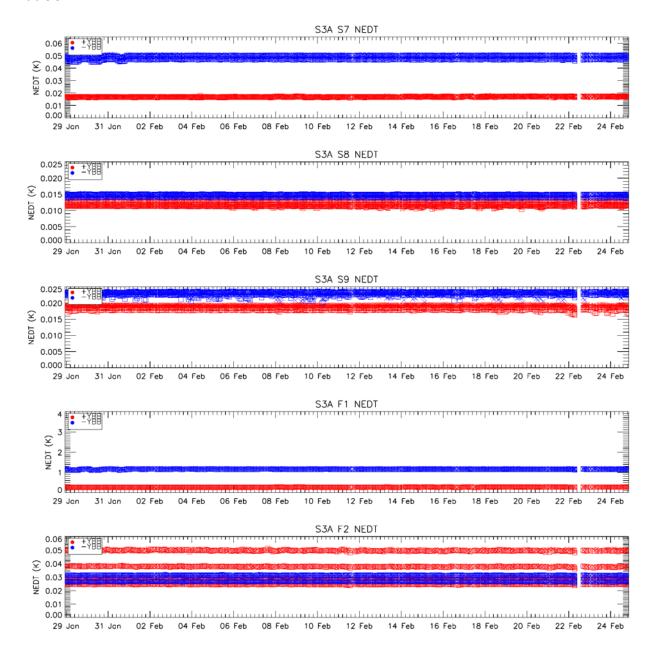


Figure 11: SLSTR-A NEDT trend for the thermal channels in Cycle 068. Blue points were calculated from the cold blackbody signal and red points from the hot blackbody. The square symbols show results calculated from the nadir view and crosses show results from the oblique view. Results are plotted for all detectors and integrators, which is why there are several different levels within the same colour points (particularly for S8 and F2).

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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).

SLSTF	SLSTR-A		Cycle 059	Cycle 060	Cycle 061	Cycle 062	Cycle 063	Cycle 064	Cycle 065	Cycle 066	Cycle 067	Cycle 068
+YBB temp (K)		303.078	302.957	302.920	302.914	302.962	303.265	303.700	303.981	304.190	304.250	304.013
	S7	17.2	17.3	17.4	17.4	17.3	17.9	17.2	16.9	16.9	16.9	17.0
NEDT	S8	11.2	11.3	11.4	11.5	11.4	11.6	11.8	11.9	11.8	11.9	11.9
NEDT (mK)	S9	17.3	17.5	17.5	17.6	17.6	17.8	18.5	18.6	18.6	18.6	18.7
(,	F1	268	274	277	277	274	342	271	267	266	267	273
	F2	35.3	35.3	35.0	35.1	36.0	35.1	35.2	35.4	35.5	35.4	35.3

SLSTF	SLSTR-A		Cycle 059	Cycle 060	Cycle 061	Cycle 062	Cycle 063	Cycle 064	Cycle 065	Cycle 066	Cycle 067	Cycle 068
-YBB temp (K)		265.797	265.645	265.545	265.438	265.401	265.731	266.335	266.751	266.930	266.930	266.583
	S7	50.4	49.5	49.4	49.5	49.6	48.0	48.7	47.6	47.0	47.1	48.7
	S8	14.1	14.1	14.1	14.1	14.1	14.2	14.6	14.7	14.5	14.6	14.7
NEDT (mK)	S9	21.5	21.5	21.6	21.7	21.7	21.6	22.7	22.8	22.8	22.8	23.0
(IIIK)	F1	1196	1197	1205	1204	1206	1173	1150	1128	1118	1128	1165
	F2	27.8	27.8	27.8	27.8	27.9	28.2	28.8	28.9	28.9	28.9	29.0

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2.5.4 SLSTR-B TIR channel NEDT

The thermal channel NEDT values for SLSTR-B in Cycle 049, calculated from the hot and cold blackbody signals are shown in Figure 12 and Table 6.

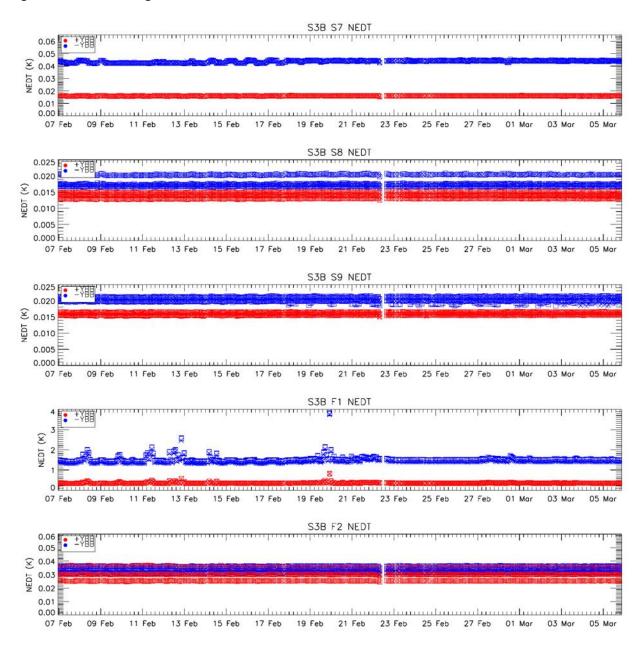


Figure 12: SLSTR-B NEDT trend for the thermal channels in Cycle 049. Blue points were calculated from the cold blackbody signal and red points from the hot blackbody. The square symbols show results calculated from the nadir view and crosses show results from the oblique view. Results are plotted for all detectors and integrators, which is why there are several different levels within the same colour points (particularly for S8 and F2).

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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).

SLSTF	SLSTR-B		Cycle 040	Cycle 041	Cycle 042	Cycle 043	Cycle 044	Cycle 045	Cycle 046	Cycle 047	Cycle 048	Cycle 049
+YBB temp (K)		303.145	302.971	302.930	302.882	303.045	303.435	303.951	304.224	304.339	304.187	303.764
	S7	16.0	16.2	16.3	16.3	16.2	16.7	16.0	15.8	15.8	15.8	16.1
NEDT	S8	14.4	14.5	14.5	14.5	14.5	14.6	14.3	13.8	13.8	13.9	14.0
NEDT (mK)	S9	16.5	16.6	16.7	16.8	16.9	17.0	16.6	15.7	15.8	15.8	15.9
,,	F1	413	442	406	435	466	481	410	396	404	339	358
	F2	30.5	30.5	30.5	30.4	30.3	30.5	30.6	30.7	30.9	30.7	30.5

SLSTF	SLSTR-B		Cycle 040	Cycle 041	Cycle 042	Cycle 043	Cycle 044	Cycle 045	Cycle 046	Cycle 047	Cycle 048	Cycle 049
-YBB temp (K)		265.443	265.224	265.105	264.952	265.097	265.506	266.184	266.547	266.643	266.385	265.817
	S7	44.1	44.0	44.2	44.8	44.5	42.8	42.9	42.5	42.5	42.5	43.7
NEDT	S8	18.2	18.2	18.2	18.3	18.4	18.2	18.2	17.8	17.9	17.9	17.9
NEDT (mK)	S9	21.2	21.3	21.5	21.6	21.7	21.5	21.4	20.0	20.1	20.3	20.4
(iiik)	F1	1756	1875	1687	1844	2002	1871	1696	1667	1717	1396	1480
	F2	33.6	33.6	33.8	34.1	34.2	34.1	33.8	32.9	33.0	33.1	33.2



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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, decontaminations were performed during Cycle 30 and Cycle 64.

There is a step in the SWIR channel radiometric response for SLSTR-B in Cycle 37 and in Cycle 64 for SLSTR-A due to the change in temperature of the detectors caused by the cooler set point change.



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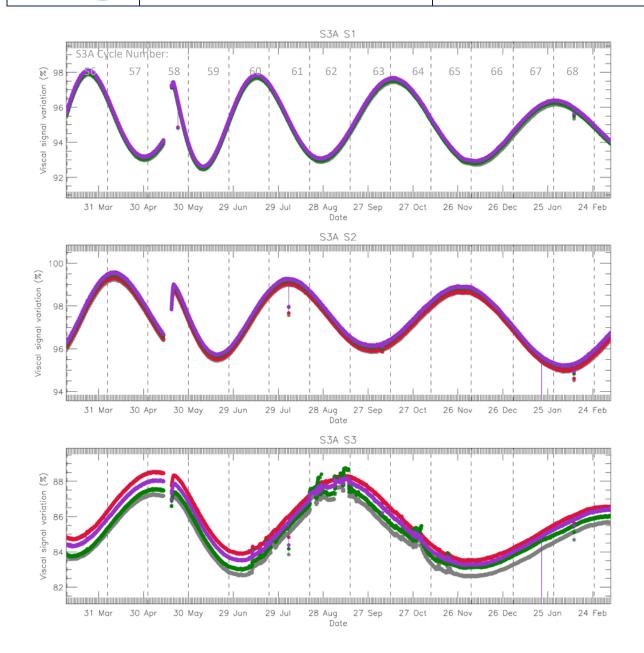


Figure 13: Variation of the radiometric gain derived from the VISCAL signals for SLSTR-A VIS channels for the last year of operations (nadir view). Different colours represent different detectors. The vertical dashed lines indicate the start and end of each cycle.



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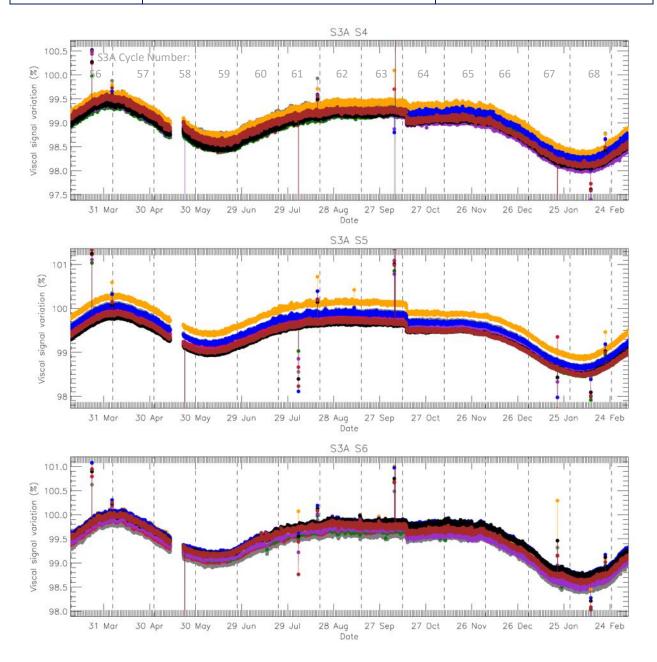


Figure 14: Variation of the radiometric gain derived from the VISCAL signals for SLSTR-A SWIR channels for the last year of operations (nadir view). Different colours represent different detectors. The vertical dashed lines indicate the start and end of each cycle.



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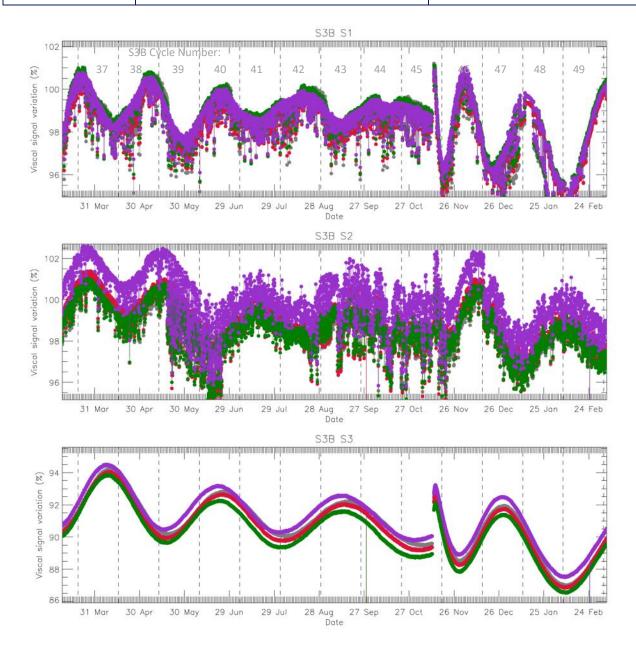


Figure 15: Variation of the radiometric gain derived from the VISCAL signals for SLSTR-B VIS channels for the past year (nadir view). Different colours represent different detectors. The vertical dashed lines indicate the start and end of each cycle.



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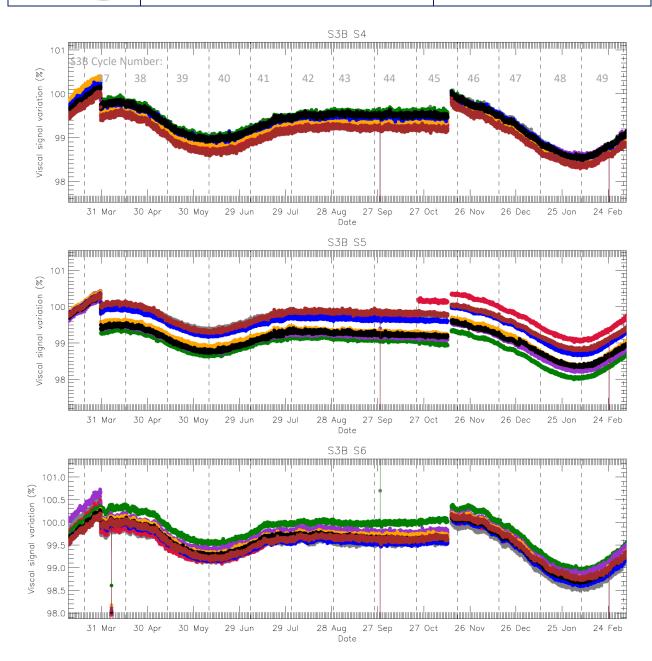


Figure 16: Variation of the radiometric gain derived from the VISCAL signals for SLSTR-B SWIR channels for the past year (nadir view). Different colours represent different detectors. The vertical dashed lines indicate the start and end of each cycle.



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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 068 and Figure 18 for SLSTR-B in Cycle 049, giving the average positional offsets in kilometres for Nadir and Oblique views.

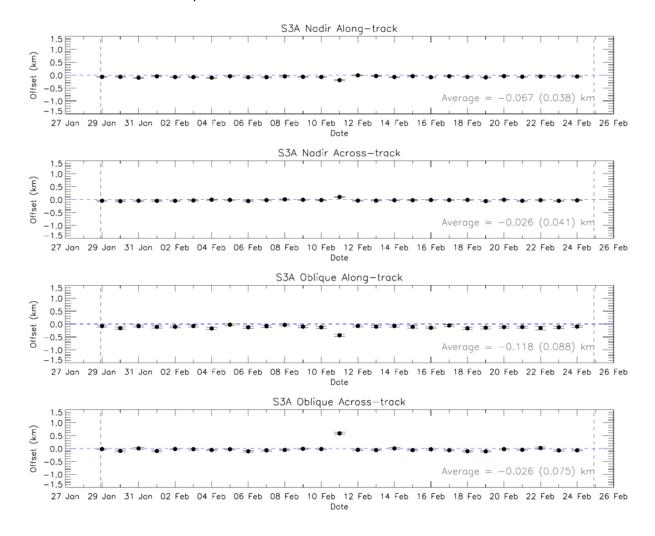


Figure 17: SLSTR-A daily offset results in km from the GeoCal Tool analysis for Nadir along- and across-track (top two plots) and Oblique along- and across-track (bottom two plots) for Cycle 068. The error bars show the standard deviation.

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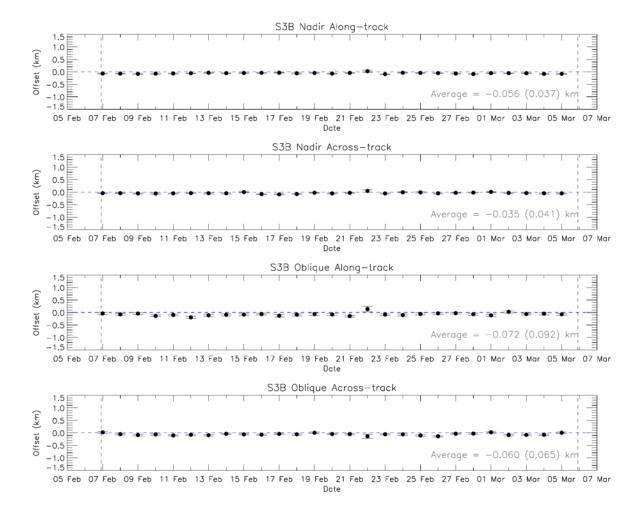


Figure 18: SLSTR-B daily offset results in km from the GeoCal Tool analysis for Nadir along- and across-track (top two plots) and Oblique along- and across-track (bottom two plots) for Cycle 049. The error bars show the standard deviation.

The offset for SLSTR-A on 11th February corresponds to the day when there was a whole orbit of missing data due to an antenna issue at the ground station (see Section 6.1).



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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 http://s3etrac.acri.fr/index.php?action=generalstatistics#pageSLSTR

- 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, and Figure 23 shows the results of the inter-comparison analysis with MODIS. Average ratios in each case are given in the figures.

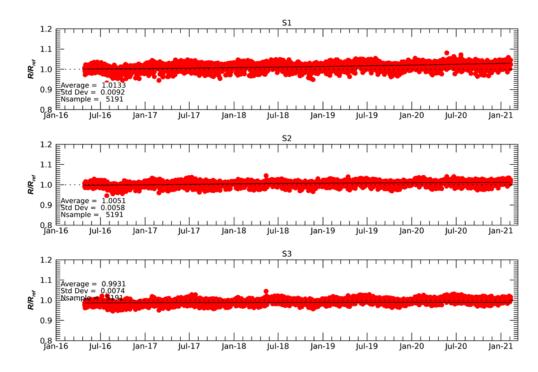


Figure 19: Ratio of SLSTR-A and OLCI-A radiances for the visible channels in Nadir view using combined results for all desert sites.

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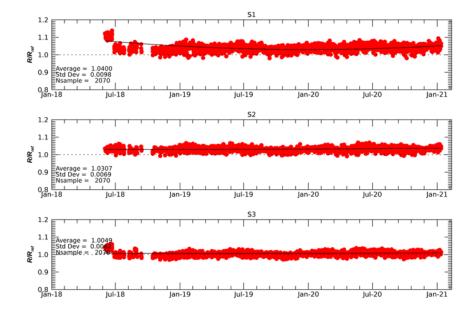


Figure 20: Ratio of SLSTR-B and OLCI-B radiances for the visible channels in Nadir view using combined results for all desert sites.

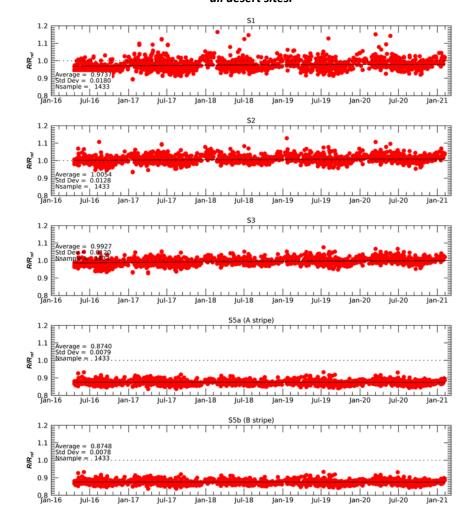


Figure 21: Ratio of SLSTR-A and AATST radiances in Nadir view using combined results for all desert sites.

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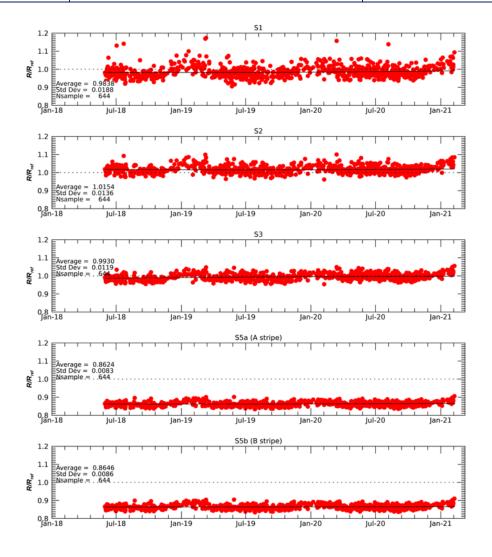


Figure 22: Ratio of SLSTR-B and AATST radiances in Nadir view using combined results for all desert sites.

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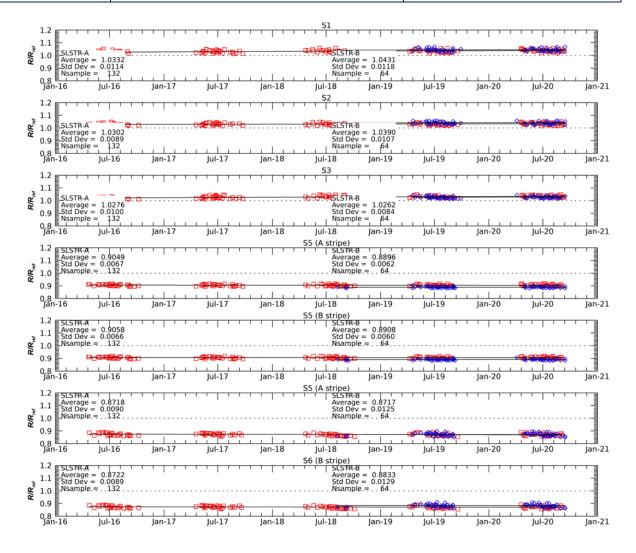


Figure 23: Ratio of SLSTR-A (red) and SLSTR-B (blue) and MODIS radiances radiances in Nadir view using combined results for all desert sites.

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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 24 shows an example combined SLSTR-A/SLSTR-B image for the visible channels from the previous cycle on 18th February 2021 (daytime only).

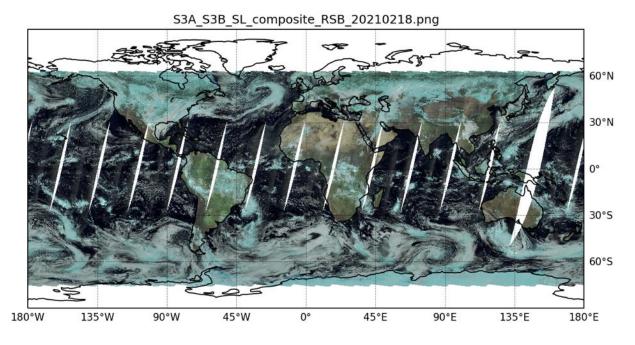


Figure 24: Daytime combined SLSTR-A and SLSTR-B Level-1 image for visible channels on 18th February 2021.

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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 068 for SLSTR-A and 049 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 25th February 2019. In each case the latest temporal interpolation for the probabilistic cloud mask is applied following the L1 operational release on 15th January 2020. The updated cloud coefficients ADF was applied on 23rd October 2020.

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)		
	Day	Night	
S3A	0.7	0.6	
S3B	0.9	0.5	

For both SLSTR-A and SLSTR-B both the daytime and night-time accuracies are within 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. 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. An updated cloud coefficients ADF was delivered on 23rd October 2020.



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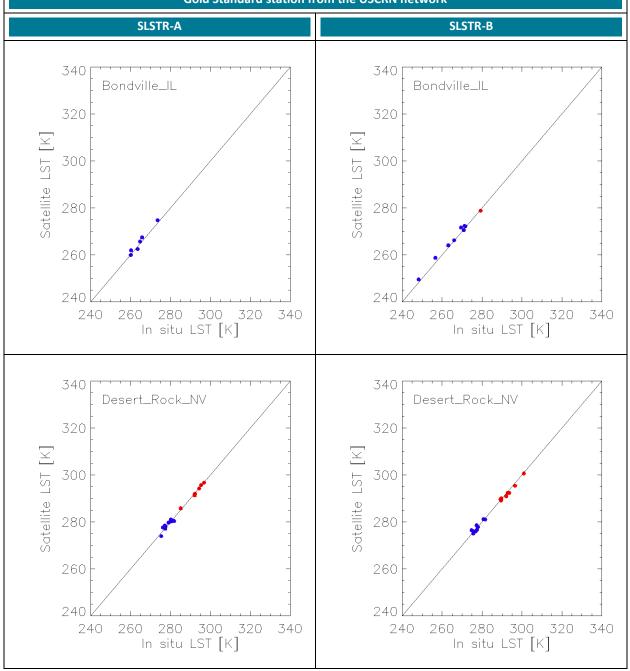
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Validation of the SL_2_LST product over Cycle 068 (SLSTR-A) and Cycle 049 (SLSTR-B) at seven Gold Standard in situ stations of the SURFRAD network plus two Gold Standard station from the ARM network, and two Gold Standard station from the USCRN network





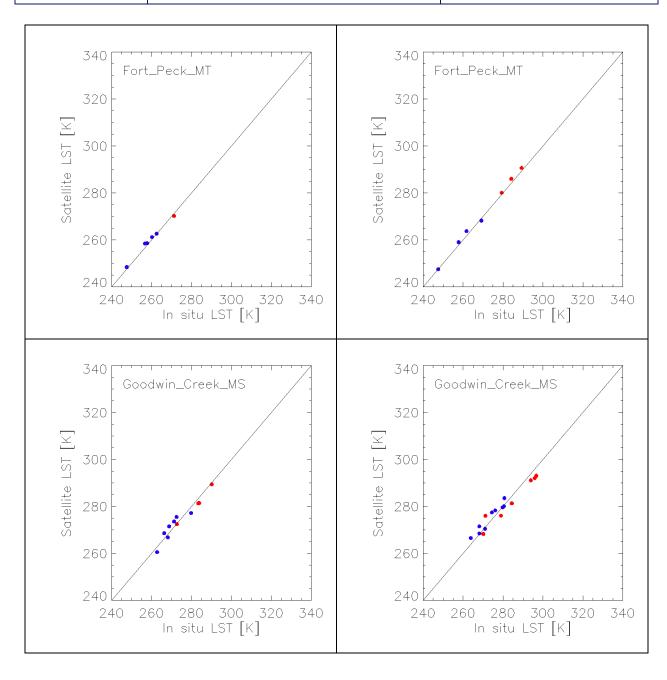
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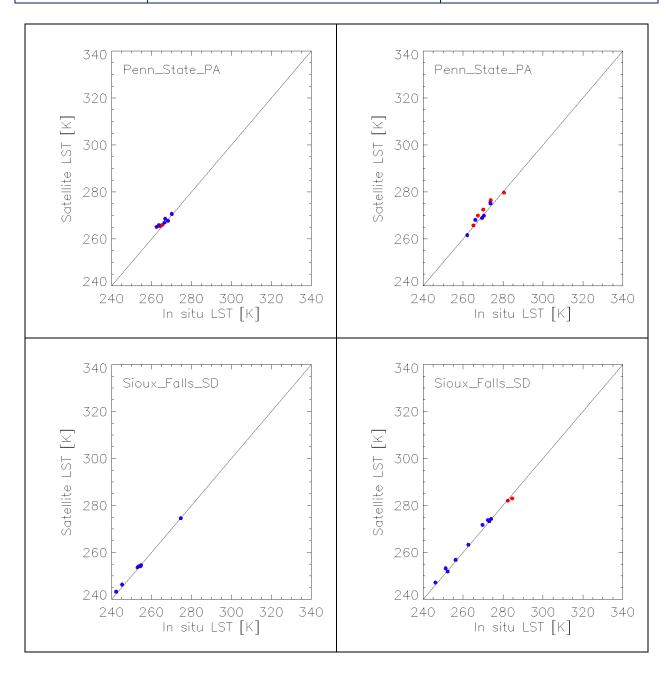
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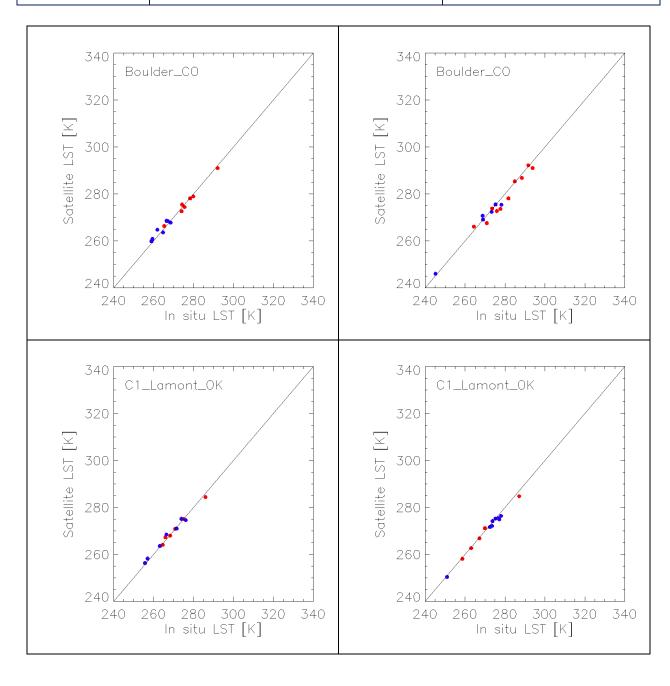
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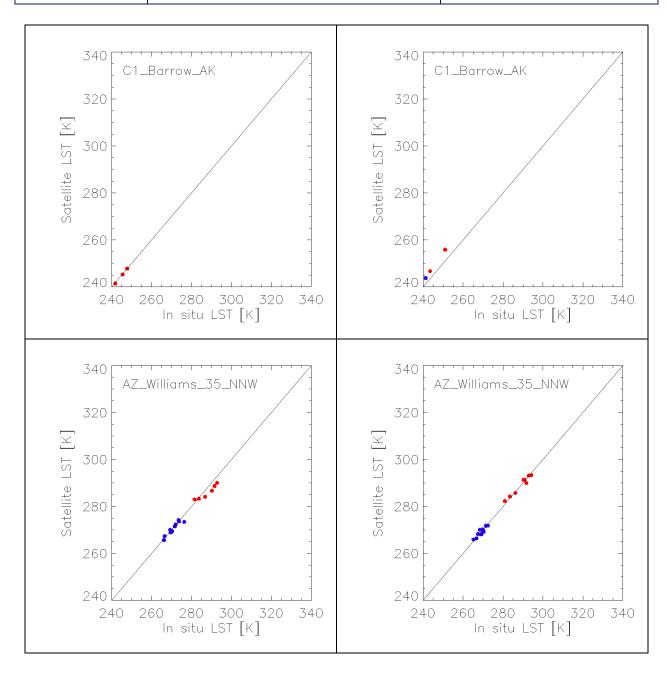
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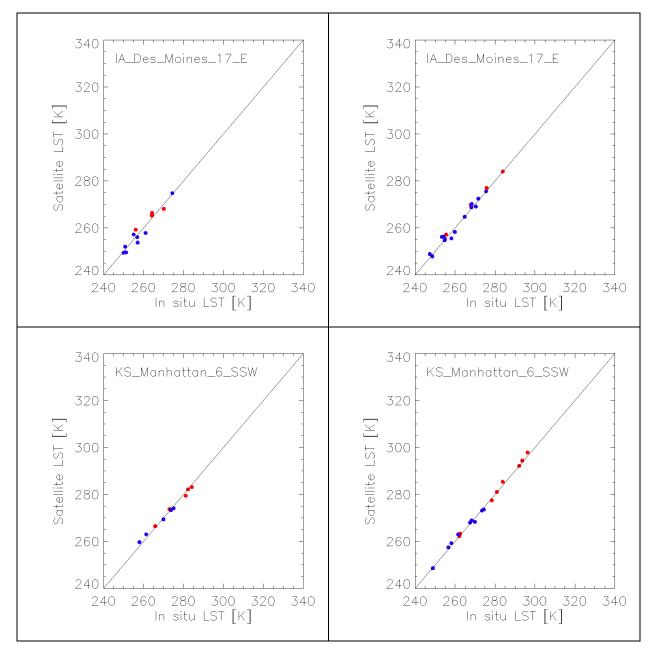
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As with past cycles cloud has reduced the number of matchups per station to single figures for most stations during day or night, with some missing statistics entirely. It is therefore challenging to determine robust statistics. Nonetheless, it can 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 068 (SLSTR-A) and Cycle 049 (SLSTR-B)				
	SLSTR-A		SLSTR-B		
	Day	Night	Day	Night	
Africa	-0.0	-0.1	0.1	0.1	
Europe	1.4	2.2	1.1	2.0	

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 and north-eastern Europe) 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



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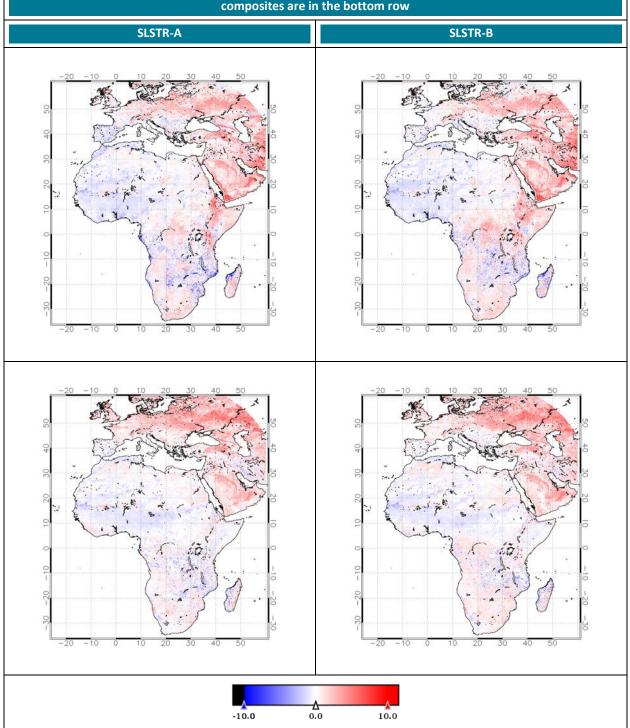
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Intercomparison of the SL_2_LST product with respect to the operational LSA SAF SEVIRI LST product for the period of Cycle 068 (SLSTR-A) and Cycle 049 (SLSTR-B). Daytime composites are in the top row and Night-time composites are in the bottom row



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



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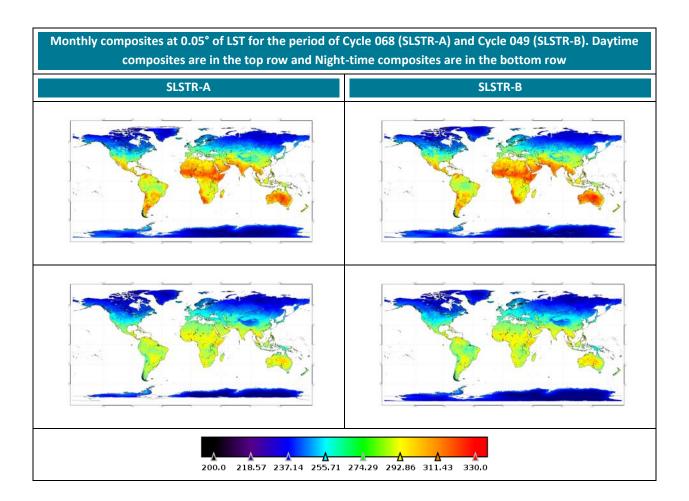
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SLSTR (strong negative differences) and SEVIRI (strong positive differences), compared with cycles where the basic cloud mask was used the contamination for SLSTR is lower indicating improved masking with the Probabilistic Cloud Mask. However, less 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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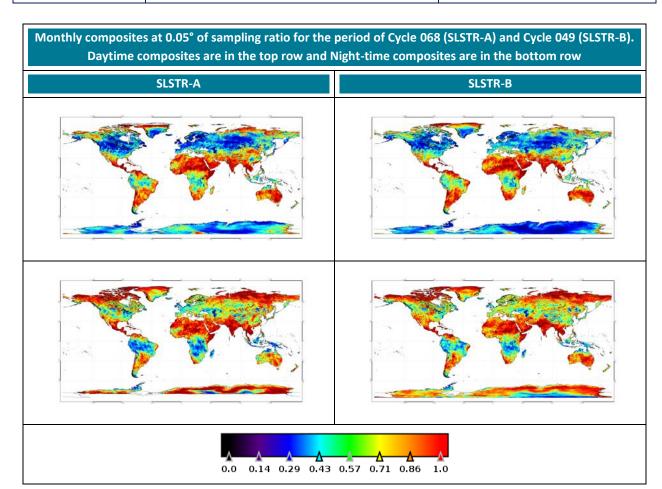
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The LST fields indicate the SL_2_LST product is producing values in line with expectations for both SLSTR-A and SLSTR-B. There are no distinct issues or non-physical values evident. The sampling ratio is now closer to what would be expected across the globe following the implementation of the temporal interpolation for the probabilistic cloud mask on 15th 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 has now been implemented as of 23rd October 2020.



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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:

- ❖ 11th February 2021, 14:01-15:46 data gap (missing orbit) caused by ground station antenna issue.
- ❖ 16th February 2021, 15:13-15:21 data gaps caused by radio frequency interference.
- ❖ 16th February 2021, 15:07-18:23 orbit affected by pointing issues due to data gap.
- ❖ 17th February 2021, 10:00-10:15 data gaps caused by radio frequency interference.
- ❖ 21st February 2021, 00:30-00:35 data gaps caused by 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:

- 24th February 2021, 09:20-09:24 data gaps caused by data transfer delay.
- ❖ 24th February 11:05 25th February 05:33 possible gaps and missing scans in NRT data due to data production issue.
- 24th February 2021, 10:46-14:08 possible pointing errors due to production issue.
- 2nd March 2021, 13:34-13:40 data gaps caused by radio frequency interference.



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7 Appendix A

Other reports related to the Optical mission are:

S3 OLCI Cyclic Performance Report, S3A Cycle No. 068, S3B Cycle No. 049 (ref. S3MPC.ACR.PR.01-068-049)

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

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