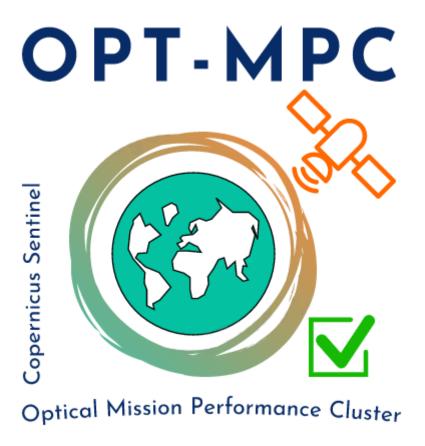
COPERNICUS SPACE COMPONENT SENTINEL OPTICAL IMAGING MISSION PERFORMANCE CLUSTER SERVICE

Data Quality Report

Sentinel-3 SLSTR - April 2024



Ref.: OMPC.LDO.DQR.04.04-2024

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Changes Log

Version	Date	Changes
1.0	13/05/2024	First version

OPT-MPC Total Mission Performance Cluster Ontical Mission Performance Cluster

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1 Executive Summary

This section provides a summary of the data quality for SLSTR-A and SLSTR-B over the month of operation.

Any relevant formal instrument data requirements are added under the subsequent section headers for reference.

Each month the data measured by SLSTR-A and SLSTR-B are checked for quality and it is determined whether they meet the requirements specified in Sentinel-3 Mission Requirements Document, using the methods in the Sentinel-3 Cal-Val Plan.

A summary of the status from each check performed is provided below. A traffic light system is used, where the categories are determined as follows

- Gray indicates no change over the reporting period
- Green indicates that aspect is performing optimally
- Amber indicates there are some issues noted that may affect data quality or availability this month, or a user correction that needs to be applied
- Red indicates a significant quality issue, or instrument anomaly for some of the month

Follow the link on each topic header for more detailed information contained in this document.

Topic	Instrument	Comments
Processing Baseline	S3A	Deployment of the latest processing baseline including OLQC and
Version	S3B	surface classification evolution
Event	S3A	Several events occurred this month without impact on data quality
	S3B	Several events occurred this month without impact on data quality
Instrument status	S3A	
	S3B	
Level-1 TIR	S3A	
Radiometric Validation	S3B	
Level- 1 VIS SWIR Radiometric Validation	S3A	Vicarious validation indicates calibration offsets need to be applied to the VIS/SWIR channels
		New validation results using PICS method
	S3B	Vicarious validation indicates calibration offsets need to be applied to the VIS/SWIR channels
		New validation results using PICS method
Level-1 Geometric	S3A	
Validation	S3B	
Level 2 LST validation	S3A	
	S3B	



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Topic	Instrument	Comments
Level 2 FRP validation	S3A	
	S3B	



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2 Processing status

2.1 Processing baseline status

The Processing Baseline Version allows traceability of any changes to the software used to process the SLSTR products, and any updates to the auxiliary data files used to generate them.

The processing baseline identifier is now provided in the manifest file and in the global attributes of each file. The identifier comprises of seven characters (e.g. SL_L1_) which indicates the product type, and seven characters to indicate its version, xxx.yy.zz (e.g. 004.04.00). The version number, xxx indicates baseline collection, yy indicates change due to the IPF or ADF and zz indicates change in system components (e.g. L0, PUG) that do not impact data quality but are included to allow full traceability.

The latest SLSTR L1 PB 3.26 (including SL1_06.22/SL__L1_.004.07.00) has been deployed on 23/04/2024 on both S3B and S3A Land Processing centers. This processing baseline is impacting both SLSTR format (with the addition of two parameters in the flags_**.nc files) and the quality of SLSTR products (with the improvement of the coastline definition and the definition of the OLQC parameter, indicating if the product is affected by a major or minor issue).

With this delivery, an updated version of the PUG (V3.50) has been deployed.

The product Notice and the SLSTR Land Handbook has been updated accordingly.

IPF	IPF / Processing Baseline version	Date of deployment
S3A		
SL1	06.22 / SLL1004.07.00	23/04/2024
SL2 LST	06.22 / SLLST.004.07.02	25/07/2023
SL2 FRP (NTC)	01.09 / FRP_NTC.004.08.02	25/07/2023

IPF	IPF / Processing Baseline version	Date of deployment
S3B		
SL1	06.22 / SLL1004.07.00	23/04/2024
SL2 LST	06.22 / SLLST.004.07.02	18/07/2023
SL2 FRP (NTC)	01.09 / FRP_NTC.004.08.02	18/07/2023

Deployment of the SLSTR L1 PB 3.26 including OLQC and surface classification evolutions has been performed on 23/04/2024 leading to an improvement of the data quality of SLSTR products.



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2.2 Processing anomalies

No specific issue or evolutions has been identified this month on SLSTR.

There has been no major anomaly on data quality within the reported period.

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3 Events and instrument anomalies

Any events that have occurred in this month that cause significant data gaps and impact on quality are reported here.

Some background to the typical events that might occur are provided below

- RFI Radio Frequency Interference occurs when another satellite causes the data downlink to the receiving station to be interrupted, and the data is lost.
- Scheduled manoeuvres may take place for Lunar views for calibration purposes, collision avoidance, or to maintain the nominal orbit. Will often result in the pointing flag being raised, and the geolocation accuracy is not nominal during this time.
- Blackbody cross over tests occur approximately once per year and the hot and cold blackbodies are swapped round for instrument testing.
- De-icing occurs when the instrument is heated to remove the build-up of ice.

3.1 SLSTR-A

SLSTR-A was switched on and operating nominally during April 2024, with Scan Unit Electronics (SUE) scanning and autonomous switching between day and night modes.

Note that on 7th April, several products were affected by gaps and missing scans due to an erroneous dump. All affected products have been reprocessed and replaced on CDSE.

- 1st April, 16:39 16:45 Data gaps due to RFI
- ❖ 3rd April, 11:20 11: 37 Pointing flag raised due to In-Plane manoeuvre.
- ❖ 5th April, 05:57 06:03 Data Gaps for unknown reason (issue visible on all OPT products)
- 9th April, 21:44 21:50 Data gaps due to RFI
- ❖ 14th April, 21:38 21:44 Data gaps due to unknown reason
- 20th April, 17:28 17:31 Data gaps
- 21st April, 14:04 14:10 Data gaps due to RFI
- 22nd April, 03:08 03:11 Data gaps
- ❖ 24th April, 14:35 14:41 Data gaps due to RFI
- ❖ 24th April, 08:51 − 09:05 − Pointing flag raised due to In-Plane manoeuvre.
- ❖ 25th April, 00:14 − 00:23 − Data gaps due to RFI

3.2 SLSTR-B

SLSTR-B was switched on and operating nominally during April 2024, with SUE scanning and autonomous switching between day and night modes.

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❖ 11th April, 21:18 – 21:54 – Data gaps due to RFI

❖ 17th April, 07:51 − 08:05 − Pointing flag raised due to In-Plane manoeuvre.

23rd April, 15:45 – 15:51 – Data gaps due to RFI

❖ 24th April, 11:21 − 11:42 − Data gaps and Pointing flag raised due to OLCI Moon Calibration

❖ 25th April, 07:40 – 07:57 – Pointing flag raised due to In-Plane manoeuvre.

26th April, 22:52 – 23:01 – Data gaps due to unknown reason

27th April, 11:51 – 11:57 – Data gaps due to RFI



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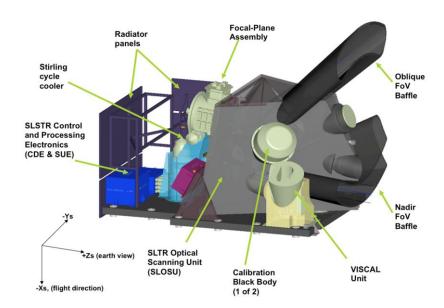
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4 Instrument Status

The health of the instrument impacts the data quality. This section contains in depth analysis of several instrument parameters over the month of operation, and in some cases, the latest annual and mission tends for context.

SLSTR is a scanning radiometer, and uses two black bodies for thermal calibration, and a VISCAL unit for visible and shortwave IR calibration via the Sun. The key instrument properties that are monitored include:

- instrument temperature of the baffles
- instrument temperature of the Optical Mechanical Enclosure (optical bench, flip mirror and scan mirror, internal baffles)
- detector temperatures
- scanner and flip mirror performance



Sentinel 3 A

The instrument was stable and compliant with requirements over the current month.

Sentinel 3 B

The instrument was stable and compliant with requirements over the current month.

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4.1 Instrument temperatures

As a thermal infrared instrument, thermal stability and uniformity of the optical mechanical enclosure (OME) is critical to the radiometric calibration. In this section we show the orbital average temperature of the OME and instrument baffles during the month. We expect to see a very small daily variation in temperature superimposed on a stable level over the month.

4.1.1 SLSTR-A

Figure 1 shows the orbital average temperature of the OME and instrument baffles for SLSTR-A during the month.

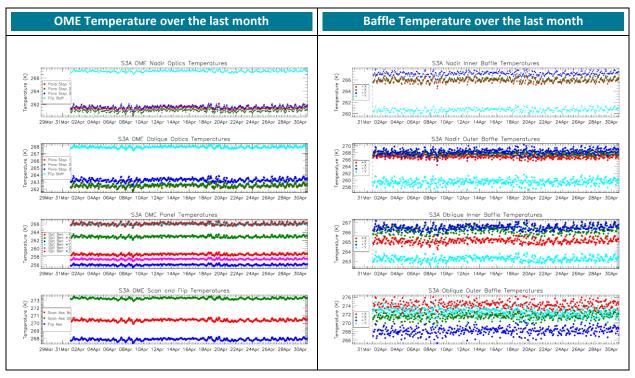


Figure 1: OME temperature trends for SLSTR-A (left) and Baffle temperature trends (right) during April 2024. The OME plot shows the three paraboloid stops and flip baffle (top two plots) and optical bench at different positions (third plots), and scanner and flip assembly (bottom plots). The Baffle plot shows the temperature at different positions on the inner and outer baffles. Each dot represents the average temperature in one orbit.

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4.1.2 SLSTR-B

Figure 2 shows the orbital average temperature of the OME and instrument baffles for SLSTR-B during the month. The temperatures were stable (on top of a daily variation cycle).

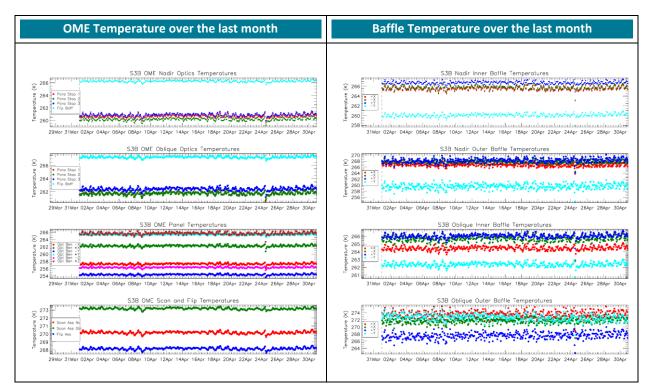


Figure 2: SLSTR-B OME temperature trends (left) and Baffle temperature trends (right) during April 2024. The OME plot shows the three paraboloid stops and flip baffle (top two plots) and optical bench at different positions (third plots), and scanner and flip assembly (bottom plots). The Baffle plot shows the temperature at different positions on the inner and outer baffles. Each dot represents the average temperature in one orbit.

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4.2 Detector temperatures

The detector temperatures for both SLSTR-A and SLSTR-B were stable at their expected values over the month.

4.2.1 SLSTR-A

Figure 3 shows the annual trend in SLSTR-A detector temperatures for the past year. The temperatures from this month are consistent with the yearly trend.

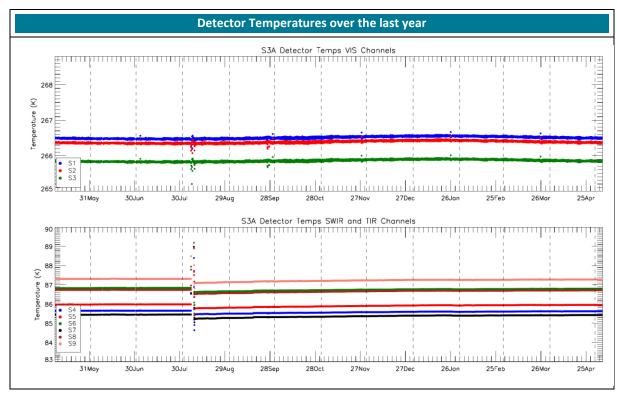


Figure 3: SLSTR-A detector temperatures for each channel for the last month of operations. The vertical dashed lines indicate the start of each month. Each dot represents the average temperature in one orbit. The different colours indicate different detectors.

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4.2.2 SLSTR-B

Figure 4 shows the annual trend in SLSTR-B detector temperatures for the past year. The temperatures from this month are consistent with the yearly trend.

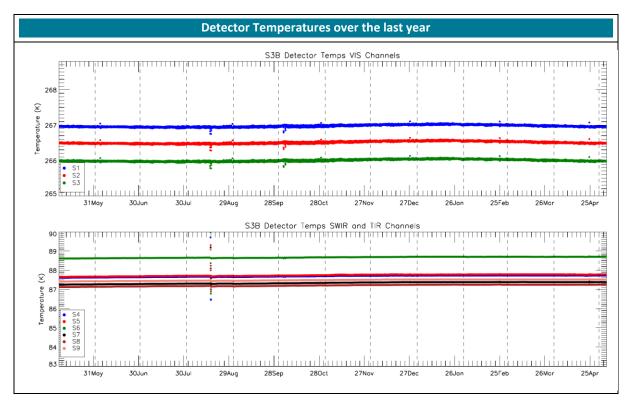


Figure 4: SLSTR-B detector temperatures for each channel for the last month of operations. The vertical dashed lines indicate the start of each month. Each dot represents the average temperature in one orbit. The different colours indicate different detectors.

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4.3 Scanner performance

The actual position of the scan and flip mirrors is measured by the instrument, and in this section we show the statistics of the difference from the expected linear control law for each mirror in each view during April 2024. The performance has been consistent with previous operations and does not appear to be degrading. For reference, one arcsecond corresponds to roughly 4 m on the ground.

4.3.1 SLSTR-A

Figure 5 shows the statistics of the difference from the expected linear control law for each mirror in each view for SLSTR-A during the month.

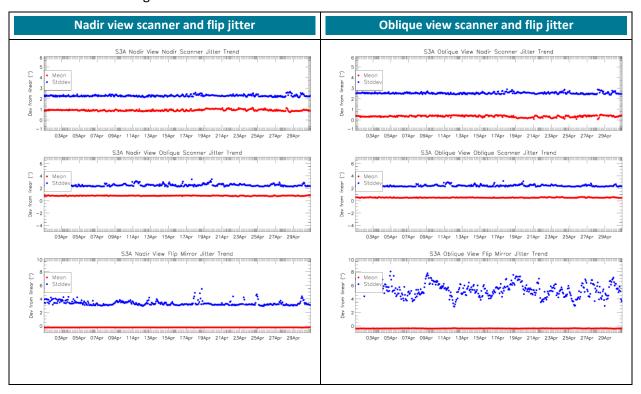


Figure 5: SLSTR-A scanner and flip jitter for April 2024, showing mean and stddev from expected position per orbit (red and blue respectively) for the nadir view (left) and oblique view (right). The plots show the nadir scanner (top), oblique scanner (middle) and flip mirror (bottom).

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4.3.2 SLSTR-B

Figure 6 shows the statistics of the difference from the expected linear control law for each mirror in each view for SLSTR-B during the month.

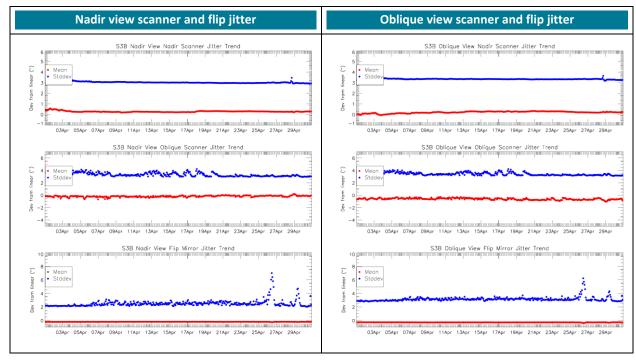


Figure 6: SLSTR-B scanner and flip jitter for April 2024, showing mean and stddev difference from expected position per orbit (red and blue respectively) for the nadir view (left) and oblique view (right). The plots show the nadir scanner (top), oblique scanner (middle) and flip mirror (bottom).

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4.4 Black-Bodies

The monthly orbital average blackbody temperatures are shown in this section. The temperatures were stable on top of a daily variation cycle. There are also longer term trends which show a yearly variation, with temperatures rising as the Earth approaches perihelion at the beginning of January – this variation is shown in the monthly averages in Figure 7 and Table 5.

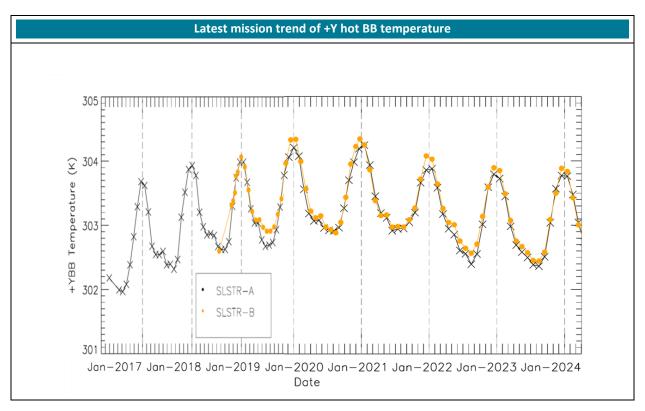


Figure 7: SLSTR-A and SLSTR-B long term trends in average +YBB temperature, showing yearly variation. The vertical dashed lines indicate the 1st January in each year.

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4.4.1 SLSTR-A

The monthly orbital average blackbody temperatures for SLSTR-A are shown in Figure 8. The temperatures were stable on top of a daily variation cycle. Figure 8 also shows the gradients across the blackbody baseplate (i.e., each Platinum Resistance Thermometer (PRT) sensor reading relative to the mean). The gradients are stable and within their expected range of ± 20 mK.

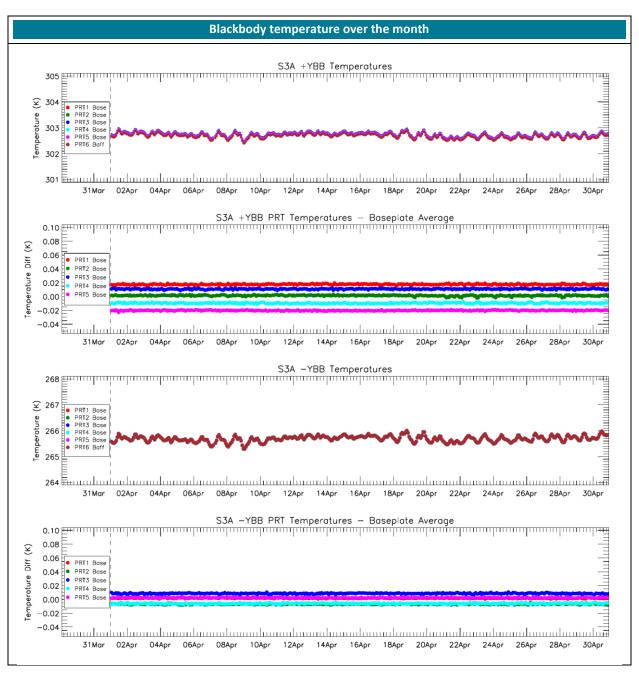


Figure 8: SLSTR-A blackbody temperature and baseplate gradient trends during April 2024 measured by different sensors at various positions in the BB and Baseplate. Each dot represents the average temperature in one orbit.

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4.4.2 SLSTR-B

The monthly orbital average blackbody temperatures for SLSTR-B are shown in Figure 9. The temperatures were stable on top of a daily variation cycle. Figure 9 also shows the gradients across the blackbody baseplate (i.e., each Platinum Resistance Thermometer (PRT) sensor reading relative to the mean). The gradients are stable and within their expected range of ± 20 mK, except for the +Y blackbody for SLSTR-B which has a higher gradient. This higher gradient is expected and consistent with measurements made before launch.

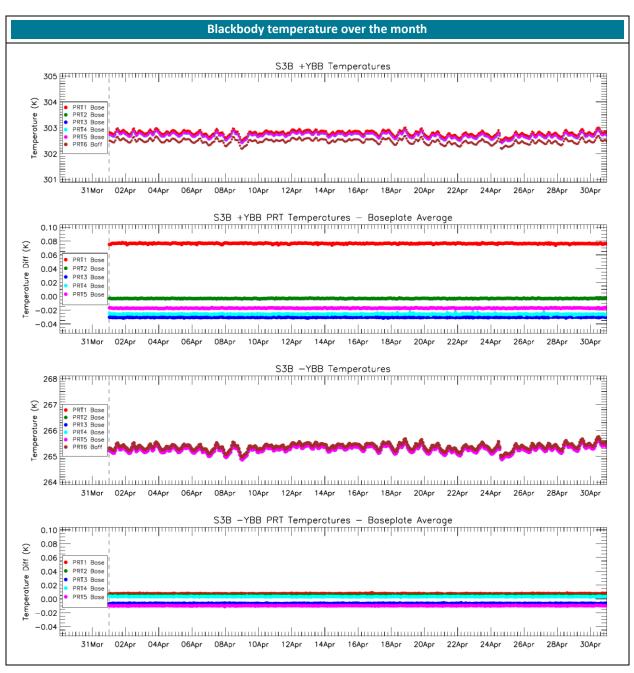


Figure 9: SLSTR-B blackbody temperature and baseplate gradient trends during April 2024 measured by different sensors at various positions in the BB and Baseplate. Each dot represents the average temperature in one orbit.

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4.5 Detector noise levels

4.5.1 SLSTR-A VIS and SWIR channel signal-to-noise

The VIS and SWIR channel noise for SLSTR-A during April 2024 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 and Figure 11. Table 1 and Table 2 give the average monthly signal-to-noise (excluding the instrument decontaminations). These values average over the significant detector-detector dispersion for the SWIR channels that is shown in Figure 11. Note that these averages are now calculated for each calendar month, whereas in data quality reports before January 2022 they were aligned to the satellite 27 day repeat cycles.

Table 1: Average SLSTR-A reflectance factor, and signal-to-noise ratio of the measured VISCAL signal for the last 11 months, averaged over all detectors for the nadir view.

	Average											
	Reflectance Factor	Jun 2023	Jul 2023	Aug 2023	Sep 2023	Oct 2023	Nov 2023	Dec 2023	Jan 2024	Feb 2024	Mar 2024	Apr 2024
S1	0.187	234	235	238	236	243	246	244	239	237	234	240
S2	0.194	242	241	242	241	243	245	245	248	247	241	241
S3	0.190	213	216	222	221	222	223	222	225	226	224	224
S4	0.191	164	164	168	171	173	174	174	174	175	172	171
S5	0.193	280	279	280	283	285	287	285	291	290	284	282
S6	0.175	178	178	181	183	184	186	188	189	187	183	182

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

	Average			_	_							
	Reflectance Factor	Jun 2023	Jul 2023	Aug 2023	Sep 2023	Oct 2023	Nov 2023	Dec 2023	Jan 2024	Feb 2024	Mar 2024	Apr 2024
S1	0.166	242	246	250	249	256	265	269	264	257	253	251
S2	0.170	250	256	257	256	259	264	269	269	267	262	256
S3	0.168	213	217	222	222	222	223	228	229	229	229	225
S4	0.166	134	136	138	139	139	140	140	140	139	139	139
S5	0.166	208	213	213	215	215	217	215	211	210	214	214
S6	0.155	130	129	132	134	134	137	136	134	132	133	132

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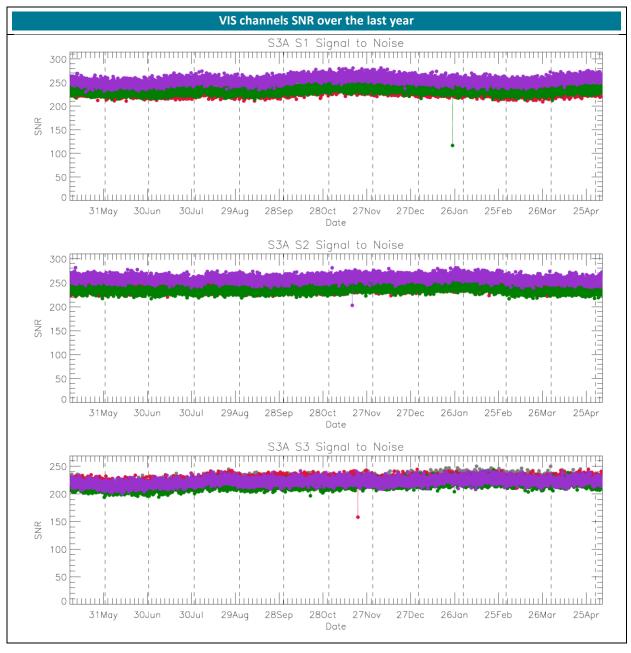


Figure 10: VIS channel signal-to-noise of the measured VISCAL signal in each orbit for the last year of operations for SLSTR-A. Different colours indicate different detectors. The vertical dashed lines indicate the start of each month.

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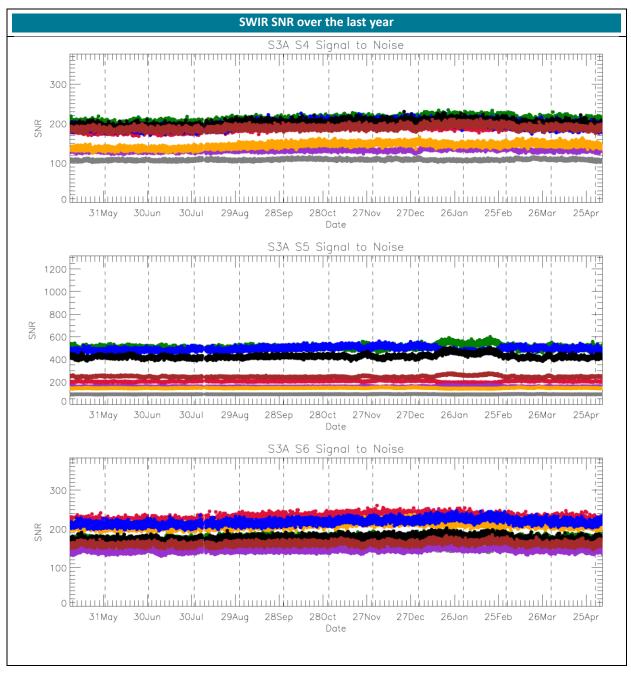


Figure 11. SWIR channel signal-to-noise of the measured VISCAL signal in each orbit for the last year of operations for SLSTR-A. Different colours indicate different detectors. The vertical dashed lines indicate the start of each month.

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4.5.2 SLSTR-B VIS and SWIR channel signal-to-noise

The monthly average VIS and SWIR channel signal-to-noise ratios for SLSTR-B 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 months, averaged over all detectors for the nadir view.

	Average Reflectance Factor	Jun 2023	Jul	Aug	Sep	Oct	Nov 2023	Dec 2023	Jan 2024	Feb 2024	Mar 2024	Apr 2024
	1	2023	2023	2023	2023	2023	2023	2023	2024	2024	2024	2024
S1	0.177	221	219	226	232	231	228	230	236	235	227	222
S2	0.192	216	214	215	217	221	225	224	223	222	218	218
S3	0.194	214	216	219	219	219	218	220	222	224	222	220
S4	0.186	126	126	126	127	127	128	129	130	129	129	129
S5	0.184	238	237	238	238	239	242	243	242	243	244	239
S6	0.162	159	157	159	158	158	162	163	166	166	162	160

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

	Average											
	Reflectance Factor	Jun 2023	Jul 2023	Aug 2023	Sep 2023	Oct 2023	Nov 2023	Dec 2023	Jan 2024	Feb 2024	Mar 2024	Apr 2024
S1	0.157	208	208	216	220	217	218	223	226	221	213	212
S2	0.168	245	241	242	246	255	258	257	255	253	251	249
S3	0.172	234	238	239	238	238	240	248	250	249	249	238
S4	0.168	124	126	126	128	128	128	130	130	129	130	130
S5	0.172	248	248	247	249	249	252	252	251	250	251	251
S6	0.152	180	180	182	184	185	188	188	188	186	187	186

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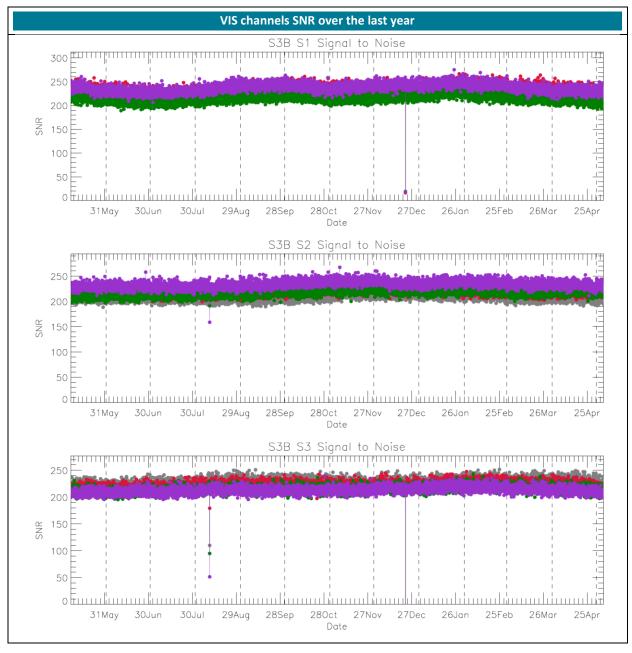


Figure 12: VIS channel signal-to-noise of the measured VISCAL signal in each orbit for the last year of operations for SLSTR-B. Different colours indicate different detectors. The vertical dashed lines indicate the start of each month.



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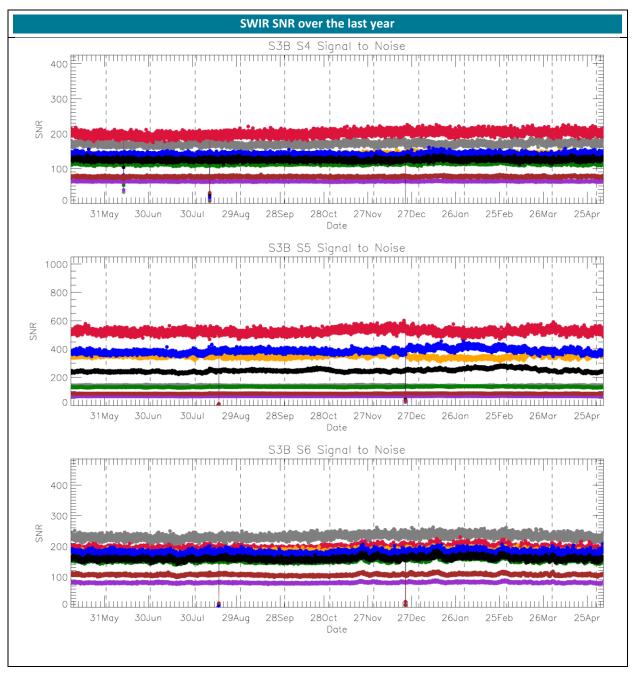


Figure 13. SWIR channel signal-to-noise of the measured VISCAL signal in each orbit for the last year of operations for SLSTR-B. Different colours indicate different detectors. The vertical dashed lines indicate the start of each month.

4.5.3 SLSTR-A TIR channel NEDT

The thermal channel NEDT values for SLSTR-A in April 2024 are consistent with previous operations and within the requirements. NEDT trends calculated from the hot and cold blackbody signals are shown in Figure 14. Monthly NEDT values, averaged over all detectors and both Earth views, are shown in Table 5.

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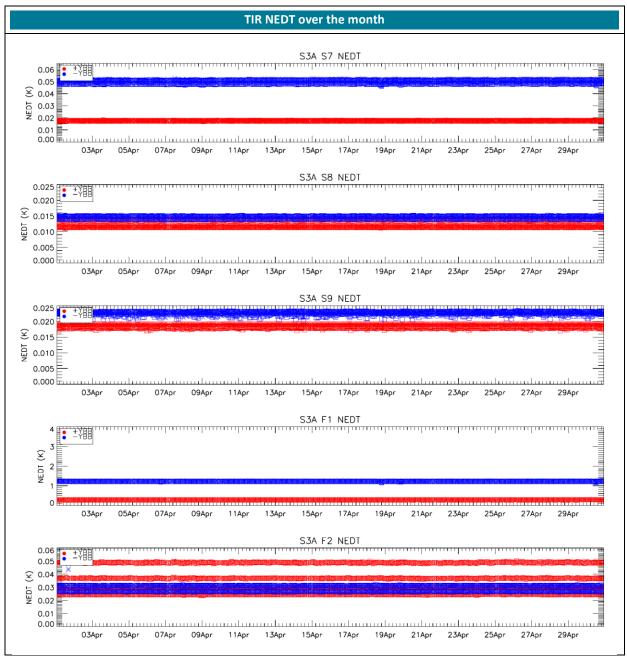


Figure 14: SLSTR-A NEDT trend for the thermal channels in April 2024. Blue points were calculated from the cold blackbody signal and red points from the hot blackbody. The square symbols show results calculated from the nadir view and crosses show results from the oblique view. Results are plotted for 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 months averaged over all detectors for both Earth views towards the hot +YBB (top) and the cold -YBB (bottom).

SLSTF	R-A	June 2023	July 2023	Aug 2023	Sep 2023	Oct 2023	Nov 2023	Dec 2023	Jan 2024	Feb 2024	Mar 2024	Apr 2024
+YBB temp (K)		302.498	302.385	302.363	302.514	303.038	303.562	303.771	303.764	303.478	303.042	302.743
	S7	17.6	17.6	17.5	18.1	17.3	17.2	17.0	17.1	17.2	17.2	17.6
	S8	12.1	12.1	11.9	12.0	11.9	12	12.0	12.0	12.0	12.0	12.1
NEDT (mK)	S9	18.6	18.7	18.3	18.4	18.3	18.3	18.4	18.4	18.4	18.4	18.5
(''''X) _	F1	290	290	284	302	281	282	277	277	277	280	288
	F2	34.6	34.6	34.5	34.5	34.9	35.4	35.5	35.4	35.2	34.9	34.9

SLSTF	R-A	June 2023	July 2023	Aug 2023	Sep 2023	Oct 2023	Nov 2023	Dec 2023	Jan 2024	Feb 2024	Mar 2024	Apr 2024
-YBB temp (K)		265.589	265.224	265.201	265.299	265.941	266.571	266.883	266.797	266.403	265.912	265.685
	S7	50.2	49.8	49.8	48.3	48.7	47.7	46.7	47.2	48.2	49.0	49.9
	S8	14.7	14.7	14.6	14.5	14.6	14.6	14.5	14.6	14.6	14.6	14.7
NEDT (mK)	S9	23	23.1	22.6	22.4	22.5	22.5	22.4	22.5	22.6	22.7	22.7
` ′	F1	1247	1243	1219	1187	1195	1177	1131	1145	1174	1203	1231
	F2	29.0	29.0	28.7	29.0	28.8	28.9	28.8	28.9	28.8	28.9	29.0

4.5.4 SLSTR-B TIR channel NEDT

The thermal channel NEDT values for SLSTR-B in April 2024, calculated from the hot and cold blackbody signals are shown in Figure 15 with monthly averages in Table 6. The thermal channel NEDT values for SLSTR-B in April 2024 are consistent with previous operations and within the requirements. Note that these averages are now calculated for each calendar month, whereas in data quality reports before January 2022 they were aligned to the satellite 27-day repeat cycles.

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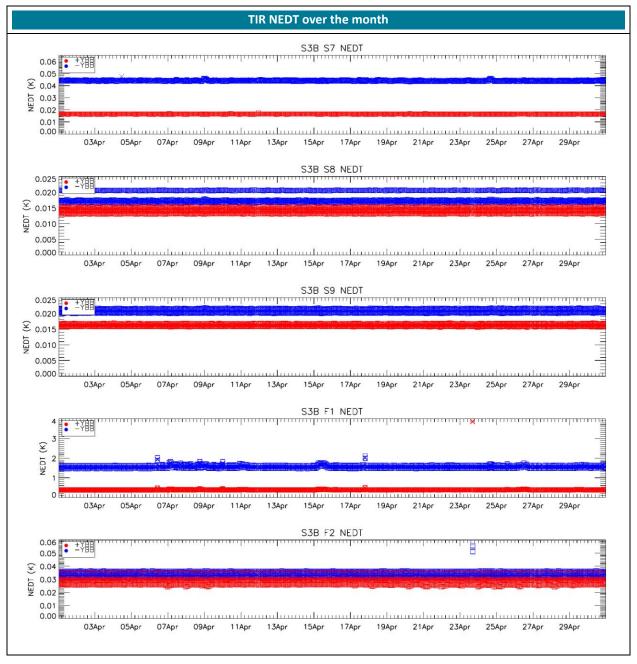


Figure 15: SLSTR-B NEDT trend for the thermal channels in April 2024. Blue points were calculated from the cold blackbody signal and red points from the hot blackbody. The square symbols show results calculated from the nadir view and crosses show results from the oblique view. Results are plotted for 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 months averaged over all detectors for both Earth views towards the hot +YBB (top) and the cold -YBB (bottom).

SLSTR-B		Jun 2023	Jul 2023	Aug 2023	Sep 2023	Oct 2023	Nov 2023	Dec 2023	Jan 2024	Feb 2024	Mar 2024	Apr 2024
+YBB temp (K)		302.572	302.452	302.442	302.582	303.088	303.500	303.885	303.836	303.428	303.006	302.723
	S7	16.5	16.5	16.5	16.5	16.8	16.1	16.1	16.1	16.1	16.2	16.5
	S8	14.0	14.1	14.1	14.0	14.1	13.9	14.0	14.0	14.0	14.0	14.2
NEDT (mK)	S9	15.9	16.0	16.0	16.0	16.1	16.0	16.0	16.0	16.1	16.1	16.2
	F1	369	374	378	380	393	369	367	365	373	365	389
	F2	30.2	30.1	30.1	30.1	30.2	30.3	30.4	30.4	30.2	30.1	30.1

SLSTF	₹-В	Jun 2023	Jul 2023	Aug 2023	Sep 2023	Oct 2023	Nov 2023	Dec 2023	Jan 2024	Feb 2024	Mar 2024	Apr 2024
-YBB temp (K)		265.146	264.944	264.837	264.943	265.568	266.185	266.652	266.516	265.958	265.488	265.271
	S7	44.8	45.5	45.9	45.3	42.3	43.0	42.9	42.6	43.2	44.3	44.2
	S8	17.9	18.0	18.0	18.0	17.8	18.0	18.1	18.0	18.0	18.1	18.1
NEDT (mK)	S9	20.4	20.4	20.5	20.5	20.3	20.4	20.5	20.5	20.5	20.6	20.7
(,	F1	1529	1571	1592	1595	1503	1501	1502	1479	1538	1533	1574
	F2	33.3	33.4	33.4	33.3	33.1	33.1	33.1	33.1	33.3	33.4	33.4

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4.6 Calibration factors

4.6.1 VIS and SWIR radiometric response

The radiometric gain derived from the VISCAL signals over the past year are shown in this section. 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 observed in the plots.

There are several features that appear in this parameter that can be explained as:

- 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 4.2, 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 build-up 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.
- 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.

4.6.2 SLSTR-A

Figure 16 and Figure 17 show the variation of the radiometric gain derived from the VISCAL signals for SLSTR-A over the past year. The data from the last month appears normal and follows the expected trend.

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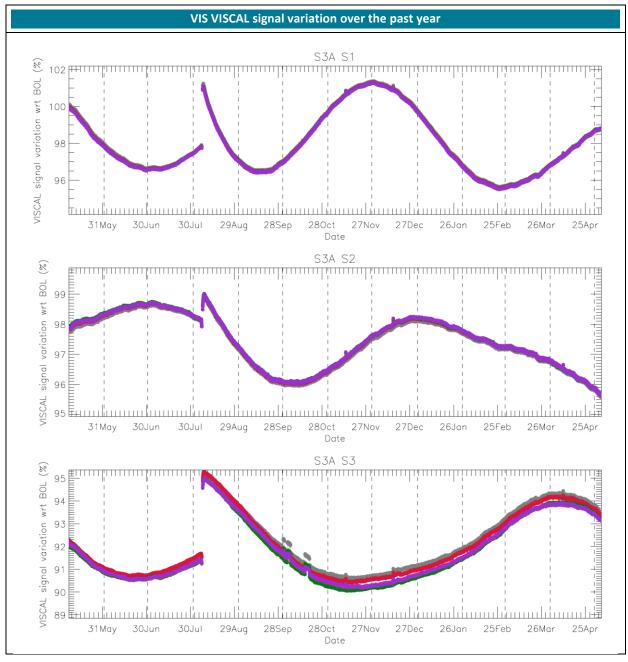


Figure 16: Variation of the radiometric gain derived from the VISCAL signals for SLSTR-A VIS channels for the last year of operations (nadir view). Different colours represent different detectors. The vertical dashed lines indicate the start of each month.

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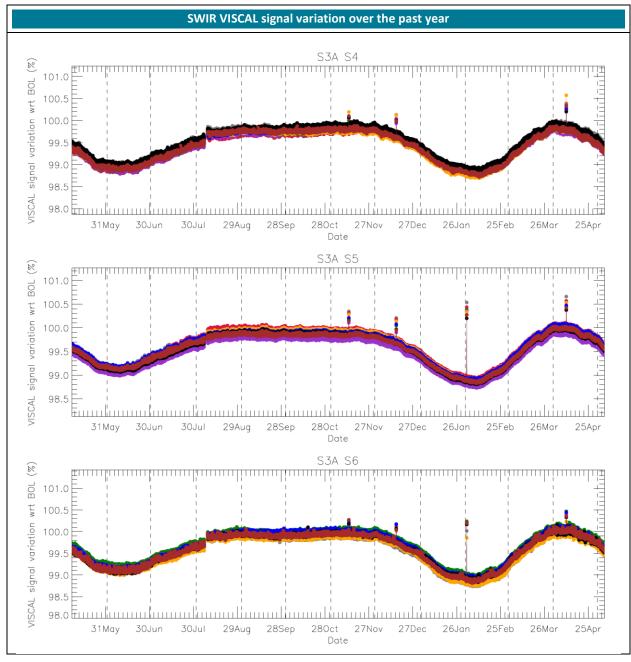


Figure 17: Variation of the radiometric gain derived from the VISCAL signals for SLSTR-A SWIR channels for the last year of operations (nadir view). Different colours represent different detectors. The vertical dashed lines indicate the start of each month.

4.6.3 SLSTR-B

Figure 18 and Figure 19 show the variation of the radiometric gain derived from the VISCAL signals for SLSTR-B over the past year. The data from the last month appears normal and follows the expected trend. There are several features in this annual trend plot to note.

There is noisy behaviour and numerous drops in signal in the radiometric gain, especially in channels S1 and S2. This gives 2-3% errors in the radiometric calibration of these channels. A

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number of candidate root causes have been identified, with the most likely due to motional chopping of the VIS detectors by an internal aperture in the VIS optical bench. Because the effect appears to be random it is most likely affecting all the data for S1 and S2.

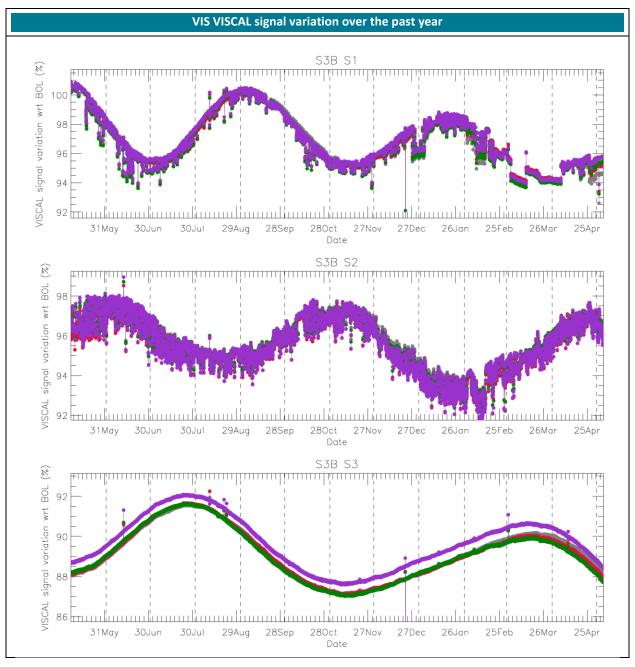


Figure 18: Variation of the radiometric gain derived from the VISCAL signals for SLSTR-B VIS channels for the past year (nadir view). Different colours represent different detectors. The vertical dashed lines indicate the start of each month.

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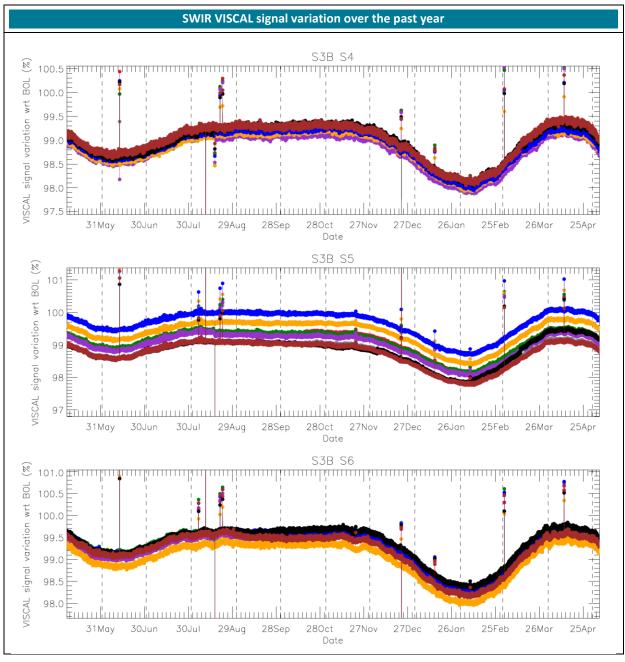


Figure 19: Variation of the radiometric gain derived from the VISCAL signals for SLSTR-B SWIR channels for the past year (nadir view). Different colours represent different detectors. The vertical dashed lines indicate the start of each month.



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5 Level-1 product validation

Level-1 product quality is assessed in terms of radiometric and geometric accuracy

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 20 shows an example combined SLSTR-A/SLSTR-B image for the visible channels on 16th April 2024 (daytime only).

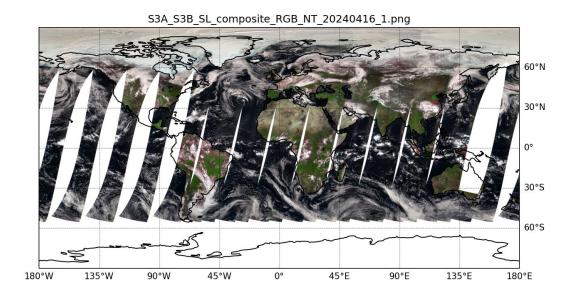


Figure 20: Daytime combined SLSTR-A and SLSTR-B Level-1 image for visible channels on 16th April 2024.

5.1 Level-1 TIR Radiometric Validation

S3_MR_1000 Relative radiometric accuracy: Sentinel-3 infrared channels shall have a relative radiometric accuracy of <0.08K (threshold) with a goal of 0.05 K over a range of 210-350 K expressed as NEDT traceable to international reference standards.

The absolute radiometric calibration of the IR channels is being validated by EUMETSAT using comparisons against IASI-A and B (Tomazic et al 2018). These results confirmed very good performance with almost no bias (< 0.1 K) for channels S8 and S9 in the nadir view over the temperature range 220 - 280 K.

5.2 Level- 1 VIS SWIR Radiometric Validation

A3_MR_1010 Absolution radiometric accuracy: Sentinel-3 VIS reflectance at TO shall have an absolute radiometric accuracy goal of < 2% with reference to the sun for the 400-900 nm wavebands and <5% with reference to the sun for wavebands >900 nm traceable to international reference standards.

Validation of the VIS/SWIR radiometric measurements is performed by various methods to establish the magnitude of any calibration offset. Some activities are routinely performed each month and reported here, and some are less regular and reported in the annual data quality reports.

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The results of these different methods have been collated and have been found to agree that there is a calibration offset present in the VIS/SWIR radiances. It is recommended therefore that users apply an offset in-line with the values presented in Table 7. These offsets are stable and apply to the entire mission. Note that uncertainty estimates are at k=1.

Nadir View	S1	S2	S3	S5	S6
Correction	0.97	0.98	0.98	1.11	1.13
Uncertainty	0.03	0.02	0.02	0.02	0.02
Oblique View	S1	S2	S3	S5	S6
Correction	0.94	0.95	0.95	1.04	1.07
Uncertainty	0.05	0.03	0.03	0.03	0.05

Table 7. The recommended corrections that should be applied to SLSTR-A and SLSTR-B VIS, SWIR channels.

5.2.1 Radiometric validation with DIMITRI

5.2.1.1 Verification and Validation over PICS

- 1. The ingestion of the available L1-RBT-NT products from SLSTR-A and SLSTR-B over the 6 desert CalValsites (Algeria 3 & 5, Libya 1 & 4 and Mauritania 1 & 2) has been performed until the **end-April 2024**.
- 2. The results are consistent over all the six used PICS sites (Figure 21 and Figure 22). Both sensors show a good stability over the analysed period over VNIR bands for both NADIR & OBLIQUE views, with slight positive trend.
- 3. The temporal average over the period 1st January 2024 end-April 2024 of the elementary ratios (observed reflectance to the simulated one) for SLSTR-A and SLSTR-B show gain values between 3-7% (NADIR) and 8-10% (OBLIQUE) over the VNIR bands S1-S3 (Figure 23).

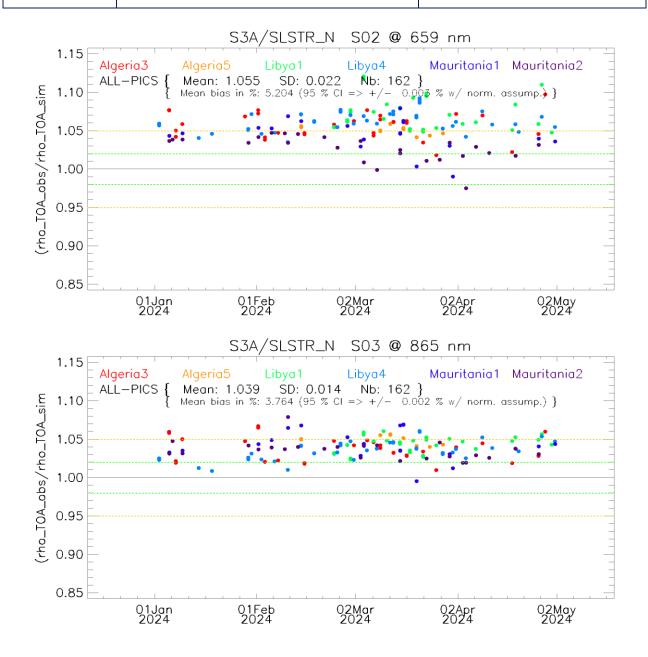
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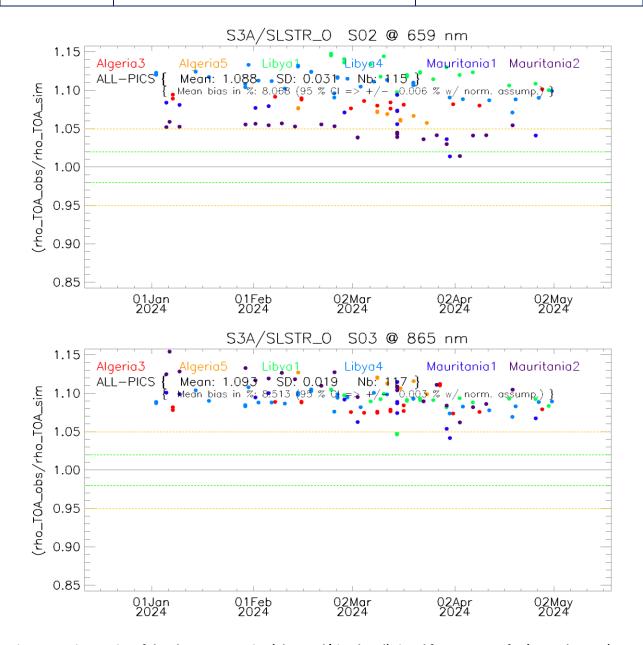


Figure 21: Time-series of the elementary ratios (observed/simulated) signal from SLSTR-A for (top to bottom) bands S02 and S03 (Nadir & Oblique views) respectively over January 2024- end-April 2024 from the six PICS Cal/Val sites. Dashed-green and orange lines indicate the 2% and 5% respectively. The desert methodology uncertainty is 5%.

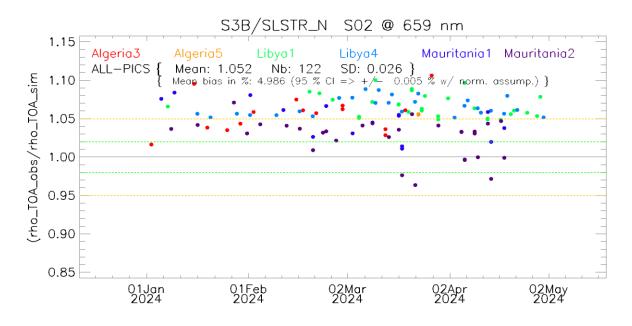


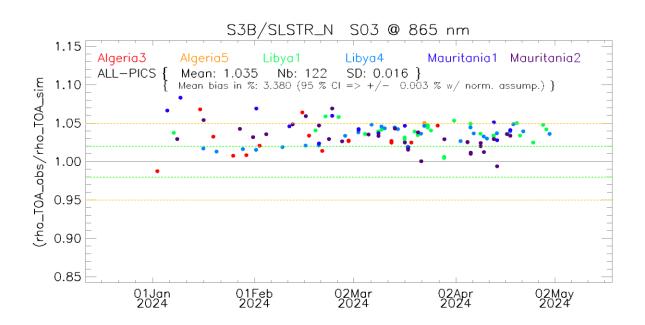
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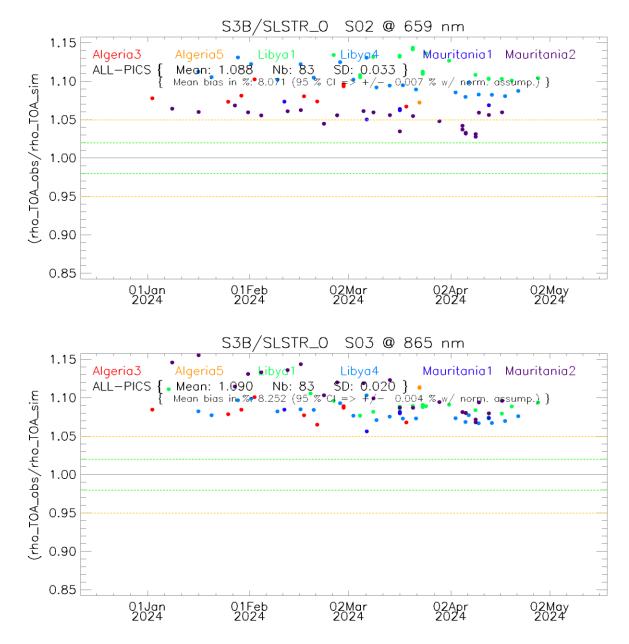


Figure 22: Time-series of the elementary ratios (observed/simulated) signal from SLSTR-B for (top to bottom) bands S02 and S03 (Nadir & Oblique views) respectively over January 2024- end-April 2024 from the six PICS Cal/Val sites. Dashed-green and orange lines indicate the 2% and 5% respectively. The desert methodology uncertainty is 5%.

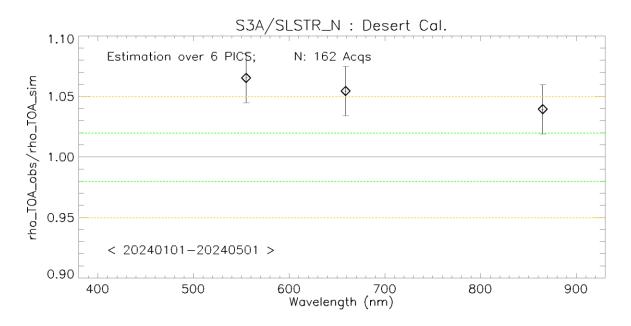


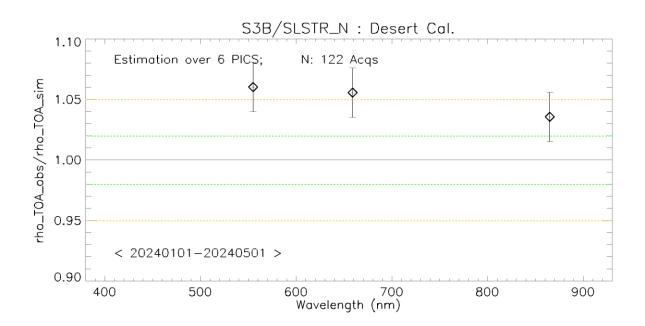
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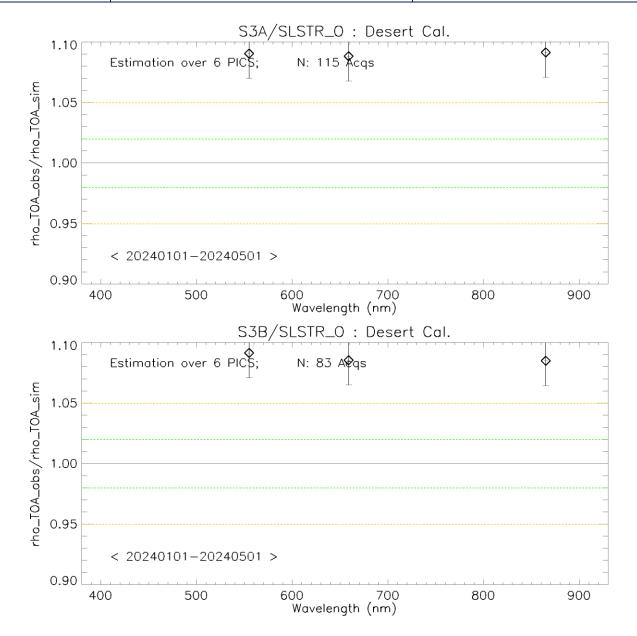


Figure 23: The estimated gain values for SLSTR-A and SLSTR-B (top to bottom) Nadir & Oblique views respectively over the 6 PICS sites identified by CEOS over the period January 2024- end-April 2024 as a function of wavelength. Dashed-green and orange lines indicate the 2% and 5% respectively. Error bars indicate the desert methodology uncertainty.

5.2.1.2 Validation over Rayleigh

Rayleigh method has been performed from the available mini-files over the period **January 2023- end-April 2024** for SLSTR-A and SLSTR-B. The gain coefficients of both sensors are consistent with the previous results (Figure 24).

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5.2.1.3 Validation over Glint

Glint calibration method has been performed over the period January 2023- end-April 2024 for both SLSTR-A and SLSTR-B. The gain coefficients of both sensors are consistent with the previous results over the Nadir view (Figure 24).

5.2.1.4 Validation results synthesis

The results synthesis displayed below on Figure 24.

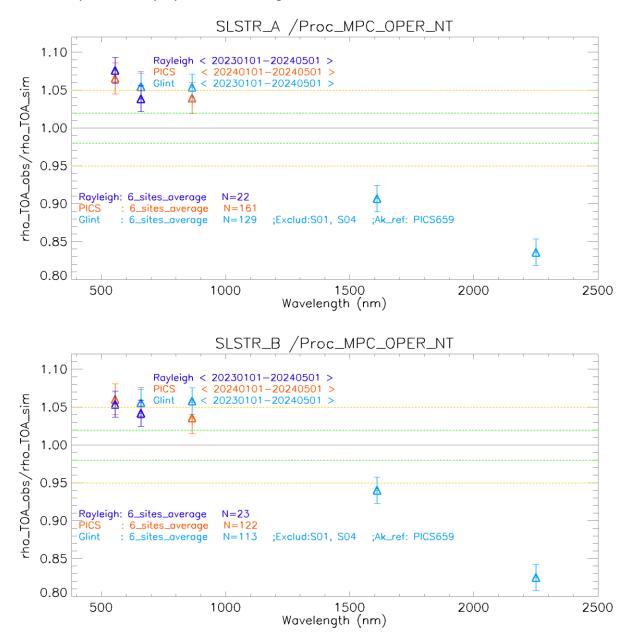


Figure 24: The estimated gain values for SLSTR-A and SLSTR-B (Nadir view) from Glint and Rayleigh methods over the period Jan 2023—end-April 2024 and PICS method over the period Jan 2024—end-April 2024 as a function of wavelength. We use the gain value of S02 from Desert-PICS method as reference gain for Glint method. Dashed-green and orange lines indicate the 2% and 5% respectively. Error bars indicate the method uncertainties

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5.2.1.5 Cross-mission Intercomparison over PICS:

X-mission Intercomparison between SLSTR-A, SLSTR-B, MERIS, MSI-A, MSI-B, OLCI-A and OLCI-B has been performed over the 6 PICS-test-sites. Figure 25 shows the estimated gain over different time-series for different sensors over PICS. The spectral bands with significant absorption of water vapor and O2 are excluded. OLCI-A, SLSTR-A and SLSTR-B seem to have higher gain wrt the other sensors of about 1-4% over VNIR spectral range.

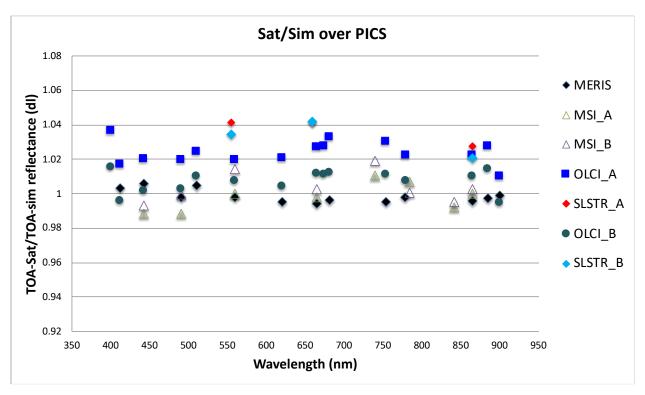


Figure 25: Ratio of observed TOA reflectance to simulated one for (black) MERIS, (pale-green) S2A/MSI, (white) S2B/MSI, (blue) S3A/OLCI, (green) S3B/OLCI, (red) S3A/SLSTR-NADIR, and (cyan) S3B/SLSTR-NADIR averaged over the six PICS test sites as a function of wavelength.

5.3 Level-1 Geometric Validation

- **S3_MR_1090 Geolocation accuracy:** Improved geo-location accuracy is possible when using ground control points and Sentinel-3 shall be designed to ensure a geolocation accuracy of better than 0.5rm of the spatial resolution of the optical sensor when using ground control points.
- **S3_MR_1100** Inter channel co-registration. The inter channel spatial co-registration for Sentinel-3 visible measurements shall be < 0.5 of the spatial resolution of the sensor over the full spectral range (goal of 0.3 of the spatial resolution of the sensor)
- **S3_MR_1100** Inter channel co-registration: The inter channel spatial co-registration for Sentinel-3 SWIR and TIR measurements shall be sufficient to allow these channels to be co registered with visible channels at higher spatial resolution data.

Regular monitoring using the GeoCal Tool implemented at the MPC is normally carried out. On average, the geolocation accuracy of the VIS-SWIR channels meets requirements for SLSTR-A and SLSTR-B.

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GeoCal is a tool that monitors the geolocation performance in Level-1 images by correlation of the images with reference features containing ground control points (GCP). Each Level-1 granule typically contains several hundred GCPs if over land, which are filtered based on signal-to-noise to obtain a daily average in the across and along track directions.

The geolocation uncertainty is stable and within requirements during the reporting period.

5.3.1 SLSTR-A

The results for April 2024 are plotted in Figure 26 for SLSTR-A, giving the average positional offsets in kilometres for Nadir and Oblique views.

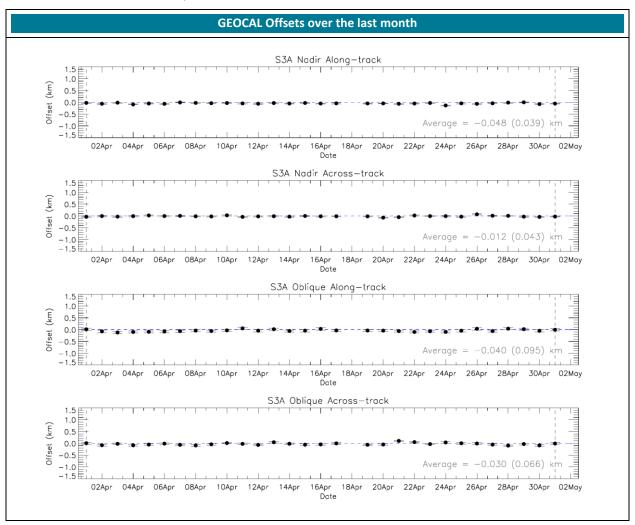


Figure 26: SLSTR-A daily offset results in km from the GeoCal Tool analysis for Nadir along- and across-track (top two plots) and Oblique along- and across-track (bottom two plots) for April 2024. The error bars show the standard deviation.

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5.3.2 SLSTR-B

The results for April 2024 are plotted in Figure 27 for SLSTR-B, giving the average positional offsets in kilometres for Nadir and Oblique views.

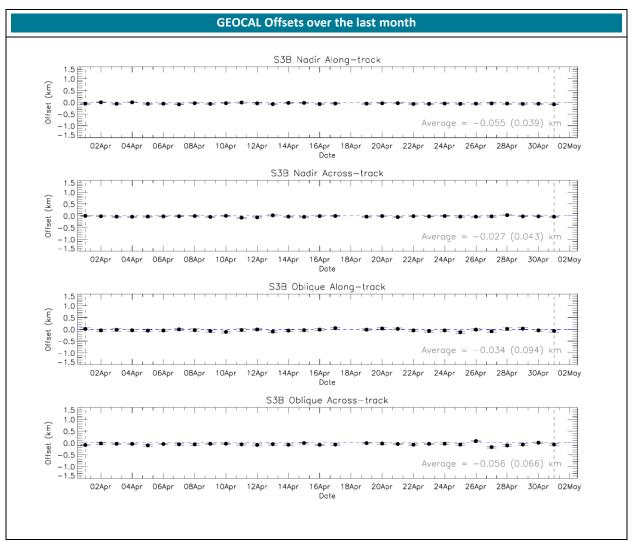


Figure 27: SLSTR-B daily offset results in km from the GeoCal Tool analysis for Nadir along- and across-track (top two plots) and Oblique along- and across-track (bottom two plots) for April 2024. The error bars show the standard deviation.



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6 Level 2 LST validation

Level 2 Land Surface Temperature products have been validated against *in situ* observations (Category-A validation) from eight "Gold Standard" Stations. The different categories of validation are first described in the LST Validation Protocol (Schneider et al., 2012) and reinforced in the CEOS WGCV-LPV Land Surface Temperature Product Validation Best Practice Protocol (Guillevic et al., 2017).

In all cases it is the NTC products that are validated, and the Probabilistic cloud masking implementation is used for all cloud masking. 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.

6.1 Category-A validation

Category-A validation involves comparing satellite-retrieved LST data with *in situ* measurements. These measurements are collected from radiometers located at multiple stations spread across the Earth, selected for their capability to provide the highest-quality validation.

For this purpose, nine "Gold Standard" stations have been considered. These stations are equipped 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 Falls, South Dakota; Table Mountain, Colorado); and two from the USCRN network (Des Moines, Iowa; Manhattan, Kansas).

For the SURFRAD field pyrgeometers, the uncertainty is estimated to be ± 5 W/m² (Augustine and Dutton, 2013). For the USCRN network, which uses Apogee SI-121s, the uncertainty is set as the manufacturers estimate of ± 0.2 K.

The validation has been assessed in terms of accuracy, defined as the median bias between observed between satellite LST and in-situ LST, and precision, defined as the robust standard deviation of said bias. Accuracy is used as the metric of interest to compare performances with mission requirements.

Following the approach outlined in the 2023 Annual Performance Report, the quality assessment method has undergone to a significant methodological update since the previous report. The current analysis systematically excludes any pixels identified as non-clear sky by both cloud and Bayesian cloud masks, as well as those artificially filled, a change from the previous approach which only used the probabilistic cloud mask and the cosmetic pixels mask. Additionally, in the current analysis the Williams station from the USCRN network was rejected, as it was presenting suspicious behaviours.

The validation results, including accuracy (median bias) and precision in Kelvin, for the nine stations over the LST from Q1 2024, have been listed in Table 9 and corresponds to the images shown in Figure 28.

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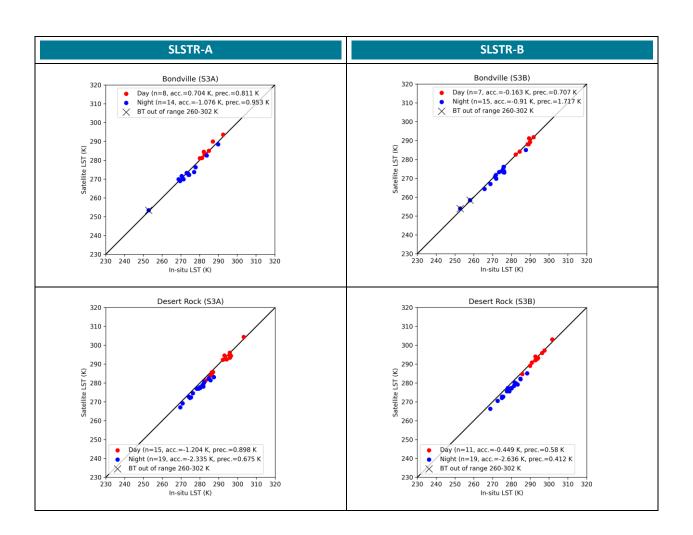
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Table 8: Results of the validation of Sentinel-3A and 3B LST using in-situ measurements during day and night time periods: for each station, N indicates the number of matchups over the period, ACC represents accuracy (median bias) and PREC represents the precision in Kelvin.

		S3A					S3B						
	Site Day		1	Night			Day			Night			
		N	Acc [K]	Prec [K]	N	Acc [K]	Prec [K]	N	Acc [K]	Prec [K]	N	Acc [K]	Prec [K]
	Bondville	8	0.704	0.811	14	-1.076	0.953	7	-0.163	0.707	15	-0.91	1.717
	Desert Rock	15	-1.204	0.898	19	-2.335	0.675	11	-0.449	0.58	19	-2.636	0.412
	Fort Peck	7	-0.047	0.48	11	-0.833	1.895	6	-2.085	0.598	12	-0.781	0.635
SURFN	Goodwin Creek	9	-1.62	1.18	19	1.887	1.297	15	-1.819	0.611	17	2.048	0.652
N N	Penn State	7	-0.192	0.488	12	1.254	1.999	9	-1.548	1.668	14	1.198	1.727
	Sioux Falls	4	1.051	1.476	20	0.926	1.772	7	0.602	0.623	25	0.651	1.457
	Table Mountain	22	-0.498	1.113	21	-2.386	0.686	18	-0.385	1.457	18	-1.128	1.182
USCRN	Des Moines	4	1.449	0.393	6	-1.757	1.228	8	0.8	0.319	5	-2.02	0.317
OSC	Manhattan	5	-1.22	1.841	8	-1.067	1.536	7	-1.334	1.352	12	-0.204	0.43



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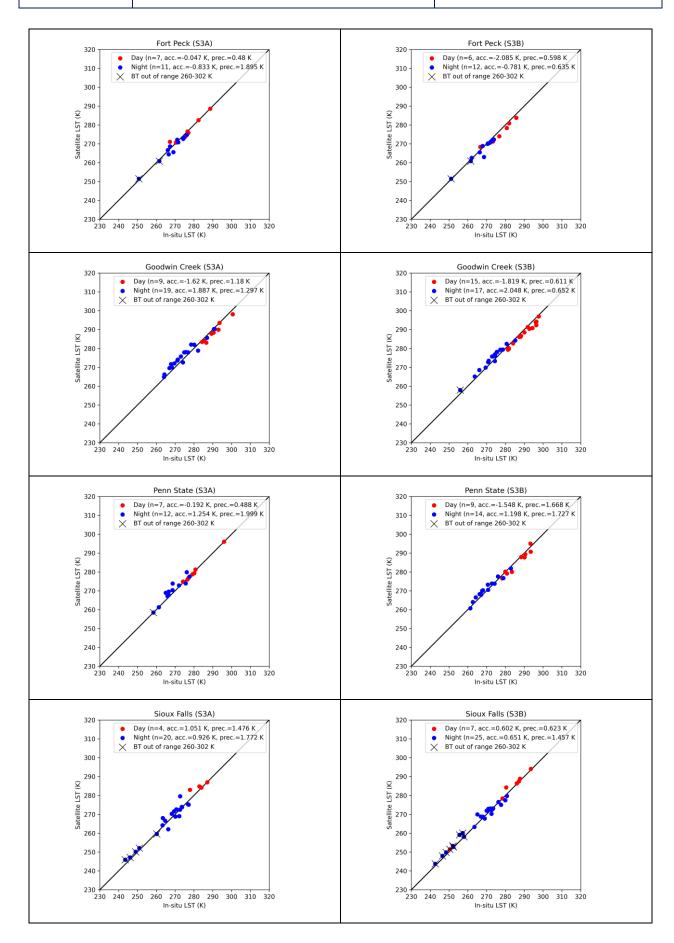
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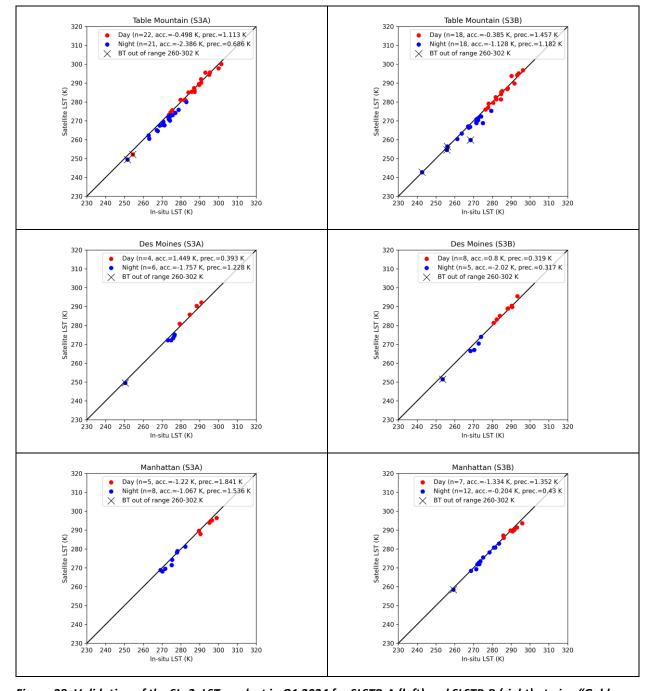


Figure 28: Validation of the SL_2_LST product in Q1 2024 for SLSTR-A (left) and SLSTR-B (right) at nine "Gold Standard" in situ stations of the SURFRAD and USCRN network. In the legend, "n" indicates the number of matchups over the period. The matchups are split between daytime (red) and night-time (blue); a black cross identify LST points derived from a BT out of the calibration range (260-302K).

The matchups generally show a good fit with the expected one-to-one correspondence, though there are occurrences of increased bias more evident in the nighttime data. Additionally, an offset is predominantly observed in the nighttime matchups.

Considering individual site biases, it is observed that some sites have larger absolute biases which contribute to the overall nighttime value. For instance, Desert Rock shows large biases for both satellites during the night, with values of 2.335 K and 2.636 K for S3A and S3B respectively. Goodwin Creek shows

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for S3A and S3B respectively 1.887 K and 2.048 K. Table Mountain also presents a notable nighttime bias for S3A at 2.386 K.

As stated in the previous DQR, the accuracy and precision may be influenced by errors in cloud masking as well as by higher temperatures.

The cloud filtering has significantly decreased the number of matchups per station, with daytime observations being particularly affected. Therefore, the statistical robustness for certain sites is compromised and might not be representative of product performances, as the analysis over the three-month span of the first quarter is limited by a small sample size.

Given the current winter season, temperature-induced errors are less of a concern. Nevertheless, in this Q1 report, an analysis has begun to address the temperature factor. LST data, which are calibrated within a 260-302K Brightness Temperature range, have been examined to identify how many matchups use LST values outside the RBT calibration range. These values are indicated in Figure 28 with a black cross. Although the exclusion of such out-of-range points may be considered in the future, no data have been discarded at this stage. Further assessments will determine the necessity of excluding these points in future quarterly reports.

The results from the nine stations can be summarised in the following Table 9 (accuracy is used as the metric rather than uncertainty as this is then a straight comparison with mission requirements):

Table 9: Average absolute accuracy in K of the SL_2_LST product with respect to Gold Standard stations for Q1 2024.

Satellite	Day	Night		
S3A	0.89	1.50		
S3B	1.02	1.29		

For both SLSTR-A and SLSTR-B the nighttime absolute accuracies (which are derived from the absolute values of all the mean biases from the individual stations) are greater than the mission requirement of 1K. However, daytime accuracy for S3A stays within this threshold while S3B accuracy is just slightly higher.

These are preliminary results related to the first quarter. The limited number of matchups for several stations during this period, often fewer than 10, do not allow to compute representative statistics for these stations. Additionally, the current validation method is affected by an intrinsic "geographic bias": since all stations are situated in the northern hemisphere, the results largely reflect winter conditions. Future analyses in subsequent quarters are expected to provide more robust statistics.

The accuracy issues identified may arise from two main sources: firstly, in-situ measurement biases are suggested by the presence of offset in the data: as shown in the 2023 APR analysis using yearly data, a clear seasonal pattern has been identified and it may contribute to the offset observed between satellite and in-situ measurements, with a tendency towards more negative biases in winter and positive ones in summer. These seasonal patterns might lead to compensations that eventually result in compliance with expected values. Continued analysis over the next quarters is necessary to track the changes in these findings across the year.

Secondly, outdated LST retrieval coefficients could be affecting its estimations. A review and potential update of the LST retrieval coefficients might be necessary to improve the accuracy. The influence of

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dynamic land cover changes should also be considered, as it contributes to the seasonal patterns previously mentioned.

Conclusions

For the first quarter of 2024, the LST validation was conducted by comparing satellite-retrieved LST data with in-situ measurements from nine stations equipped with well-calibrated instrumentation: seven from the SURFRAD network and two for the USCRN network.

Following the approach outlined in the 2023 Annual Performance Report, the quality assessment method has been updated since the previous report. The current analysis excludes any pixels identified as nonclear-sky by both cloud and Bayesian cloud masks, as well as those artificially filled, a change from the previous method which only used the probabilistic cloud mask and the cosmetic pixels mask. Therefore, a direct comparison with previous results is not feasible. Additionally, in the current analysis the Williams station from the USCRN network was rejected, as it was presenting suspicious behaviours.

The validation results were assessed in terms of accuracy (defined as median bias) and precision (defined as robust standard deviation) in Kelvin. Overall, the matchups show a good fit with the expected one-to-one correspondence, though there are few occurrences showing a higher bias and a noticeable nighttime offset is observed across several sites.

LST data, calibrated within a 260-302K Brightness Temperature range, were analysed to identify matchups using LST values outside the RBT calibration range. Further assessments will determine whether to exclude these points in future quarterly reports.

Cloud filtering significantly reduced the number of available matchups per station, particularly for the daytime. Consequently, statistics for certain sites may be not representative of product performances.

Satellite performance, measured by the average of all stations absolute accuracies (median bias), shows that nighttime accuracies for both SLSTR-A and SLSTR-B exceed the mission target of 1K (respectively 1.50 for S3A and 1.29 for S3B); daytime accuracy for S3A remains within this threshold (0.89), while S3B accuracy is slightly higher (1.02).

The identified accuracy issues may be due to in-situ measurement biases (when offset is present in the data) or the use of potentially outdated LST retrieval coefficients. In any case, as previously mentioned, these are preliminary results for the first quarter: since the number of matchups per site often stay below 10, representative statistics for these stations are not yet possible. Additionally, since all stations are situated in the northern hemisphere, the results largely reflect winter conditions. Future quarter analyses will ensure more robust statistics for the whole year.

The 2023 APR analysis using yearly data showed a clear seasonal pattern that may contribute to the offset observed between satellite and in-situ measurements, with more negative biases in winter and positive in summer. This seasonality might lead over the year to compensations that eventually result in compliance with expected values. Additionally, the influence of dynamic land cover changes should also be considered, as it contributes to the seasonal patterns mentioned. Continued analysis in the next quarters is necessary to track the changes in these findings across the year and to allow robust statistics.

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7 Level 2 FRP validation

7.1 The SLSTR Fire Radiative Power product

The SLSTR FRP NTC product (both SLSTR-A and SLSTR-B) has been released to the public on August 19th, 2020. The current processing baseline for SLSTR-A and SLSTR-B FRP products is FRP_NTC.004.08.00 and was deployed in the Land processing centres on August 23, 2022 and September 5, 2022 for SLSTR-A and for SLSTR-B, respectively.

This report only focuses on measurements obtained from the thermal channels using the FRP V2 algorithm over the months of January, February, and March 2024. First, the fires detected during nighttime are assessed. Then, the same analysis is repeated for daytime fires.

7.2 Validation methodology

Validation of the SLSTR L2 FRP products can be performed using either in-situ data such as airborne measurements or using products from a reference satellite for inter-comparison. Active fires in situ data are unfortunately not frequent enough to validate fire satellite data products on an operational basis. The current comparison methodology uses products from NASA Moderate-Resolution Imaging Spectroradiometer (MODIS) as reference fire data for the intercomparisons.

This present inter-comparison, initially based on previous work from M. Wooster and W. Xu on the FRP Prototype and on the evaluation of SEVIRI fire data, aims to assess two things:

- (i) The detection of fires' position and extent in time and space.
- (ii) The estimated radiative fire power (FRP) of active fires.

To do so, the SL_2_FRP product from SLSTR-A and SLSTR-B are compared with the operational MODIS MOD14 FRP product from MODIS Terra. This inter-comparison should not be interpreted as a full validation exercise but rather as a check of the consistency of the FRP products derived from the satellites, as ground truth is not available.

The methodology to obtain data fit for comparison purposes is outlined hereafter:

- Once areas of interest have been defined, identify all SL_2_FRP scenes containing active fires;
- Download MODIS MOD14 data with a scene overpass time within ± 6 minutes from that of SLSTR;
- Restrict observations to a scan angle of ±20° or equivalent pixel area of 1.7 km² to avoid edge-of-swath data, and to the common area of detection between the two products. The scan angle was decreased from ±30° to limit possible pixel size discrepancies between MODIS and SLSTR data;
- Reproject MODIS pixels on the SLSTR F1 grid. If multiple MODIS active fire pixels (AFP) are present in the same equivalent SLSTR grid cell, their combined FRP is used.

Omissions, commissions, and double detections are then evaluated. A fire is classified as omitted if no SLSTR fire pixel is present in a 7 x 7 pixels window around a MODIS fire pixel. Conversely, a fire is classified as commissioned if no MODIS fire pixel is present in a 7 x 7 pixels window around a SLSTR fire pixel. If SLSTR and MODIS pixels are present within the windows, the fire is classified as double detected.

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The FRP analysis is twofold: it is done both at the pixel level, and at the cluster level. A cluster is defined as fires close enough to be interpreted as a single fire event (i.e. the detected fire pixels are next to one another). In both cases, as MODIS FRP data is provided before atmospheric correction, they are atmospherically corrected using the water vapor content estimated by Sentinel 3 as the basis to compute the transmission.

The detected fire clustering is done according to the following procedure: for both sensors, a connected-component labeling using an 8-connectivity is used to label clusters. Then, iteratively, clusters from one satellite having an overlap with clusters from the other are merged to form superclusters, until each supercluster from one satellite only overlaps with a single supercluster from the other. Figure 29: Formation process of the pairs of superclusters depending on AFP detected each satellite. Fire clusters and superclusters are identified by their colors. At the end of the process, pairs of SLSTR and MODIS superclusters share the same color. Figure 29 illustrates the process. Finally, superclusters associated with problematic flags (clouds/water/detection/high S7-S8 difference) are removed from the datasets. The remaining matching pairs of SLSTR and MODIS superclusters are used for further analysis regarding FRP estimates.

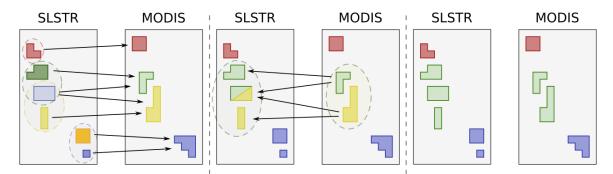


Figure 29: Formation process of the pairs of superclusters depending on AFP detected each satellite. Fire clusters and superclusters are identified by their colors. At the end of the process, pairs of SLSTR and MODIS superclusters share the same color.

Four areas of high fire activity between January 1st and March 31st were selected: eastern USA, Australia, Southern Africa, and China (see Figure 30). Since the last report, monitoring of the number of AFP detected globally by S3A and S3B has been introduced in order to identify potential sensitivity drifts.

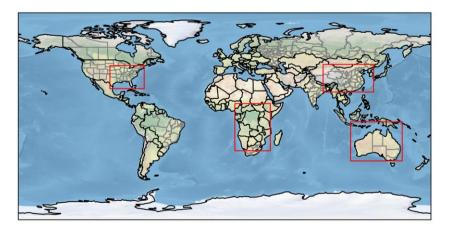


Figure 30: Selected zones for the intercomparison over the January-March 2024 period

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7.3 Results

7.3.1 Global distributions of the fires

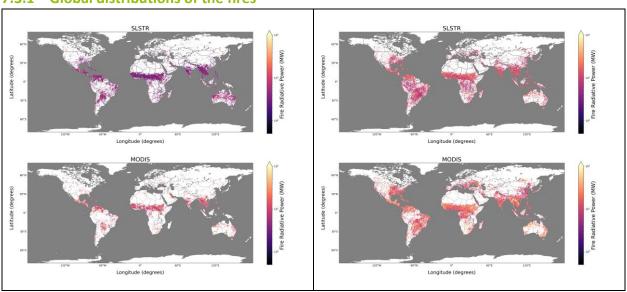


Figure 31: Fires detected by SLSTR and MODIS at nightime (left) and daytime (right).

Figure 31 shows the location and radiative power of fires detected by SLSTR and MODIS during night and daytime. On one hand, SLSTR seems to be detecting more fire than MODIS during nighttime, most of them having a lower intensity, while there are few omissions. It is possible to see that SLSTR, unlike MODIS, detects fires over larger swathes of Argentina and Madagascar in particular. On the other hand, during daytime, the areas over which MODIS and SLSTR detect fires appear rather equivalent, although SLSTR still seem to detect more lower intensity fires (darker areas).

7.3.1.1 Fires detected per satellite

For each day, a reference number of detected AFP is computed as the average of the AFP detected by S3A and S3B. Then, the deviation from this average is calculated for each satellite. If both sensors have the same sensitivity to detect fires, then the median of the distributions of the daily deviations of each satellite should both be close to 0. Additionally, trend lines of the deviations are computed to identify potential long-term drifts.

Figure 32 shows the results of this analysis. A few outliers are clearly visible on the left-hand plot, however the signal looks more akin to a white noise, and the statistical distributions indicate that there is no clear apparent sensitivity offset between both satellites (right-hand plot), with S3A having only -1.1% less detected AFP than the reference. As the two sensors never observe the exact same scenes, such variations are not surprising. It also appears that there is currently no long-term trend in the number of AFP detected by both sensors, with p-values above 0.05 in both cases. As such, S3A and S3B can currently similarly sensitive when it comes to active fire detection.

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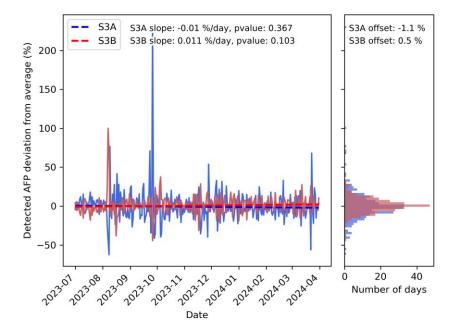


Figure 32: (left) daily deviations from the reference number of AFP for each satellite, and long-term trend lines. (right) statistical distributions of the daily deviations for each satellite. The blue shades correspond to S3A, the red shades to S3B.

7.3.2 Nighttime Fires Validation

7.3.2.1 MWIR fires

Table 10 presents a summary of the intercomparison between active fires detected by SLSTR and MODIS over the January—March 2024 period, as well as past periods. As for previous periods, the data present a significantly larger quantity of commissions (this quarter, more than half of SLSTR-detected fires are commissions) compared to the omissions. Omissions occurrences are are higher than the three previous period, but still similar those from the same quarter last year . The FRP distributions of both MODIS and SLSTR clusters are similar to those from the January—March 2023 period for the 25th, 50th, and 75th percentile values.

Table 10: Summary of the intercomparison between nighttime SLSTR and MODIS active fires over the January—March 2024 period. Results from previous 3-months comparisons are included for information purposes.

	Value						
Variable	2024	2023					
	Jan.—Mar.	Oct.—Dec.	Jul.—Sep.	Apr.—Jun.	Jan.—Mar.		
Commissions (% of total SLSTR AFP)	67%	49%	54%	49%	56%		
Omissions (% of total MODIS AFP)	15%	4%	3%	3%	14%		
SLSTR AFP double detec. (% of total SLSTR AFP)	33%	51%	46%	51%	44%		
MODIS AFP double detec. (% of total MODIS AFP)	85%	96%	97%	97%	86.0%		
Total SLSTR AFP	17,551	26,910	82,970	19,265	26,911		
Total MODIS AFP	1,962	5,019	10,921	3,323	4,048		
Percentiles 25, 50, 75 of SLSTR clusters FRP (MW)	11, 20, 37	18, 37, 86	19, 39, 102	10, 34, 61	11, 19, 35		
Percentiles 25, 50, 75 of MODIS clusters FRP (MW)	7, 13, 30	10, 23, 63	10, 25, 72	17, 23, 79	7, 12, 23		
Mean bias of FRP per cluster (MW)	3	-18	17	-59	7		
Median bias of FRP per cluster (MW)	5	9	9	8	5		

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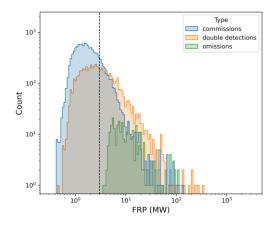


Figure 33: For nighttime. In blue, AFP exclusively detected by SLSTR; in orange, SLSTR AFP also detected by MODIS; in green, AFP exclusively detected by MODIS. The dashed line indicates MODIS detection threshold.

As visible in Figure 33, a large proportion of the fire pixels SLSTR detects present a very low FRP (< 4 MW). Conversely, almost fire pixel detected by MODIS had a FRP above 4 MW. The distribution of the FRP of commission pixels confirms that almost all commissions concern fires with very low FRP, highlighting the fact that SLSTR is much more sensitive than MODIS to detect active fires. Omissions, on the other hand, concern fires of very common intensities (~10 MW). Figure 34 shows that there is a good agreement between the FRP of clusters detected by MODIS and those detected by SLSTR. For low FRP values, SLSTR clusters seem to be more intense, which is in line with the lower threshold of SLSTR to detect an AFP: this allows for the detection of larger low-intensity clusters. Overall, the median absolute error between MODIS and SLSTR cluster FRP is 5 MW.

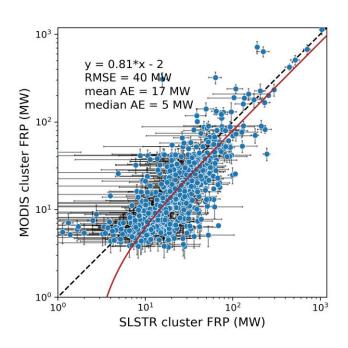


Figure 34: Comparison between the FRP of cluster pairs detected by SLSTR and MODIS during nighttime

7.3.2.2 SWIR fires

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The AFP and FRP detected by the SWIR channels are now part of this validation report. Only the FRP value estimated from the SWIR channels is validated, through by cross-comparison with those estimated from the MWIR channels. As SWIR and MWIR channels do not have the same sampling grid (500 m vs 1 km), the validation algorithm is as follow:

1. Reproject the SWIR fires on the MWIR grid using nearest-neighbours;

2. Omissions and commissions are evaluated in the same fashion as between MODIS and SLSTR MWIR AFP, using 7x7 pixels windows. AFP detected by the SWIR channels but not by the MWIR channels are commissions, while AFP detected by the MWIR channels but not by the SWIR channels are omissions.

Table 11: Summary of the intercomparison between nighttime SLSTR MWIR and SWIR active fires over the January – March 2024 period. Results from previous 3-months comparisons are included for information purposes.

	Value			
Variable	2024	2023		
	Jan.—Mar.	Oct.—Dec.		
Commissions (% of total SWIR AFP)	1%	0.5%		
Omissions (% of total MWIR AFP)	19%	14%		
SWIR AFP double detec. (% of total SWIR AFP)	99%	99.5%		
MWIR AFP double detec. (% of total MWIR AFP)	81%	86%		
Total SWIR AFP	5,356	11,159		
Total MWIR AFP	17,551	26,910		

It appears that the SWIR channels, after reprojection of the SWIR AFP on the MWIR grid, detect much less AFP than the MWIR ones (5,356 vs 17,551). As such, there are very barely any commissions, while 3,274 MWIR AFP did not have a SWIR counterpart. However, this does not necessarily indicate a lack of sensitivity of the SWIR channels, as isolated SWIR AFP might have been lumped with larger cluster, due to the reprojection on the MWIR grid and the 7 x 7 pixels window used for AFP matching.

7.3.3 Daytime Fires Validation

Table 12 presents a summary of the intercomparison between active fires detected by SLSTR and MODIS over the January—March 2024 period, as well as past periods. The proportion of commissioned fire pixels is in line with previous periods, while the proportion of omissions is higher than the last three quarters. However, it is still in line with what was obtained in 2023 for the same quarter. The FRP distributions of both MODIS and SLSTR clusters are higher than past periods before April 2023 for the 25th, 50th, and 75th percentile values. While this may be due to the occurrence of more intense fires, it be due to the updated clustering values introduced since April.

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Table 12: Summary of the intercomparison between daytime SLSTR and MODIS active fires over the January – March 2024 period. Results from previous 3-months comparisons are included for information purposes.

	Value						
Variable	2024	2023					
	Jan.—Mar.	Oct.—Dec.	Jul.—Sep.	Apr.—Jun.	Jan.—Mar.		
Commissions (% of total SLSTR AFP)	42%	44%	43%	31%	27%		
Omissions (% of total MODIS AFP)	42%	26%	33%	27%	42%		
SLSTR AFP double detec. (% of total SLSTR AFP)	58%	56%	57%	69%	73%		
MODIS AFP double detec. (% of total MODIS AFP)	58%	74%	67%	73%	58%		
Total SLSTR AFP	11,703	13,845	37,754	22,069	16,257		
Total MODIS AFP	8,064	8,144	20,458	10,930	14,946		
Percentiles 25, 50, 75 of SLSTR clusters FRP (MW)	20, 37, 72	25, 47, 119	18, 36, 86	17, 37, 90	15, 28, 51		
Percentiles 25, 50, 75 of MODIS clusters FRP (MW)	16, 33, 75	21, 46, 128	15, 32, 82	19, 35, 91	12, 22, 46		
Mean bias of FRP per cluster (MW)	-9	-18	-9	-13	6		
Median of FRP scatter per cluster (MW)	2	1	3	3	4		

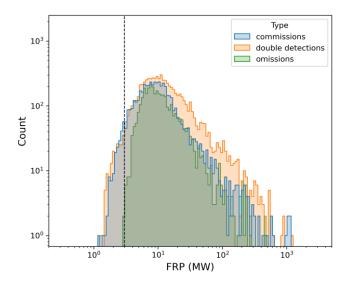


Figure 35: For daytime. In blue, AFP exclusively detected by SLSTR; in orange, SLSTR AFP also detected by MODIS; in green, AFP exclusively detected by MODIS. The dashed line indicates MODIS detection threshold.

Figure 35 is the equivalent to Figure 33, but for daytime. The peaks of commissions, omissions, and double detections are very close, meaning commissions and omissions are mostly in ranges detectable by both SLSTR and MODIS and concern the same type of fires.



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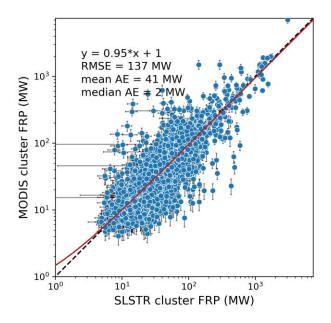


Figure 36: Comparison between the FRP of cluster pairs detected by SLSTR and MODIS during daytime.

Figure 36 shows that daytime and nighttime clusters have, in general, the same patterns, with the FRP values of SLSTR clusters being generally in line with those of MODIS. Once again, there is a close match between SLSTR and MODIS cluster, with a median absolute error of 2 MW.

7.3.4 Biome influence on active fire detection

The present section consists in a preliminary study on the biome influence over errors of commission and omission. The biome corresponding to each fire is determined using the Global Land Cover 2000 data. This per-biome analysis may help identify biome-dependent behaviours concerning active fire detection. For each biome, over nighttime and daytime, the absolute numbers of commissions and omissions as well as the relative numbers (with regards to the total number of SLSTR and MODIS AFP for commissions and omissions, respectively) are evaluated over the January—March 2024 period.

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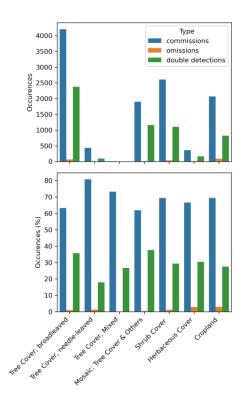
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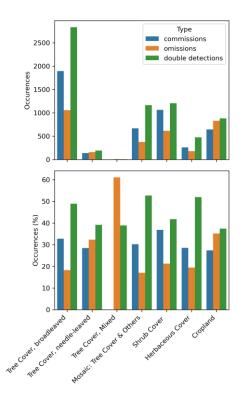


Figure 37: Occurrences of commissions and omissions of active fire pixels per biome. On the left, nighttime; on the right, daytime.

Figure 37 shows the absolute (top) and relative number (bottom) of commissions, omissions, and double detections. For clarity purposes, similar biomes were aggregated together, while some were rejected from the analysis. Overall, most fires occurred over Broadleaved, Shrub, Croopland, and Mosaic biomes for both nighttime and daytime. Commissions represented the vast majority (>70%) of SLSTR AFP over the Needle-leaved and Mixel classes during nighttime. During daytime, classes Broadleaved, Shrub, Mosaic, and Cropland presented a large quantity of AFP. Overall, during daytime, it is more frequent to have a detection by both MODIS and SLSTR than the opposite, even for classes such as Needle-leaved, for which almost every SLSTR night detection is a commission.

7.4 Conclusion

Overall, in line with previous reports, it appears that for both nighttime and daytime products, much more AFP are detected by SLSTR than MODIS. Indeed, SLSTR's FRP threshold to detect active fires is much lower than that of MODIS (<1 MW vs ~3 MW), leading to a very high number of low intensity commissioned fires, especially at night.

For most active fire clusters, trends are coherent with past periods, with good agreement between SLSTR and MODIS clusters' FRP. Overall, for both daytime and nighttime, there seem to be a linear relationship between MODIS and SLSTR cluster FRP, and a median absolute error around or below 15 MW – for this period, it was 5 and 2 MW for nighttime and daytime, respectively.

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The analysis of the number of AFP detected from the SWIR channels shows that the extent of fires detected by the SWIR is slightly less than that of the MWIR, with 15% of MWIR AFP not having a SWIR counterpart. Conversely, almost all (99.5%) of SWIR AFP have a MWIR counterpart. Overall, these results are in line with the previous quarter, and there is a good agreement between the location a SWIR and MWIR AFP.

Looking at the number of AFP detected by S3A and S3B, the analysis showed that they could currently be considered similarly sensitivity, with only a very small detection offset. No long-term trend line was detected either.

Finally, most fires were detected over the Broadleaved, Mosaic, Shrub, and Cropland land classes. The results of the per-biome analysis seem to confirm behavioural differences between Broadleaved and Needle-leaved biomes: the former are much more prone to commissions than the latter. For nighttime, Herbaceous and Cropland biomes contain most omissions. For daytime, while there are most of the time more commissions than omissions for each biome, the Needle-leaved and especially Cropland biomes stand out as the only biomes where there are more fires detected by MODIS than by SLSTR.



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8 Appendix A

All Data Quality Reports, as well as past years Data Quality Reports and Annual Performance Reports, are available on dedicated pages in Sentinel Online website, at:

- S2 MSI L1C Data Quality Report
- S2 MSI L2A Data Quality Report
- S3 OLCI Data Quality Reports
- S3 SLSTR Data Quality Reports
- OPT Annual Performance Report Year 2023 (PDF document)

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