OPT-MPC

Copernicus Sentinel Optical Mission Performance Cluster

SLSTR Performance

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STFC RAL Space

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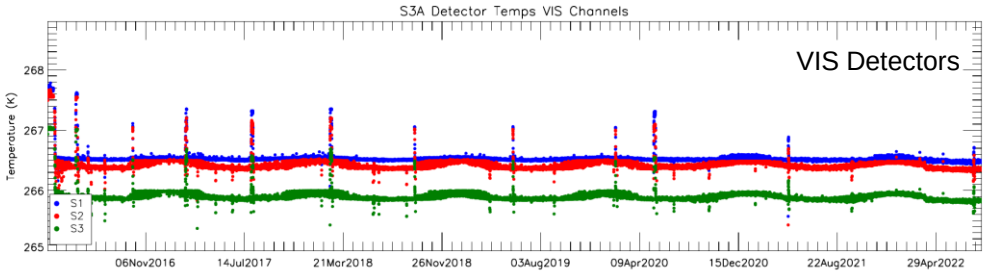
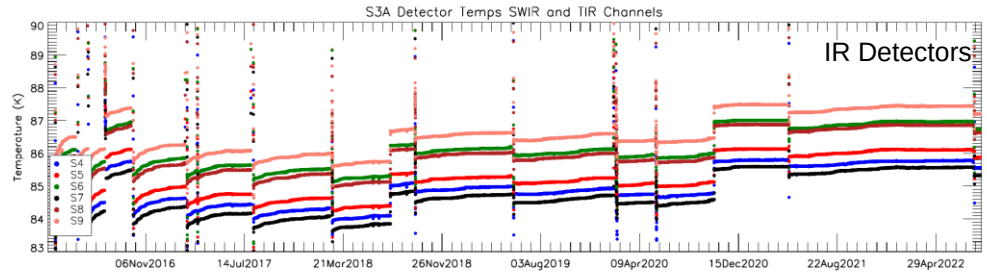
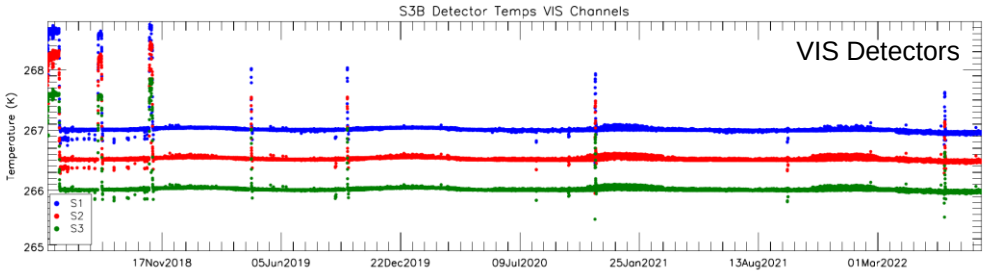
Detector Temperatures

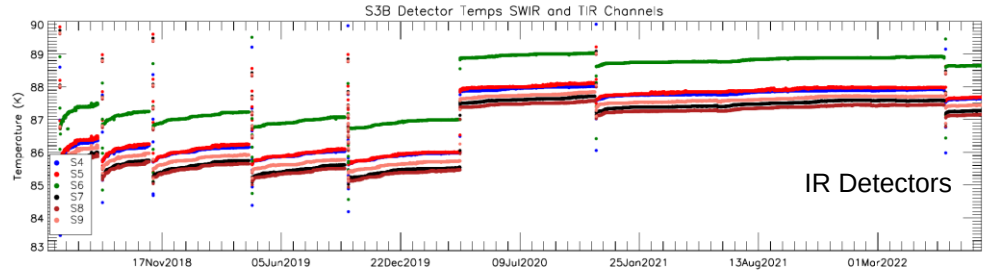
SLSTR-A





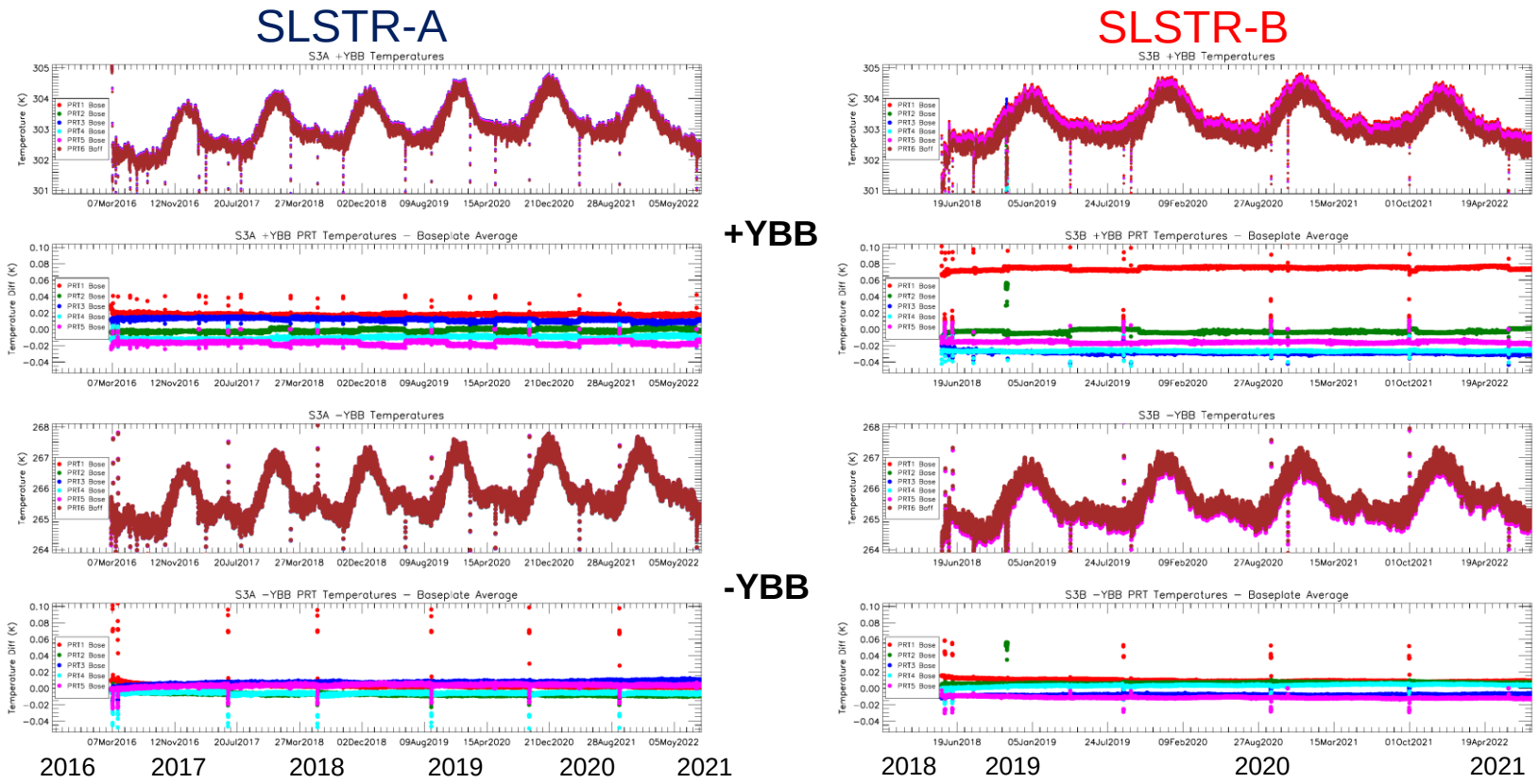
SLSTR-B





- IR detector temperatures maintained between 84 K and 89 K
- Periodic de-contamination is needed to remove water ice from cold surfaces
- SLSTR-A FPA Cooler set-point increased by 1K in July 2018 and 1K in Oct 2020 to increase running time between decontaminations
- SLSTR-B FPA Cooler set-point increased by 2K in March 2020
- ‘Forced’ decontaminations in 2022 due to instrument anomalies

Black-Body Performance



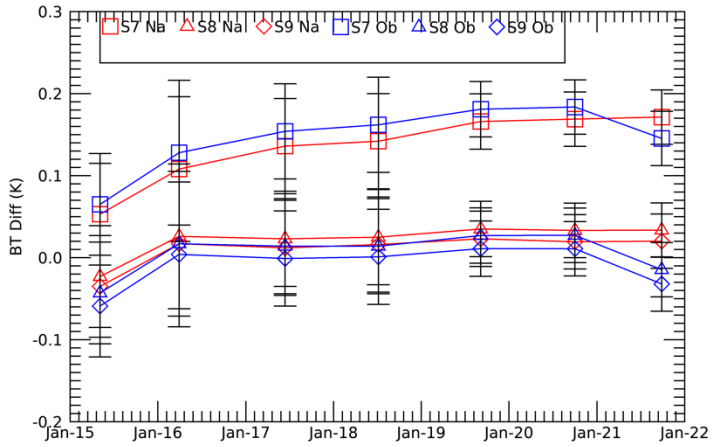
Blackbody temperatures have a seasonal cycle on top of the daily/orbital temperature cycles. Heated BB remains below 305K limit necessary for S7 calibration.

Temperature gradients consistent with pre-launch values for SLSTR-A and B

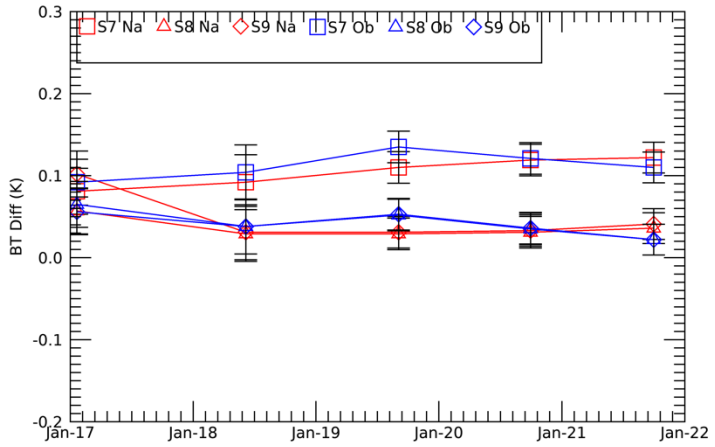
BB Temperatures have decreased slightly since reduction in heater power

BB Cross-Over Test Results

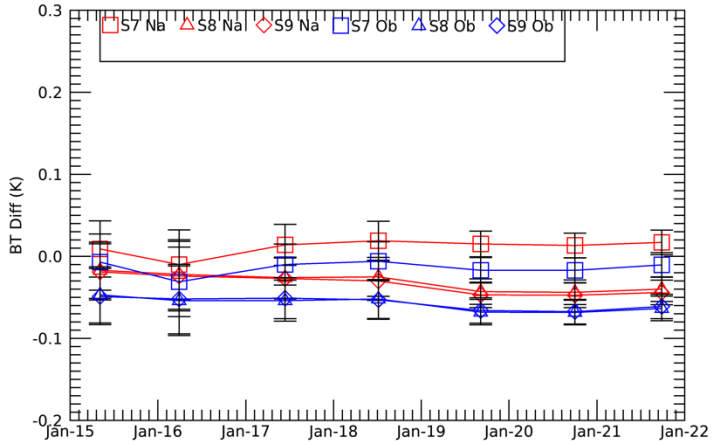
SLSTR-A Part-1



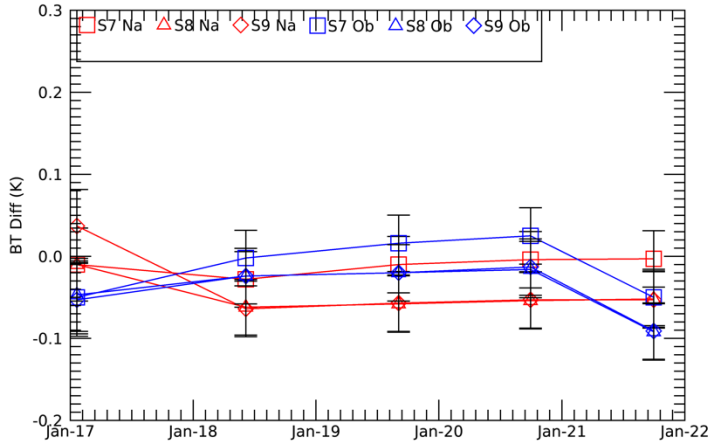
SLSTR-B Part-1



SLSTR-A Part-2



SLSTR-B Part-2



Once a year we perform a cross-over test where the heated BB is swapped and the signals are compared when the temperatures cross-over.

We estimate the effective temperature error by comparing the detector counts at the cross-over point

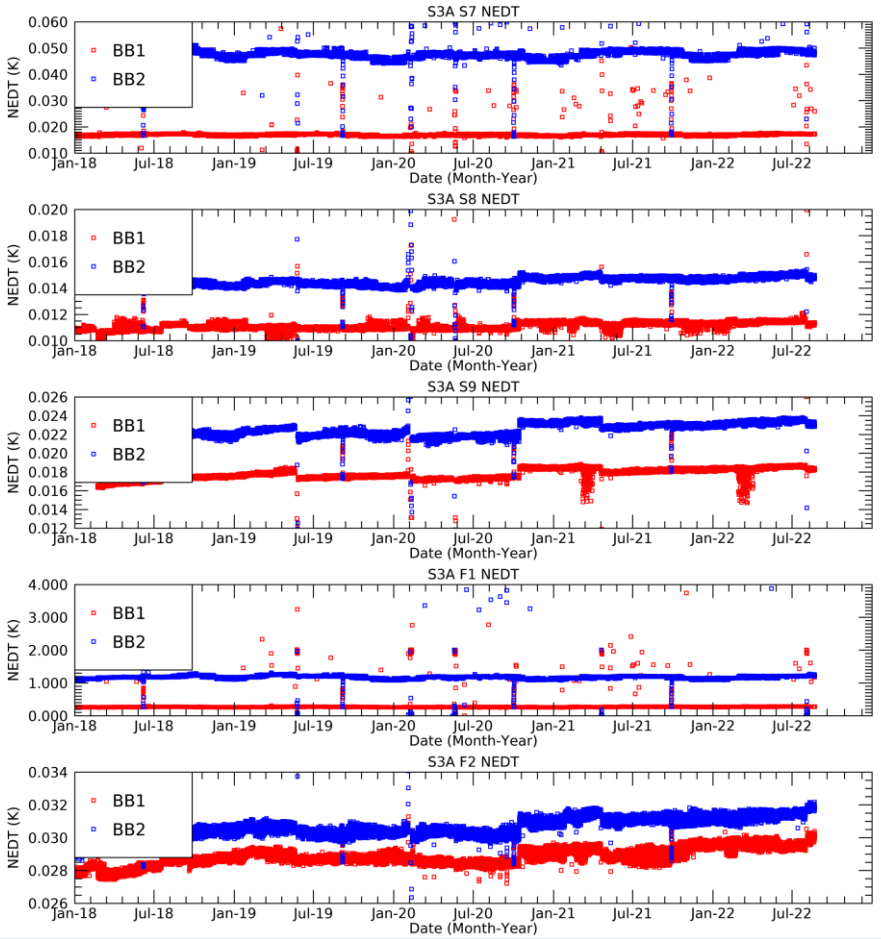
$$\Delta T = \Delta C \frac{\partial T}{\partial C}$$

Important to note the result is an indication of the BT radiometric uncertainty under certain conditions.

I.e. a combination of thermometer calibration drift, emissivity, thermal gradients.

IR Channels Noise

SLSTR-A



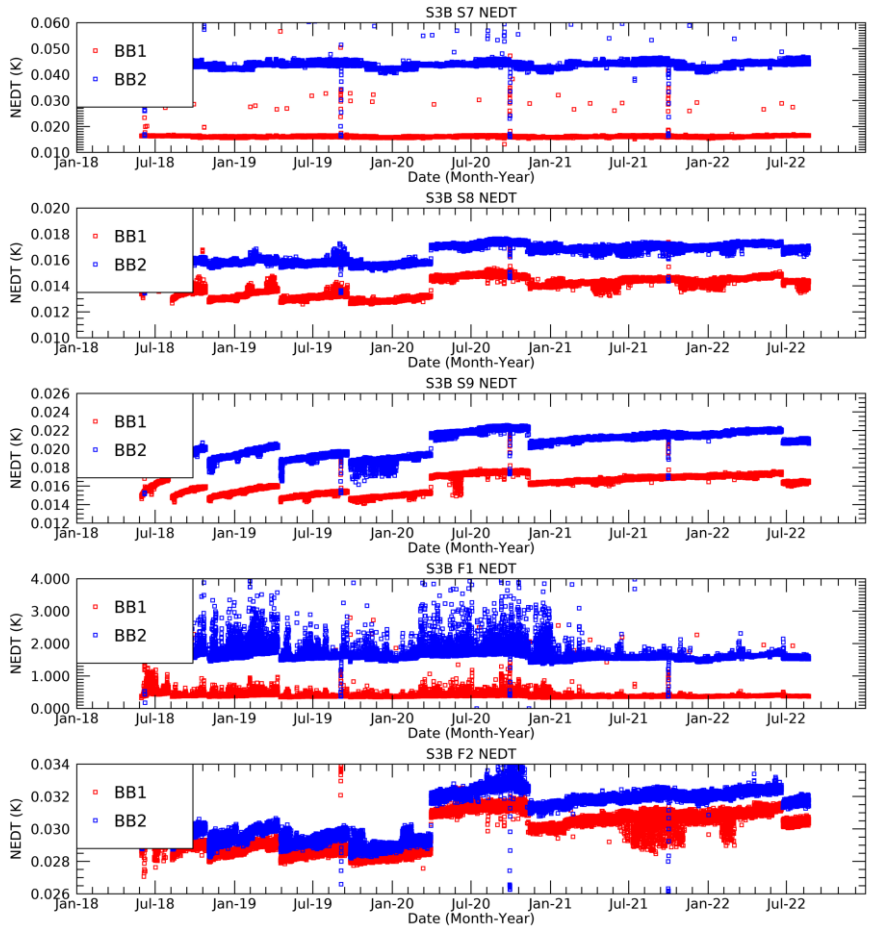
S7

S8

S9

F1

F2



SLSTR-B

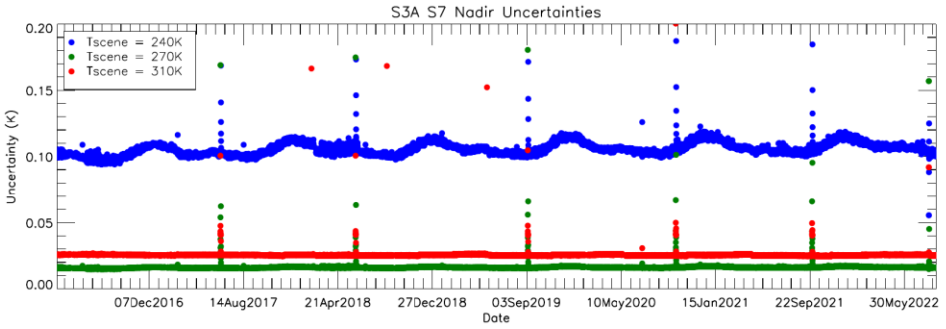
Radiometric noise levels for the TIR channels have remained stable throughout at pre-launch values.

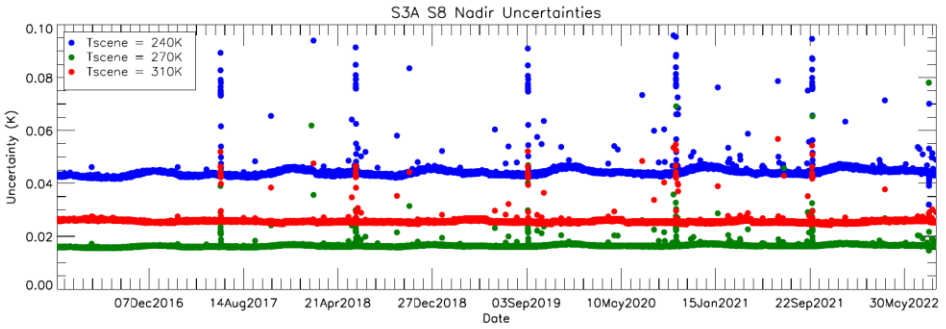
NEDT for the S8 and S9 channels are below 20mK. For SLSTR-B there appears to be a small but gradual increase over time.

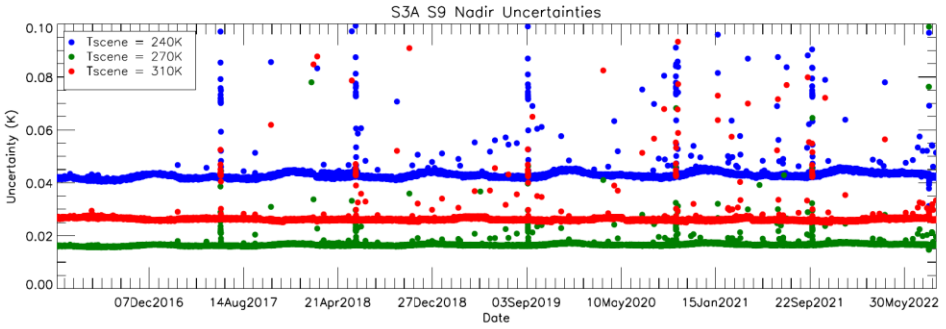
S3B F1 shows periodic increases in noise – possibly due to motional chopping

IR Channels Uncertainties

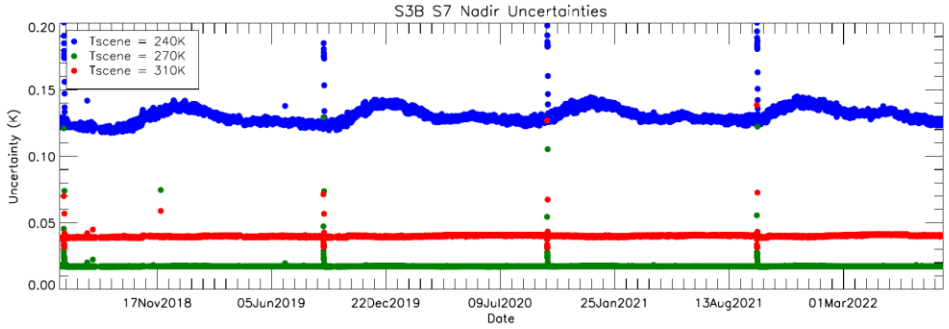
SLSTR-A

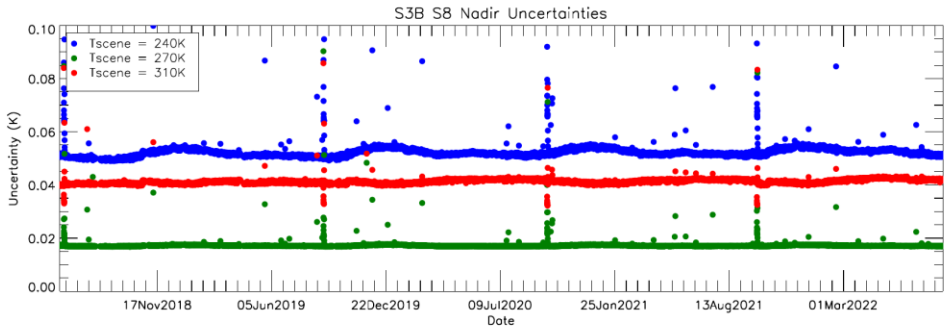


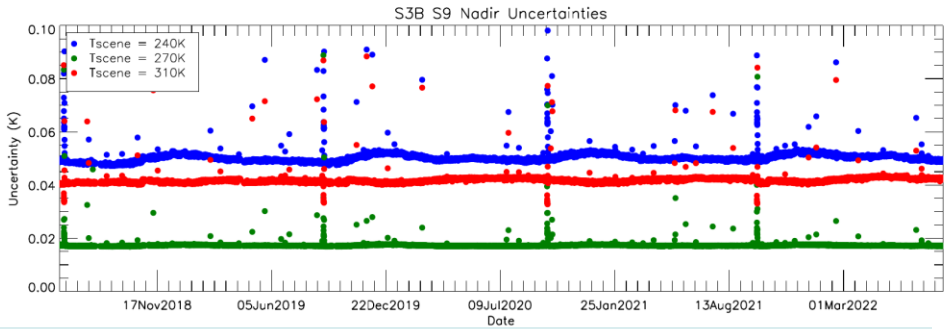




SLSTR-B





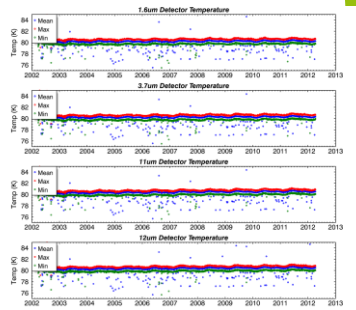


Uncertainties are derived from L0 monitoring outputs. Plots show uT at k=1 for scene temperatures of 240K, 270 K and 310 K.

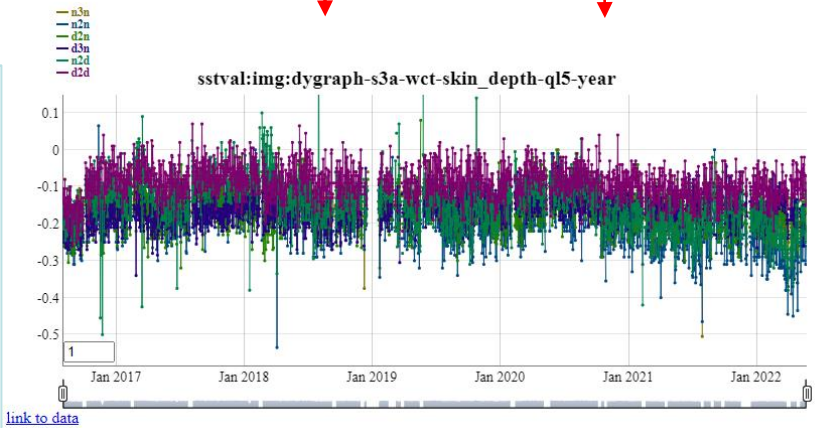
Seasonal variations at low scene temperatures due to BB temperature variations.

SLSTR (in)stability

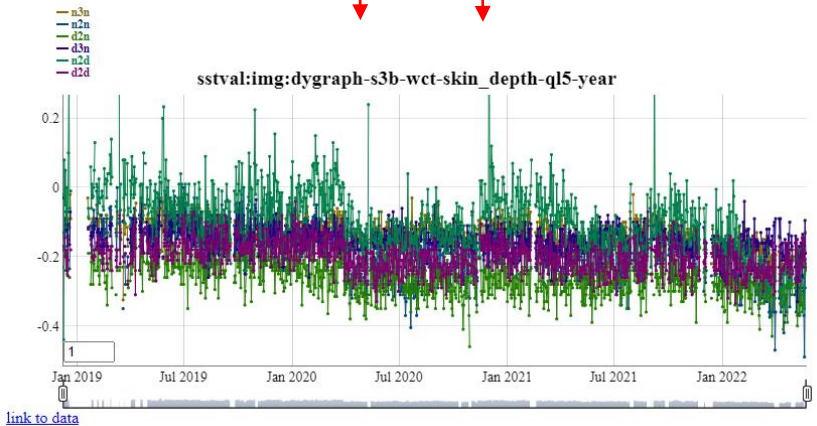
CF: AATSR from RAL Space end of mission report ->



Daily mean difference (deg C) between SLSTR SST and drifters; no adjustments for skin-depth differences; no SSES; SLSTR-A left and SLSTR-B right

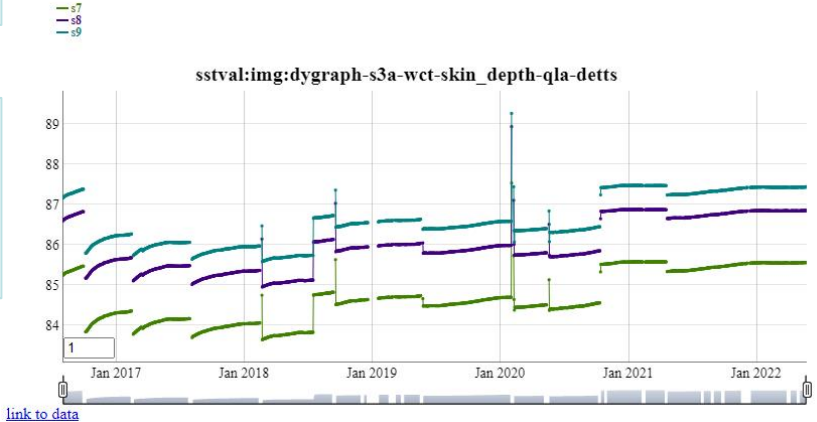


link to data

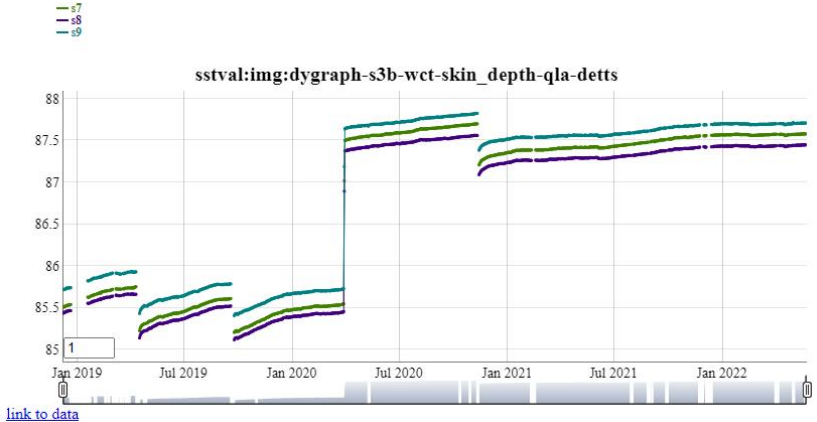


link to data

Detector Temps (in K) for S7, S8 and S9; SLSTR-A left and SLSTR-B right



link to data



link to data

Changes in SST over time cannot be explained solely by changes in detector T

Instrument instability means it's difficult (impossible) to separate out calibration and retrieval issues

SLSTR detector temperatures vary due to decontaminations as well as changes to cold finger temperatures

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VIS/SWIR Radiometric Calibration – Current Status

- **Verification of the S1-S6 channel calibration is primarily based on analysis of PICS sites, but complemented by Lunar and Sun-glint methods**

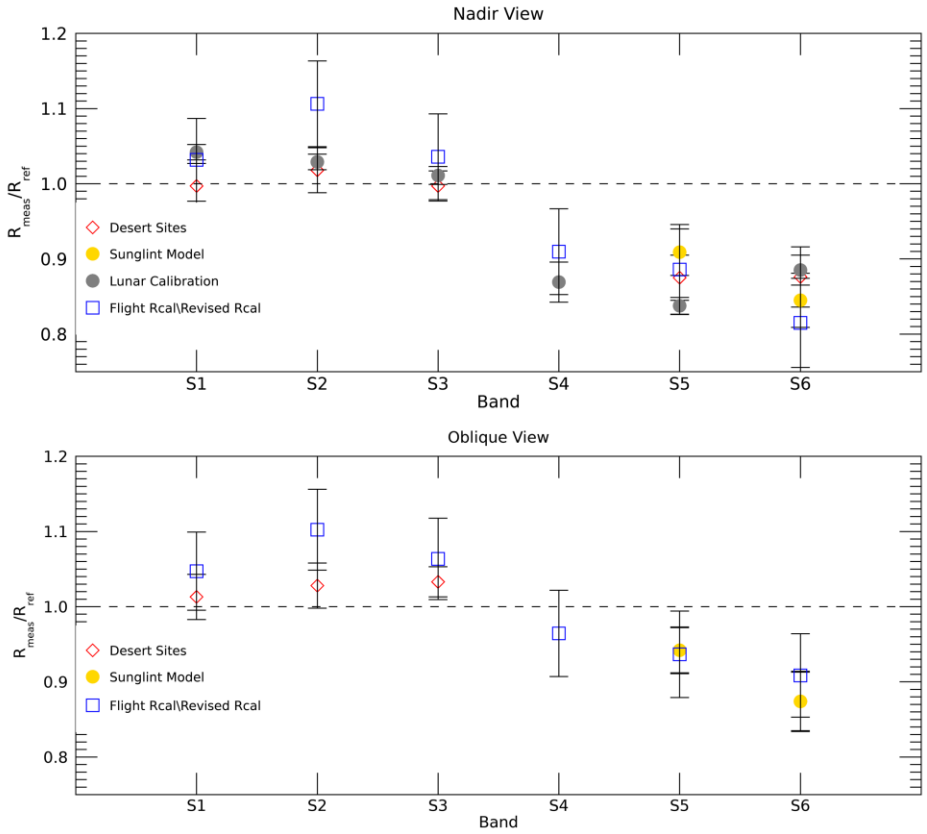
Nadir View

	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
Input Analysis	UoAz Rayference CNES	UoAz MPC (RAL) Rayference CNES	UoAz MPC (RAL) Rayference CNES	UoAz MPC (RAL) Rayference CNES	UoAz MPC (RAL) Rayference CNES

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
Input Analysis	Rayference CNES	MPC (RAL) Rayference CNES	MPC (RAL) Rayference CNES	MPC (RAL) Rayference CNES	Rayference CNES

Note: Uncertainty estimates are at k=1.



Users are advised to adopt the correction factors for the radiometric calibration of channels S1-S6

Long Term Trends - Nadir

- **The long-term stability of the VIS/SWIR channels is determined using comparisons over PICS sites.**
  - Long term stability of sites is assumed to be <1% based on historical analysis of sites.
  - Seasonal variations are accounted for.

	S3A	S3B
S1	0.24% yr^{-1}	0.17% yr^{-1}
S2	0.09% yr^{-1}	0.11% yr^{-1}
S3	0.28% yr^{-1}	0.08% yr^{-1}

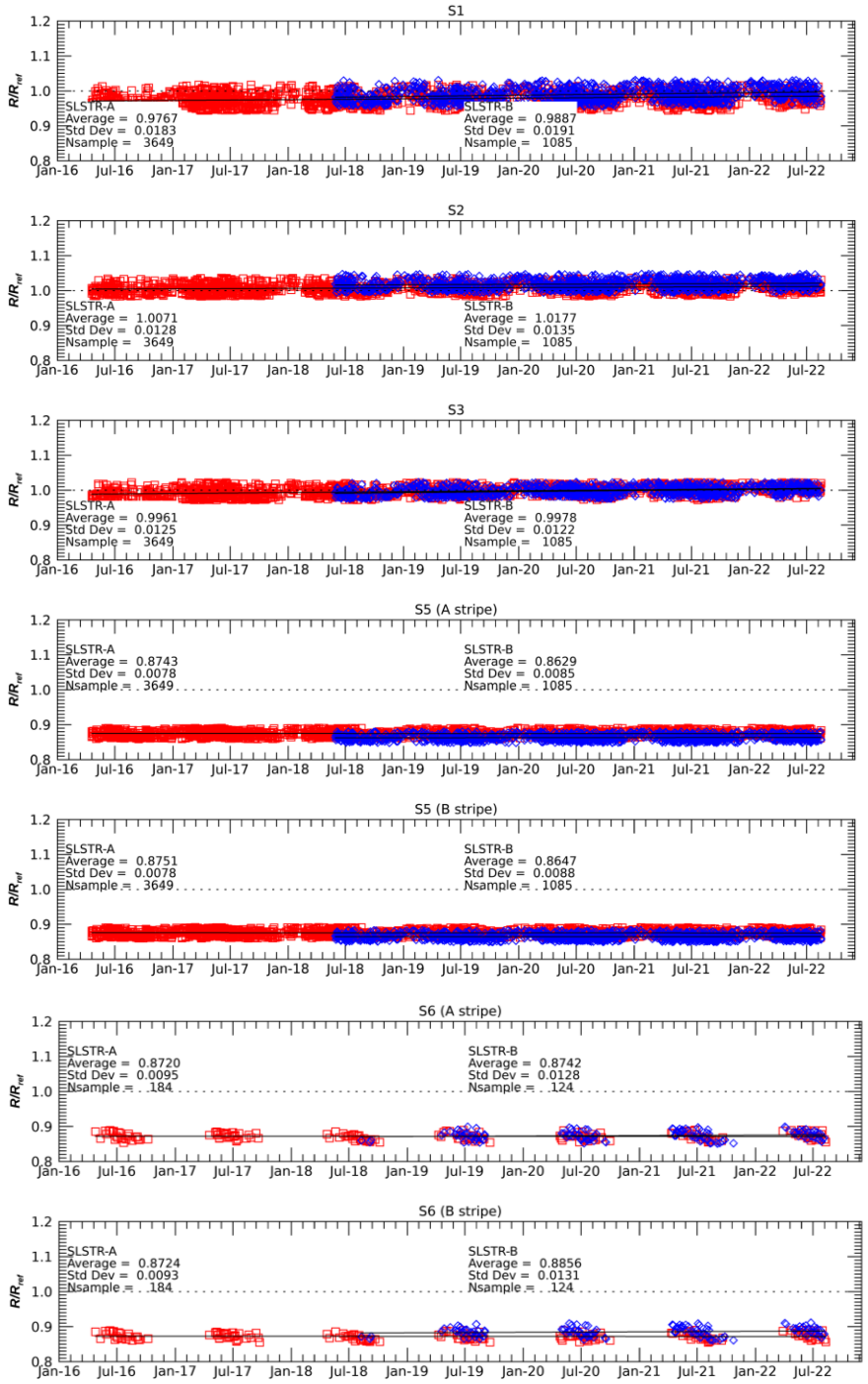
- **All channels show good long term stability.**
  - No corrections applied yet due to operational constraints

- **Good consistency between SLSTR-A and B**

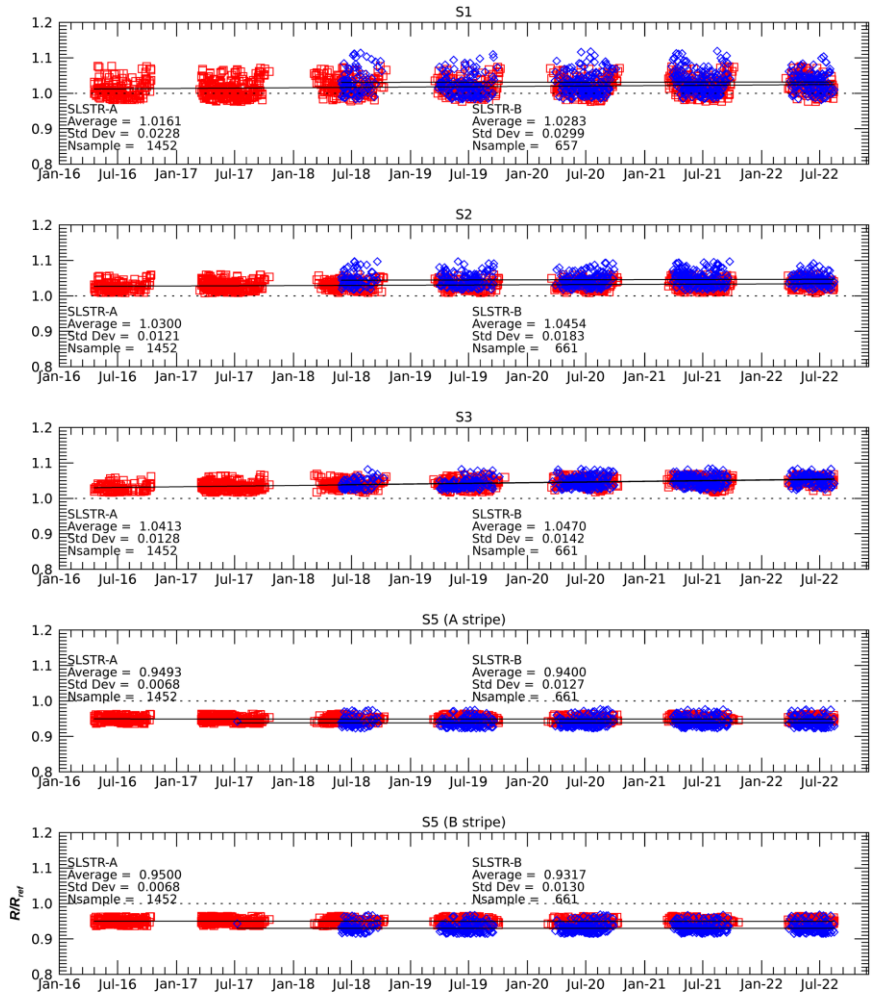
- **Small drift observed for S1-S3 observed over mission lifetime.**

Calibration Stability

Nadir View



Oblique View



Drift Rates for Oblique View are via AATSR for matching geometry – hence no match-ups for S6

Yearly Drift

Year-by-year breakdown of the drift in % since the start of the mission

SLSTR-A

	S1		S2		S3		S5a		S5b		S6a		S6b	
Year	**Na**	**Ob**	**Na**	**Ob**	**Na**	**Ob**	**Na**	**Ob**	**Na**	**Ob**	**Na**	**Ob**	**Na**	**Ob**
2017	0.3	0.0	0.2	0.3	0.5	0.5	0.1	0.0	0.2	0.1	0.1	-	0.0	-
2018	0.7	1.0	0.2	0.3	0.8	0.9	0.0	-0.1	0.0	-0.1	-0.6	-	-0.7	-
2019	0.9	0.5	0.4	0.4	1.1	1.2	0.0	0.0	0.0	0.0	-0.2	-	-0.3	-
2020	1.1	0.7	0.6	0.5	1.4	1.6	0.0	-0.1	0.0	-0.1	-0.2	-	-0.3	-
2021	1.4	0.9	0.6	0.6	1.6	1.8	0.0	0.0	0.0	0.0	-0.2	-	-0.3	-
2022	2.2	1.3	1.1	0.7	2.2	2.3	0.2	0.0	0.2	0.0	0.7	-	0.6	-

SLSTR-B

	S1		S2		S3		S5a		S5b		S6a		S6b	
Year	**Na**	**Ob**	**Na**	**Ob**	**Na**	**Ob**	**Na**	**Ob**	**Na**	**Ob**	**Na**	**Ob**	**Na**	**Ob**
2019	0.7	-1.2	0.5	-0.3	0.3	0.0	0.2	-0.1	0.3	-1.1	-	-	-	-
2020	0.9	-0.8	0.5	-0.2	0.5	0.4	0.3	-0.3	0.3	-1.3	-0.2	-	-0.2	-
2021	1.3	-0.4	0.7	0.2	0.8	0.7	0.3	-0.3	0.2	-1.3	0.0	-	-0.1	-
2022	2.1	-0.5	1.2	-0.1	1.5	1.2	0.7	-0.2	0.6	-1.2	1.0	-	0.9	-

Uncertainty in the drift rate is estimated at 1%.

Reference year for S6 of S3B is 2019

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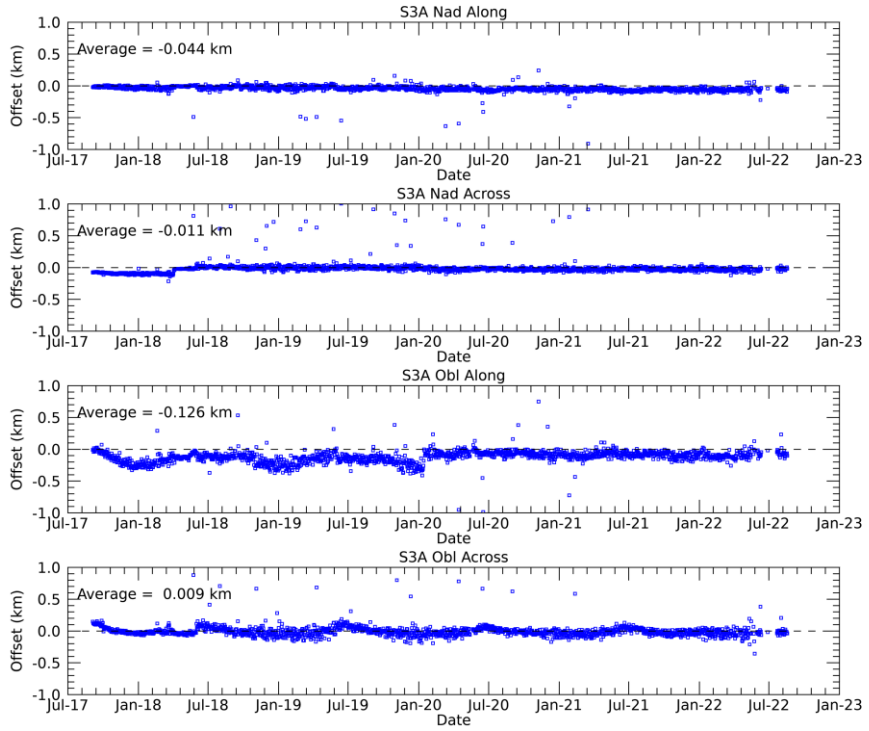
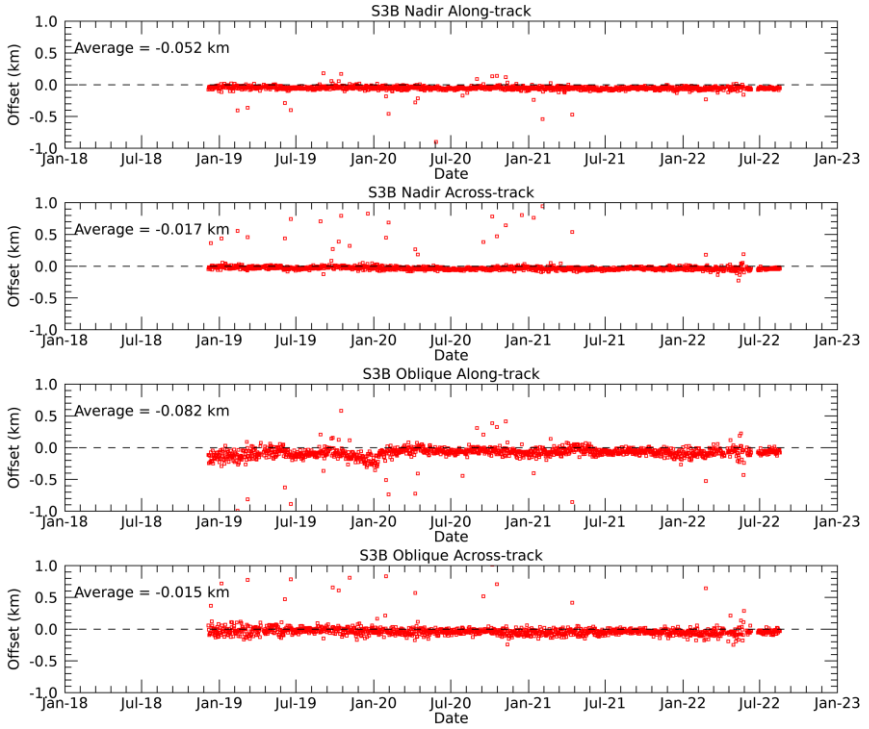


SLSTR-B



SLSTR-A Mission Averages	
Na Across Track	-0.044 km
Na Along Track	-0.011 km
Ob Across Track	-0.126 km
Ob Along Track	0.009 km

SLSTR-B Mission Averages	
Na Across Track	-0.052 km
Na Along Track	-0.017 km
Ob Across Track	-0.082 km
Ob Along Track	0.015 km

Geometric calibration assessed against ground control points using S3GEOCAL tool
Note: Plots only cover period for monitoring performed by MPC – hence early mission data not included

TIR Co-Registration

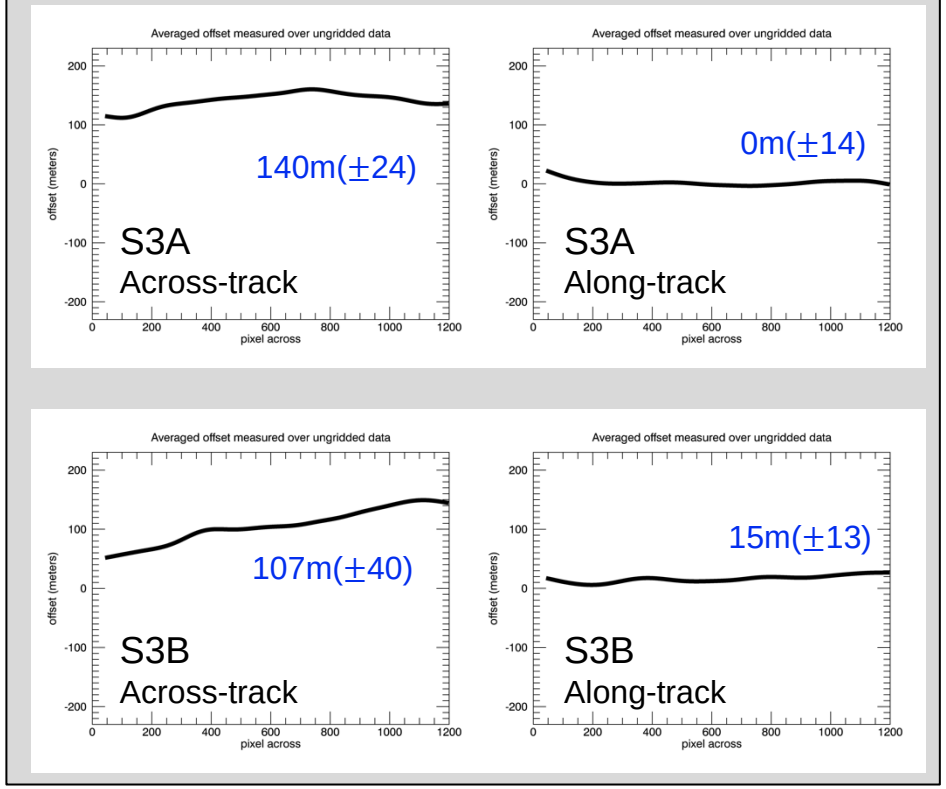
- **GeoCal tool provides absolute calibration of SLSTR wrt. S3 channel**

- **Interband co-registration of all channels is based on CCDB assumed to be correct.**
  - CCDB provides detector line-of-sight based on static alignment tests derived from pre-launch calibration measurements. Does not account for different grid resolutions, scanning effects, on-orbit variations (assumed to be negligible)

- **Earlier analysis of L1 images showed an offset of S7 vs S8/S9.**
  - Most likely due to timing effect.
  - Which channel is correct with respect to the VIS/SWIR channels (if any)?

S7 vs S8 Positional offsets were measured for S3A and S3B during the Tandem Phase

Nadir



Geolocation of TIR channels

Co-registration analysis between S7 and S8/S9 is straightforward

- Same image grid and good correlation between bands.

To perform co-registration analysis between TIR and VIS/SWIR channels, the VIS/SWIR radiance images must be remapped from the 0.5 km grid to the IR 1km.

- 0.5 km grid was triangulated into IR 1km grid

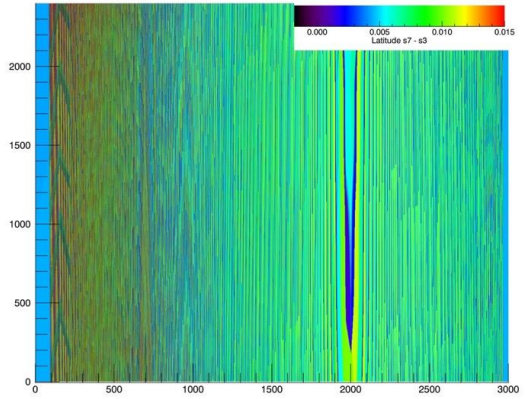
The TIR vs VIS co-registration is performed between channels S7 and S5

- S8/S9 show very poor correlation wrt. VIS/SWIR channels so could not be done directly (i.e. radiometrically uncorrelated).

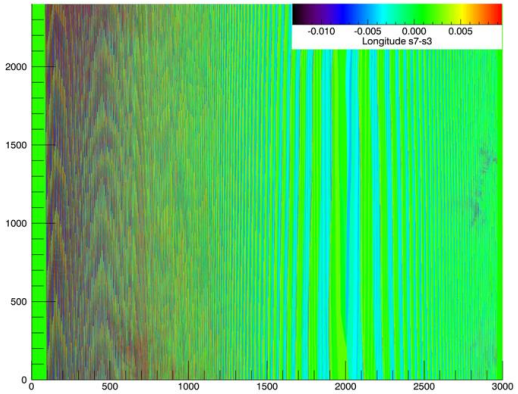
Co-registration analysis has been completed over every L1 product in 2021.

- Full Earth coverage

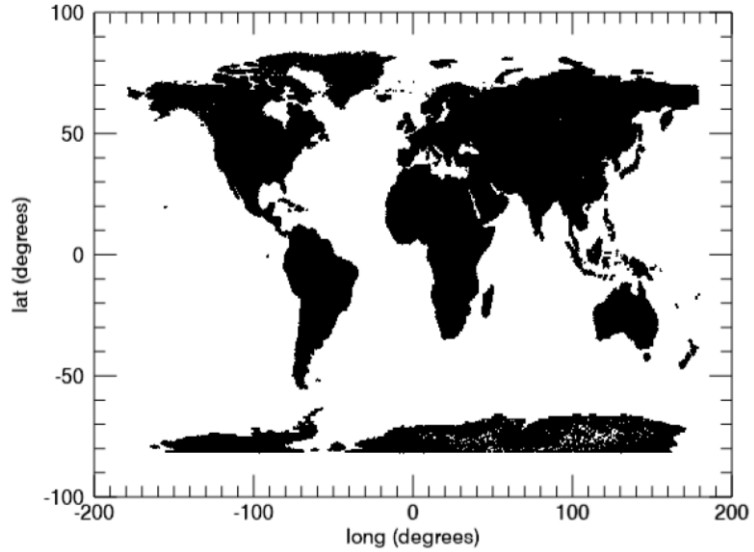
Latitude_in – latitude_an



longitude_in – longitude_an



Spatial distribution of all the positional offset measurement locations.



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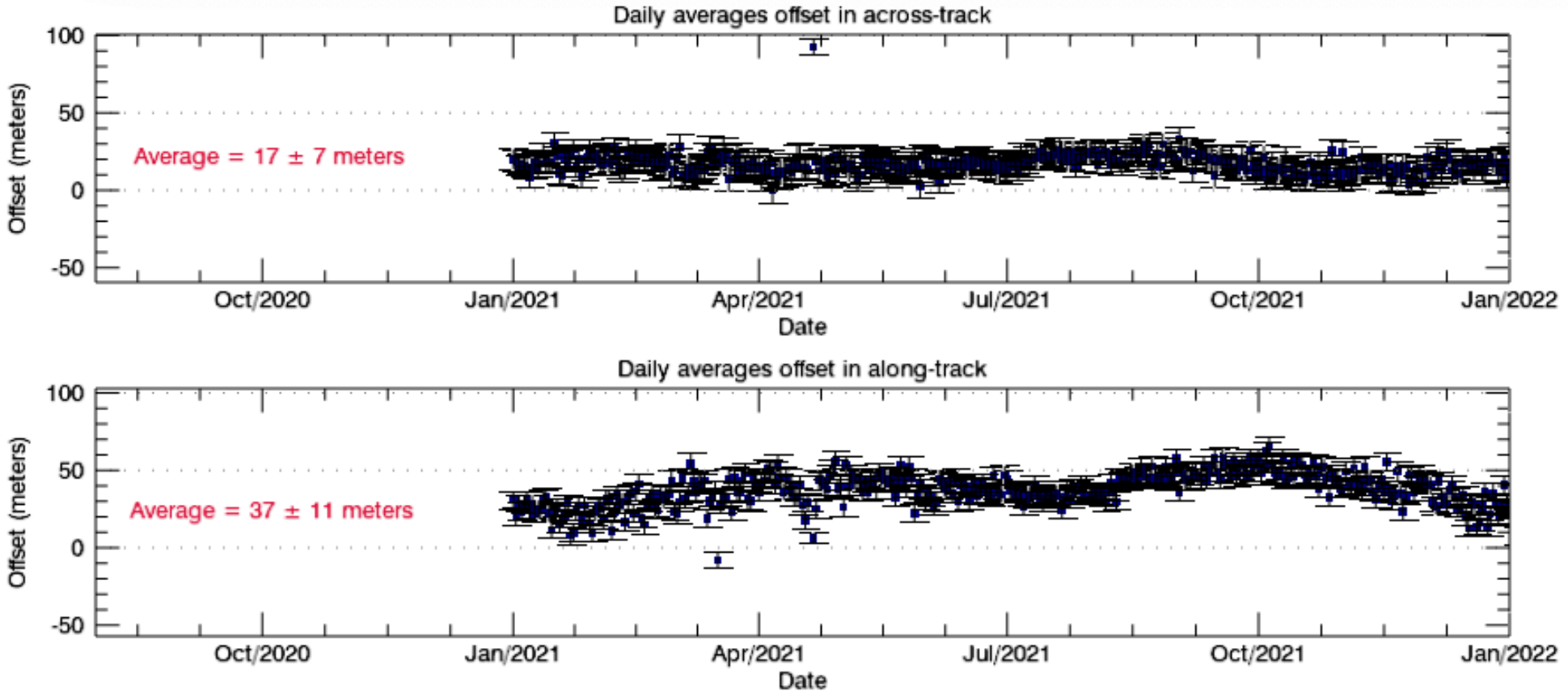
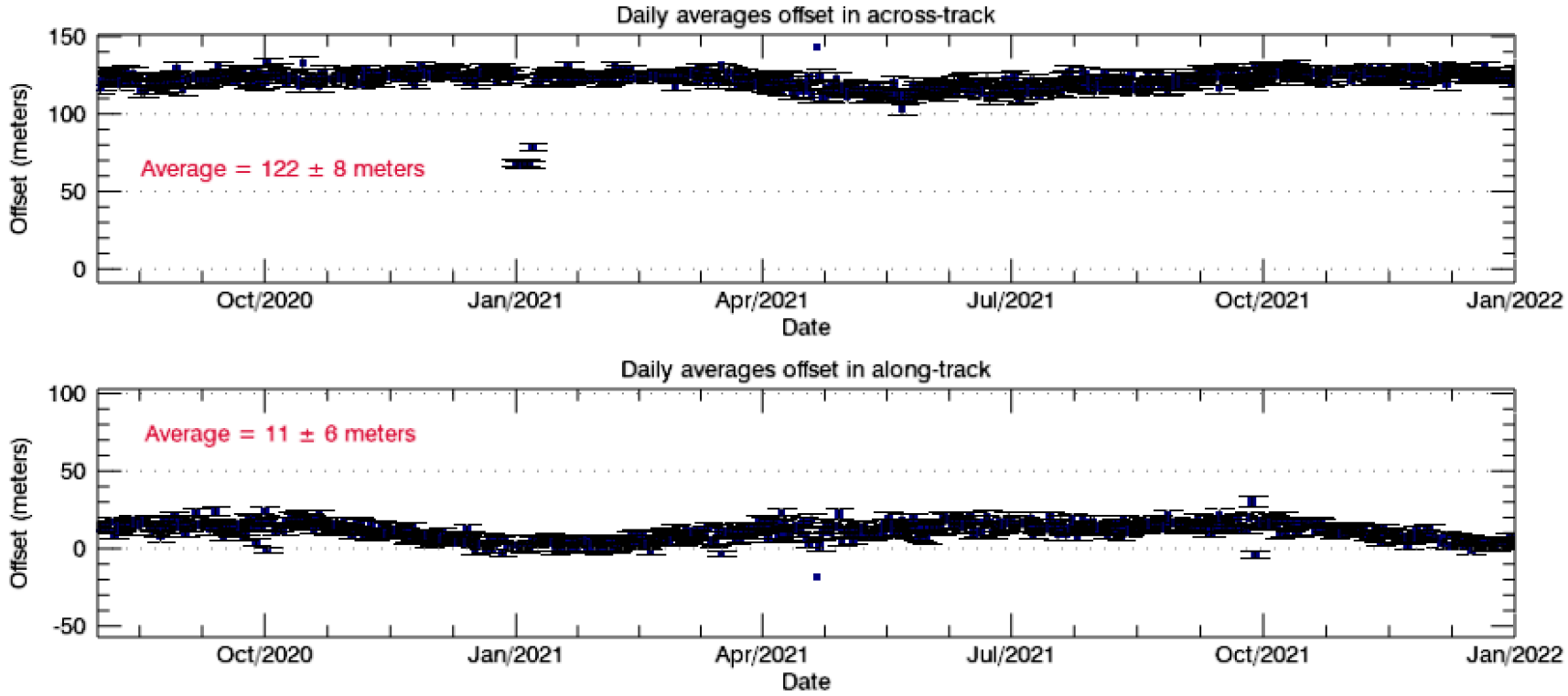
Co-registration of S5 wrt S7



S5 and S7 are well co-registered in across-track and along-track

Co-registration of S8 wrt S7



- **Results are consistent with earlier analysis of on L0 data**
- **Co-registration of S8 vs S7 show a seasonal variation**

TIR Geometric Calibration Summary

- **S8/S9 wrt. S7**
- ~130 metres in across track ~ 0 metres along-track

- **S7 wrt. S5**
- ~0 metres across-track, along-track shows seasonal variation bellow 50 meters
- Correlation factors and the number of positions in which the co-registration is measured vary seasonally
- Changes on the instrument temperatures

- **S8/S9 wrt. VIS/SWIR**
- By reference, we can infer a similar offset variation with S8/S9 wrt S5 and therefore S3.