sentinel-3A SLSTR – Early results

A BIGGER PICTURE FOR COPERNICUS

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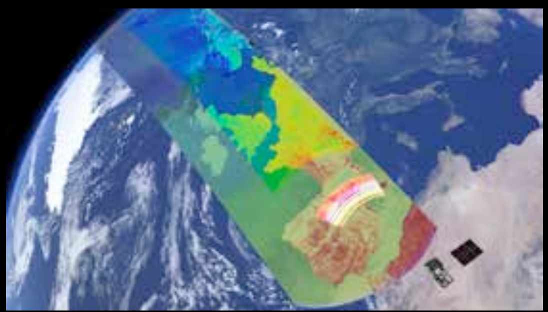
About sentinel-3 Sea and Land Surface Temperature Radiometer

The main objective of the Sentinel-3 SLSTR instrument is to maintain continuity with the ENVISAT (A)ATSR series of instruments within the European Copernicus programme. SLSTR will retrieve global coverage sea surface skin temperature (SSTskin) with zero bias and an uncertainty of ± 0.3 K (1σ) for a 5 x 5 degree latitude longitude area, having a temporal stability of 0.1 K/decade in support of Copernicus climate monitoring and operational Numerical Ocean/Weather Prediction (NOP/NWP) applications. In addition, SLSTR using a suite of visible and infrared radiance measurements, monitoring, ice surface temperature, cloud imagery, atmospheric aerosol, land, forestry and hydrology products in support of Copernicus serviceswill provide land surface temperature, active fire.

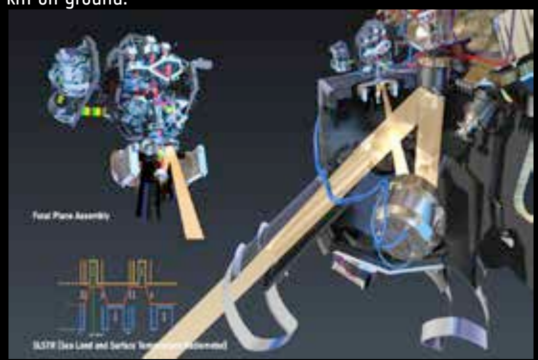
This poster presentation presents initial results from the Sentinel-3A SLSTR as of May 25th 2016.

SLSTR Optical design

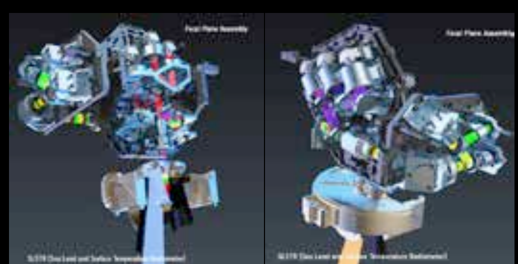


← While more complex than the single scan system employed by the (A)ATSR instrument series, the SLSTR 3-mirror scan configuration increases the instrument oblique view swath to ~750 km (centred at the SLSTR nadir point) and the nadir swath to~1400 km (offset in a westerly direction). The nadir swath is asymmetrical with respect to the nadir point to provide identical and contemporaneous coverage with OLCI ocean/land colour measurements. Visible and short-wave infrared detectors have a spatial resolution of 0.5 km on ground. Thermal infrared detectors have a spatial resolution of 1 km on ground.

→ SLSTR uses two independent scan chains each including a separate scan mirror (scanning at a constant velocity of 180 rpm), an off-axis paraboloid mirror, and a fold mirror to focus measured radiance into the instrument Detector Assembly (DA). An innovative recombination "flip" mirror alternately relays each of the scanned optical beams into a common field plane at the entrance of the DA where there is a cold baffle.



↓ On the left image, the optical path inside the focal plane array (FPA) to the the visible (yellow-multi-coloured path) and infrared (red path) detectors is shown. The flip-mirror assembly is to the bottom of the image shown in cutaway. This selects which optical path – from the nadir or oblique scan mirror - is directed into the FPA. On the right the path taken to inside the visible and shortwave infrared (purple path) detectors is revealed FPA.



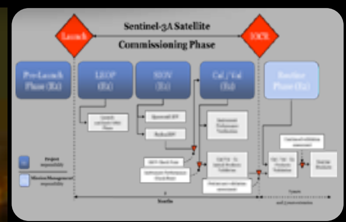
Spectral channels

SLSTR Band	L Centre [μm]	ΔL [μm]	SNR [-] / NeΔT [mK]	Spatial Sampling Distance (SSD) [km]	Function
S1	0.555	0.02	20	0.5	Cloud screening, vegetation monitoring, aerosol
S2	0.659	0.02	20	0.5	NDVI, vegetation monitoring, aerosol
S3	0.865	0.02	20	0.5	NDVI, Cloud flagging, Pixel co-registration
S4	1.375	0.015	20	0.5	Cirrus detection over land
S5	1.61	0.06	20	0.5	Cloud clearing, Ice and snow, vegetation monitoring,
S6	2.25	0.05	20	0.5	Vegetation State and Cloud Clearing
S7	3.74	0.38	80 mK	1.0	SST, LST, Active Fire
S8	10.95	0.9	50 mK	1.0	SST, LST, Active Fire
S9	12	1.0	50 mK	1.0	SST, LST
F1	3.74	0.38	< 1 K	1.0	Active Fire
F2	10.95	0.9	< 0.5 K	1.0	Active Fire

← The complete suite of AATSR and ATSR-2 spectral channels (0.55, 0.66, 0.85, 1.6, 3.7, 10.8 and 12 μm) is included in the SLSTR design in order to maintain continuity. Additional channels at 1.378 μm and 2.25 μm are included to enhance thin cirrus cloud detection. SLSTR has an additional capability to derive active fire measurements using an extended dynamic range of the 3.7 μm channel and dedicated optimized detectors at 10.8 μm that are capable of detecting fires at ~450 K without saturation.

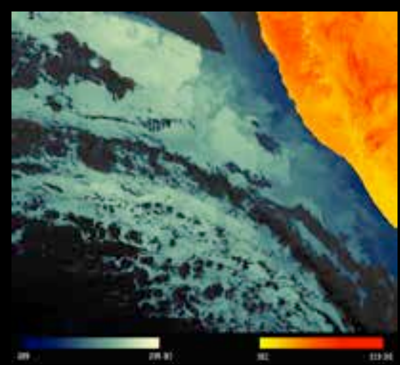
Sentinel-3A launch and Commissioning

↑ The 1150 kg Sentinel-3A satellite was carried into orbit on a Rockot launcher from Plesetsk, Russia, at 17:57 GMT (18:57 CET; 20:57 local time) on 16 February. Injection into the reference orbit was near perfect and the first signal from Sentinel-3A was received after 92 min by the Kiruna station in Sweden. Telemetry links and attitude control were then established by controllers at ESA's ESOC operations centre in Darmstadt, Germany, allowing them to monitor the health of the satellite.



↑ Once the satellite was launched, a series of activities commission the satellite and its payload on orbit were initiated. Starting with the LEOP (where the satellite is brought into a stable state (solar array deployed and orbit stable), each part of the satellite and payload system is switched on and verified (SIOV). In the case of SLSTR this took ~1.5 months due to structural outgassing (minimising contamination) and the cool down of the Focal Plane Array. Then the cal/val phase began - to be followed by nominal operations in Phase E2 of the mission

SLSTR example first images

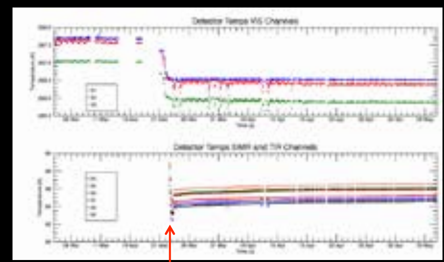


05/04/2016 10:02 am. The first image from the Sentinel-3A SLSTR thermal-infrared channels at 1km spatial resolution reveals thermal signatures over a part of western Namibia and the South Atlantic Ocean. Cold water is seen along the Namibian coast upwelling from deeper waters. The Benguela current flows north along the west coast of South Africa driven by southeasterly winds, creating coastal upwelling. Many eddies and meanders are generated in this complex system and these small-scale features are captured beautifully. Over land, the distinct folds of desert dunes can be seen. In fact, further north, Gobabeb is the location of a land-surface temperature validation site – chosen because of its featureless arid nature and lack of vegetation. *Contains modified Copernicus Sentinel data [2016]*

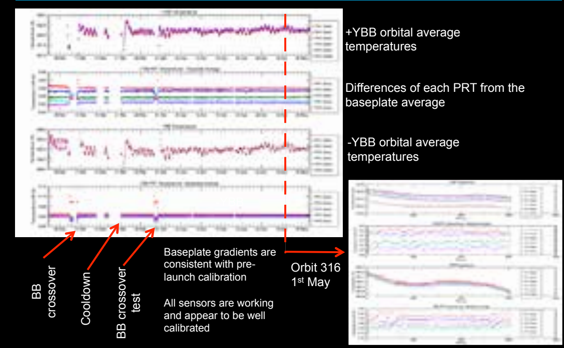
08/03/2016 3:06 pmone of the first images from Sentinel-3A's Sea and Land Surface Temperature Radiometer (SLSTR). Acquired with the instrument's visible channels (at 500m spatial resolution) on 3 March 2016 at 11:23 GMT, this image features the Spanish Canary Islands, the Portuguese island of Madeira and the northwest coast of Africa. This false-colour image shows the vegetated islands in red, in contrast to Western Sahara, where there is little vegetation. The snow-capped peak of Mount Teide on the island of Tenerife is also clearly visible in the image. Both the radiometer and the colour instrument will monitor plant health. *Contains modified Copernicus Sentinel data [2016]*

Sentinel-3A SLSTR early in flight performance

Detector temperatures

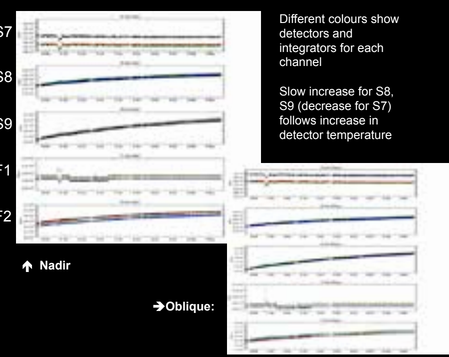


Blackbody temperature trends

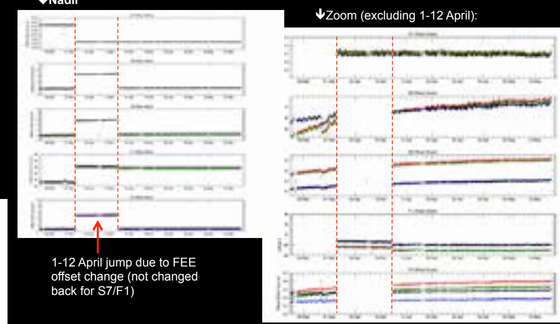


Radiometric gain

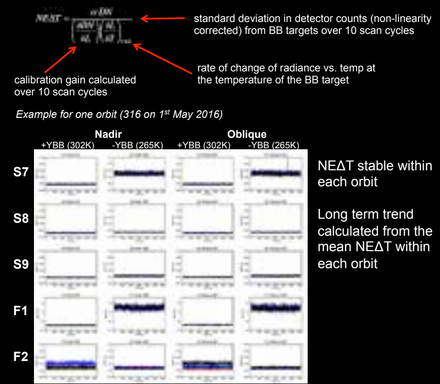
Radiometric gain and offset calculated over 10 scan cycles, using averages of BB temps and counts. The method is matched to the L1 processor



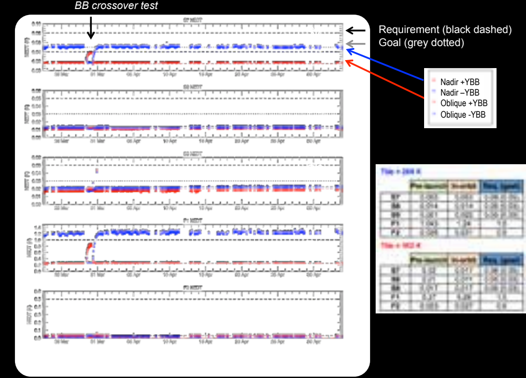
Radiometric offset



Radiometric noise



NEΔT trends



Next steps

The Sentinel-3A SLSTR instrument is being successfully commissioned in orbit and is performing well. Further tests and verification activities are on-going together with ground-segment verification activities. Work continues to refine the processors, the SLSTR instrument configuration and calibration systems to optimise performance. An initial assessment of SLSTR L1b products and instrument calibration parameters via Cal/Val activities covering functional test, performance analysis, product verification and first product validation reveals no major anomalies and the SLSTR is performing well. SLSTR data are due to be released to the S3VT in the next few weeks for further validation activities in preparation for the In Orbit Commissioning Review planned in July 2016 at which point the mission will be passed into nominal operations. In the next ~8 months, the ground segment will then evolve to full operational performance. The full assessment of higher level products, SST and LST is expected to commence in detail in the coming months once the instrument commissioning tasks have concluded.