SENTINEL-3 MARINE CENTRE AND OPERATIONS OF SLSTR SST

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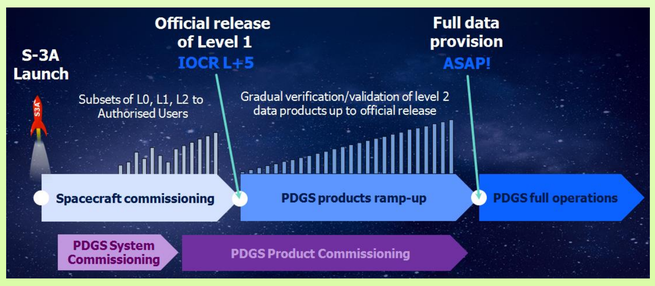
Introduction

Following the successful launch of the Copernicus Sentinel-3A satellite on 16 Feb 2016, preparations are underway for the distribution of Sea Surface Temperature (SST) products from the Sentinel-3 Sea and Land Surface Temperature Radiometer (SLSTR). SST products will be distributed from the Marine Centre, part of the Sentinel-3 Payload Data Ground Segment, located at the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT) [1]. The Marine Centre together with the existing EUMETSAT facilities provide a centralised service for operational oceanography as participation in the European Commission's Copernicus programme.

The SLSTR SST product has been developed together with The European Space Agency (ESA) and industry. The first production of SST products at EUMETSAT began on 19th April 2016. These are undergoing evaluation at EUMETSAT and together with the ESA-led commissioning team. These Calibration and Validation activities contribute to the Sentinel-3 Mission Performance Framework, in collaboration with the ESA's Mission Performance Centre (MPC), the joint ESA/EUMETSAT SLSTR Quality Working Group (SLSTR-QWG) and the Sentinel-3 Validation Team for Temperature (S3VT-T).



Commissioning activities are due to end in July 2016, with data availability expected to users thereafter. This poster presents the EUMETSAT Sentinel-3 marine centre, shows initial examples of SLSTR SST processed at EUMETSAT, gives a description of the products, and information where to find further information.

Sea Surface Temperature from SLSTR

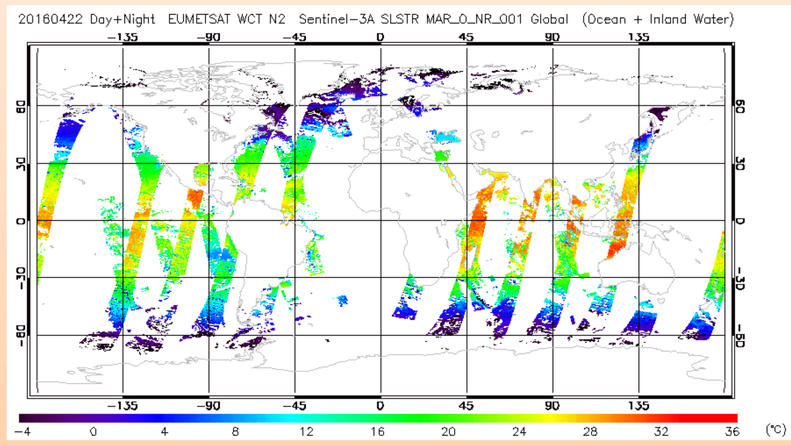


Fig 1a. Sea Surface Temperature from Sentinel-3A SLSTR for 22nd April 2016 (partial daily coverage shown)

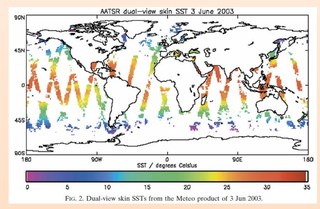


Fig 1b. SST from AATSR 3rd June 2003 [6]

AATSR SSTs are also shown for one day in 2003 indicating the increase in swath and global coverage for SLSTR.

A preliminary example of SST from SLSTR during one day, for both day and night, using a nadir only 2-channel retrieval. A total of 195 granules (each of 3 minutes) are shown out of a possible total of 480 during one day. SLSTR skin SSTs are designed to be accurate to 0.3K over the dual-view swath. The design of the SLSTR instrument [2] allows for dual-view skin SST retrievals in the central (offset) part of the swath (740km) and nadir-view only SST over the wide swath (1400km), at 1km spatial resolution [2].

SLSTR SST Product

The SLSTR SST product (called WST) will be provided to follow the Group for High Resolution SST (GHRSST) Data Format Specification (GDS2r5) L2P [4]. This is in NetCDF4, as a level-2 swath product containing the best choice algorithm skin SST. The specification also contains auxiliary data such as ECMWF wind-speed, sea-ice fraction, background SST and aerosol dynamic indicator.

The SST retrieval is performed for five different SST algorithms. The preferred choice algorithm for WST is based on the day / night and nadir / oblique view. Future development will also include dependency on aerosol conditions. These are referred to as a dual-view 3-channel retrieval (D3), a dual-view 2-channel retrieval (D2), a nadir-view only 3-channel retrieval (N3), a nadir-view only 2-channel retrieval (N2) and an aerosol robust nadir-view only 3-channel retrieval (N3R). The 3-channel retrievals utilise the SLSTR channels S7 (3.7µm), S8 (10.8µm) and S9 (12µm); and the 2-channel retrievals utilise S8 and S9 [5]. SLSTR skin SSTs are retrieved using the methodology described in [3], following the AATSR Reprocessing for Climate SST retrieval.

Follows GHRSST L2P Specification (GDS2r5)

https://www.ghrsst.org/documents/q/category/ghrsst-data-processing-specification-gds/operational/

- NetCDF4
- Level-2 swath product
- Skin Sea Surface Temperature (one of D3, N3, D2, N2, N3R)
- Auxiliary ECMWF wind-speed, sea-ice fraction, background SST
- Aerosol dynamic indicator – Saharan Dust Index
- Uncertainty estimates: SSES, pixel theoretical uncertainty
- Experimental fields: nedt, nadir BTs.

Fig 2a. SLSTR GHRSST L2P SST

- Five single SST algorithms (view/time of day/aerosol) derived from weighted combinations of BTs measured in both views (nadir and oblique) by the thermal channels.
- Weights are functions of viewing geometry and WV loading.
- Commissioning/ESA-MPC activities on inter-algorithm adjustments
- Lake Surface Water Temperature to be provided in the L2P (initially using SST retrieval).

-> Sentinel-3 SLSTR products guides and ATBD's available from http://www.eumetsat.int/website/home/TechnicalBulletins/CopernicusUserPreparation/DAT_2649694.html

Fig 2b. SST retrieval [3]

SLSTR GHRSST L2P (WST), per pixel:

1) SSES bias and standard deviation (to drifting buoys)
   -> LUT to be calculated (and methodology assessed).
   -> SLSTR L2 DPM

2) Theoretical uncertainty (experimental field)
   -> SLSTR L2 ATBD

https://sentinel.esa.int/web/sentinel/user-guides/sentinel-3-slstr/key-resources/technical-documents

Fig 2c. SLSTR L2P SSES and uncertainties

Formation follows GHRSST data specification:

Quality Level:
0 no data
1 cloud contaminated data
2 worst quality of usable data
3 low quality of usable data
4 acceptable quality of usable data
5 best quality usable data

Quality Levels 3 to 5 based on thresholds of the Theoretical Uncertainty per pixel. Quality Level 2 based on threshold or if Theoretical Uncertainty is a fill_value.

SSES bias and standard deviation:
-> Bias and standard deviation for each Quality Level to be determined from drifting buoy comparisons beginning in S3 Commissioning Phase in collaboration with ESA-MPC and continuing.

Fig 2d. SLSTR L2P Quality Levels

"Experimental field":

Combination of – measurement noise to retrieved SST; uncertainty from water vapour loading; uncertainty from proximity to land and cloud

Derived separately for each SLSTR SST retrieval (D3, D2, N3, N2, N3R).

- Interpolation of scan nedt to pixel value.
- Interpolation of SST coefficients to tie point, WV and path length (symmetric uncertainties).
- Cloud and land contamination (asymmetric uncertainties).

Fig 2e. SLSTR L2P theoretical (modeled) uncertainty

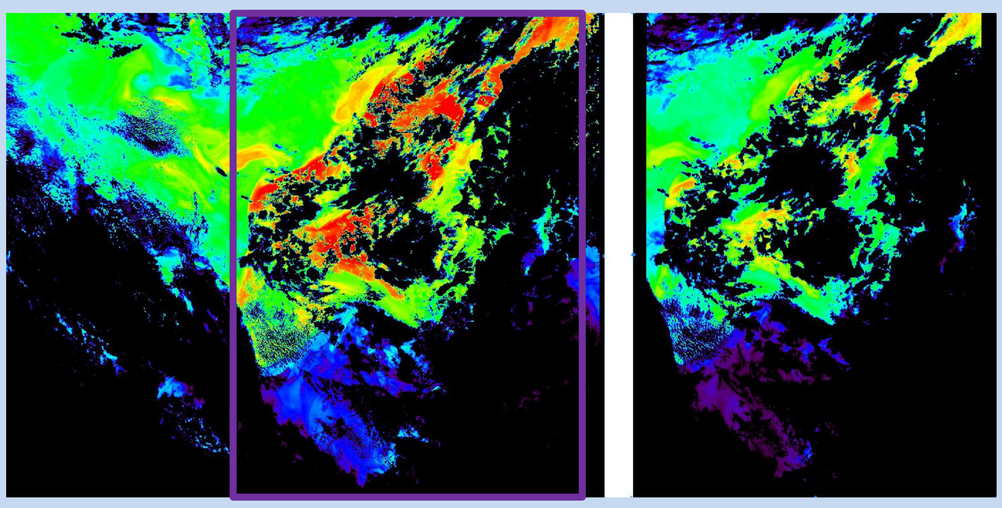
In progress:
- Bayesian/probabilistic cloud detection scheme (sea and land)
- L1 Uncertainty improvements
- Additional experimental fields: dual_nadir_sst_difference & nadir_sst_theoretical_error

Considerations (including interactions with ESA MPC, QWG, S3VT):
- Dust and volcanic aerosol flags
- Utilisation of Bayesian Cloud flags in L2P
- Sea-ice cloud detection
- SSES; algorithm adjustment

Future possibilities:
- Tailored Lake Surface Water Temperature (with SST retrieval update)

Fig 2f. SLSTR L2P evolutions

Figs 2a to 2f describe the components of the SLSTR L2P SST product in GHRSST specification.



SLSTR example over South Africa

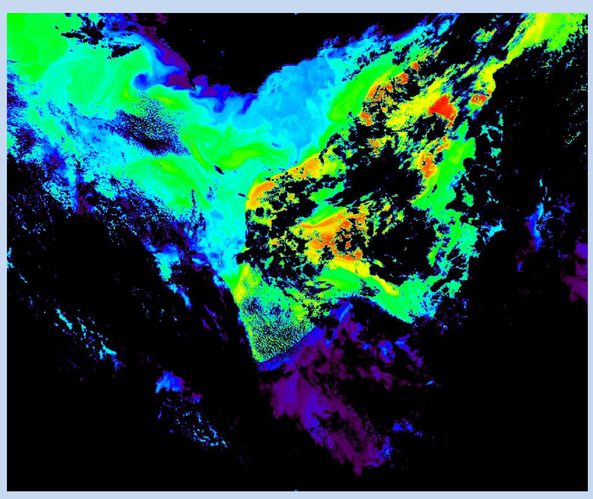


Fig 4a. SLSTR 10.8 µm BT (S8), left: nadir-view, right: oblique-view; 20160520T075944

Fig 4b. SLSTR Nadir 2-channel SST

Brightness temperatures (BT) are shown in the left images and retrieved SST for the nadir 2-channel SST on the right. The purple rectangles show how the dual part of the swath corresponds with the wider nadir swath. Cold upwelling is shown off the coast of South Africa and the warm Agulhas current to the East. The scale on the left ranges from BT 282K to 292K and on the right from SST 286K to 296K.

Data access and Validation team

Marine Sentinel-3 commissioning data will shortly be available for Sentinel-3 Validation team (S3VT) members through the EUMETSAT Online Data Access. Selected NRT data will also be distributed on EUMETCast. Additionally Sentinel-3 data will be available from our Data Centre (long-term archive). Participation to the S3VT is possible through a rolling call and further information is at https://earth.esa.int/aos/S3VT. Data access in NRT is also being arranged through EUMETCast Terrestrial to the USA (NOAA-STAR) and Australia (NCI). Sentinel-3 information from EUMETSAT can be found from: http://www.eumetsat.int/website/home/Satellites/FutureSatellites/CopernicusSatellites/Sentinel3/index.html

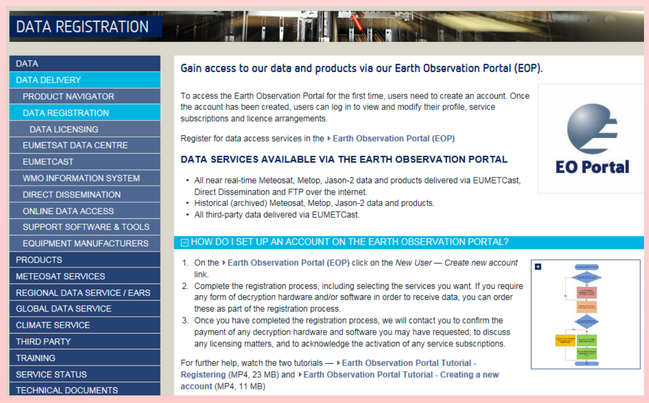


Fig 3a. EO Portal and data centre registration

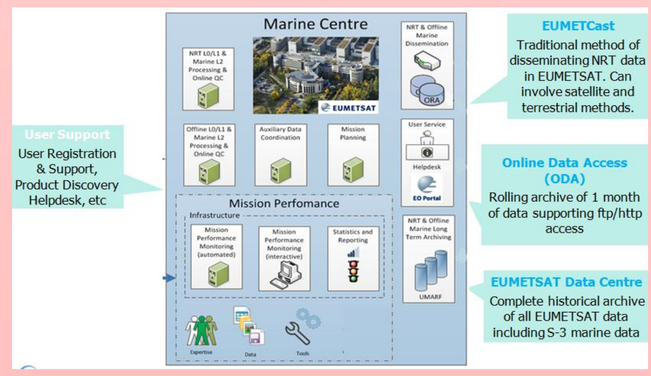


Fig 3b. Sentinel-3 Marine Centre at EUMETSAT

Product	EUMETCast	ODA	Data Centre (UMARF)	Timeliness	Dissemination Unit size
SLSTR L1B		✓	✓	NRT, NTC	Frame (3 min)
SLSTR L2 WST (GHRSST L2P)	✓	✓	✓	NRT	Frame (3 min)
			✓	NTC	Full orbit: South Pole to South Pole
SLSTR L2 WCT	Internal products only available to "special users"		✓	NRT	Frame (3 min)
			✓	NTC	Full orbit: South Pole to South Pole

Fig 3c. SLSTR data availability (NRT < 3 hrs, NTC < 30 days at maximum)

- Helpdesk
  - User support, queries etc
    - open during normal working hours:
      - Monday to Thursday 08:30–17:15 CET
      - Friday 08:30–16:00 CET.
  - Tel: +49 6151 807 3660 / 3770
  - Fax: +49 6151 807 3790
  - Email: ops@eumetsat.int
- EO Portal
  - eoportal.eumetsat.int
- Product Navigator
  - navigator.eumetsat.int
- User Notification Service

Fig 3d. EUMETSAT helpdesk information

References

[1] Bonekamp, H. F. Montagner, V. Santacesaria, C. Nogueira Loddo, S. Wannop, I. Tomazic, A. O'Carroll, E. Kwiatkowska, R. Scharroo and H. Wilson, 2016: Core operational Sentinel-3 marine data product services as part of the Copernicus Space Component, Ocean Sci. Discuss, doi: 10.5194/os-2015-89
[2] Donlon, C.J., B. Berruti, A. Buongiorno et al, The Global Monitoring for Environment and Security (GMES) Sentinel-3 mission, RSE, 120 (2012), 37-57
[3] Sentinel-3 Sea Surface Temperature ATBD http://www.eumetsat.int/website/home/TechnicalBulletins/CopernicusUserPreparation/DAT_2649694.html
[4] The recommended GHRSST Data Specification (GDS) https://www.ghrsst.org/documents/q/category/ghrsst-data-processing-specification-gds/
[5] O'Carroll, A.G., H. Bonekamp, F. Montagner, V. Santacesaria, I. Tomazic, 2015: Sea Surface Temperature from EUMETSAT including Sentinel-3 SLSTR, Proceedings of Sentinel-3 for Science Workshop, Venice, June 2015, ESA SP-734, ISBN 978-92-9221-298-8
[6] O'Carroll, A.G., J.G. Watts, L.A. Horrocks, R.W. Saunders, and N.A. Rayner, Validation of the AATSR Meteo Product SST, 2006, JAOT, V23, N5, pp 711-725

Acknowledgements

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