OPERATIONS OF SENTINEL-3A SLSTR SST AND EUMETSAT ACTIVITIES

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Introduction

The first Copernicus Sentinel-3 satellite, Sentinel-3A, was successfully launched on 16th February 2016 from Plesetsk, with the mission to provide a consistent, long-term collection of marine (and land) data for operational ocean analysis, forecasting and service provision. The EUMETSAT marine centre has been preparing to deliver operational Sea Surface Temperature (SST) products based on measurements from the Sea and Land Surface Temperature Radiometer (SLSTR) on board Sentinel-3. Information is provided on the Sentinel-3A SLSTR SST product, which has been developed together with ESA and industry partners.

Details of the scientific characteristics of the SST product and information on the algorithm are given, plus opportunities on how to participate in the ESA and EUMETSAT Sentinel-3 Validation Team for marine surface temperature. The SLSTR SST product is provided according to the GHRSST specification, and includes some experimental fields. The Sentinel-3 Commissioning Phase was successfully completed in July 2016 and the operational SLSTR SST products are planned to be widely released in June / July 2017.

Further EUMETSAT activities relevant to GHRSST including Copernicus studies, updates to IASI SST and third party data are described.

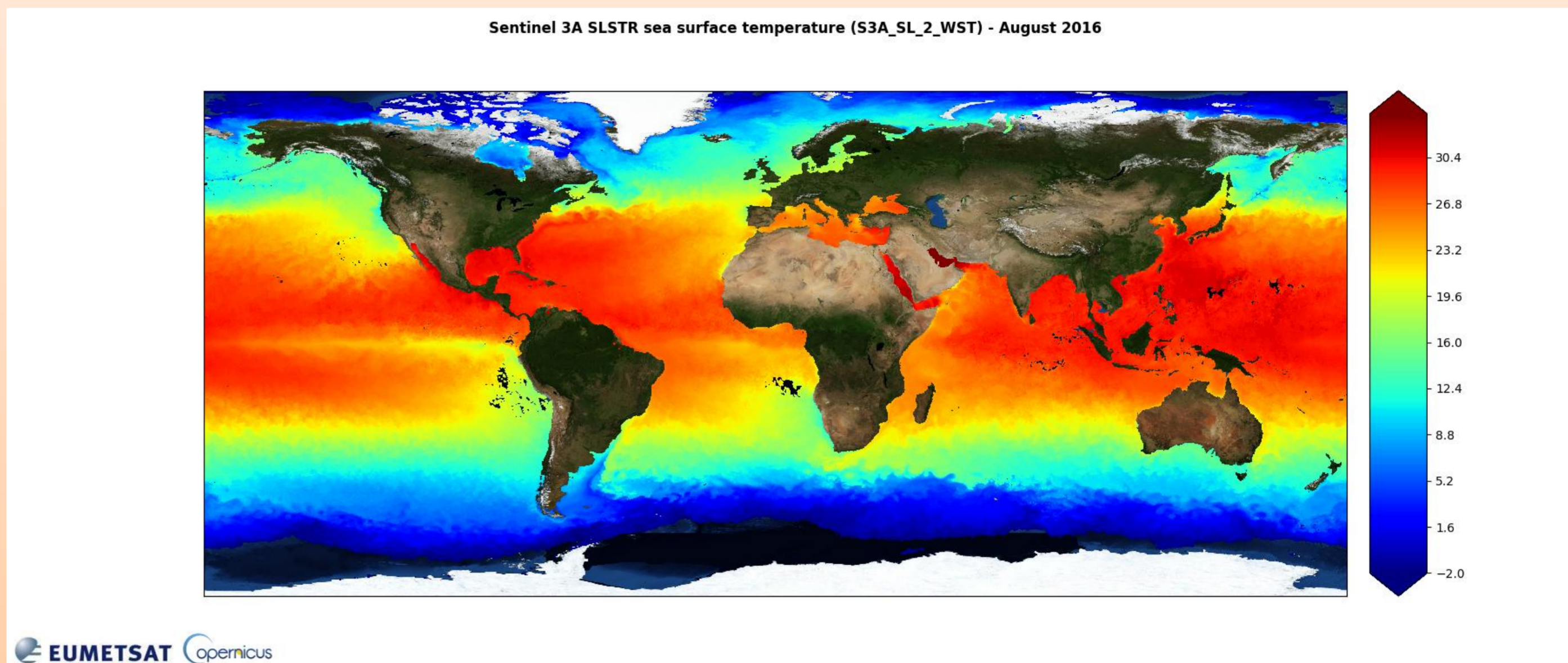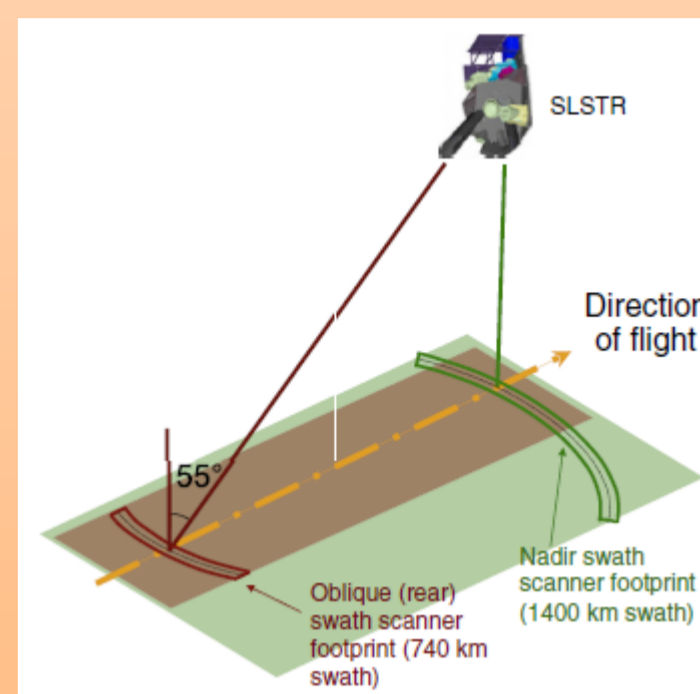## Sea Surface Temperature from SLSTR

Fig 1a. Sea Surface Temperature from Sentinel-3A SLSTR for August 2016

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].

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).

Fig 2b. SST retrieval [3]

The SLSTR L2P contains both SSES bias and standard deviation; plus pixel theoretical (modeled) uncertainties.
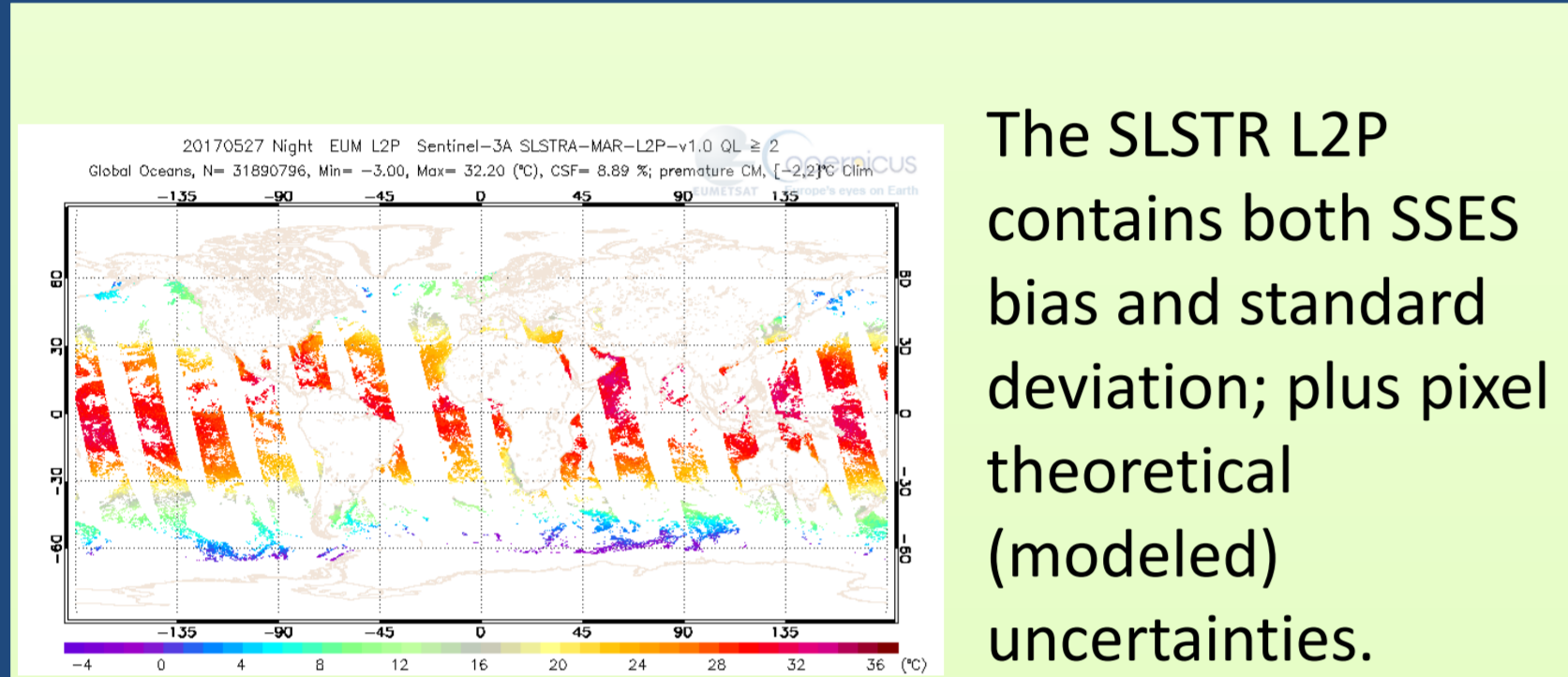
Fig 2c. SLSTR L2P SSES and uncertainties

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

SLSTR SST Product

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

The SLSTR SST product is due to be made available to all users at the end of June / July 2017.
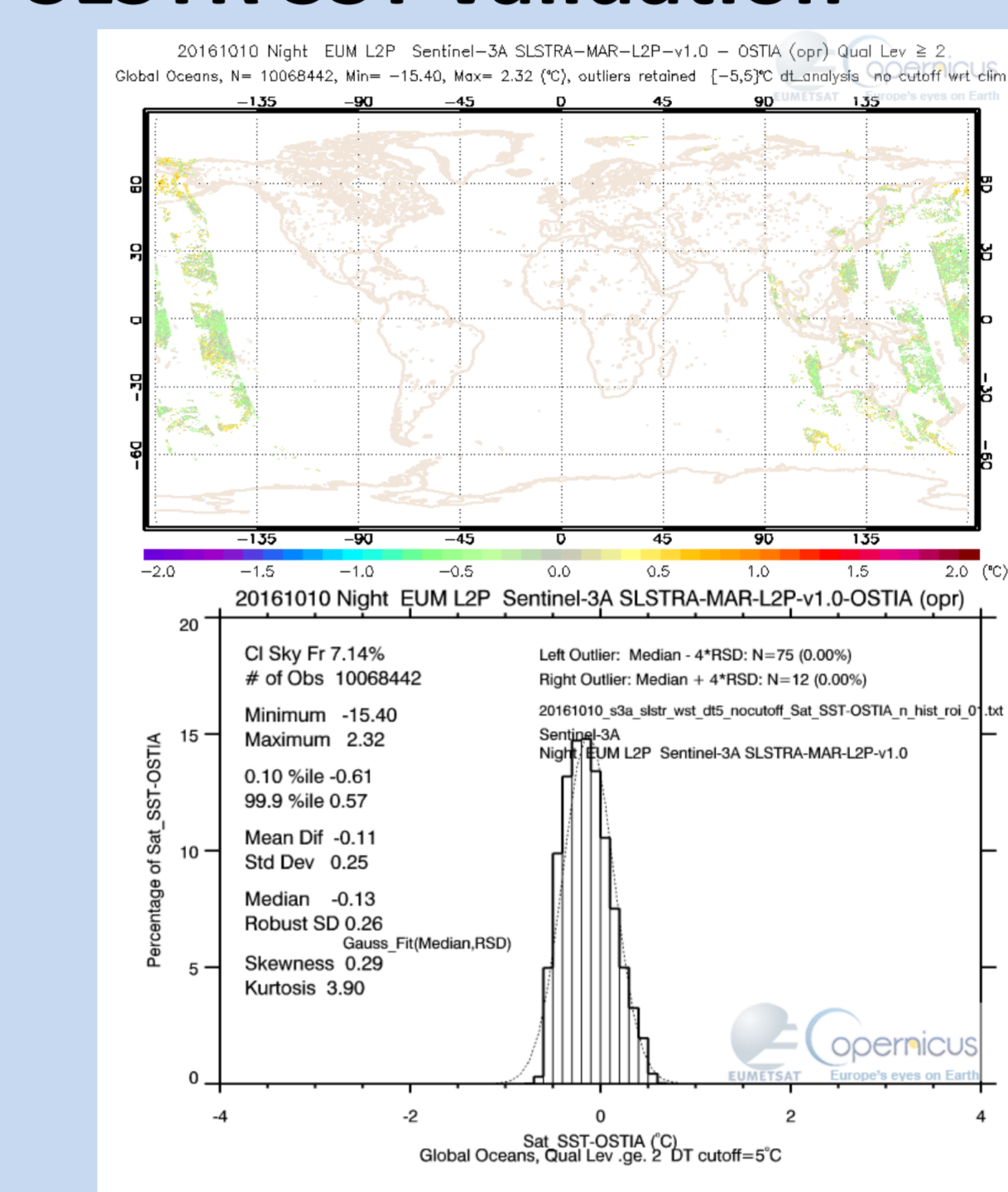
SLSTR SST validation

Fig 4. SLSTR L2P SST compared to OSTIA: products under testing for operational release June / July 2017

Further information in presentations from I. Tomazic, J-F. Piolle, and P. Dash.

OSI-SAF SLSTR matchup dataset information from:
http://www.ifremer.fr/cerweb/sentinel-3/mdb-slstr

SLSTR data access

SLSTR data is operationally available through the EUMETSAT data centre and long-term archive. Level-1 radiance and brightness temperature products were widely released in November 2016. Sentinel-3 information from EUMETSAT can be found from:
http://www.eumetsat.int/website/home/Data/CopernicusServices/index.html

Fig 3a. EO Portal and data centre registration

Fig 3b. Sentinel-3 Marine Centre at EUMETSAT

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 3c. EUMETSAT helpdesk information

Data access in NRT is also arranged through EUMETCast Terrestrial to the USA (NOAA-STAR) and Australia (NCI).

S3 validation team

SLSTR-A SST data is currently available for Sentinel-3 Validation team (S3VT) members through the EUMETSAT data centre and long-term archive. SST products are also distributed on EUMETCast. Participation to the S3VT is possible through a rolling call and further information is at https://earth.esa.int/aos/S3VT. The SLSTR-A SST product is due to be made available to all users at the end of June / July 2017.

Copernicus projects

Sea-ice cloud screening for Copernicus Sentinel-3 Sea and Land Surface Temperature Radiometer
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OBJECTIVES
EUM/OPS-COPER/SOW/15/814091

- Evaluation and assessment of current cloud screening or cloud control techniques over the sea-ice and marginal ice zones for dual-view infra-red sensors, with a focus on probabilistic Bayesian methods.
- The study should recommend appropriate algorithms for the Sea and Land Surface Temperature Radiometer (SLSTR) and derive and supply the relevant auxiliary Probability Distribution Functions (PDFs).
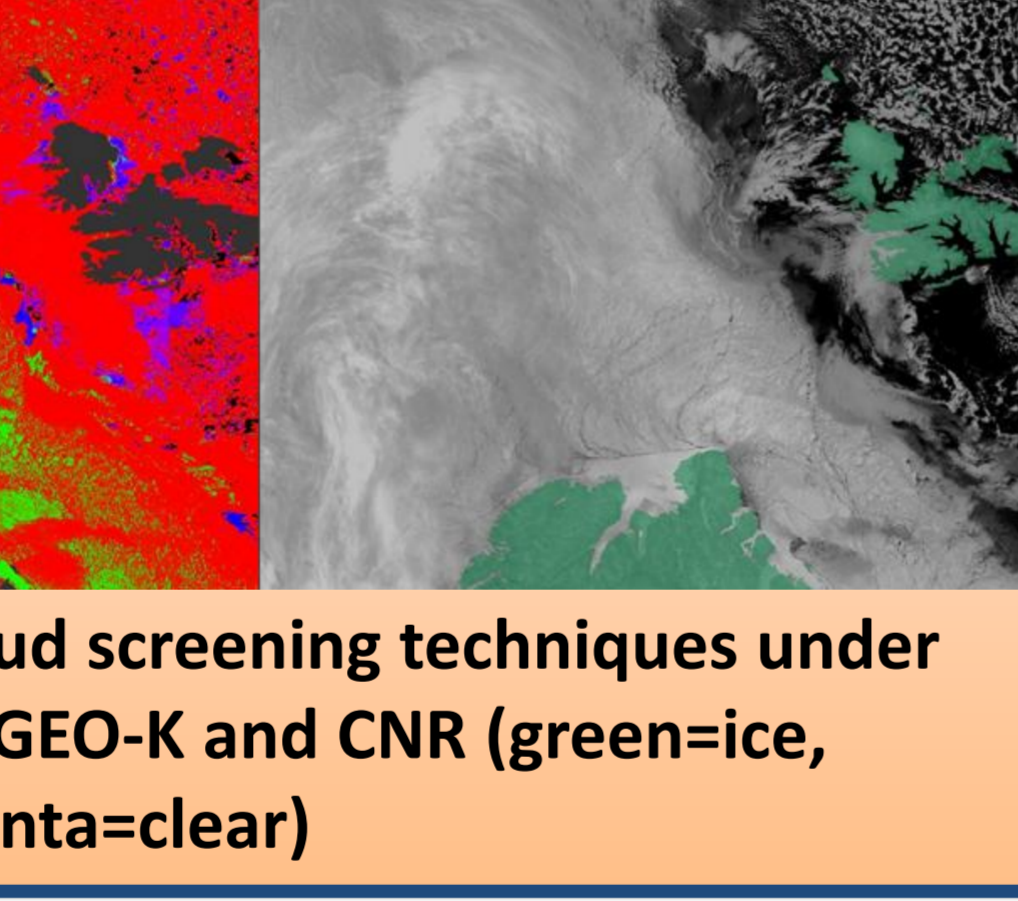

Fig 5. Sea-ice cloud screening techniques under investigation by GEO-K and CNR (green=ice, red=cloud, magenta=clear)

Copernicus / EUMETSAT: improved drifters

- Project on Improved Drifting Buoy Sea Surface Temperature for Copernicus Satellite Validation due to start in 2017.
- Provide measurements from a significant number of drifting buoys equipped with digital SST probes in order to achieve a better calibrated capability.
- "Assess and establish the benefit of improved incremental capability of drifting buoys for satellite SST validation"
- Assessment through Sentinel-3 SST Cal/Val activities, and with GHRSST.
- Coordination towards traceable standards.
- Data availability through GTS.

-> Need for well calibrated, towards traceable drifting buoys for validation

To provide well-calibrated drifting buoy SST, towards SI-traceable standards of **Fiducial Reference Measurements (FRM)** i.e. HRSST-FRM.
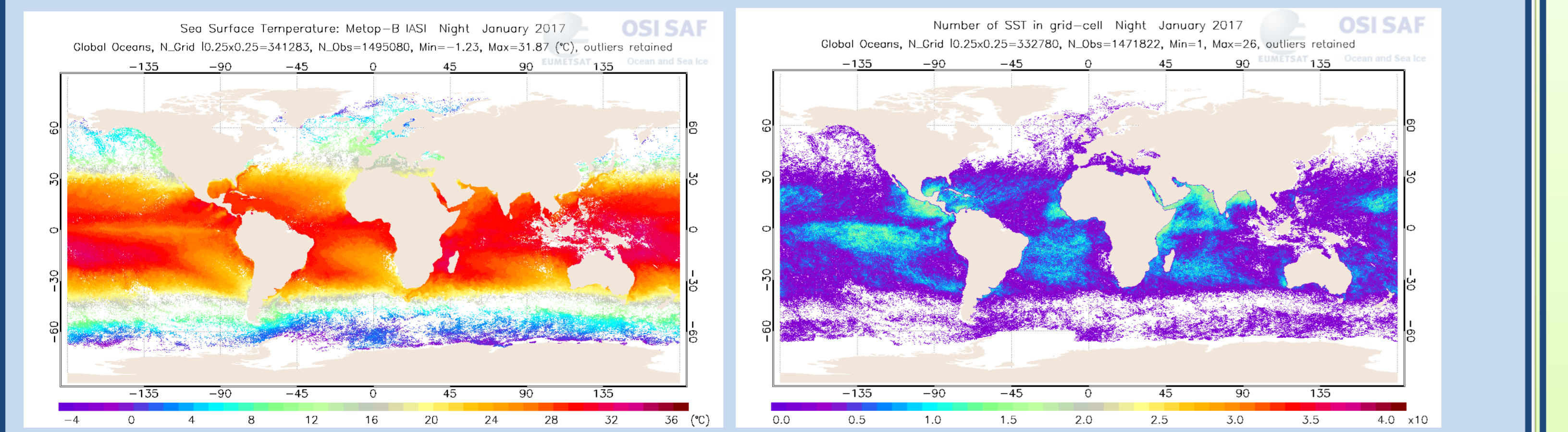
Sea Surface Temperature from Metop-IASI

Fig 6. IASI SST for new retrieval scheme (implementation summer 2017) for Jan 2017 (left: SST, right: number of observations), operational product available from EUMETSAT OSI SAF www.osi-saf.org

A new SST retrieval scheme is under testing at EUMETSAT for Metop-IASI L2P products, in order to increase the yield and number of observations at high latitudes. A new version is due to be implemented in summer 2017, and will include additional uncertainty information and dust flags.

Third-party data

Work towards access to relevant data from third-parties with the preparation of agreements, including ISRO and SOA, gives EUMETSAT access to an enhanced ocean products catalogue.

This includes access to data, and distribution to EUMETSAT member states, of data from the HY-2 and FY-3 series. In addition, EUMETSAT have agreements with data distribution including with NOAA (VIIRS, GOES-R), ISRO, JMA, JAXA and others.

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

Acknowledgements