SLSTR sea surface temperature: validation activities and first results

Anne O'Carroll, Prasanjit Dash, Igor Tomazic,

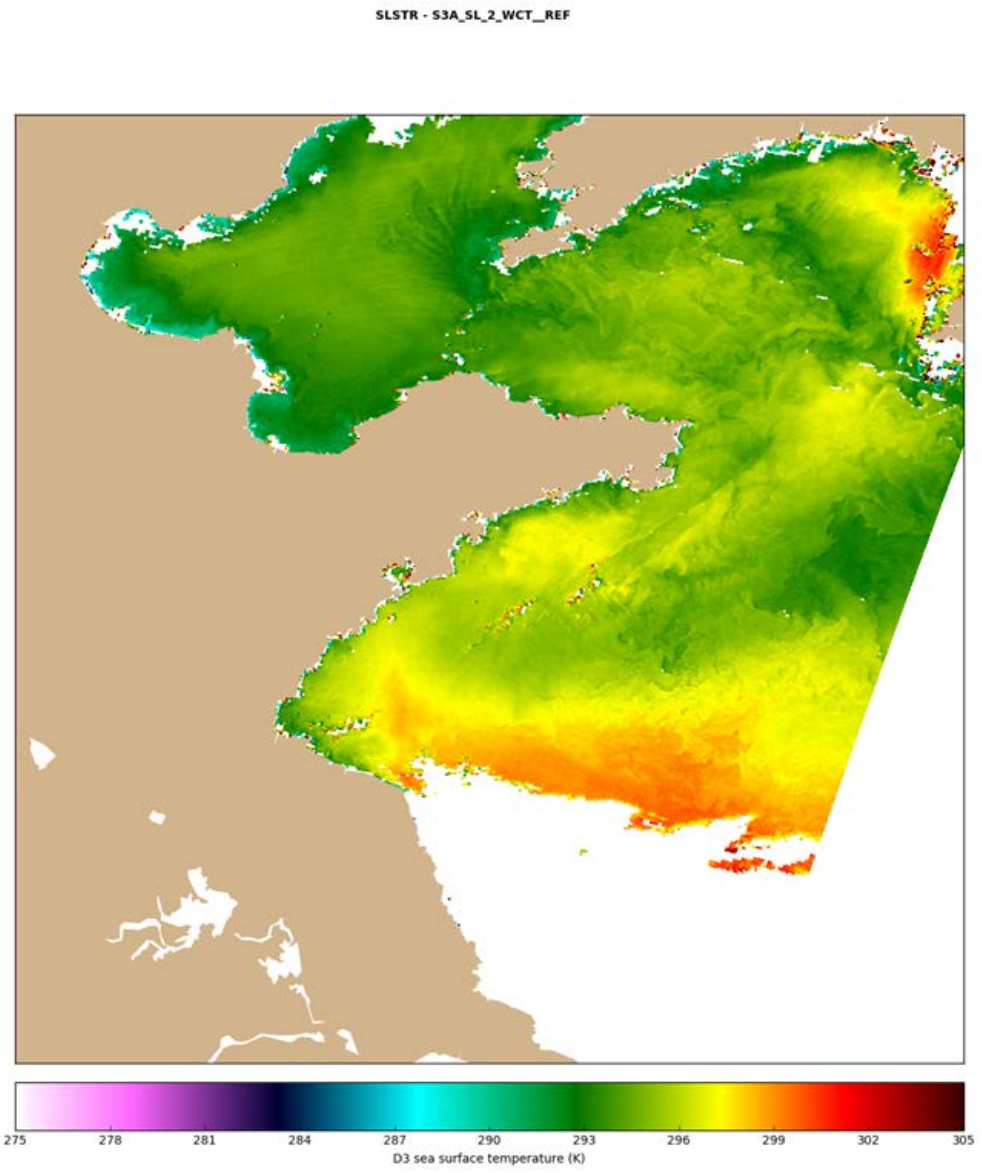
Jean-Francois Piolle, Gary Corlett, Craig Donlon

AMT4SentinelFRM, International Workshop,

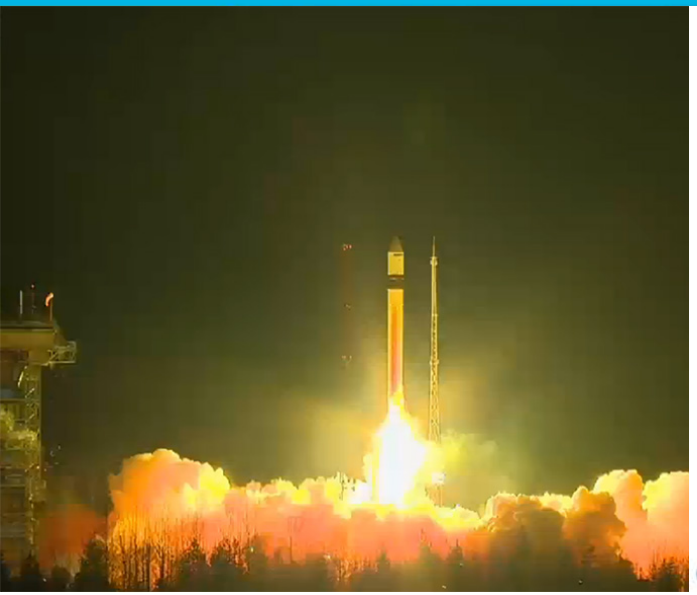
Plymouth, 20-21st June, 2017

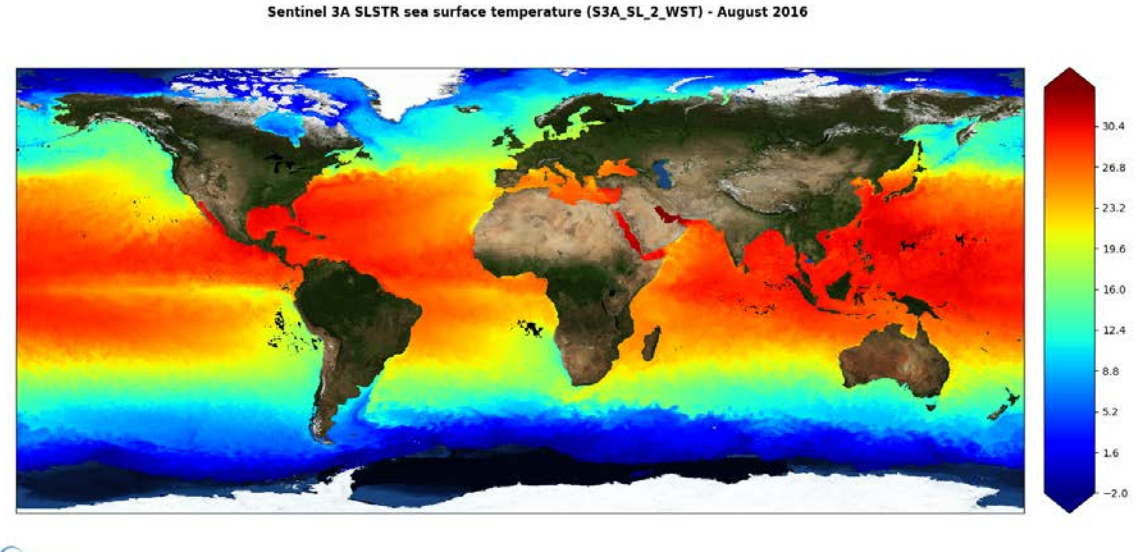
Outline

- Sea Surface Temperature from Sentinel-3 SLSTR
- Mission Performance Framework and Sentinel-3 Validation Team (S3VT)
- Results and SLSTR validation
  - SLSTR / IASI L1b inter-comparisons
  - METIS-SST
  - Matchup databases and first results
  - CMEMS monitoring
- Importance of Fiducial Reference Measurements
  - Towards FRM drifting buoys
- Summary

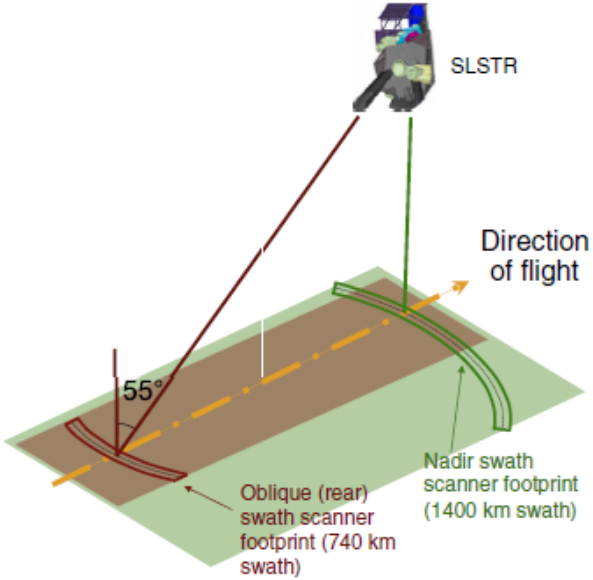


Sea Surface Temperature from Sentinel-3 SLSTR



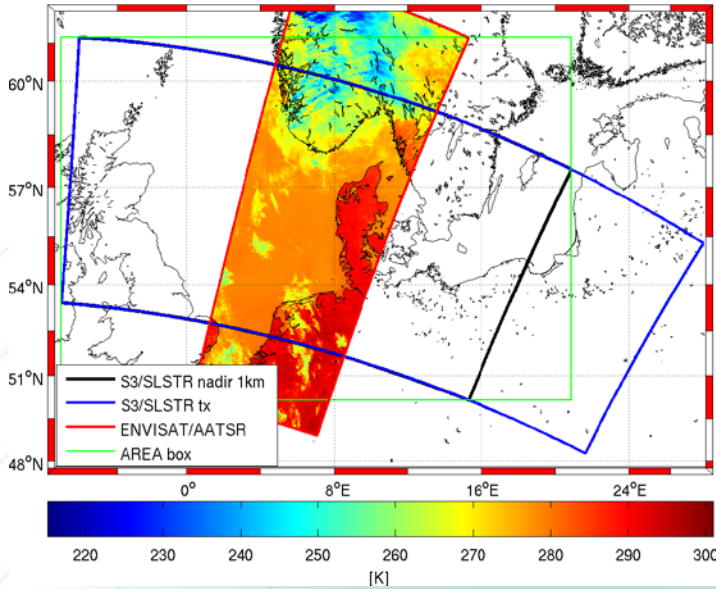


EUMETSAT Copernicus



Band characteristics of the Sentinel-3 Sea and Land Surface Temperature Radiometer (SLSTR). F1 and F2 are dedicated active fire monitoring bands.

SLSTR band	L centre [μm]	ΔL [μm]	SNR [–]/ NeΔT [mK]	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
S-3	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



European Commission Copernicus EUMETSAT

Mission requirements for SLSTR SST

- To provide SST measurement capability to at least the quality of AATSR on Envisat: SST shall be accurate to < 0.3 K @ 1 km spatial resolution and with improved swath coverage.

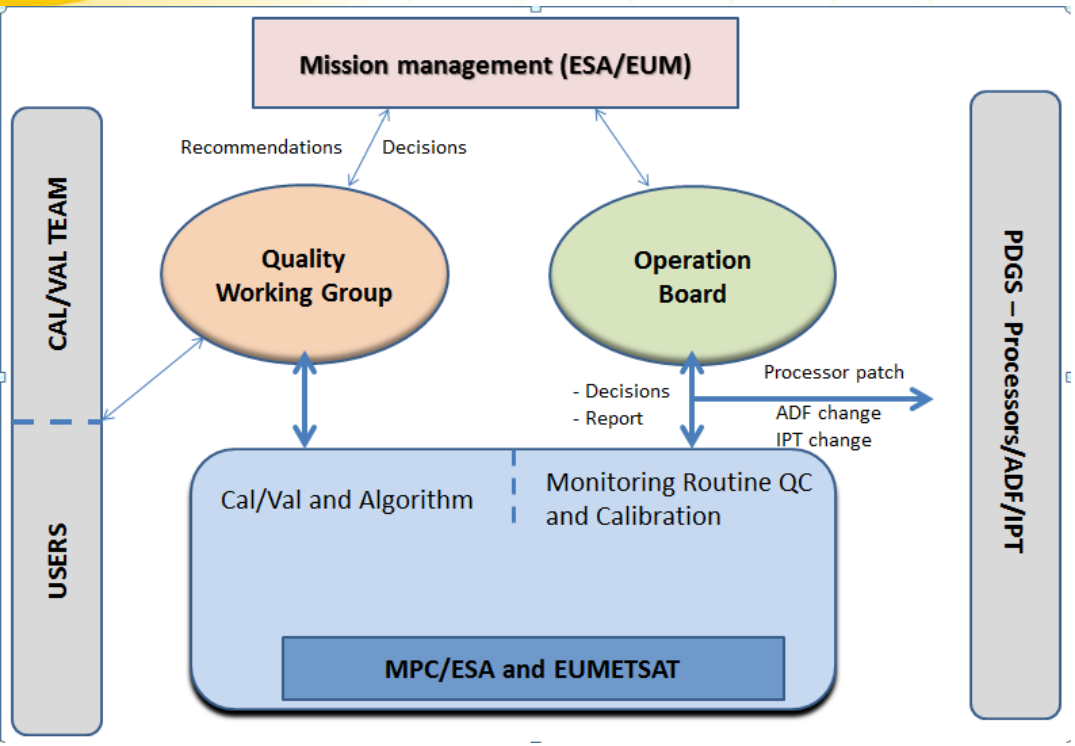
- SST measurements shall have a long-term radiometric stability goal of 0.1 K/decade (≤0.2K/decade threshold) for a 5 x 5deg latitude longitude area.

  -> AATSR achieved 0.1K uncertainties for most of the global ocean.

  -> Aiming for 0.3K uncertainty for L2 operational release, 0.1K will be the later target.

  -> Stability difficult to demonstrate out of the tropics

Mission Performance Framework and SLSTR Cal/Val

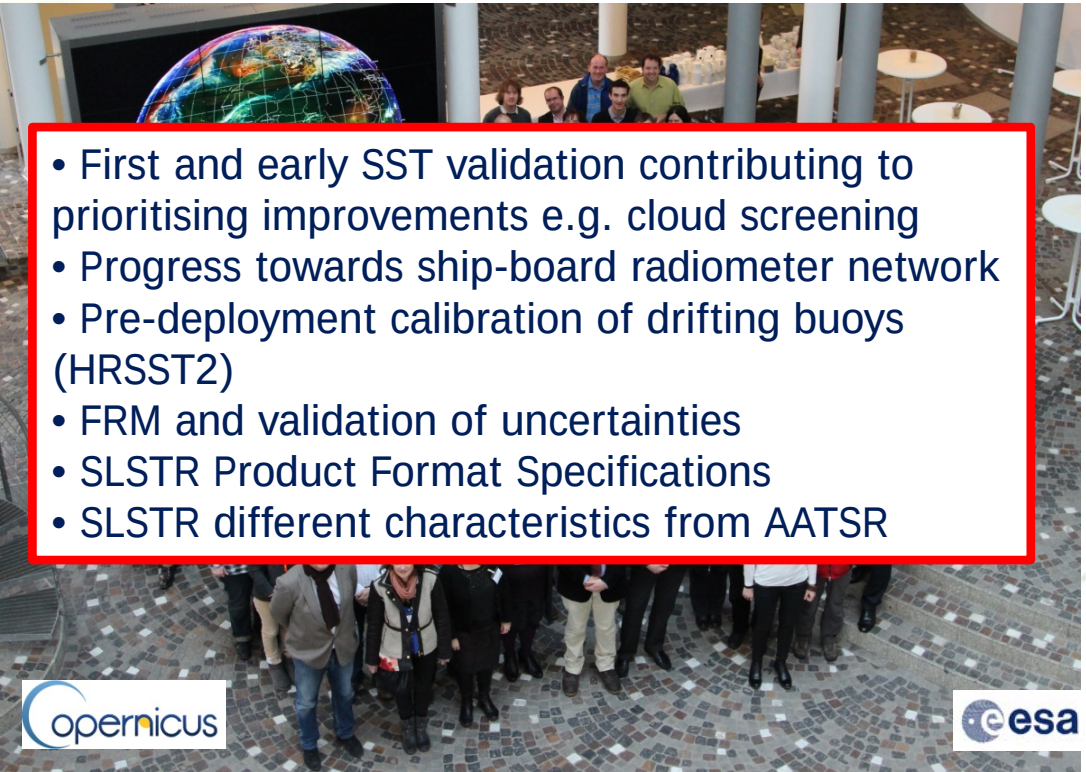


- Operational and offline marine monitoring and validation, multi-mission approach, working together with ESA and ESA-MPC. Includes:
  - Mission Performance Monitoring Facility (MPMF)
  - L1 IASI/SLSTR inter-comparisons
  - ESL (UoR, UoL)
  - METIS - SST
  - OSI-SAF SLSTR MDB – NRT/NTC validation and monitoring
  - EUMETSAT L2 Cal / Val tools and infrastructure
- Sentinel-3 Validation Team and...

Sentinel-3 Validation Team for Temperature (S3VT)

14 groups currently participating on validation using ship-board radiometers; in situ data; analysis/ model system; applications; climate / NRT users.

- Early access to SLSTR SST data (including internal products) in NRT through EUMETSAT ODA and EUMETCast, plus archive services.

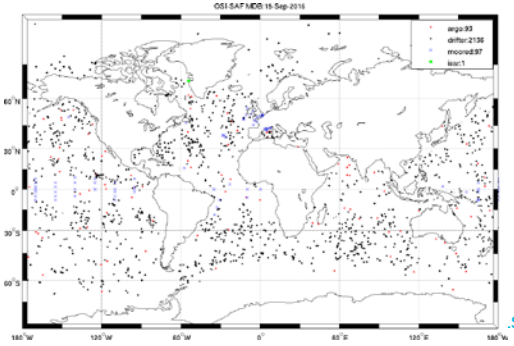


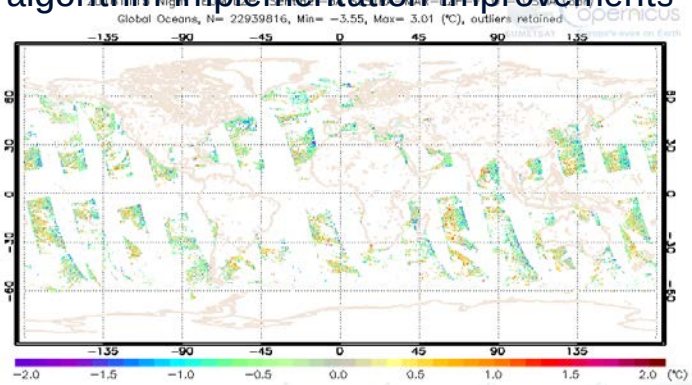
More teams always welcome, please contact: Anne.Ocarroll@eumetsat.int or Craig.Donlon@esa.int for more information on how to participate

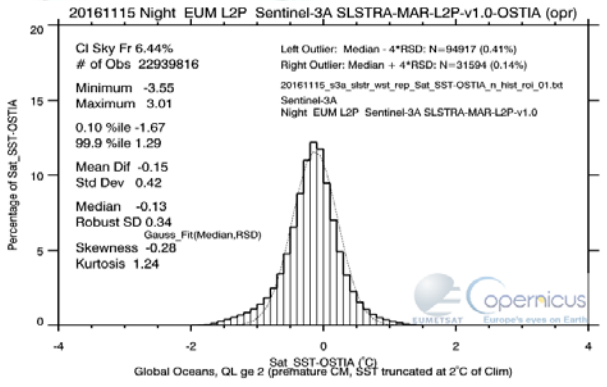
Last meeting: http://www.eumetsat.int/website/home/News/ConferencesandEvents/DAT_2326254.html

Current status of Sentinel-3 SLSTR SST

- **Product Releases:**
  - Initial Marine Level-2 products released to **S3VT 21st June 2016**
  - Reprocessed data released to S3VT **25th January 2017** (covering 15th June to 15th November 2016)
  - Operational Marine L2 NRT/NTC data release planned in **June / July 2017**
- **Product Validation Status (for operational release):**
  - Validated against in situ measurements (felyx - SLSTR MDB):
    - Using experimental SLSTR L1/L2 matchup dataset collocated with in situ data (drifters, buoys, radiometer) for reprocessed period and NRT
    - Used to adjust the inter-algorithm biases
    - Derivation of Sensor Specific Error Statistics (SSES) to complete the SST product
  - Evaluated against L4 analysis (METIS)
- **Product improvements for operational release**
  - Updates to oblique geolocation and co-registration to the nadir view (L1) **5 May 2017**
  - Further cloud screening updates (L1) **June / July 2017**
  - Sensor Specific Error Statistics and quality level (L2) **June / July 2017**
  - Check that SST analysis is within 5K (residual cloud) **June / July 2017**
- **Future improvements**
  - Bayesian cloud-screening, SST algorithm implementation improvements



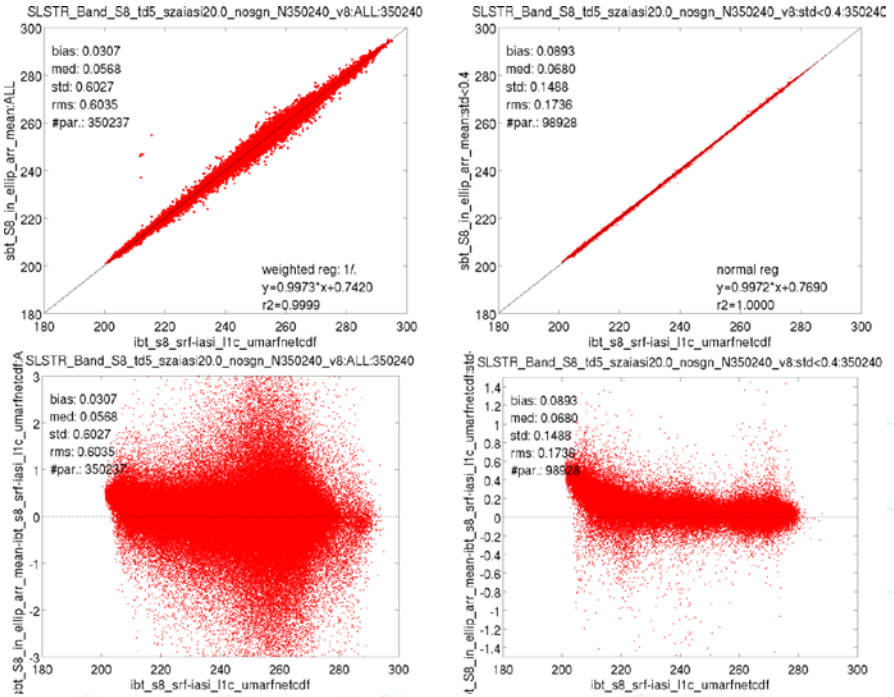




L1 status and SLSTR / IASI L1b inter-comparisons

- **Status**
  - Regular monitoring of VIS and IR calibration
  - Improvement of oblique view geo-location (within 0.5 pix), nadir view geo-location calibration performance at the limit (-0.5 pix across-track)
  - TIR radiometric performance nominal, good agreement with IASI
  - Improvement in cloud flagging
  - L1B Product service is operational (NRT/NTC)

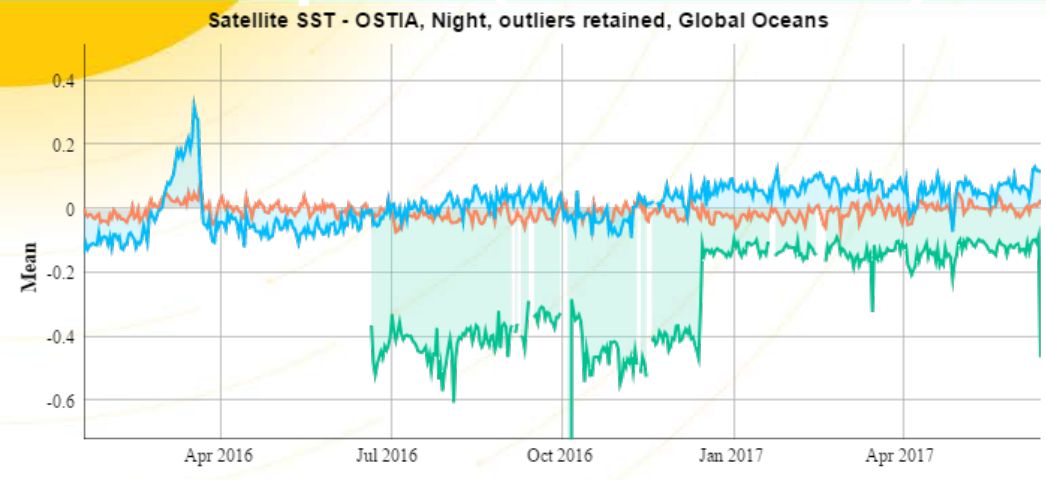
- **Issues**
  - Geometric calibration: nadir at the limit
  - VIS/SWIR (S4 to S6) radiometric calibration still not nominal: Up to 10% too low
  - Cloud flagging limitations (mainly daytime)
  - Channel co-registration
    - S7 vs. S8/S9 – sub-pixel miss-alignment
    - Fire channel: S7 vs. F1

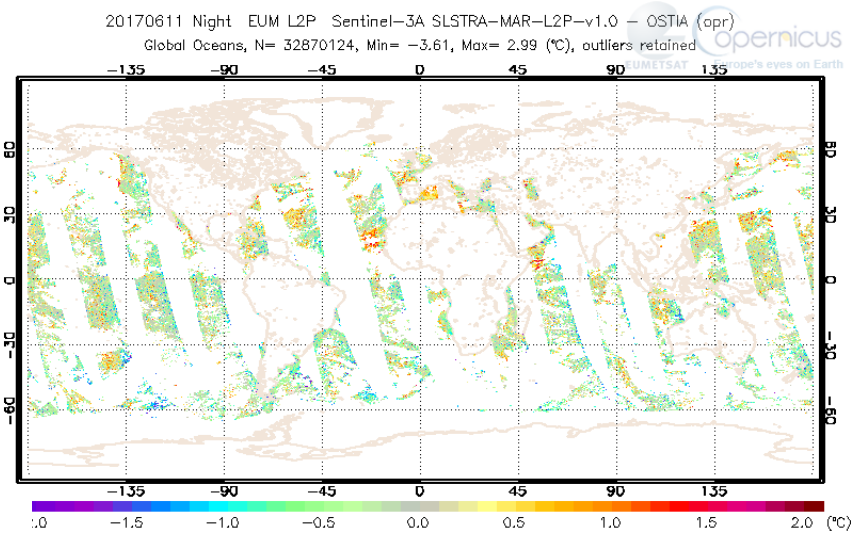


I. Tomazic, EUM Copernicus Cal/Val expert

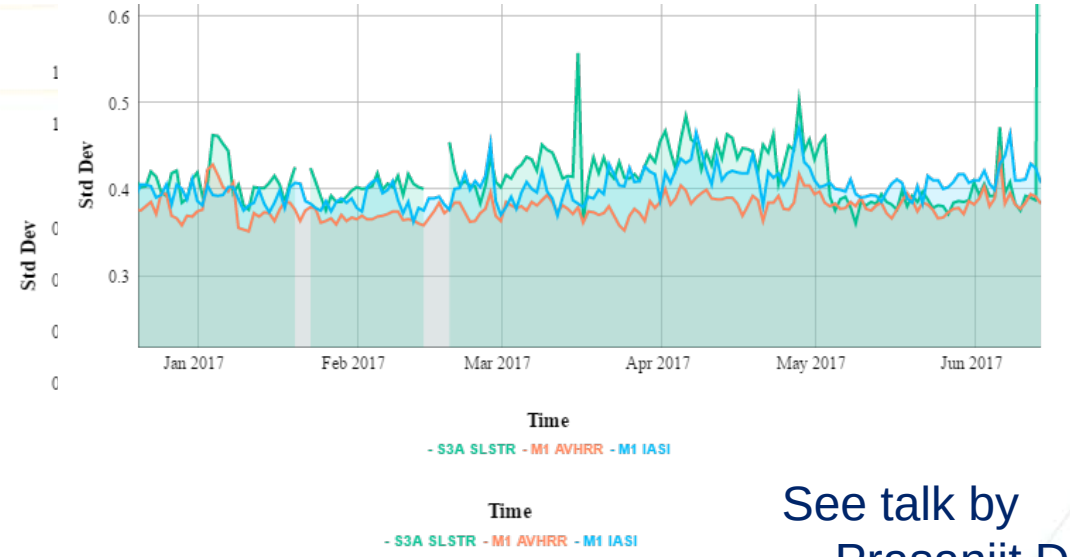
See Tomazic et al, GSICS quarterly, 2016: https://docs.lib.noaa.gov/noaa_documents/NESDIS/GSICS_quarterly/v10_no3_2016.pdf

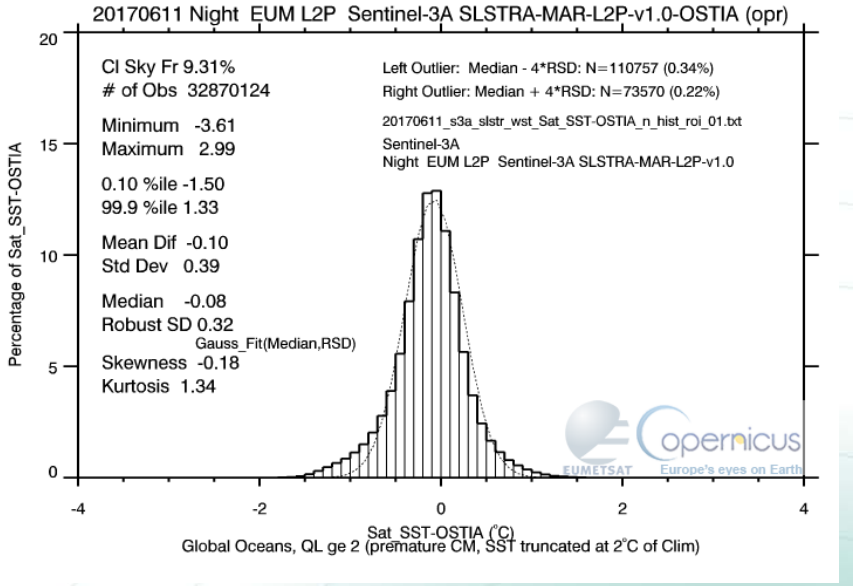
Monitoring and Evaluation of Thematic Information from Space (METIS-SST) – routine monitoring





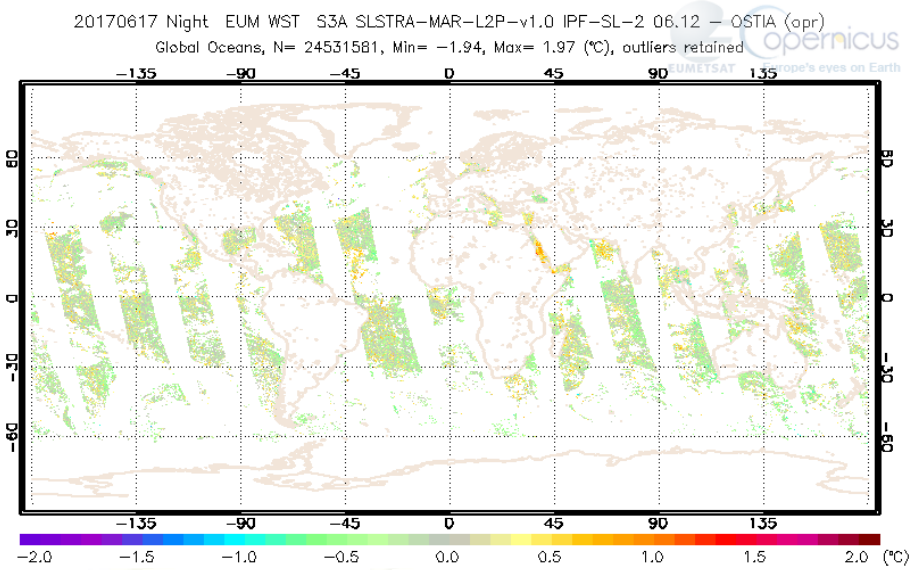
http://metis.eumetsat.int

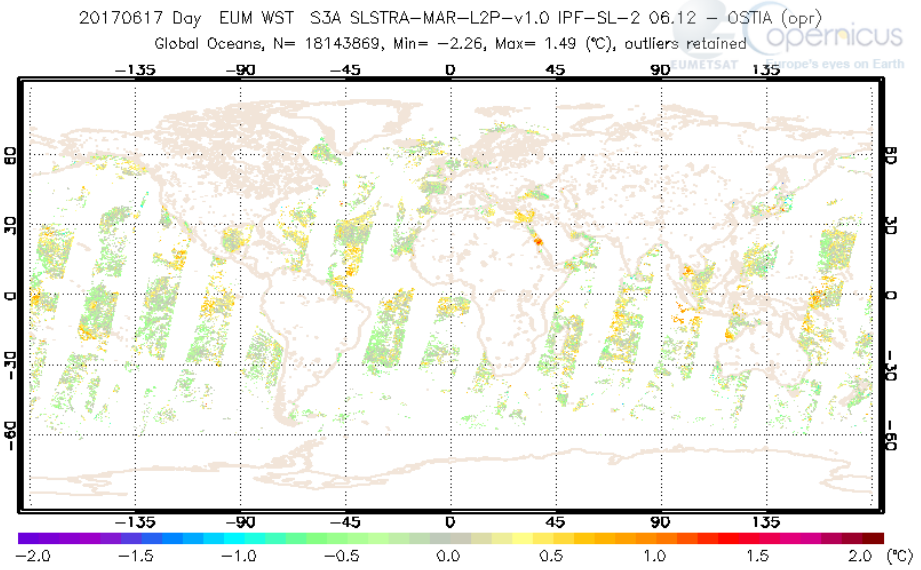


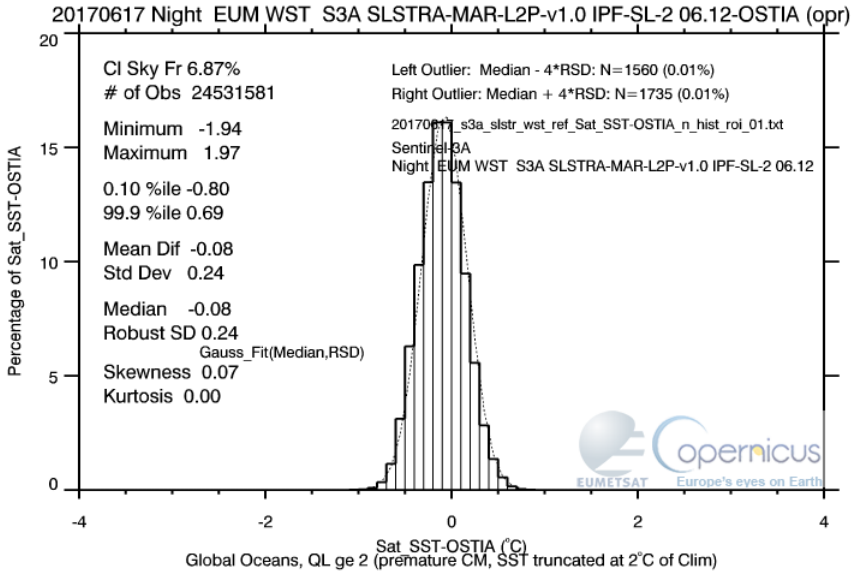


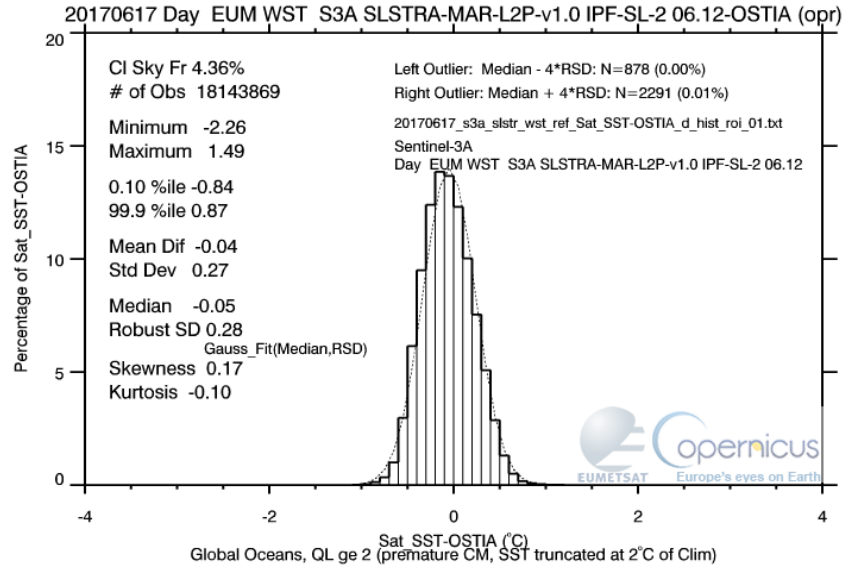
See talk by Prasanjit Dash

METIS-SST: monitoring of PB2.16 for L2 release









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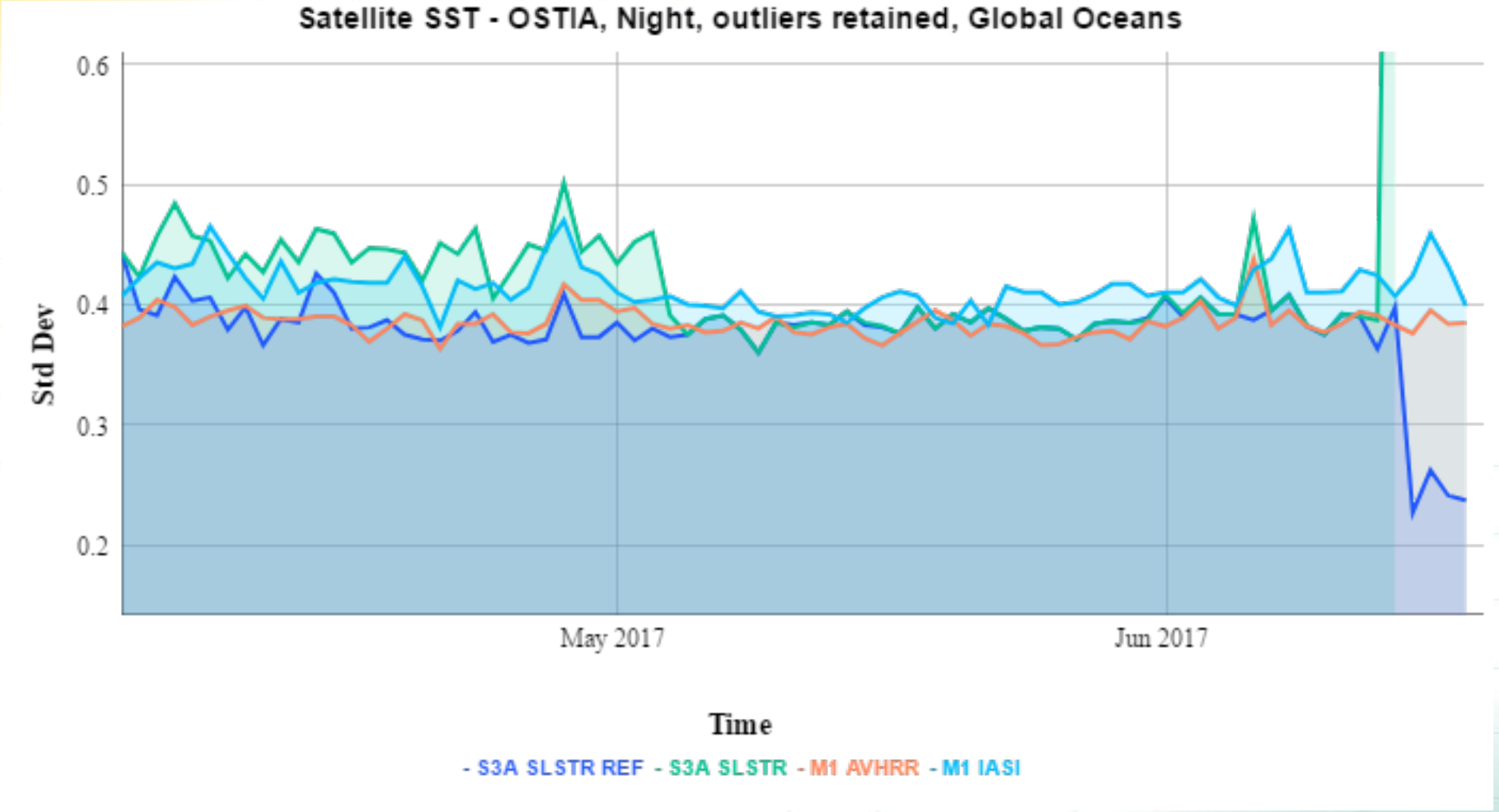
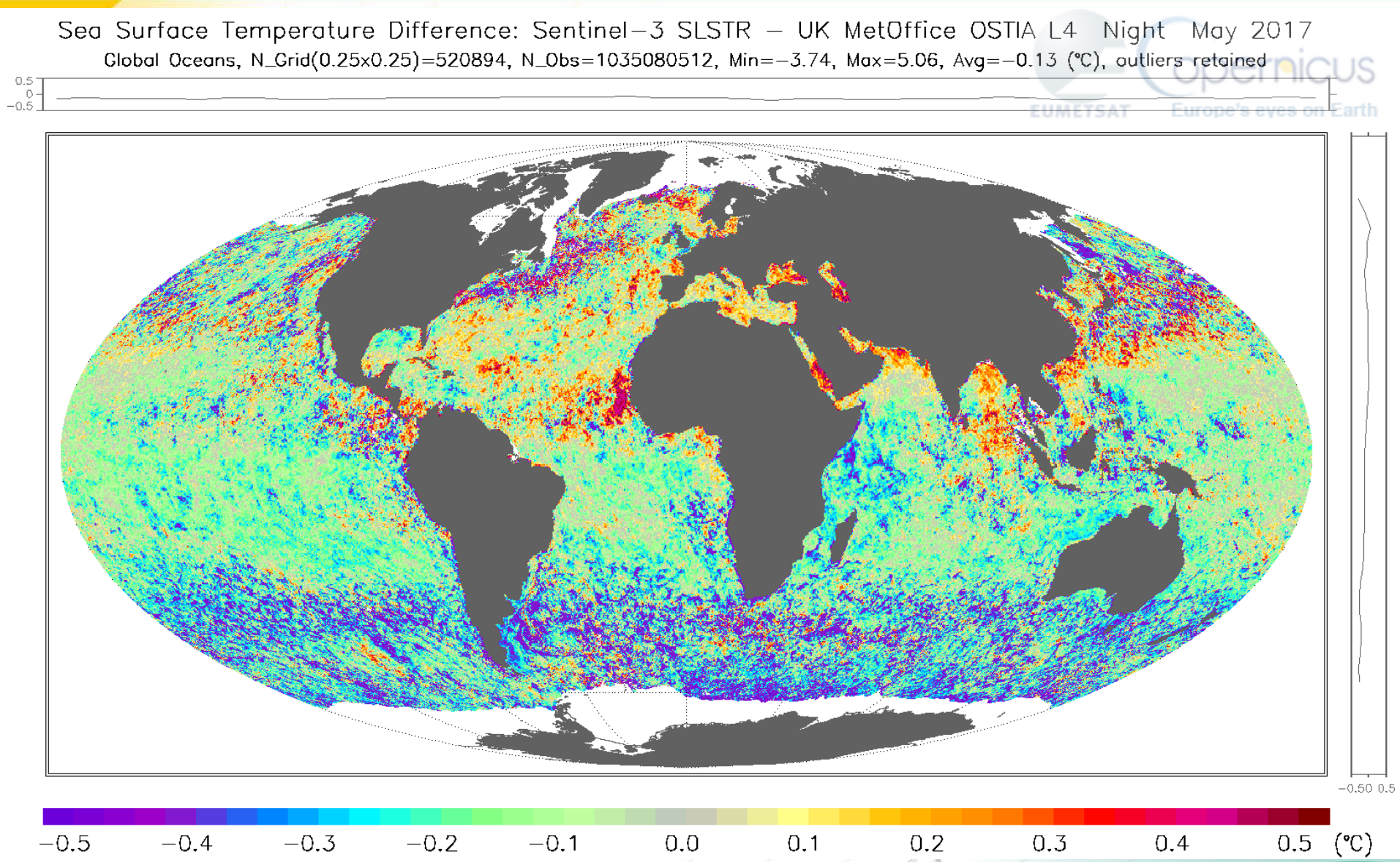
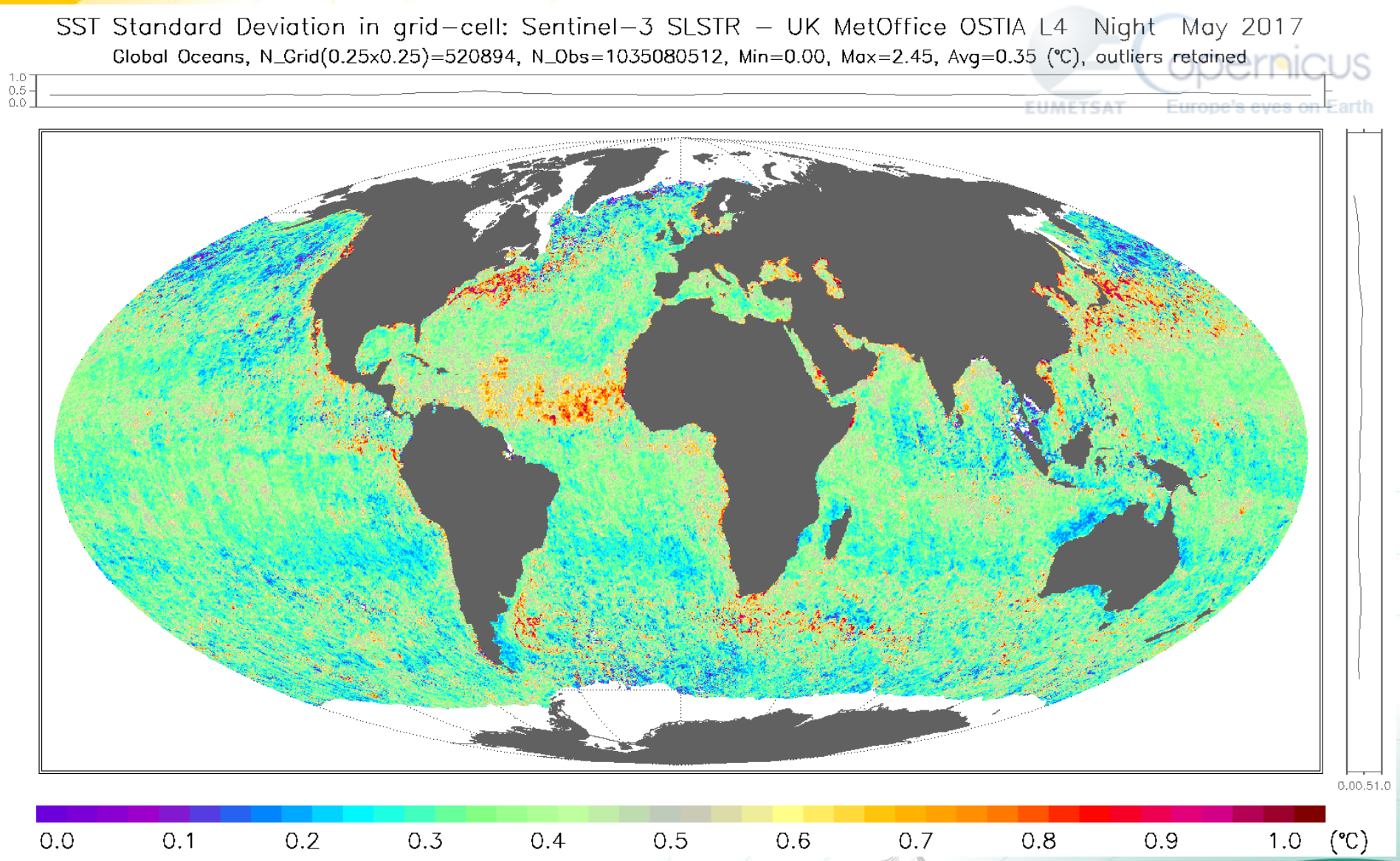


METIS-SST: mean global maps vs OSTIA for May 2017

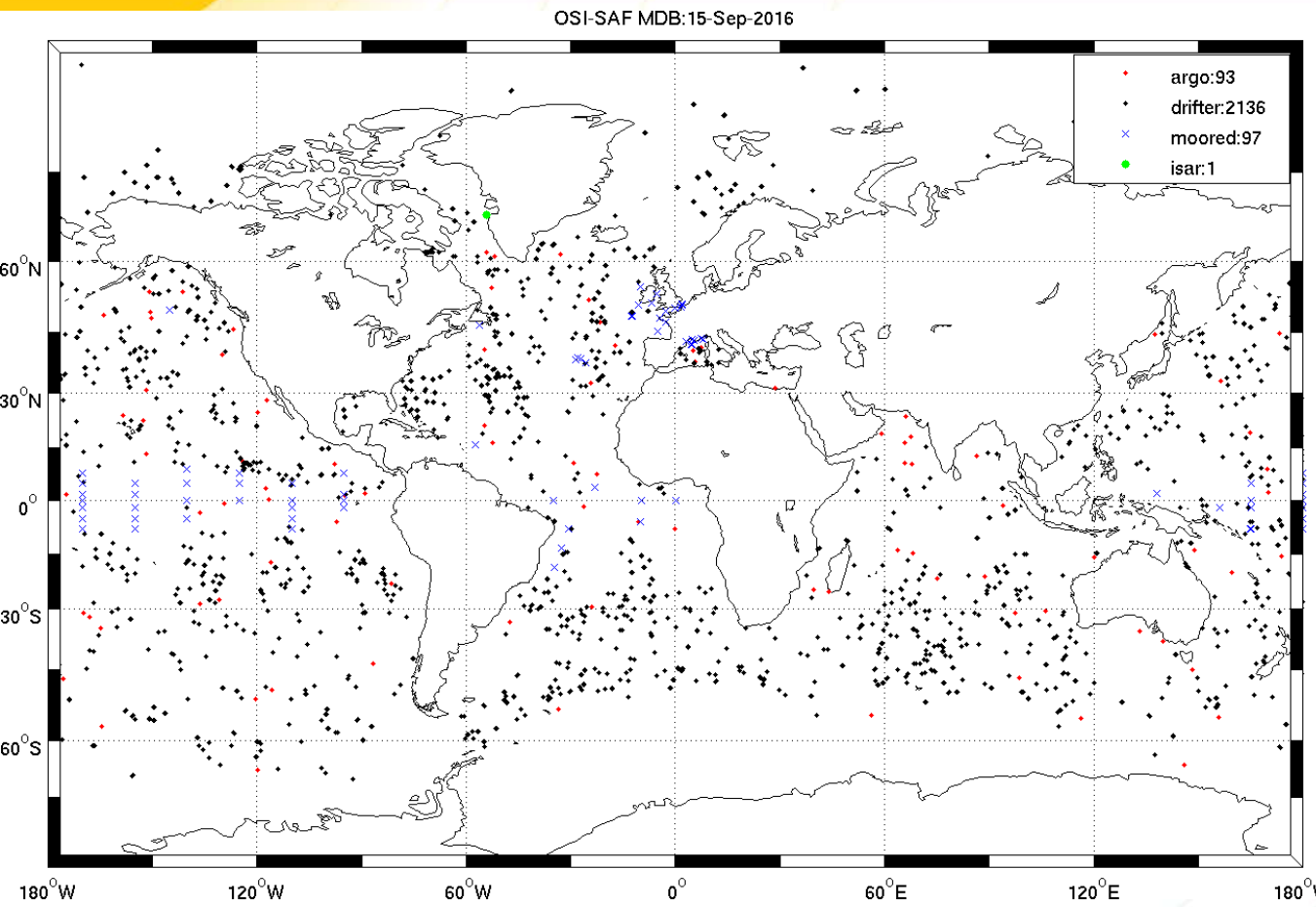


METIS-SST: stdev global maps vs OSTIA for May 2017



SLSTR SST matchup database

See talk by J-F Piolle



- Routine collocation of in situ and satellite data.
- Drifters, Moored buoys, Argo, Ship Borne radiometers.
- Use of Coriolis.
- Use of FRM
- Coordination with international teams.

The EUMETSAT Network of Satellite Application Facilities
OSI SAF
Ocean and Sea Ice

felyx

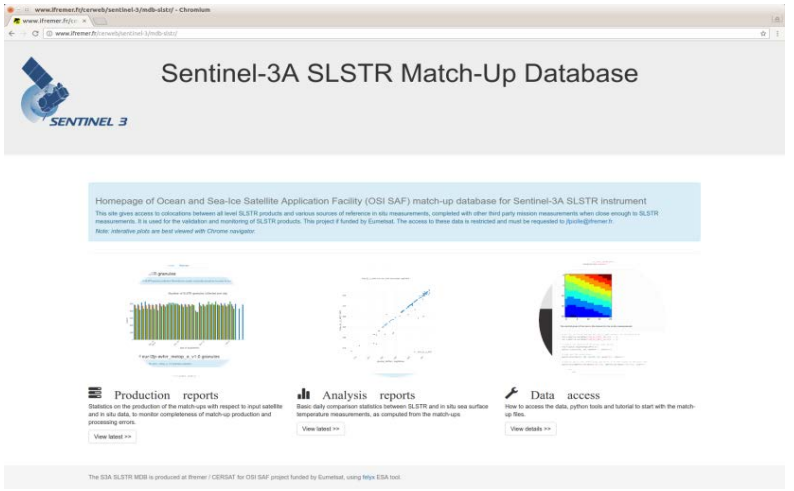
esa

European Commission
opernicus
EUMETSAT

SLSTR MDB activities

See talk by J-F Piolle

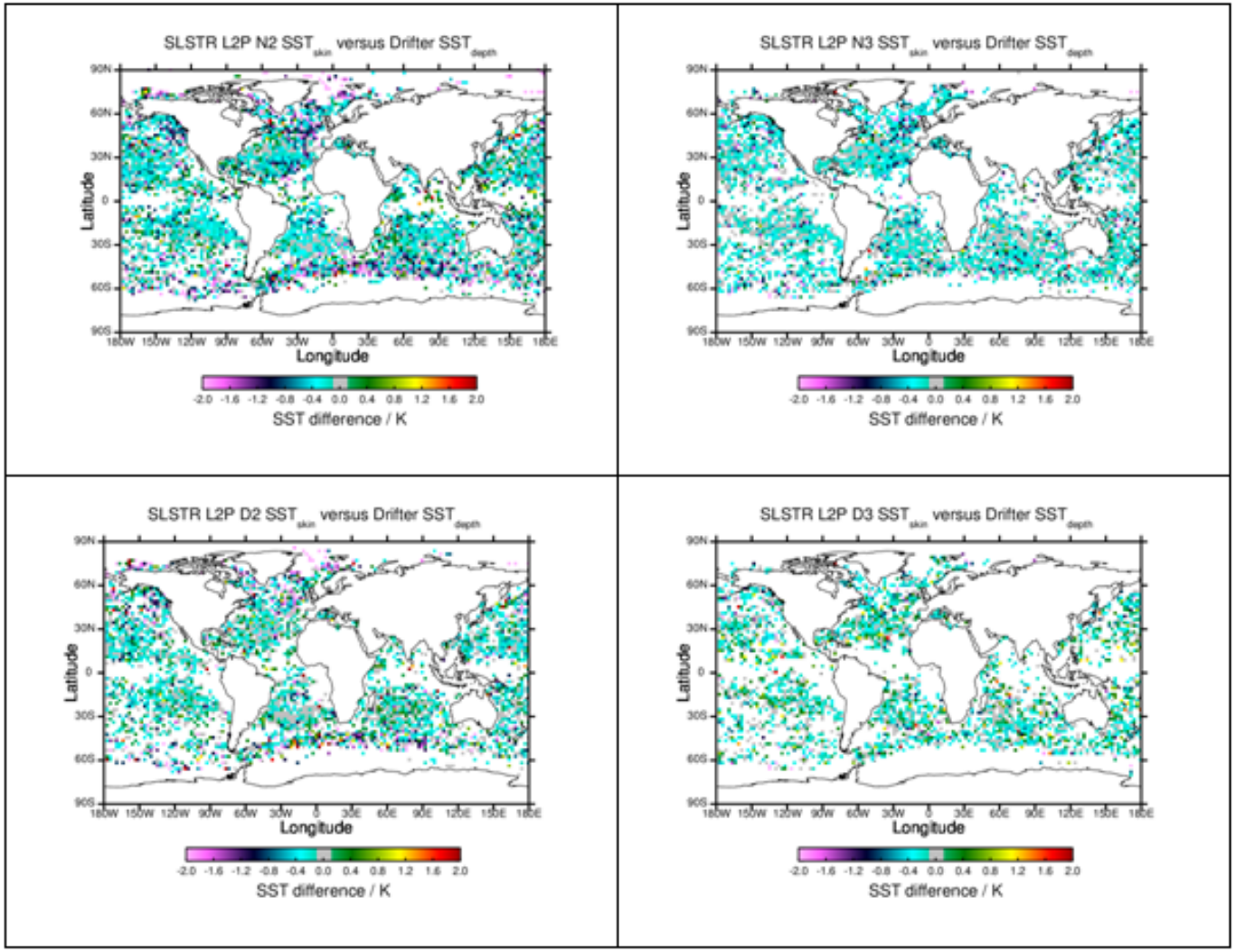
- Coordination of the OSI SAF / EUMETSAT MDB for use by all Sentintel-3 Validation Team (temp sub-group)
  - Also needed for inter-algorithm adjustments, SSES and uncertainty, cloud-screening assessments



http://www.ifremer.fr/cerweb/sentinel-3/mdb-slstr/

- FRM radiometer activities from PIs:
  - U of Miami, U of Southampton, RAL, DMI, Bureau of Meteorology
  - Data coordinated by EUMETSAT / S3VT for inclusion in OSI SAF MDB
  - Collocated data available to S3VT and later open

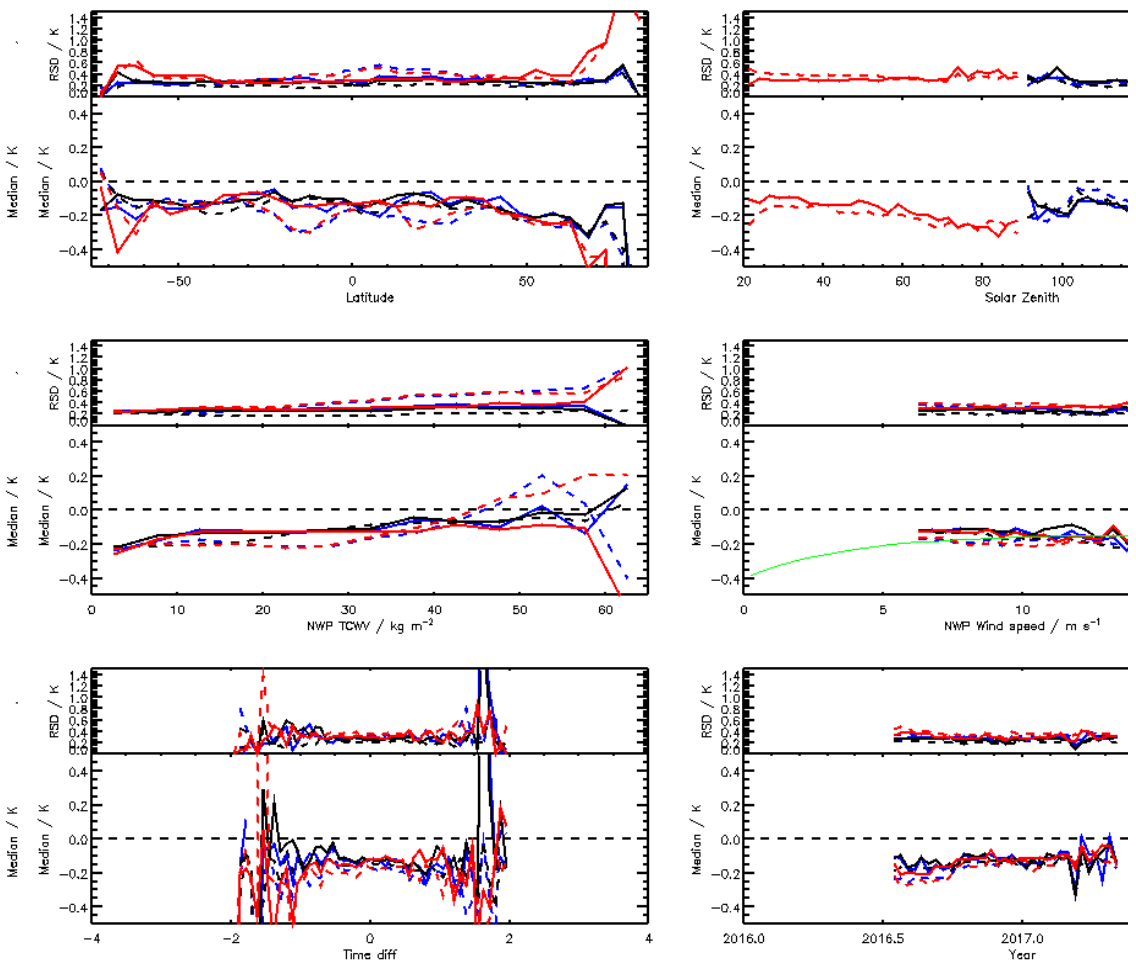
Global buoy SST differences



Includes 5K dt_analysis filter

G. Corlett, SLSTR validation scientist

Buoy matchup results (d = red, n2 = blue, n3 = green) (dual = solid, nadir = dashed)



With cut off wind speed > 6 ms-1 and SatZA < 55 deg

Retrieval: Number mean (St. Dev) Median (RSD) in K

EXP matchups:

N2:	7387	-0.480 (1.410)	-0.209 (0.429)
N3:	4956	-0.349 (0.976)	-0.178 (0.249)
D2:	5712	-0.326 (1.279)	-0.136 (0.309)
D3:	3163	-0.114 (0.675)	-0.121 (0.263)

All matchups:

N2:	19373	-0.420 (1.397)	-0.185 (0.367)
N3:	13697	-0.294 (0.859)	-0.152 (0.208)
D2:	10556	-0.327 (1.328)	-0.134 (0.306)
D3:	6498	-0.115 (0.642)	-0.123 (0.266)

Includes filter where dt_analysis > 5K, wind speed < 6 m/s, SZA > 55 deg

G. Corlett, SLSTR validation scientist

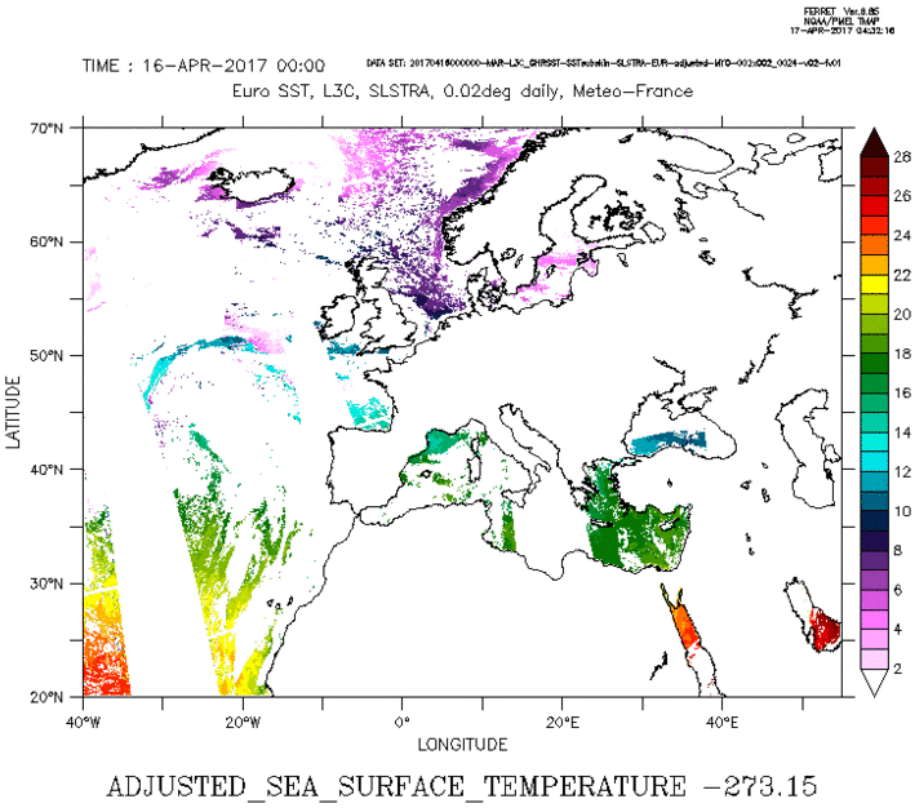
SLSTR SST validation summary

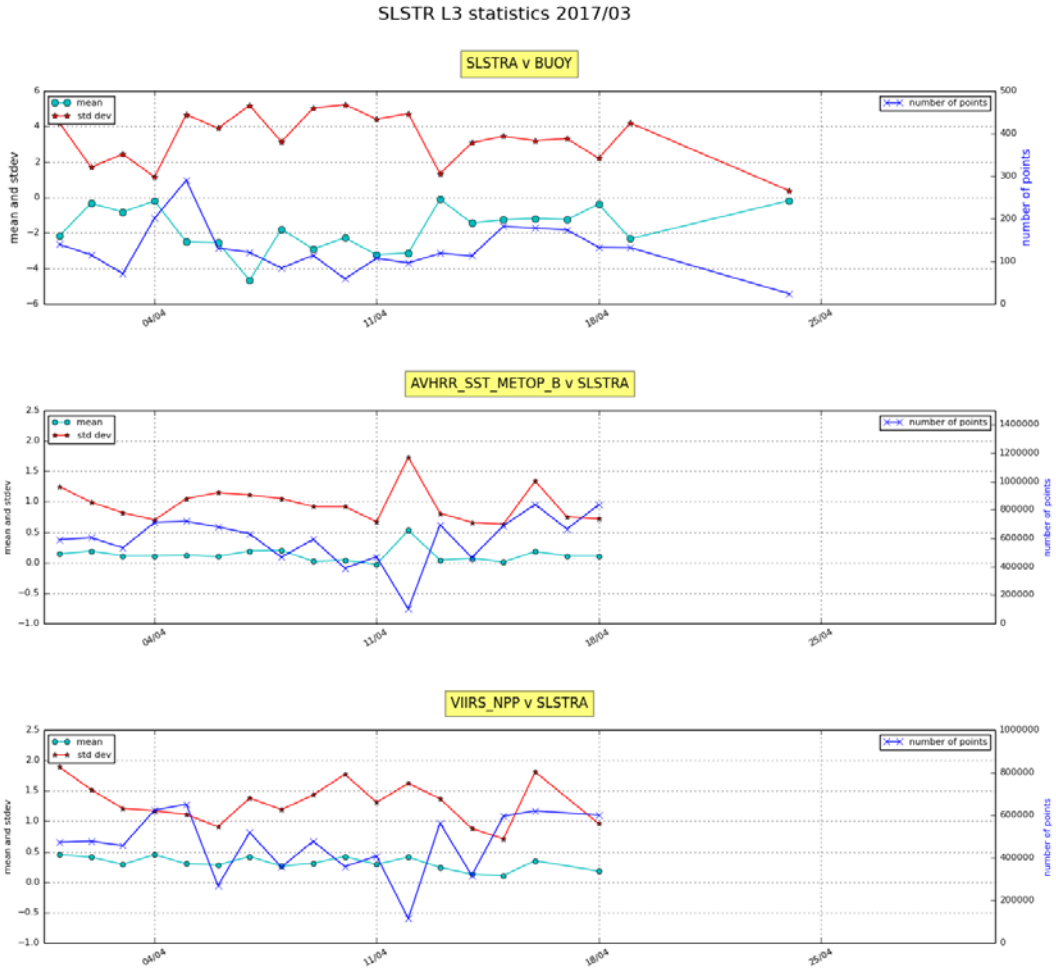
- Large difference in number of daytime and night time match-ups
- DT analysis cut-off at 5 K reduces influence of cloud
  - Largest influence on nadir only cases
- Residual algorithm bias in N2 retrievals outside of oblique view
  - Can reduce with SSES (in the mean)
- D2 uncertainty stratification needs optimizing
  - Most uncertainties are overestimated for cases > 0.3 K
- N2 uncertainties okay to about 0.8 K
  - Then significant variation in bias seen
  - Overestimated slightly for cases > 0.4 K
- Little correlation between uncertainty and difference to drifter for current QL model
  - Advise users to ignore data with satellite zenith angle > 55.0

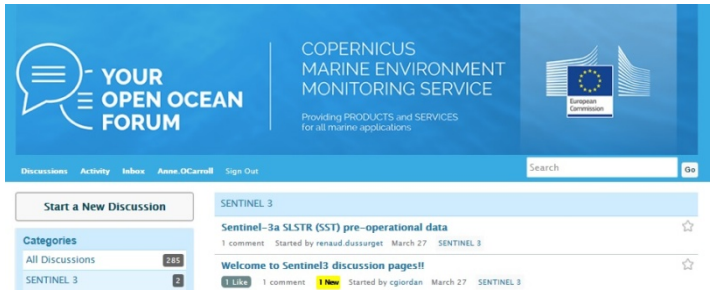
G. Corlett, SLSTR validation scientist

CMEMS monitoring (pre-operational and L3 EUR SST)

Url: http://forum.marine.copernicus.eu/







Validation analyses and results by CMEMS, S3VT, and all other contributors essential for continuing improvement of products

Fiducial Reference Measurements - drifters

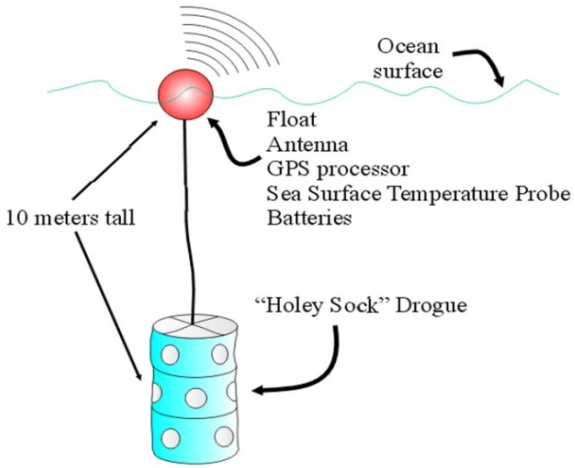
- New project to provide measurements from a significant number of drifting buoys equipped with digital SST probes in order to achieve a better calibrated capability.

"Assess and establish the benefit of improved calibrated capability of drifting buoys for satellite SST validation"

"Well calibrated, towards traceable drifting buoys, HRSST-FRM"

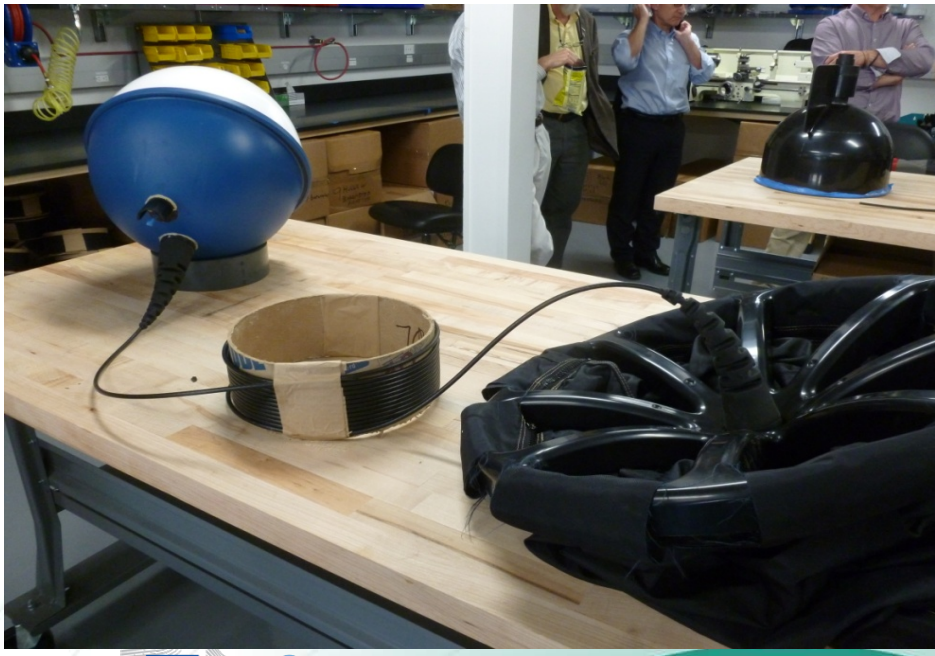
- Include assessment through Sentinel-3 SST Cal/Val activities, and together with GHRSST.

- Endorsed by S3VT meeting, February 2017



HRSST- 2 / FRM project details

- Improved calibration capability, provision of measurements over a 2+2 year period.
- Provide a service via ftp and GTS, possible inclusion of high frequency data
- Additional digital SST probe to standard SVP-B -> two sensors for use and evaluation
- Near surface water pressure sensor -> understand depth of drifter and loss of drogue.
- All relevant technical documentation, metadata, manufacturing information.
- Preparations for S3B SLSTR SST.



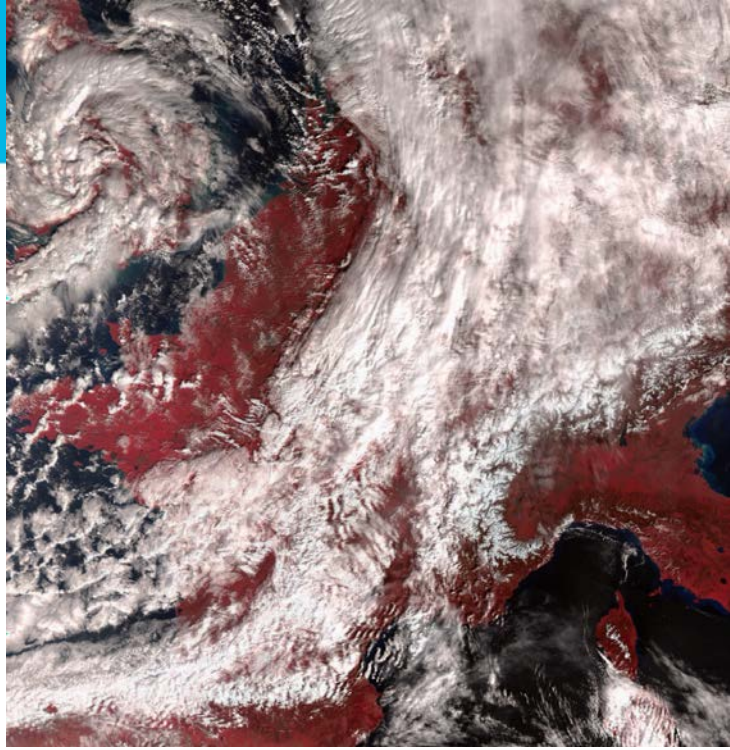
Summary

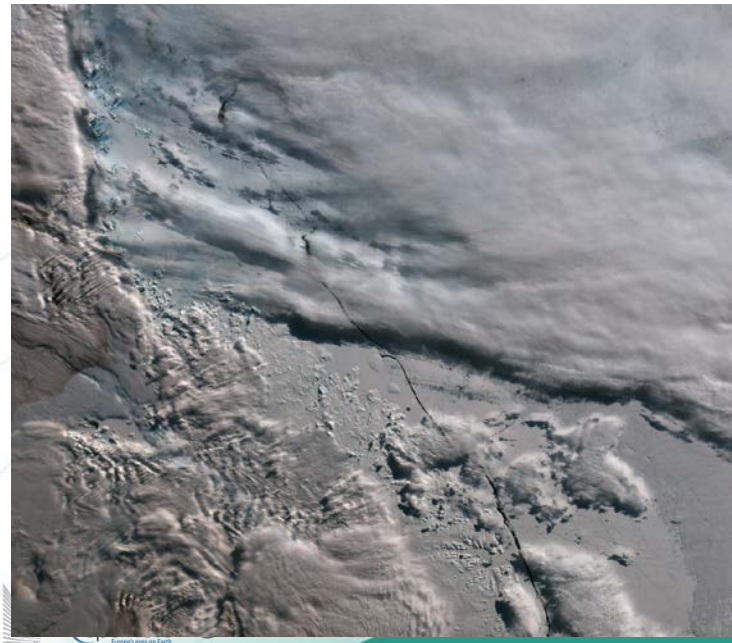
- SLSTR SST validation continue, with priority use of MDB and METIS-SST

- SLSTR SST meet mission requirements (<0.3K), advisory to use only dual-view part of swath for reference purposes

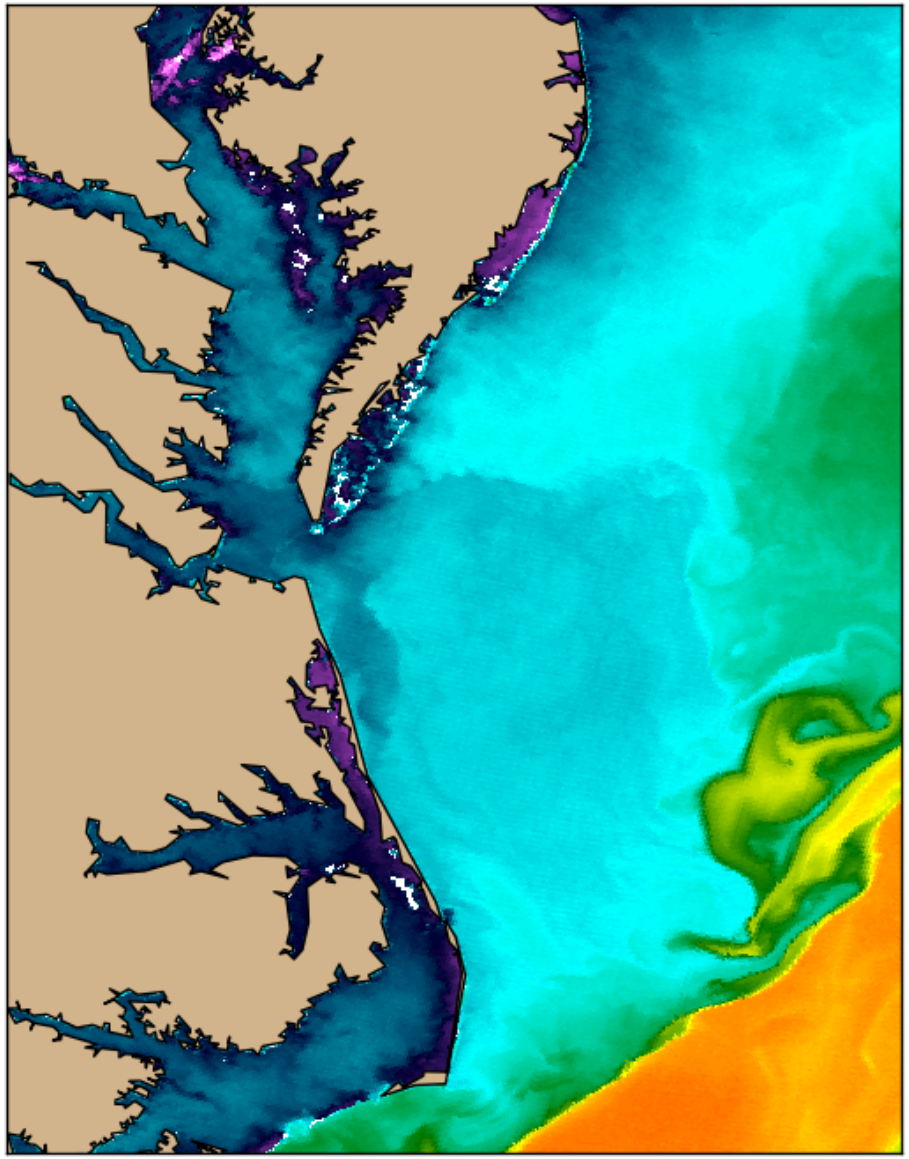
- Sentinel-3 Validation team and other contributing projects / activities important for feeding back into product improvements

- SLSTR SST general data release planned for June / July 2017





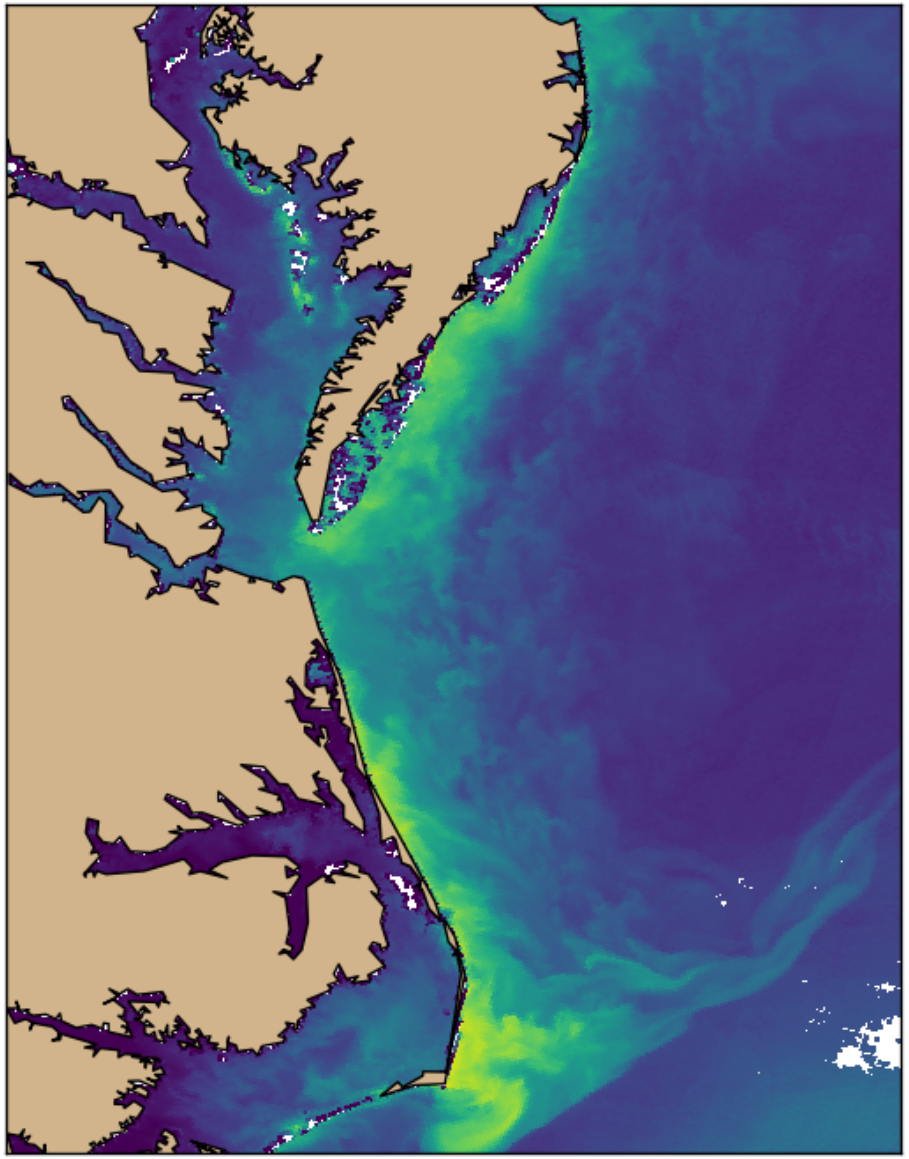
SLSTR - S3A_SL_2_WCT 11 Nov 2016 15:26:16



280.0 282.5 285.0 287.5 290.0 292.5 295.0 297.5 300.0 302.5 305

N3 sea surface temperature (K)

OLCI - S3A_SL_2_WRR 11 Nov 2016 15:26:16



0.000 0.007 0.014 0.021 0.028 0.035 0.042 0.049 0.056 0.063 0.070

Reflectance for OLCI acquisition band Oa05