The Sentinel-3 mission – SST
SST data in practice

Anne O'Carroll, Igor Tomazic, Gary Corlett
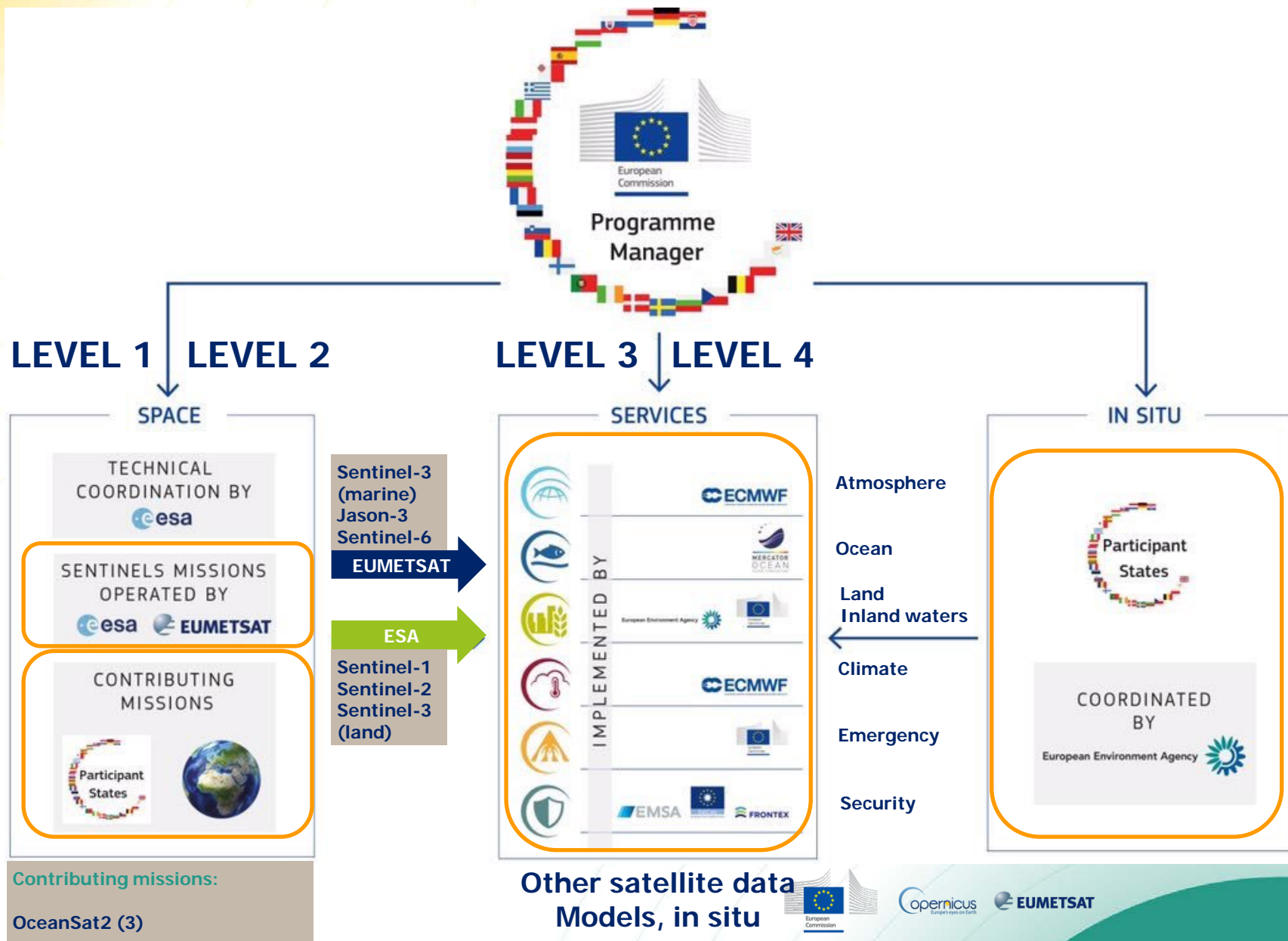
EUMETSAT

ISFRN workshop

17th September 2020

Copernicus Ocean data

Programme Manager

LEVEL 1 | **LEVEL 2**   **LEVEL 3** | **LEVEL 4**

SPACE

TECHNICAL COORDINATION BY **esa**

SENTINELS MISSIONS OPERATED BY **esa** **EUMETSAT**

CONTRIBUTING MISSIONS

Participant States

Contributing missions:

OceanSat2 (3)

Sentinel-3 (marine)
Jason-3
Sentinel-6
EUMETSAT

ESA
Sentinel-1
Sentinel-2
Sentinel-3 (land)

SERVICES

IMPLEMENTED BY

ECMWF

MERCATOR OCEAN

European Environment Agency

ECMWF

EMSA FRONTEX

Atmosphere

Ocean

Land
Inland waters

Climate

Emergency

Security

IN SITU

Participant States

COORDINATED BY

European Environment Agency

Other satellite data
Models, in situ

European Commission Copernicus Europe's eyes on Earth EUMETSAT

Sentinel-3 Mission Product Responsibilities

EUMETSAT

esa

L2 Atmosphere:
NRT AOD & FRP

L2 Atmosphere:
Offline AOD & FRP

L1 Global:
OLCI full and reduced resolution
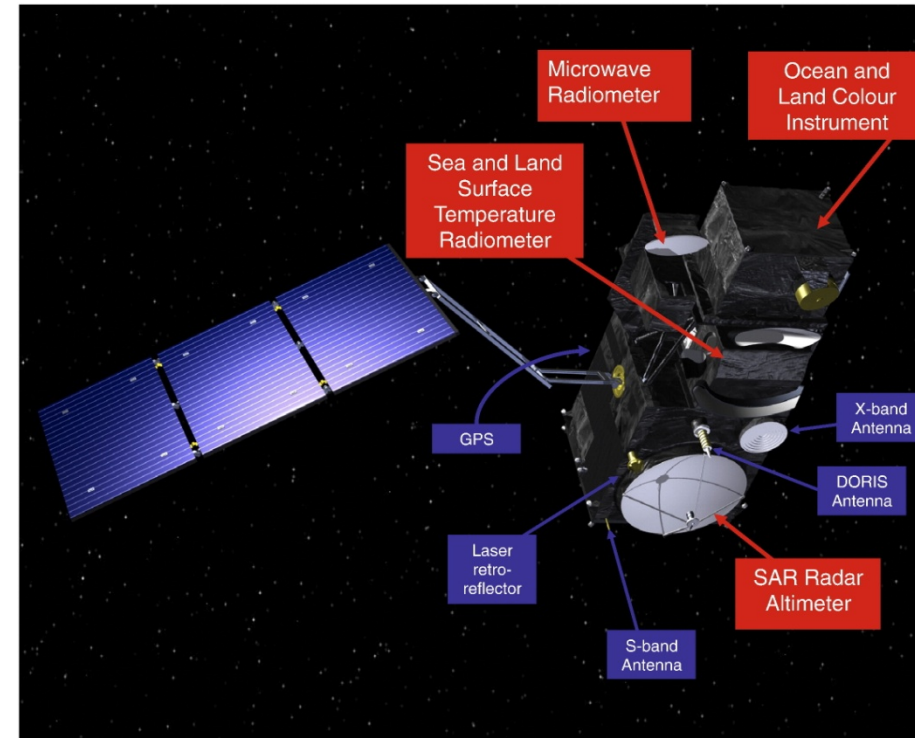SLSTR
SRAL / MWR

L2 Marine:
OLCI full and reduced resolution
SLSTR
SRAL / MWR

L2 Land:
OLCI full and reduced resolution
SLSTR
SRAL / MWR
Synergy

European Commission · Copernicus Europe's eyes on Earth · EUMETSAT

EUMETSAT Copernicus Data Services: Sentinel-3

- **Sentinel 3**
  - SLSTR (SST)
  - OLCI (Ocean Colour)
  - SRAL/MWR/POD (Surface topography/altimetry)

- Builds on heritage but with improved resolution and sensors.
- S3A (launched 16th Feb 2016),   S3B (launched 25th April 2018)
- Spacecraft Operations (routine phase) and marine data processing/performance/dissemination
- Many applications for ocean research and commercial operations.

Also operating Jason-3 (altimetry) and Sentinel-6/Jason-CS (from 2020) on behalf of European Commission.

Microwave Radiometer

Ocean and Land Colour Instrument

Sea and Land Surface Temperature Radiometer

GPS

X-band Antenna

DORIS Antenna

Laser retro-reflector

SAR Radar Altimeter

S-band Antenna

Sentinel-3A and -3B

- Two satellites working together to optimize coverage.
  - 27 day repeat cycle
  - 140° phasing between A and B
  - Full global coverage in <3 days (OLCI) and <2 days (SLSTR) at the equator.

- Secondary benefit: opportunities for inter-calibration.
  - Tandem phase
 - Data available to S3VT from EUMETSAT

SRAL (>2 km) and MWR (20 km) nadir track

1400 km SLSTR (nadir)
740 km SLSTR (oblique)
1270 km OLCI

Descending Pass
Ascending Pass
Closed Loop
Open Loop: fixed gain
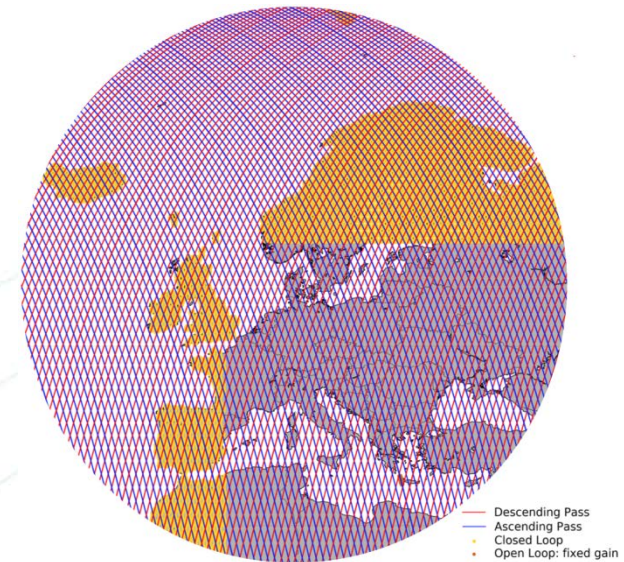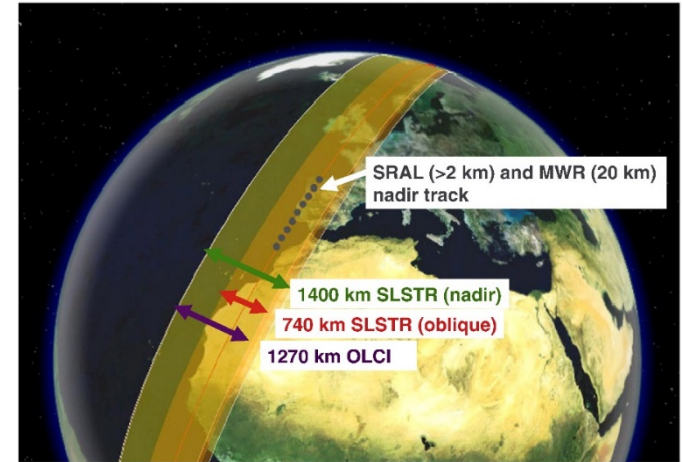
Figure 1: S3A SRAL track spacing and operating modes

EUMETSAT Copernicus Marine Data Service

- **Sentinel-3A and 3B**
  - Operation of satellite
  - Ground segment
    - Data processing
    - Data to services

- **Global Level 1 and Marine Level 2 data**
  - Daily, highest resolution (sensor specific, native)
  - NRT/STC/NTC
  - Level 1 allows for the user to implement custom processing
  - Level 2 - geophysical products provided as standard
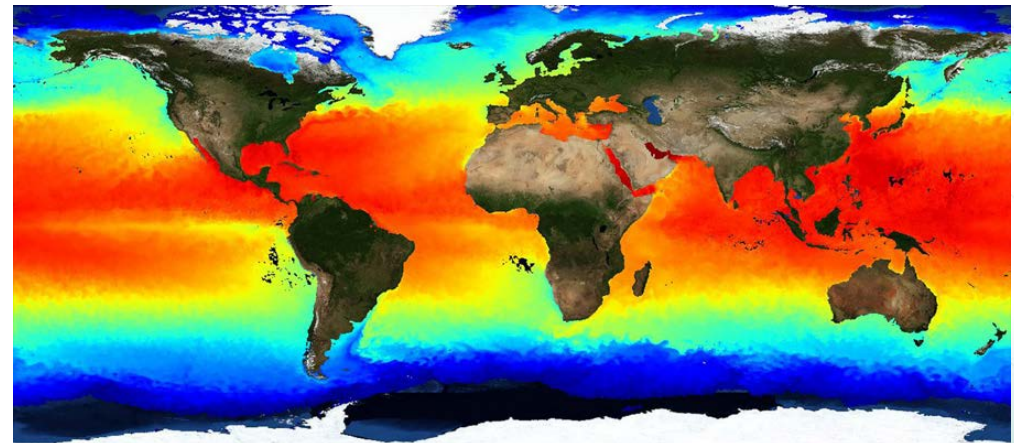
Sea Surface Temperature from SLSTR

- Spatial resolution: 500 m (optical) & 1 km granules (TIR) (all L1 and L2 NRT), 500 m & 1 km full-orbit dumps (L2 NTC)
- 9 spectral bands: 6 optical, 3 TIR (S7 S8 and F1 F2, overlap)
- With S-3A and S-3B < 2 day revisit
- Daytime (descending) and nighttime (ascending) passes

Band	λ centre (μm)	Width (μm)	Function	Comments		Res. (m)
S1	0.555	0.02	Cloud screening, vegetation monitoring, aerosol	Visible Near IR (VNIR)	Solar reflectance bands	500
S2	0.659	0.02	NDVI, vegetation monitoring, aerosol			
S3	0.865	0.02	NDVI, cloud flagging, Pixel co-registration			
S4	1.375	0.015	Cirrus detection over land	Short-Wave IR (SWIR)		
S5	1.61	0.06	Cloud clearing, ice, snow, vegetation monitoring			
S6	2.25	0.05	Vegetation state and cloud clearing			
S7	3.74	0.38	SST, LST, Active fire	Thermal IR bands (TIR)		1000
S8	10.85	0.9	SST, LST, Active fire			
S9	12	1	SST, LST			
F1	3.74	0.38	Active fire	Thermal IR fire bands (TIRf)		
F2	10.85	0.9	Active fire			
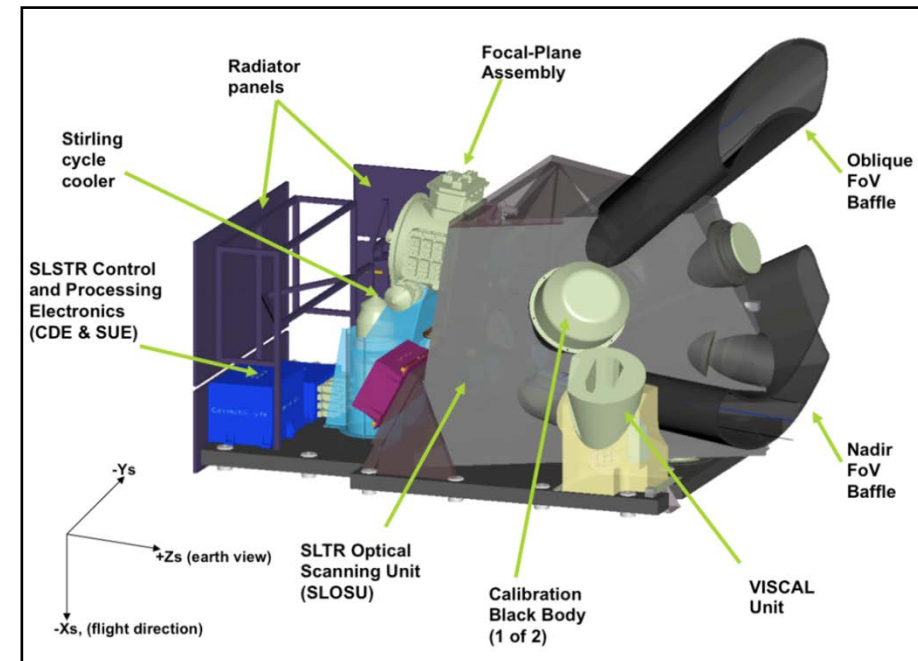
Sea Surface Temperature from SLSTR

- Level 1 – Radiances (S1-S6, 500 m) and brightness temperatures (S7-S9, 1 km), fire bands (F1 and F2, 1 km).

- Level 2 – GHRSST user product L2P SST (1 km) with quality flags, meteorological parameters, single sensor error statistics, algorithm flags plus internal WCT SST (single algorithms)

sea surface skin temperature
15-19 Jun 2017 composite - Sentinel-3A / SLSTR WST NR [PB2.16]-
N = 1427346, min = -1.99 C, max = 36.71 C

L2 Processing
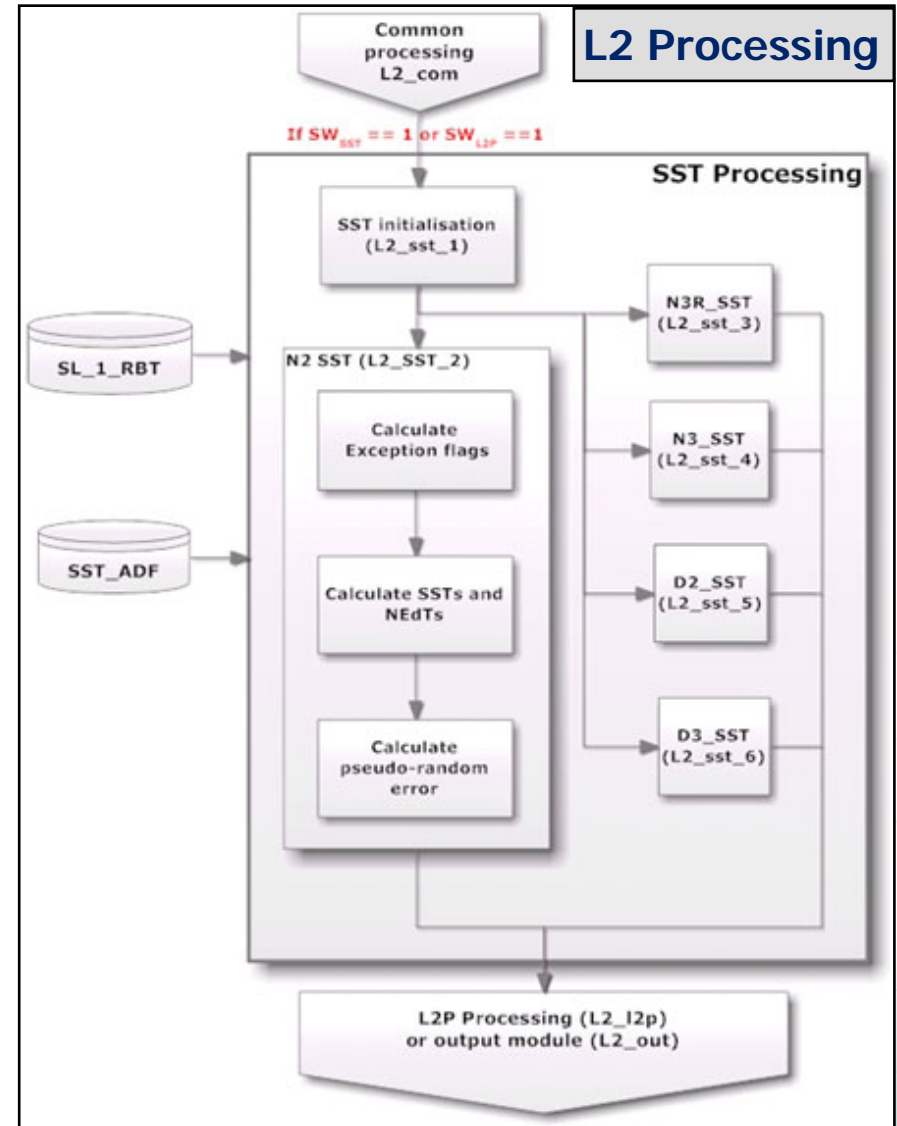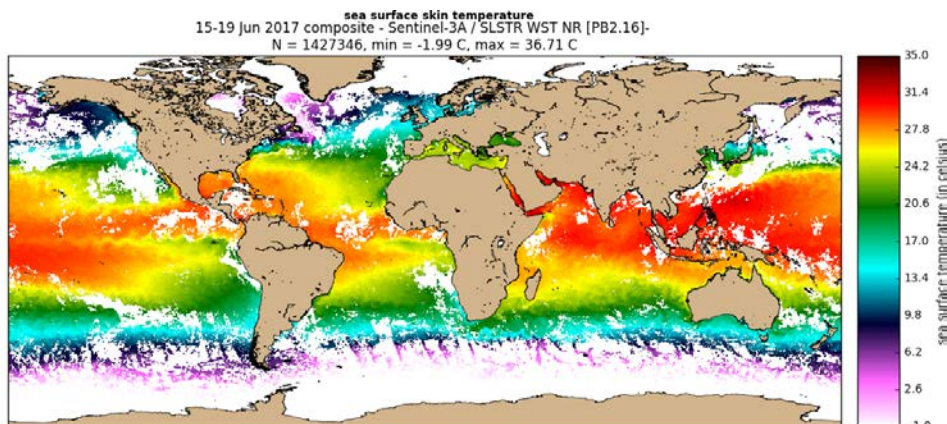
Measuring SST - Algorithms

- SLSTR has 5 algorithm for SST retrieval

- "N" only algorithms use only the nadir looking view.

- "D" algorithms combine both nadir and oblique view to give a "dual" view.

- D & N algorithms have variants that use 2 (day) or 3 channels (at night).

- Dual-view retrievals have the ability to provide a better atmospheric correction.
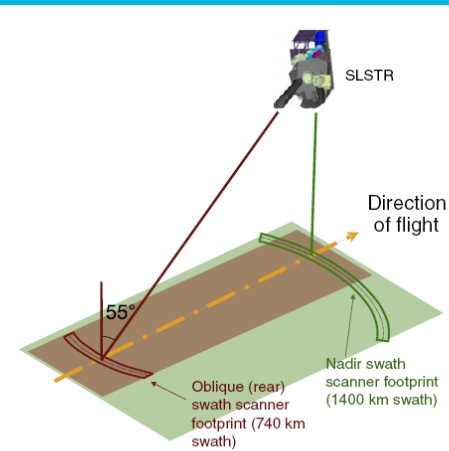
Fig. 8. Outline sketch of the Sentinel-3 SLSTR instrument viewing geometry highlighting the asymmetric nadir swath with respect to the nadir point.

SLSTR

Direction of flight

55°

Oblique (rear) swath scanner footprint (740 km swath)

Nadir swath scanner footprint (1400 km swath)

Oblique

D2 (S8/9)

D3 (S7/8/9)

N3/N3R* (S7/8/9)

Nadir

N2 (S8/9)
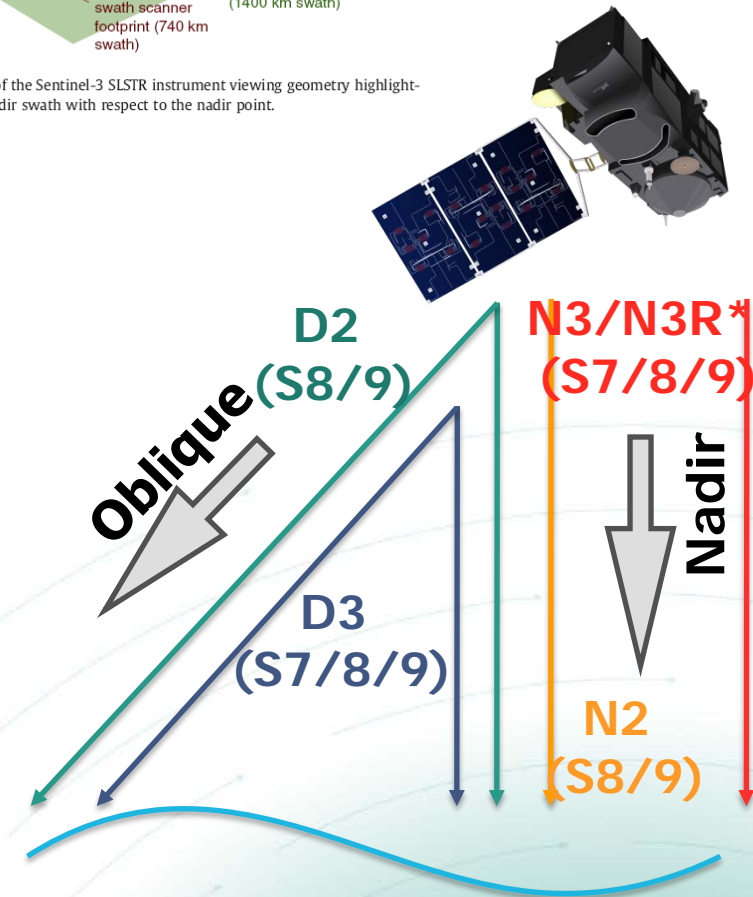
Coverage maps – sea surface temperature (dual, top) (nadir, bottom)

Sentinel-3 SLSTR revisit period and marine coverage [days]

Sentinel-3 SLSTR revisit period and marine coverage [days]

- Uses can consider S3A and S3B as one sensor

- Harmonisation is currently performed through the SSES, but will be refined shortly with revised retrieval coefficients
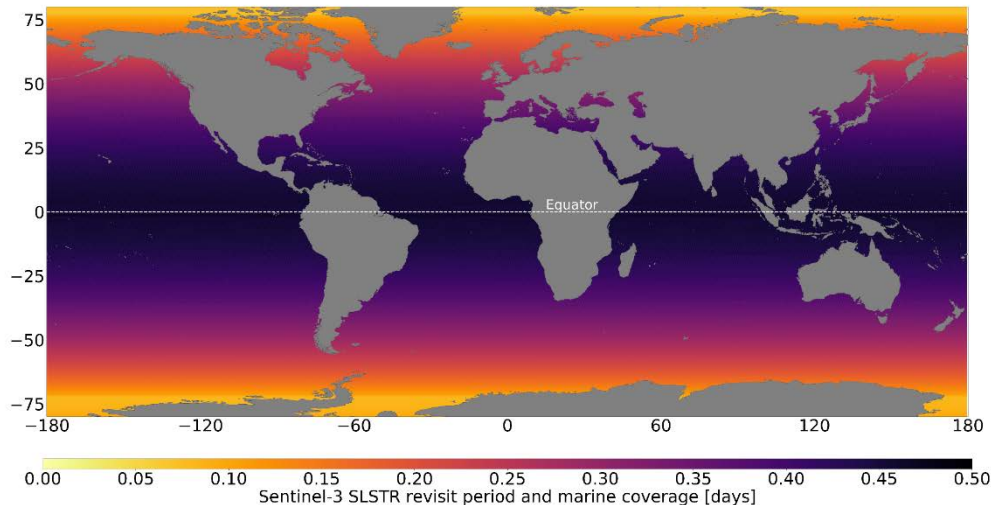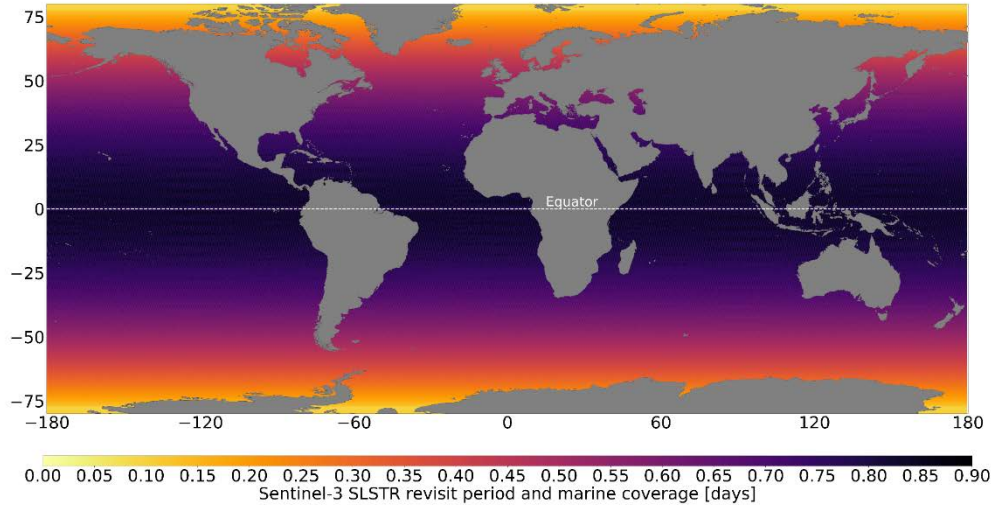
Combined coverage: SLSTR-A & SLSTR-B – two days

Copernicus Sentinel–3 SLSTR–A and SLSTR–B SST 18–19 Mar 2019
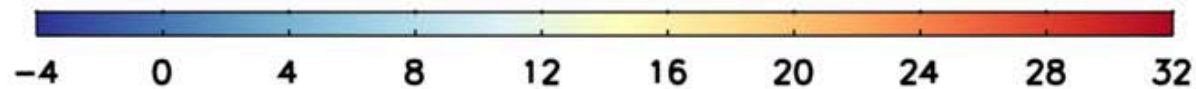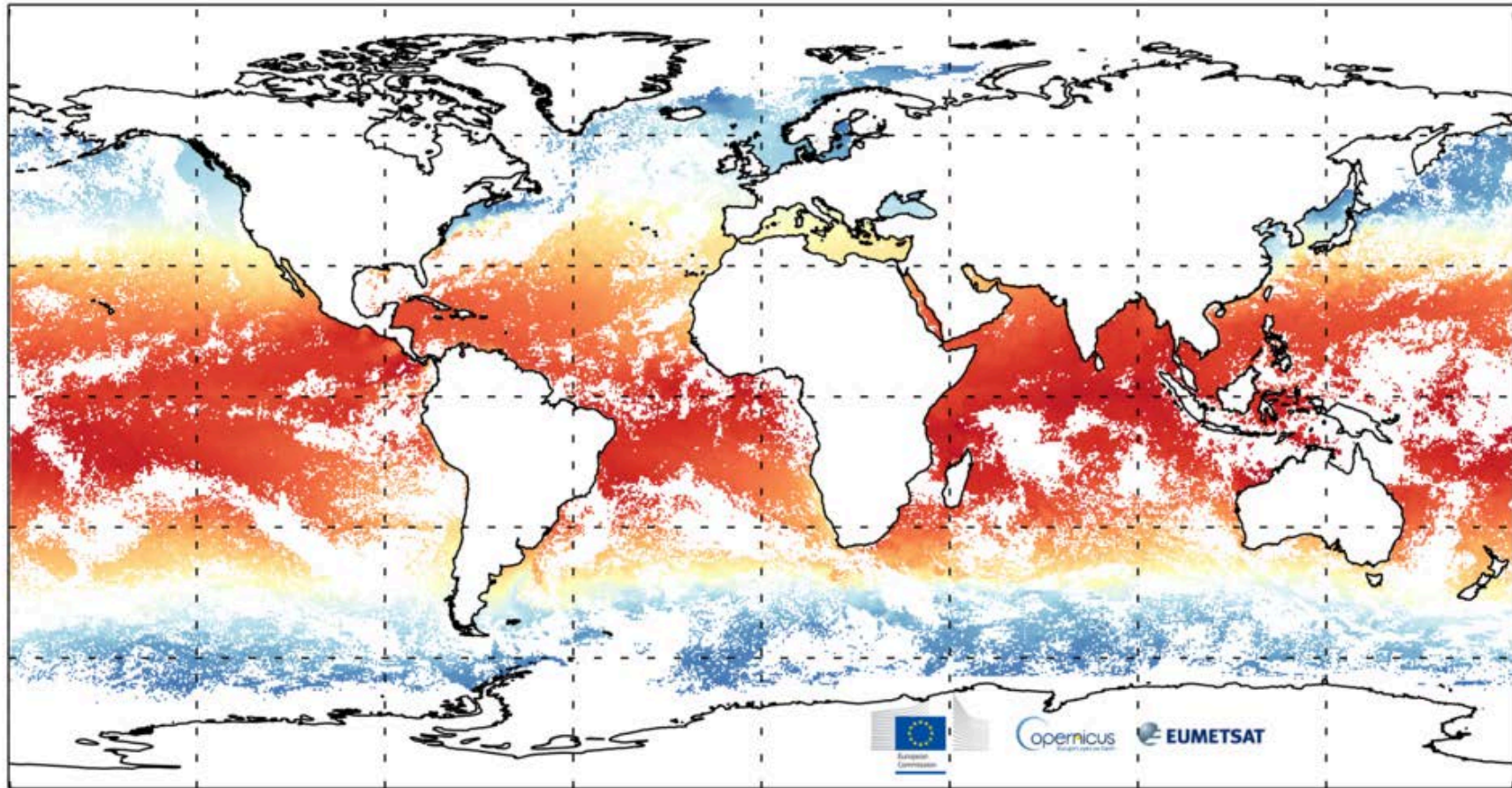
Sea Surface Temperature (°C)

SLSTR SST processing baseline - status

- Since 15 January 2020:
  - L1 PB -> S3A: 2.59 & S3B: 1.31
  - L2 Marine PB -> S3A: 2.61 & S3B: 1.33

  L1 major changes -> ortho-regridding, F1 channel co-registration improvement, temporal interpolation of meteorological fields, removal of S7 upper brightness temperature limit

  L2 marine changes -> small Quality Level update; no major change to SST

- Since 28 May 2020:
  - L2 Marine PB -> S3A: 2.61 & S3B: 1.40

  Update the SLSTR-B SSES ADF to compensate for the cold finger temperature increase that occurred on 30th March 2020. No change to SLSTR-A

- Since 9 June 2020:
  - L1 PB -> S3A: 2.59 & S3B: 1.40

  Correction of upper BT limit for the SLSTR-B S7 oblique view channel

sea_surface_temperature - 2018-04-05 19:36:56+00:00
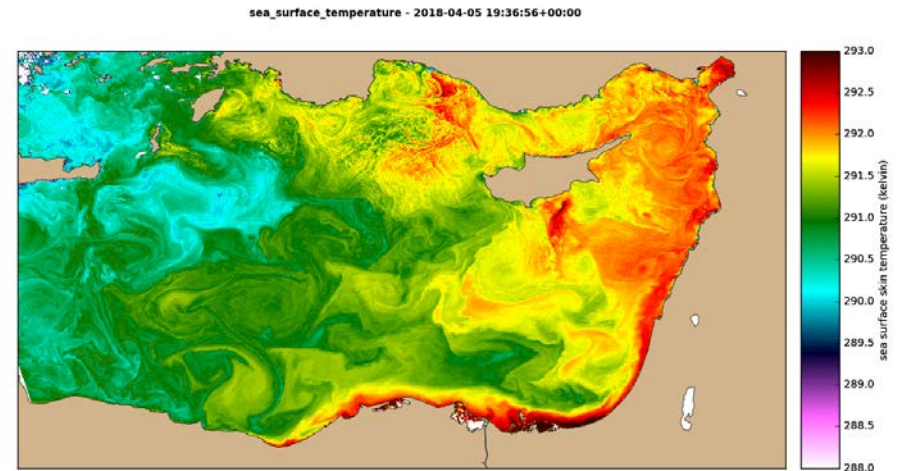
- Future plans:
  - Improvements to Bayesian cloud especially coastal zones
  - SLSTR day-2 SST: 2023

SST validation (metis.eumetsat.int)
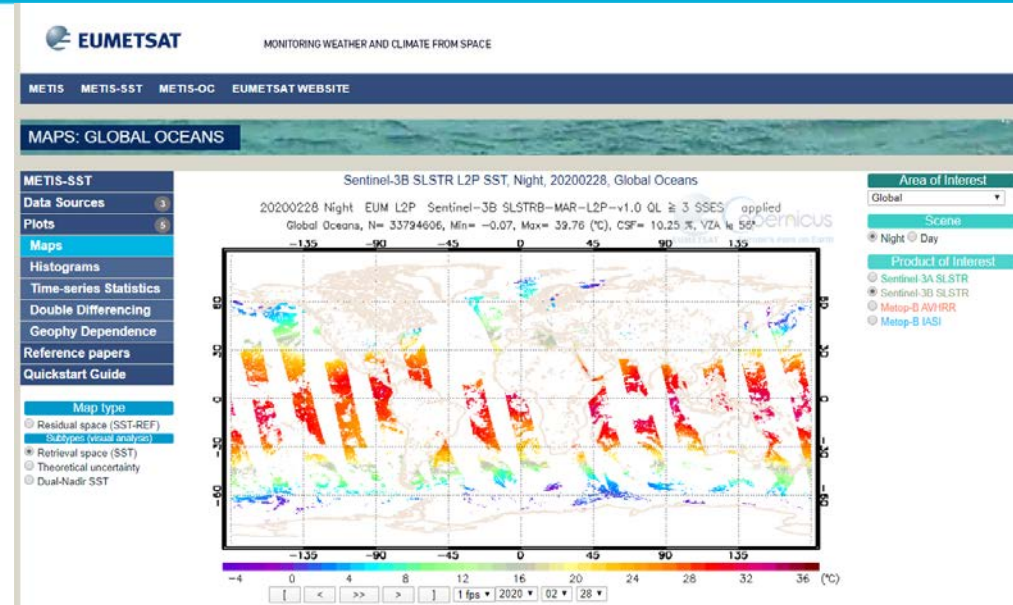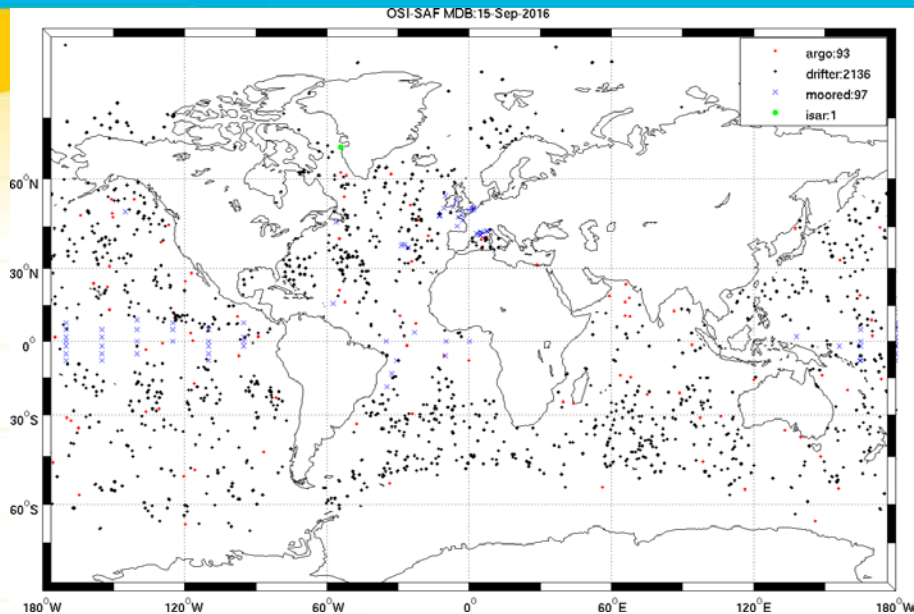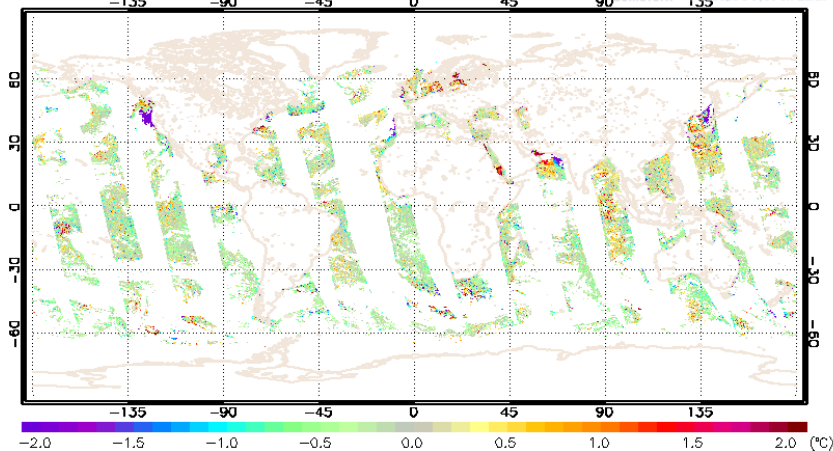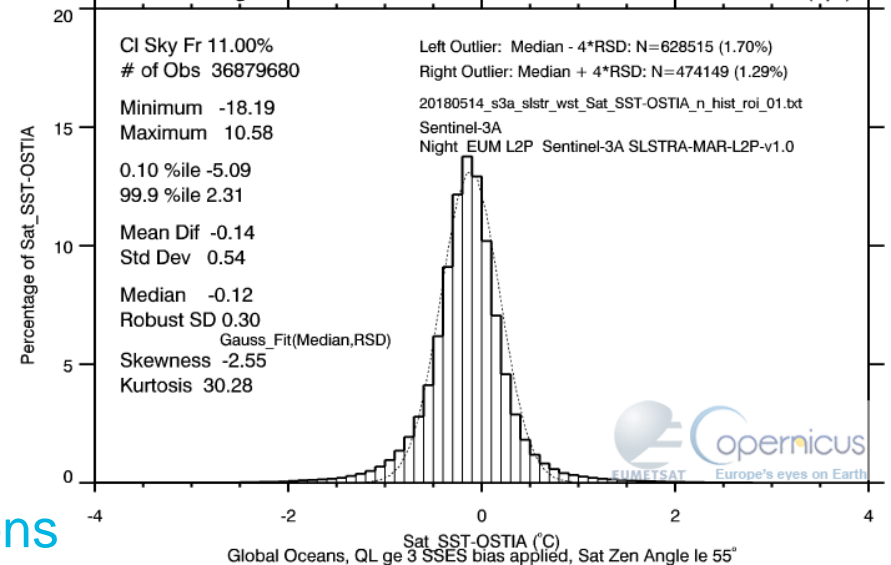
-> More info from Gary and Igor's presentations

TRUSTED – Towards FRM

- **Towards *Fiducial Reference Measurements* of Sea-Surface Temperature by European drifters (TRUSTED)**

-> Additional digital SST probe to standard SVP-B
-> Near surface water pressure sensor.
-> High frequency data available.

- Began January 2018 – 4 year project
  - Technical and Service Spec: SVP-BRST
  - Phase 1: verification of 2 prototype buoys
  - Phase 2: Manufacture and deployment of 100 TRUSTED drifting buoys and further 50 underway
  - Initial validation and analysis presented to WMO DBCP in October 2019
  - Preparation of TRUSTED MDB for sharing
  - TRUSTED sensor experiment on AMT 2019: W. Wimmer
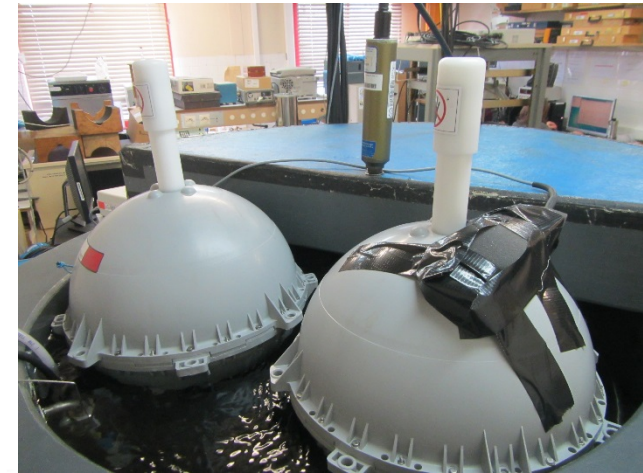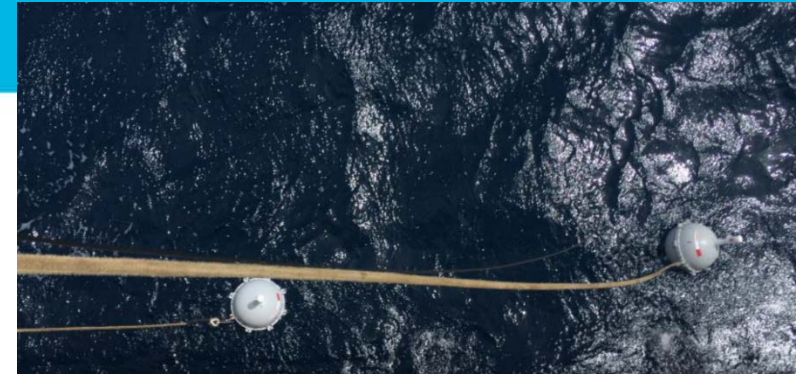
Poli et al, 2019; Le Menn et al, 2019

TRUSTED HRSST workshop 2-4 March 2021

European Commission · EUMETSAT
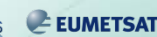
TRUSTED – recovery of drifting buoy 4101771

- TRUSTED buoy recovered on 8th August and is currently on a SHOM ship due back in Brest in November
- The buoy is in good condition, with the drogue lost
- The buoy was originally deployed on 20th September 2019
- The plans are that it will be re-calibrated at SHOM facilities and the uncertainty characteristics and any drift analysed.

https://www.eumetsat.int/website/home/Data/ScienceActivities/ScienceStudies/TowardsfiducialReferencemeasUrementsofSeaSurfaceTemperaturebyEuropeanDriftersTRUSTED/index.html
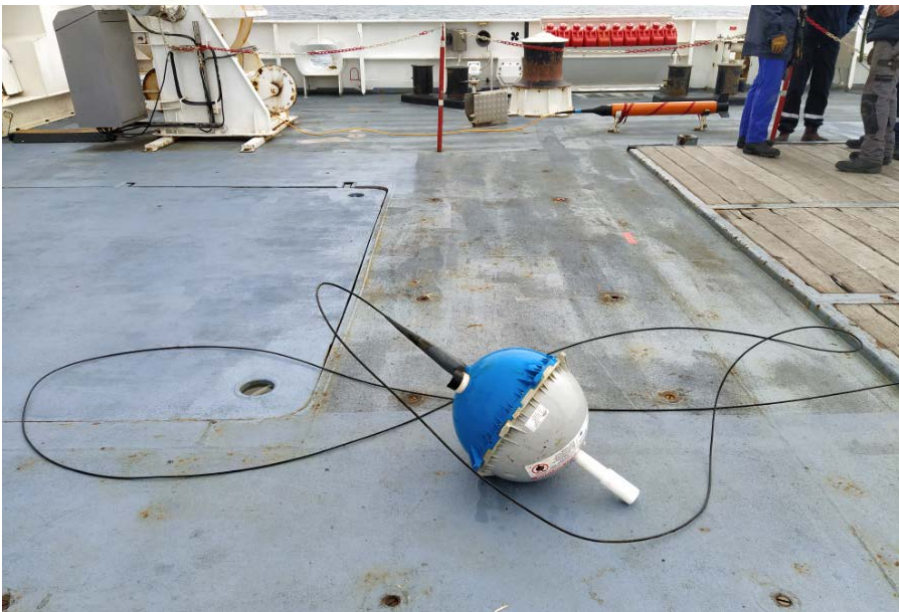
CLS, Meteo-France, SHOM, BSH, NKE, JCOMMOPS (funded by Copernicus)

Thermal-infrared inter-comparisons

- Study to inter-compare thermal infra-red in situ and satellite datasets
- The preparation of ISAR and KIT radiometers on the car ferry MS Friedrichshafen over Lake Constance / Bodensee just started
- More info:
  https://www.eumetsat.int/website/home/Data/ScienceActivities/ScienceStudies/ThermalInfraredProductIntercomparisonandValidationwithFRMRadiometers/index.html

Frank Goettsche and Werenfrid Wimmer

(funded by EUMETSAT)

SLSTR SST: further information and product notes

slstr.eumetsat.int

• Any questions?