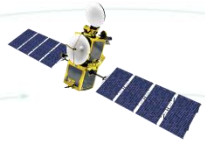
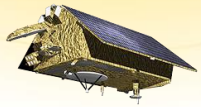
Towards Fiducial Reference Measurements from drifting buoys for Copernicus satellite validation



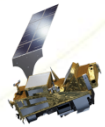


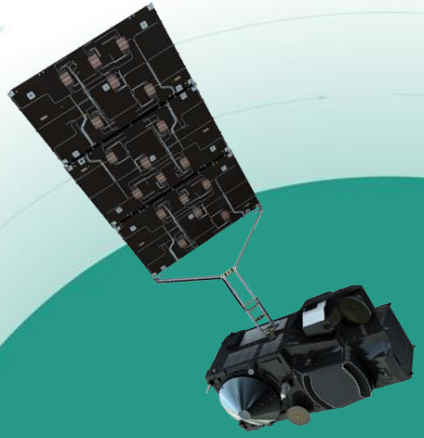
Anne O'Carroll

Bojan Bojkov, Francois Montagner

NPL FRM4STS International workshop

18/10/17





Outline

- Background
- Copernicus EUMETSAT project on improved drifters
- Sentinel-3 validation
- Future outlook

Cal / Val and evaluation of space-borne data

- Cal/Val is essential to quantify the data quality for both scientific and operational missions through the lifetime of an EO mission
- Relies on existing network surface measurements
- Also needs specialised and direct investments in Cal/Val manpower, infrastructure, and coordination of activities / access
- Calibration and validation activities both essential to fully evaluate satellite products to meet service needs

Fiducial Reference Measurements - definition

"The suite of independent ground measurements that provide the maximum return on investment for a satellite mission by delivering, to users, the required confidence in data products, in the form of independent validation results and satellite measurement uncertainty estimation, over the entire end-to-end duration of a satellite mission"

(Sentinel-3 Validation Team)

- Based on specific requirements
- Linked to a mission's Cal/Val plan activities
- Building on existing capabilities
- Forward thinking and long-term vision
- Not necessary mission specific

Why FRM are needed

- FRM are needed to understand how accurate the data products really are
- To deliver the required confidence in the data products – GEO/CEOS QA4EO
- Balance on the number of FRM required with additional costs to deliver a satellite mission with known product quality that is “fit for purpose”
- International coordination to bring FRM investment into mainstream where beneficial to satellite and ground based measurement users

DBCP-GHRSST pilot project

Original proposal in 2013 requested:

- A number of drifters to be upgraded to a higher specification
  - Position accuracy and reporting to 0.01degrees (HRSST-1)
  - SST accuracy < 0.05K; reporting to 0.01K (HRSST-2)
  - ->Total standard uncertainty in measured SST to be < 0.05K
- Requirements (e.g. Blouch, DBCP-29)
  - Hourly measurements
  - Report design depth in calm water to ±5cm
  - Report of geographical location to ±0.5km or better
  - Report of time of SST measurements to ±5 minutes
- Endorsed by GHRSST 2013; Sentinel-3 Validation team 2013; and discussed at CEOS WGCV

Why we need improved drifting buoys

- Original GHRSST request for improved drifters was driven by the high quality of SST from AATSR
- Understand uncertainties on SSTs with routine, long-term, consistent analysis
- Increased importance now in Sentinel-3 SLSTR era, long-term

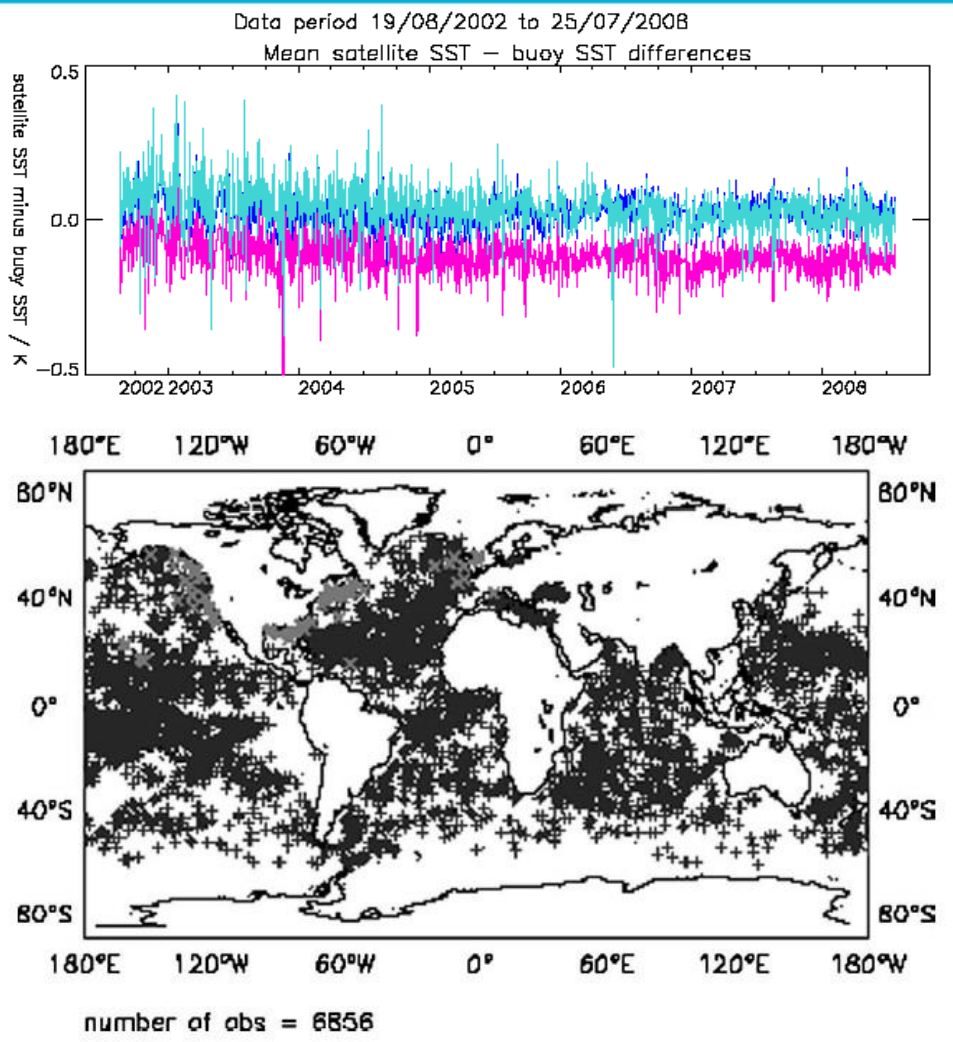


FIG. 6. Locations of moored (gray) and drifting (black) buoy SSTs matched with AATSR SSTs from 19 Aug 2002 to 20 Aug 2003.

Towards improved drifting buoys from drifters

- Measurement protocols should be documented, in long term, with high frequency and be satellite specific
- Improved calibration techniques
- Towards full traceability to SI standards
- Access to metadata and additional measurements.

Coordination towards FRM from drifters

Various activities:

- FRM4STS – route to traceability
- GHRSST coordination with the DBCP
- EUMETSAT delegate body recommendations
- EUMETSAT / Copernicus ITT project starting soon
- Discussions with EUMETNET towards incremental possibilities for satellite agencies to fund experimental and incremental capability that is not usually available from 2019/2020 on

-> Increased coordination between in situ and satellite data providers

Workshop on “in situ data for satellite SST validation”

- Hosted by Ifremer, January 2016.

- Aim to bring together SST in situ data providers and satellite SST producers in Europe to share requests and requirements, particularly in preparation for Copernicus Sentinel-3 SLSTR Sea Surface Temperature validation.

- Requests on NRT requirements, metadata and manufacturer information, position accuracy / reporting, temporal sampling…

- Coriolis identified as source for Copernicus Sentinel-3 SST validation (http://marine.copernicus.eu).

- Quality control is important for flagging but not screening e.g. http://www.meteo.shom.fr/qctools.

- ftp://ftp.ifremer.fr/ifremer/cersat/workshop/20150127__in_situ_workshop/

Copernicus EUMETSAT project: improved drifters

“Towards Fiducial Reference Measurements from drifting buoys for Copernicus satellite validation”

- Project on improved drifting buoy Sea Surface Temperature for Copernicus Satellite Validation due to start soon.

Purpose:

“Provide well-calibrated drifting buoy SST, towards SI-traceable standards, HRSST-FRM”

So it is then possible to:

“Assess and establish the benefit of improved incremental capability of drifting buoys for satellite SST validation”

Overview of project details for HRSST-2+

- To equip a significant number (100-150) of drifting buoys with improved calibration capability and provision of measurements over a 2+2 year period.
- Additional digital SST probe to standard SVP-B.
- Near surface water pressure sensor.
- Provide a service via ftp and GTS, possible inclusion of high frequency data
- All relevant technical documentation.
- Careful scheduling with Sentinel-3A / 3B SLSTR SSTs.

Phase 1 requirements

Specification of new drifting buoy design, requirements include:

- Two sensors (SVP-B + additional sensors)
- The additional sensor shall provide measurements to an uncertainty of at least ±0.05degree K or better, and reporting to at least 0.01K resolution.
- Measurements of sea-water pressure at the SST sensor depth shall be provided to understand and estimate the depth of the SST sensor.
- Deployment of two improved drifting buoys.
- Specification documentation for review.

Phase 2 requirements

Building and deployment of new drifting buoys, measurement service and data analysis, include:

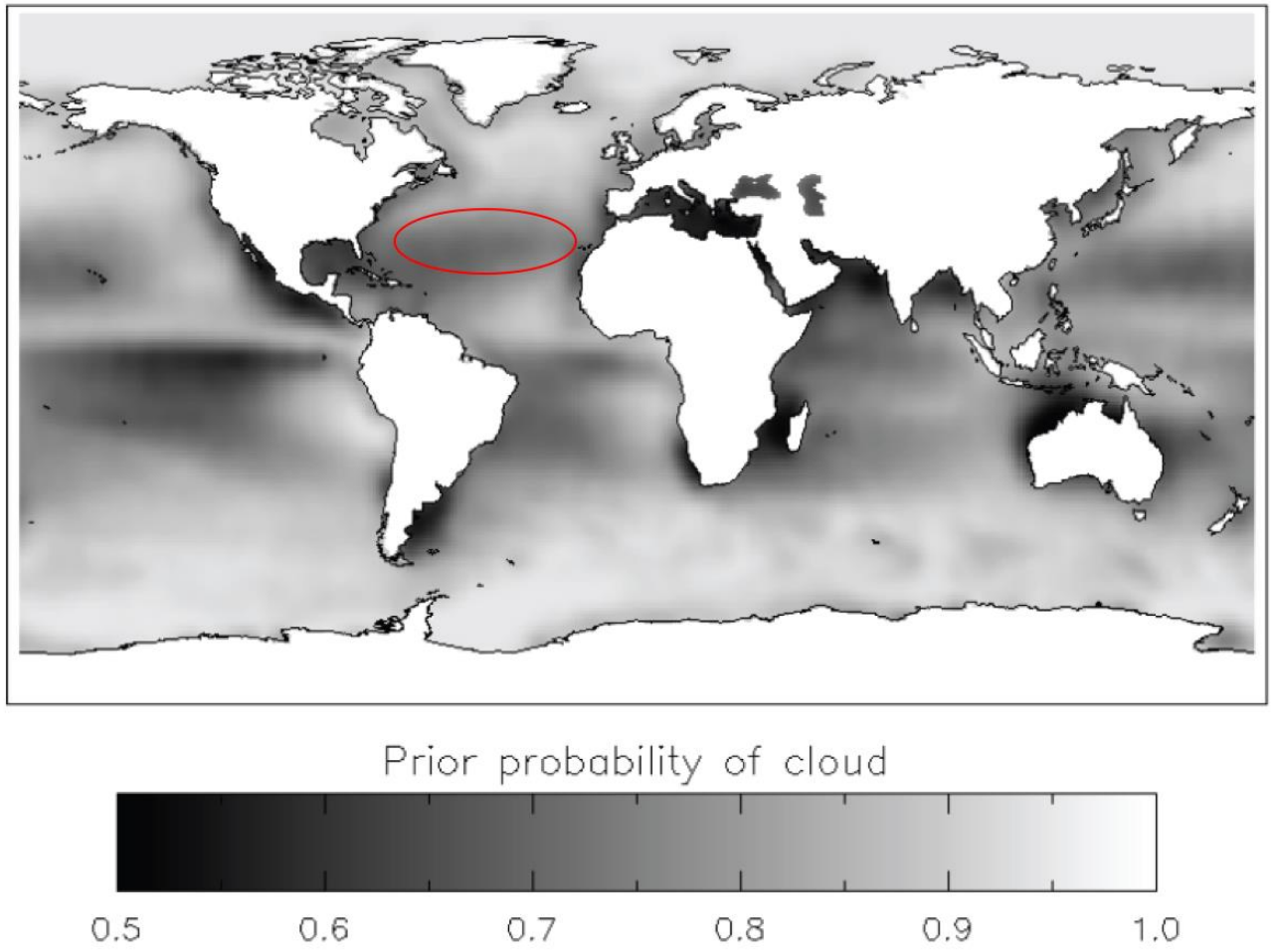
- Build, procure, deploy 100 HRSST-2 drifting buoys as per agreed specification.
- Provision of measurements through the GTS and ftp.
- Downstream scientific analysis and Quality Control of the drifting buoy measurements.
- Review workshop to assess project outcomes (KO+36m).
- Present at relevant meetings and write up outcomes in journal.
- Continuation and maintenance of a global drifter metadata database as established by FRM4STS, and in coordination with the DBCP.
- Required metadata information included within data files on GTS.

Option

- Further 50 drifting buoys.

- The ability to provide measurements from sampling at 1Hz for a period of 5 minutes every hour and report the raw data (approx. 1kbyte/hr).

Regions of preference



Possibilities:

- Canary Islands
- SE-Asia
- Upwelling areas
- High-latitudes

e.g. AATSR Reprocessing for Climate Prior probability of cloud, University of Reading

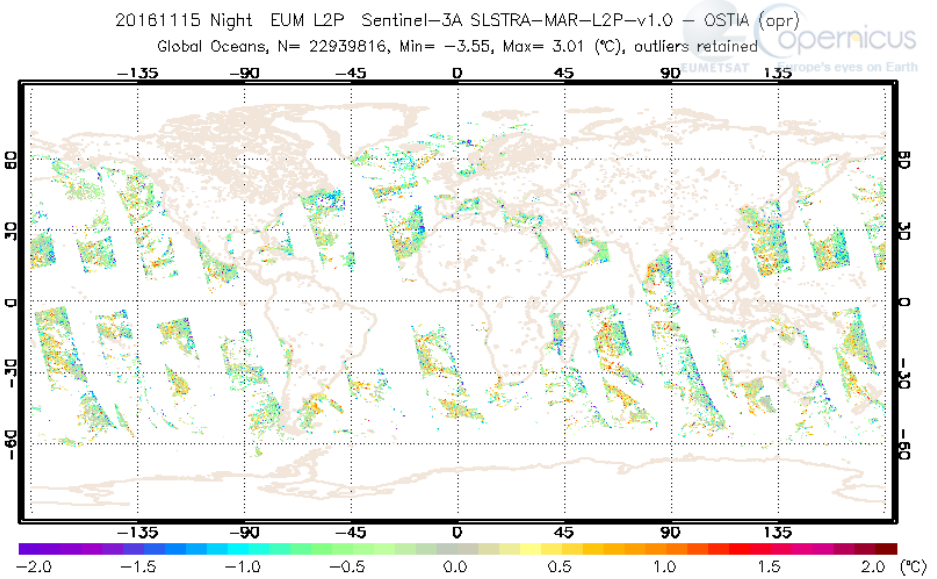
Outreach and data

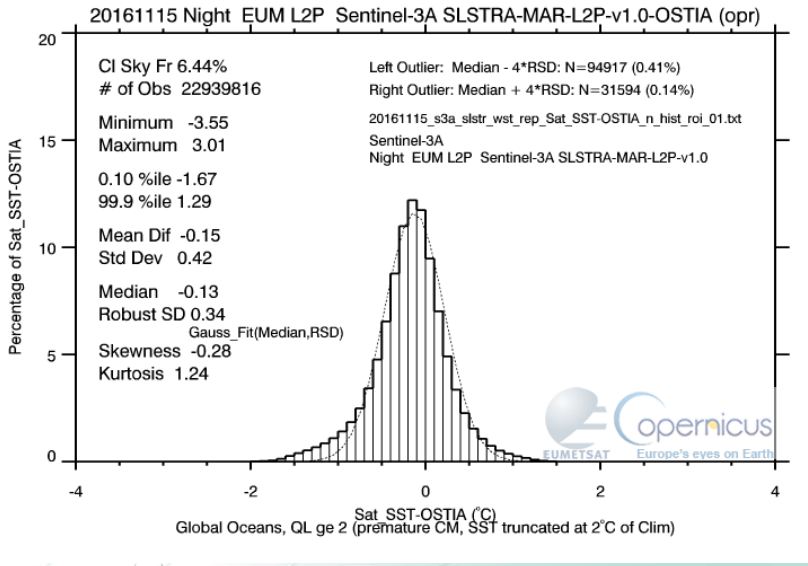
- Assessment through Sentinel-3 SST Cal/Val activities, and with GHRSST.
- Coordination towards traceable standards.
- Data availability through GTS.

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

Copernicus Sentinel-3 SST

- Improved drifters needed in 2017 for Sentinel-3A validation and in preparation for Sentinel-3B validation in 2018.





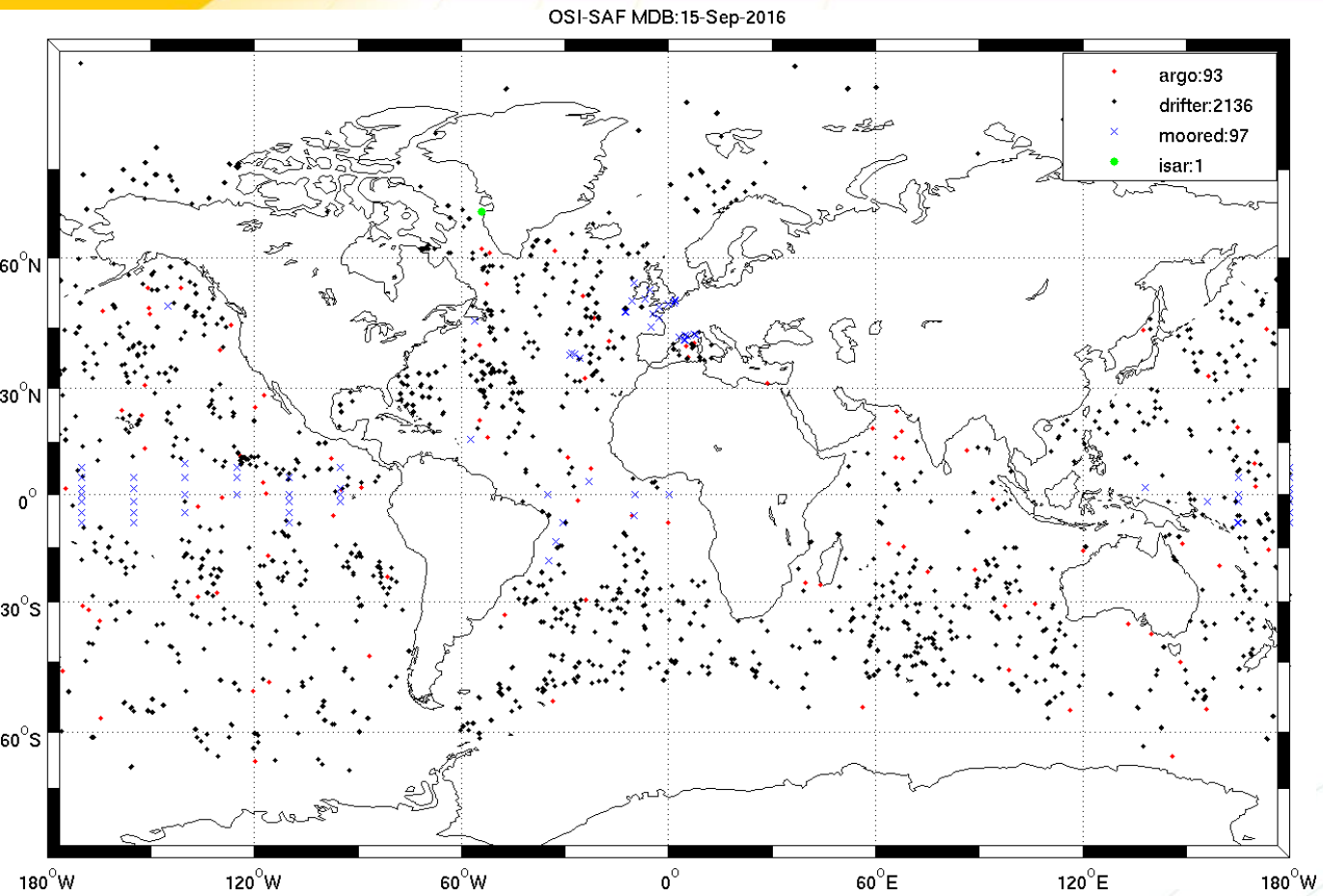
Sentinel-3 Validation team - temperature

PI	Country	Institution
Minnett Peter	USA	RSMAS
Nightingale Tim	UK	STFC
Tsamalis Christoforos	UK	Met Office
Beggs Helen	Australia	BoM
Høyer Jacob	Denmark	DMI
Mittaz Jonathan	UK	University of Reading / NPL
Wimmer Werenfrid	UK	University of Southampton
Dybkjær Gorm	Denmark	DMI
Corlett Gary	UK	University of Leicester
CMEMS	FRANCE	Mercator-Ocean
Ignatov Alexander	USA	NOAA-NESDIS
Bob Brewin	UK	PML
Aida Alvera-Azcarate	Belgium	University of Liege
Emmanuelle Autret	France	Ifremer
Harris Andrew	USA	University of Maryland

Activities range:

- Ship borne radiometers
- Drifting buoys / Argo
- Climate / NWP
- Coastal, fronts, high latitude / MIZ, lakes, new measurement techniques, calibration

OSI SAF SLSTR SST matchup dataset



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

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

Felyx
felyx

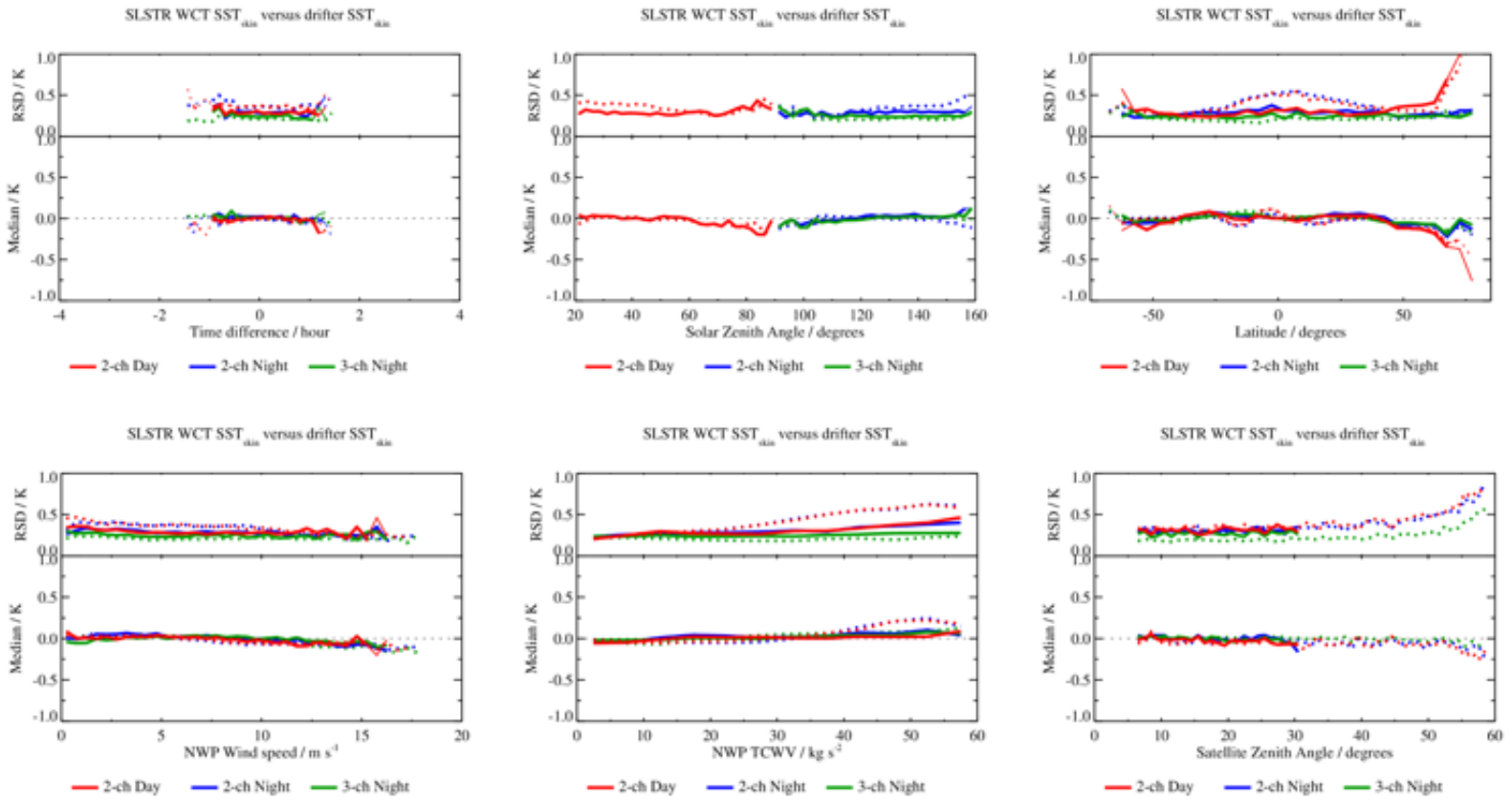
esa

European Commission
opernicus
EUMETSAT

SLSTR buoy matchup results

UNIVERSITY OF LEICESTER

Dependence with DT cut-off and FKC



G. Corlett, UoL

Data availability

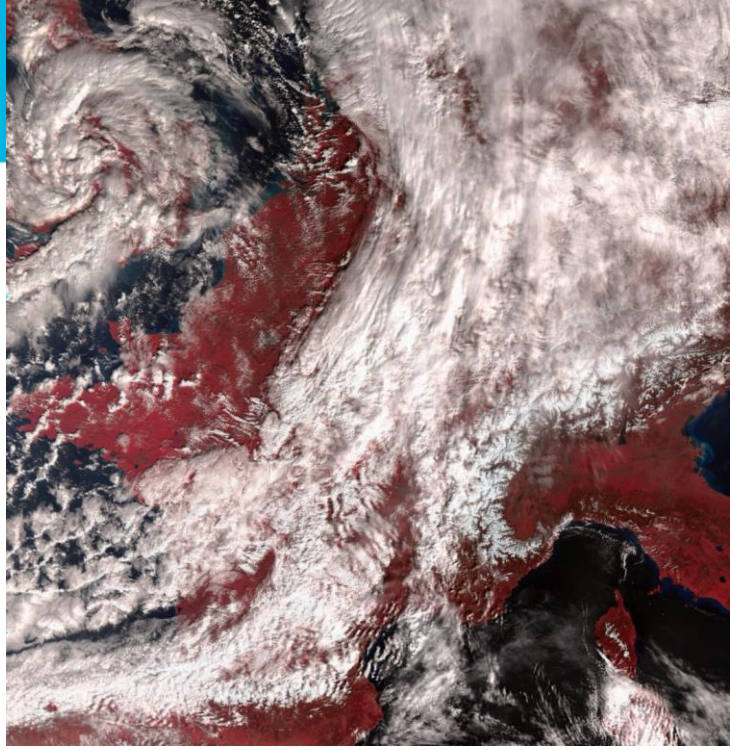
- Measurements from HRSST-2 should start to be available in early 2018
- Ready for Sentinel-3B early validation
- Available on the GTS to all for satellite SST validation (Sentinel-3, plus…)

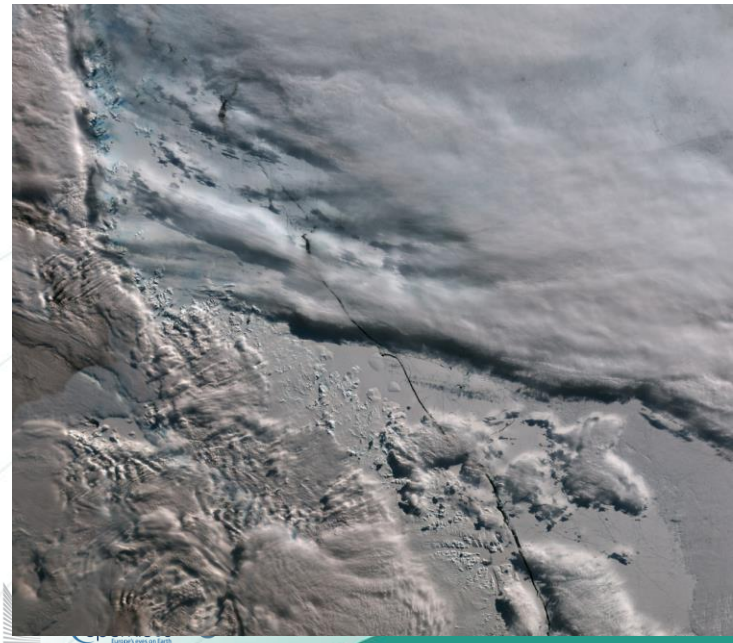
Overall summary and aim

- To assess and establish the benefit of improvements of drifting buoy for satellite SST validation
    - Total standard uncertainty in measured SST to be < 0.05 K
    - Sentinel-3 SLSTR validation activities
    - Wider validation team, GHRSST, related workshops

- Towards HRSST-FRM

- Coordination on the route to traceability; operational access to metadata and quality information.



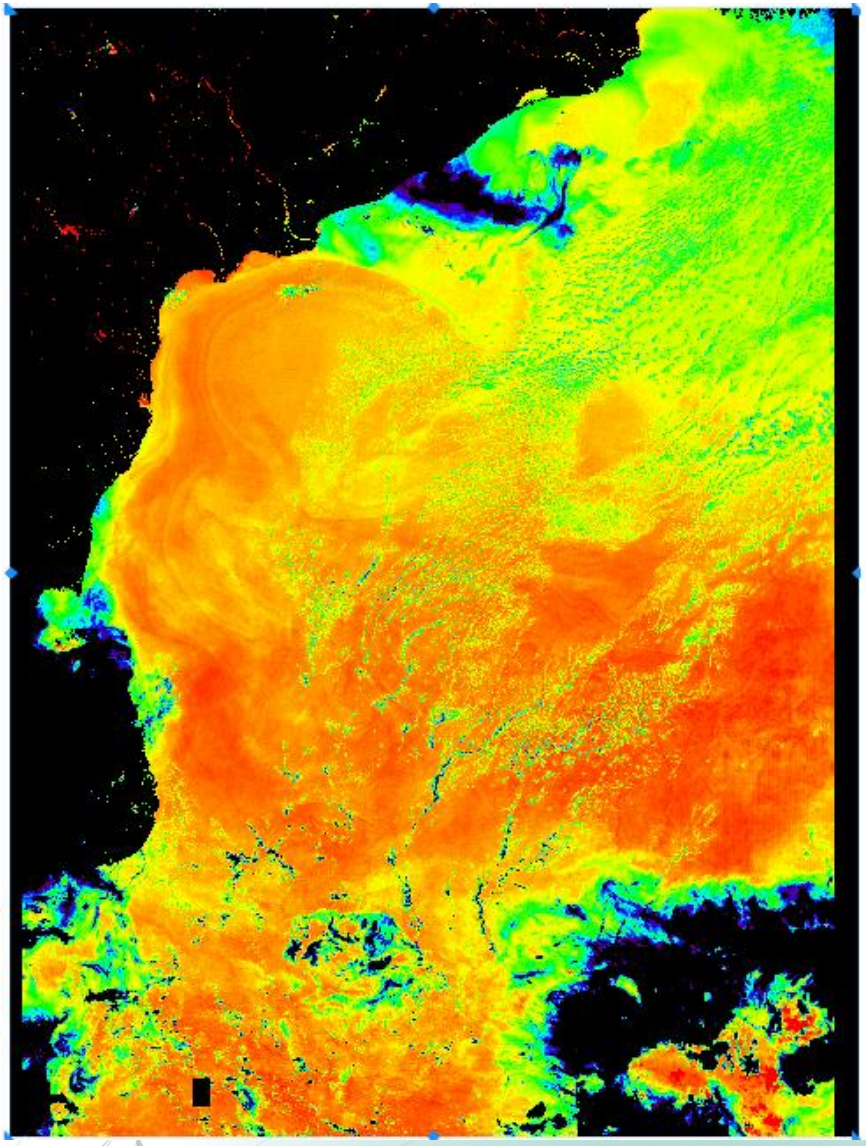


Future outlook

- Discussion and coordination to understand how a higher specification of drifter capability can become the default design used worldwide.

- Future Copernicus / EUMETSAT projects foreseen to continue cooperation and collaboration.

- EUMETSAT delegate body groups endorsing FRM inclusion in science and Cal/Val plans.



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