DBCP-38

Towards Fiducial Reference Measurements (FRM) from drifting buoys for satellite Sea-Surface Temperature Calibration and Validation (Cal/Val)

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Outline

Global satellite Sea-Surface Temperature validation

- Use of drifting buoy SST
- Group for High-Resolution SST (GHRSST)

Climate quality satellite SST

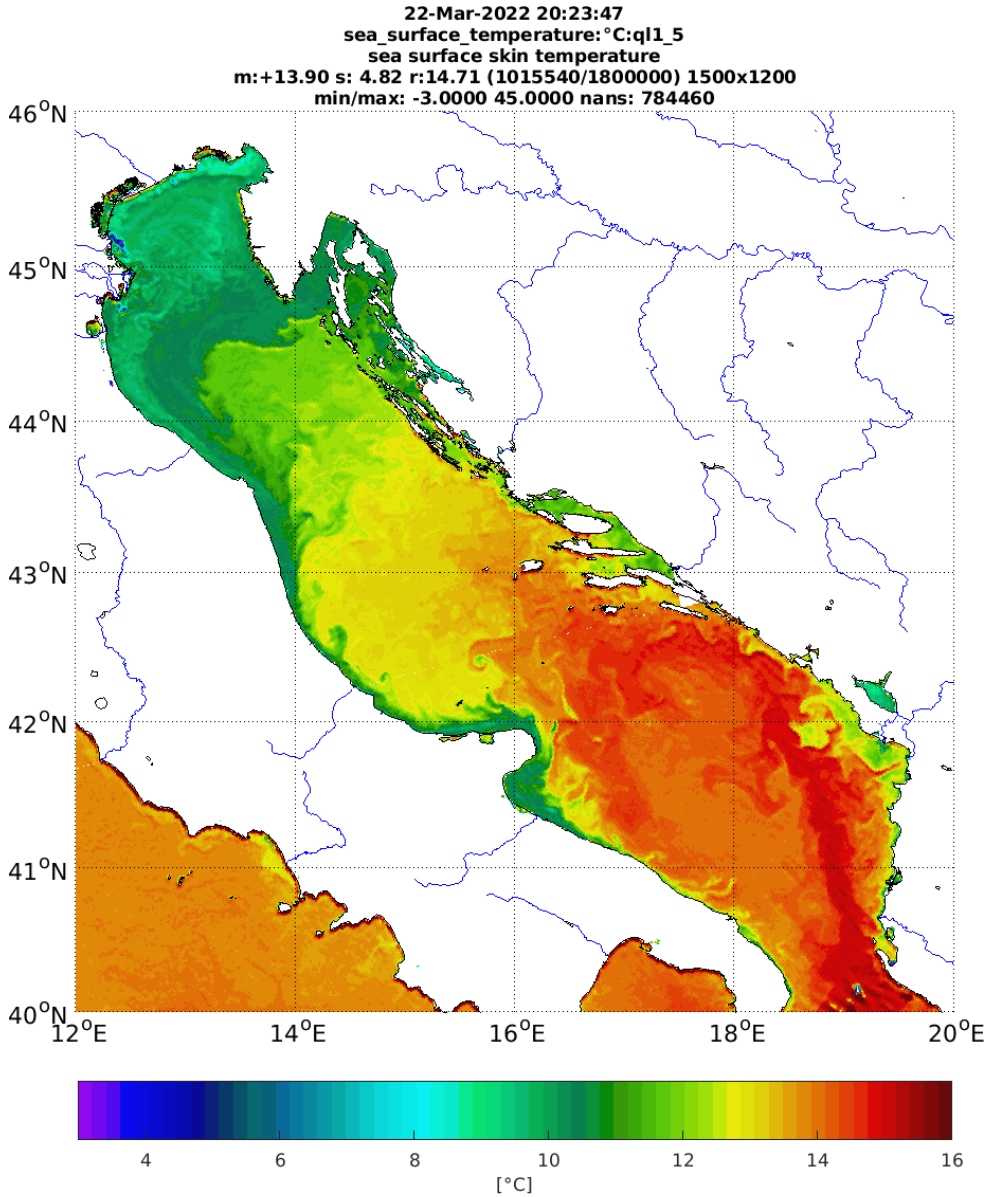
- Copernicus Sentinel-3
- Need for Fiducial Reference Measurements (FRM)

Copernicus FRM drifting buoys (TRUSTED)

- Science Review workshop recommendations (2021)
- Continuation of FRM buoys and further steps
- International metrology coordination
- Quality Control and metadata

Sea-ice buoy design and prototype

Summary and outlook



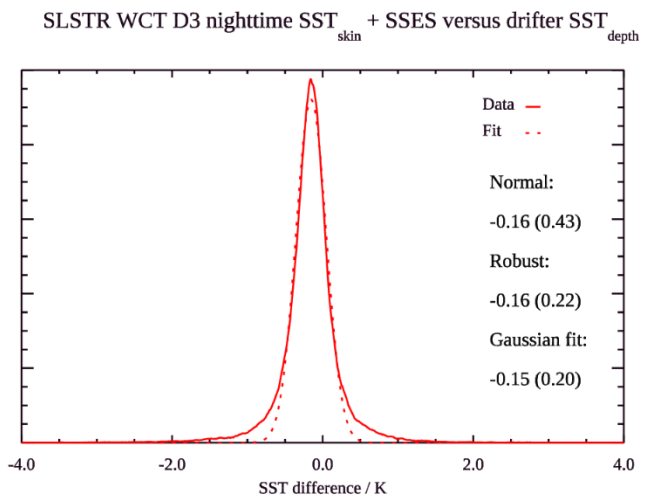
Global satellite Sea-Surface Temperature validation

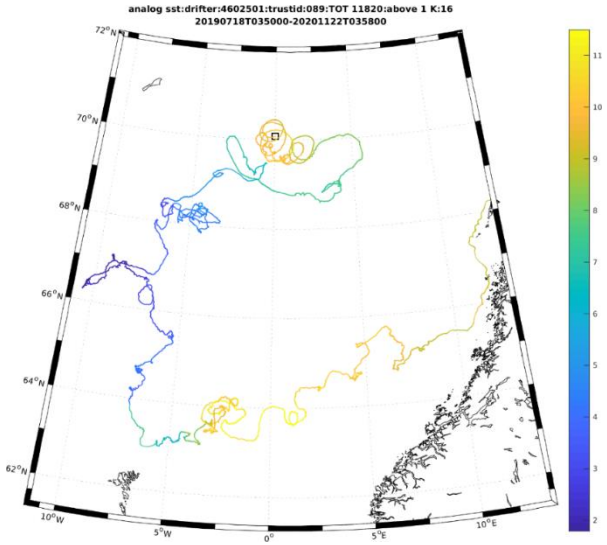
Reference data, such as drifting buoys, are essential for satellite SST validation

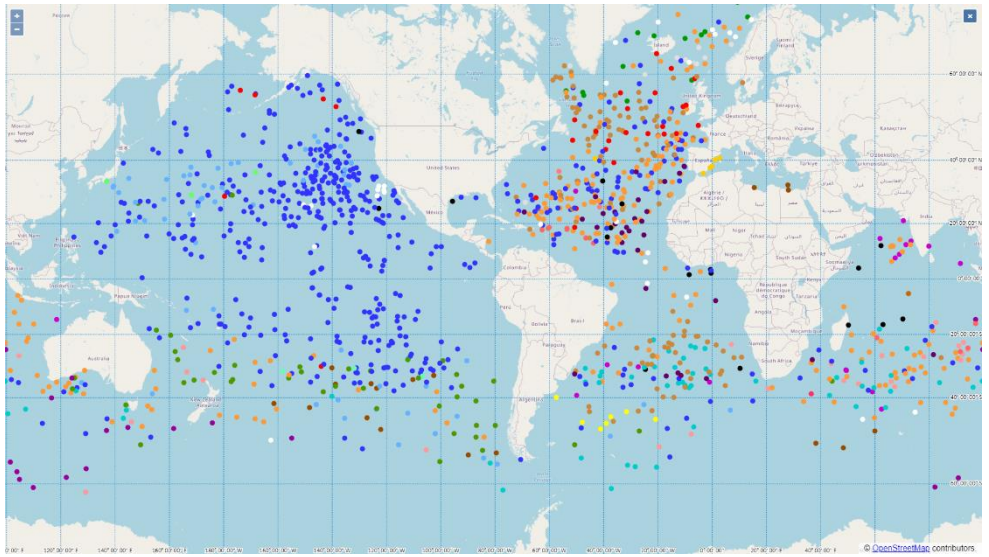
Validation activities crucial to assessing and maintaining SLSTR SST product quality

- Collocations with all drifting buoy SST, Argo, GTMBA
- Inter-comparisons with other satellite SST
- Collocations with Fiducial Reference Measurements

Matchup database (MDB) with satellite Sea Surface Temperature available on request from EUMETSAT







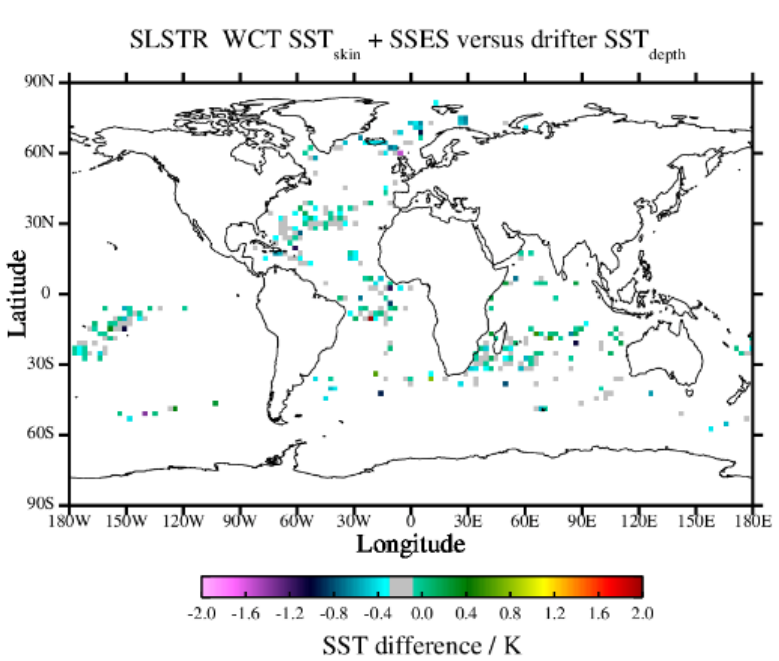
Global Drifter Programme array 4th May 2022 https://www.aoml.noaa.gov/phod/gdp/interactive/drifter_array.html

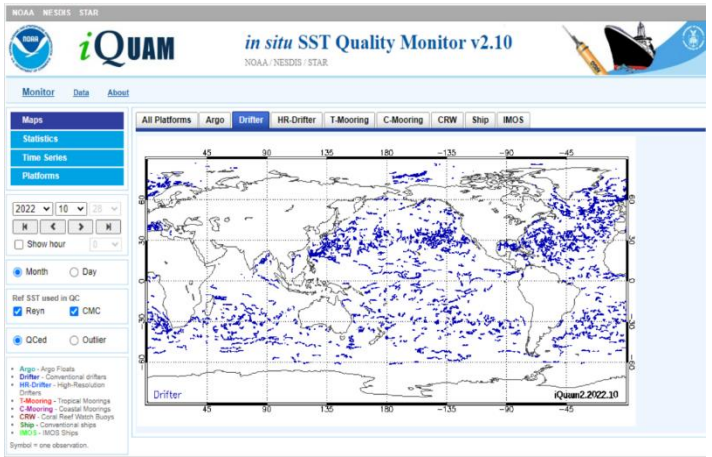
Use of drifting buoy SST for satellite validation

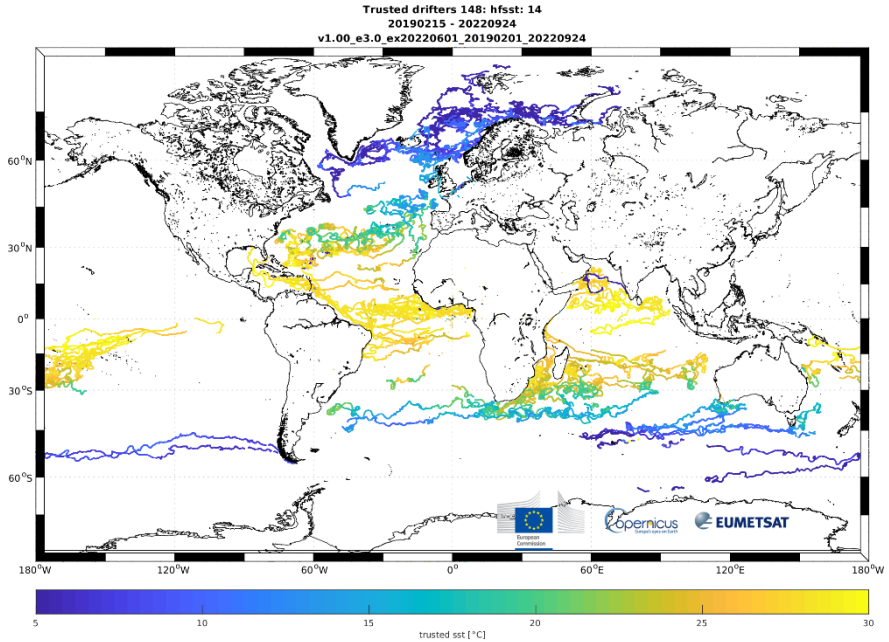
- Global drifting buoy SST widely used within GHRSST for satellite SST validation

- GHRSST Task Team on HRSST (Gary Corlett)
  - Coordination with GDP, DBCP and OceanOps
  - Most drifting buoy data are now HRSST-2
  - Need for robust online searchable metadata

- Corlett et al, 2022, DBCP-37 (https://www.eumetsat.int/media/48923)







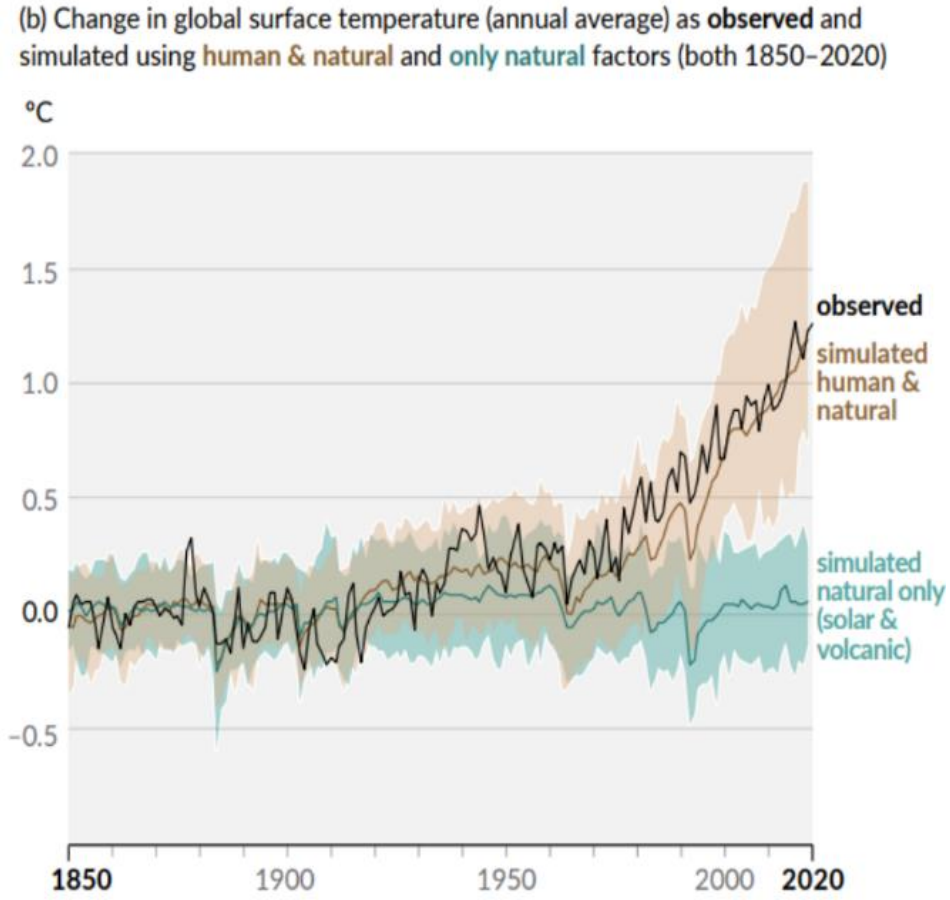
Group for High-Resolution Sea-Surface Temperature (GHRSST)

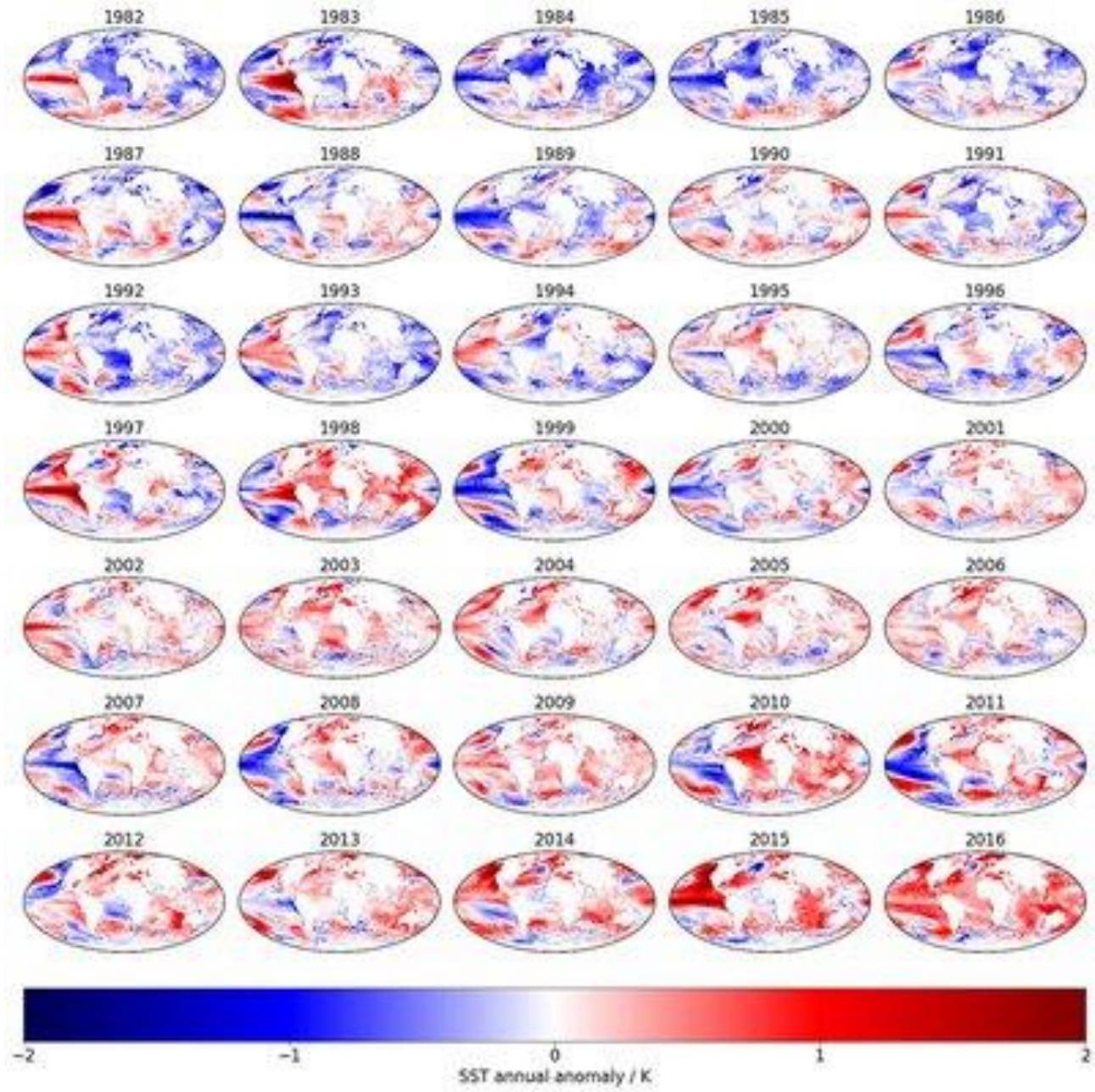
- Original DBCP-GHRSST Pilot Project (2013)
  - Position accuracy and reporting to 0.01degrees (HRSST-1)
  - SST accuracy < 0.05K; reporting to 0.01K (HRSST-2)
  - Total standard uncertainty in measured SST to be < 0.05K

- Endorsed by GHRSST 2013; Sentinel-3 Validation team 2013; and discussed at CEOS WGCV; DBCP-27

Climate quality Satellite Sea-Surface Temperature

Reference satellite Sea-Surface and Sea-ice Surface Temperature for the marine domain





Copernicus Sentinel-3 satellites

Sentinel-3 provides highly accurate Sea-Surface Temperature providing a reference dataset and time-series for other SST missions:

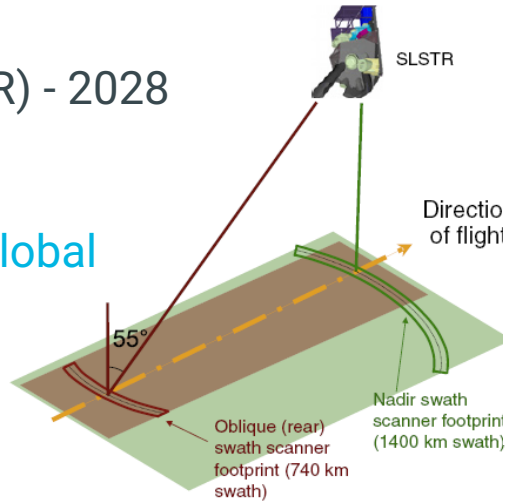
- Dual-view
- Two on-board calibration sources
- Continuation of climate SST time-series from (A)ATSR series of instruments (1991 onwards)

- More info: www.eumetsat.int/SLSTR

Further launches and continued operations:

- Sentinel-3A - 16 February 2016
- Sentinel-3B - 25 April 2018
- Sentinel-3C/D - 2025/2028
- Copernicus Imaging Microwave Radiometer (CIMR) - 2028
- Sentinel-3 NG OPT - 2033

-> EUMETSAT's responsibility to deliver high-quality global Sea-Surface Temperature



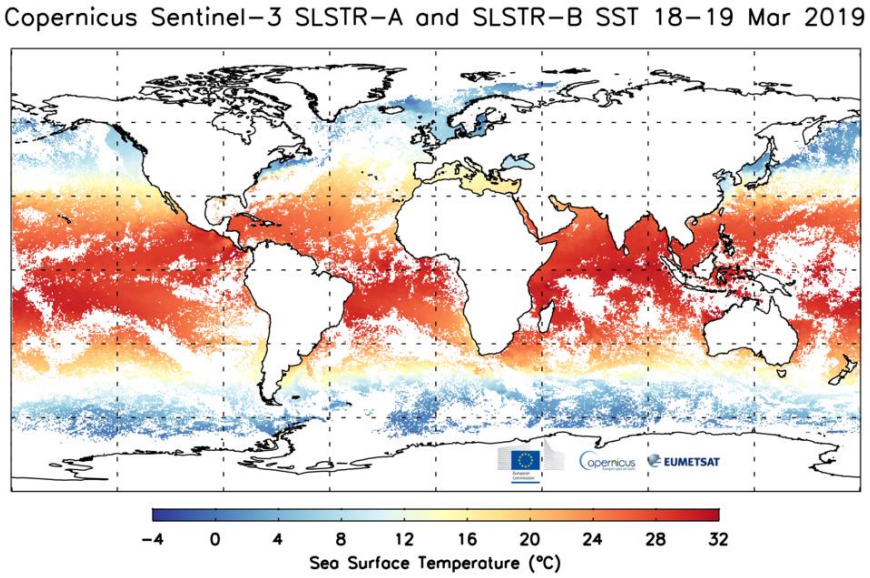
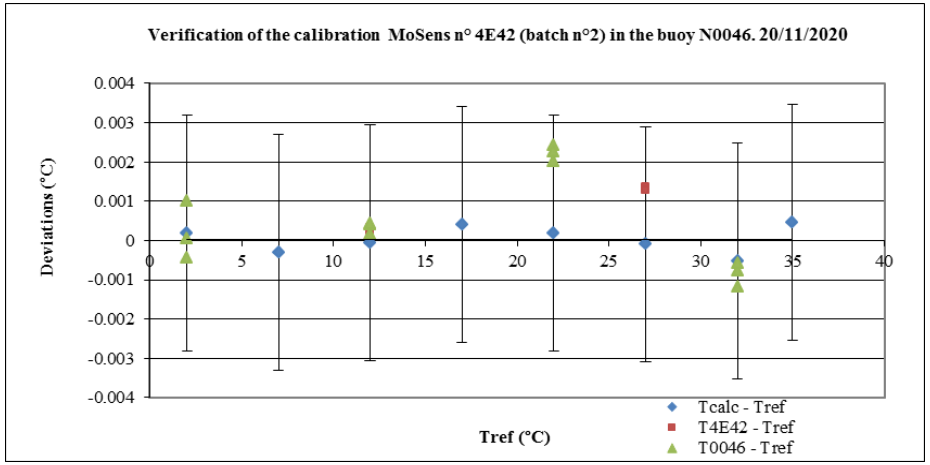


Fig. 8. Outline sketch of the Sentinel-3 SLSTR instrument viewing geometry highlighting the asymmetric nadir swath with respect to the nadir point.

Need for Fiducial Reference Measurements

- Copernicus Sentinel-3 Sea-Surface Temperature validation requires a sub-set of extremely high quality Fiducial Reference Measurements
  - Traceability for climate data records -> understand how accurate products really are and to deliver the required confidence e.g. GEO/CEOS QA4EO
  - Long-term investment -> balanced to deliver a satellite mission with a known product quality that is fit for purpose
  - Global coordination increases quality in whole network -> beneficial for both satellite and ground based users



Summary of science review workshop - 2021

Review workshop, March 2021, https://www.cls-temetry.com/workshop-high-resolution-sea-surface-temperature-hrsst-drifting-buoys-for-satellite-sst/

Two definitions for HRSST-2 and FRM drifters presented to DBCP-37 (Lucas et al, https://www.eumetsat.int/media/48924):

- HRSST-2
  - Current DBCP / GHRSST agreed specification plus ensuring machine searchable / accessible global metadata information (in progress with OceanOps)

- FRM for drifters
  - Calibration per sensor in laboratory independent of sensor manufacture
  - Definition of uncertainty budget / traceability diagram
  - Measurement metadata and improved Quality Control
  - Coordination with National Metrology Institutes
  - Post-deployment calibration and analysis where opportunity

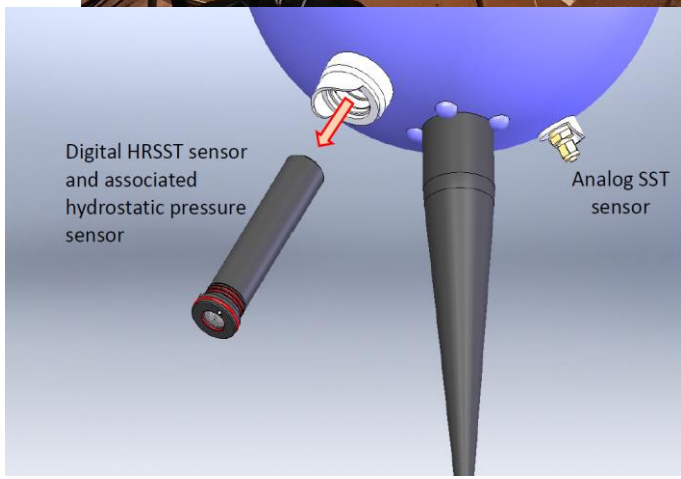
Copernicus FRM drifting buoys (TRUSTED)

- Towards Fiducial Reference Measurements from drifting buoys for Copernicus satellite validation,TRUSTED (2018-2024+)
  - Specific sub-set of buoys to support climate-quality space-based observations

- Main activities:
  - 150+75 SVP-BRST (HRSST-2) drifters and measurements
  - Two high quality SST sensors; hydrostatic pressure; high-frequency option
  - Calibration per sensor
  - Stability analyses

- Further steps in progress towards FRM
  - Uncertainty traceability diagrams and endorsement by NMIs
  - Improvements towards QC and metadata access and storage

- Lucas et al, DBCP-38



FRM – Traceability diagrams and international metrology coordination

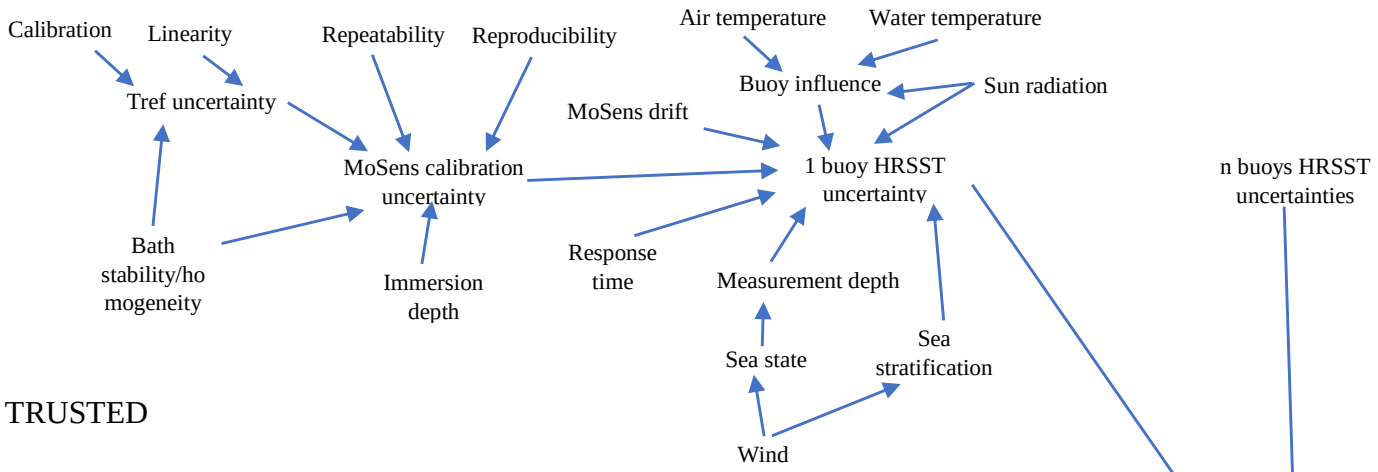
Uncertainty traceability diagrams for TRUSTED drifting buoys under development by SHOM (M. Le Menn)

Aim for an uncertainty model per buoy

Coordination underway with European Metrology Network

Important to include link from in situ to satellite measurement component

More details from Lucas et al, DBCP-38



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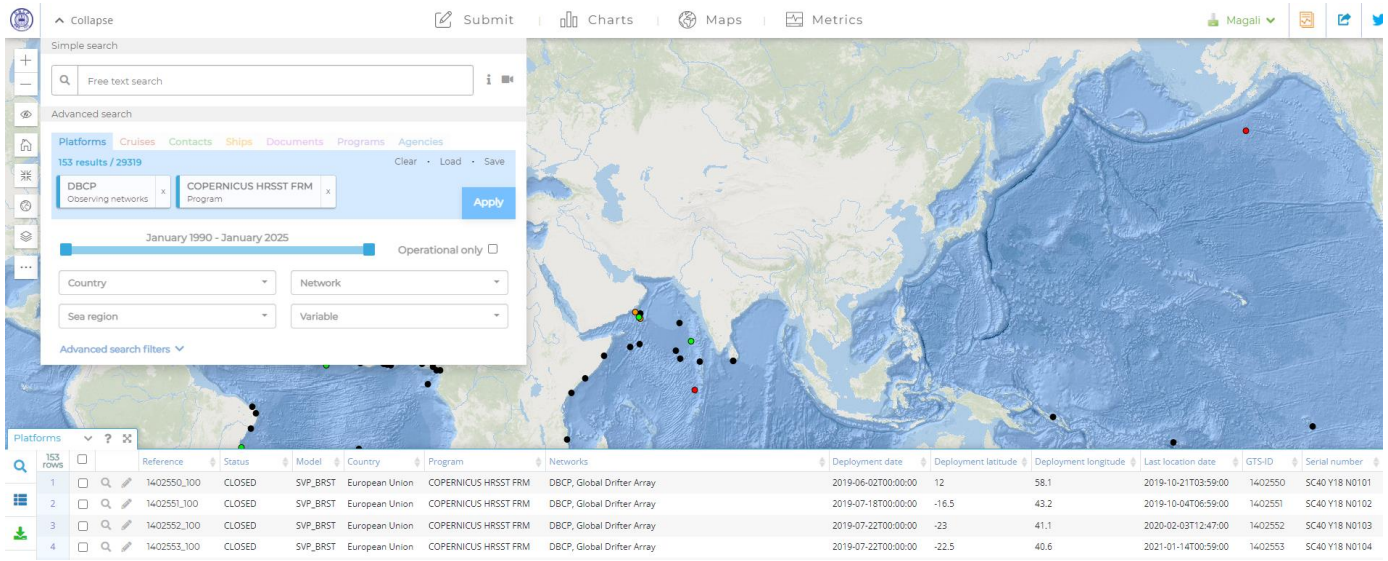
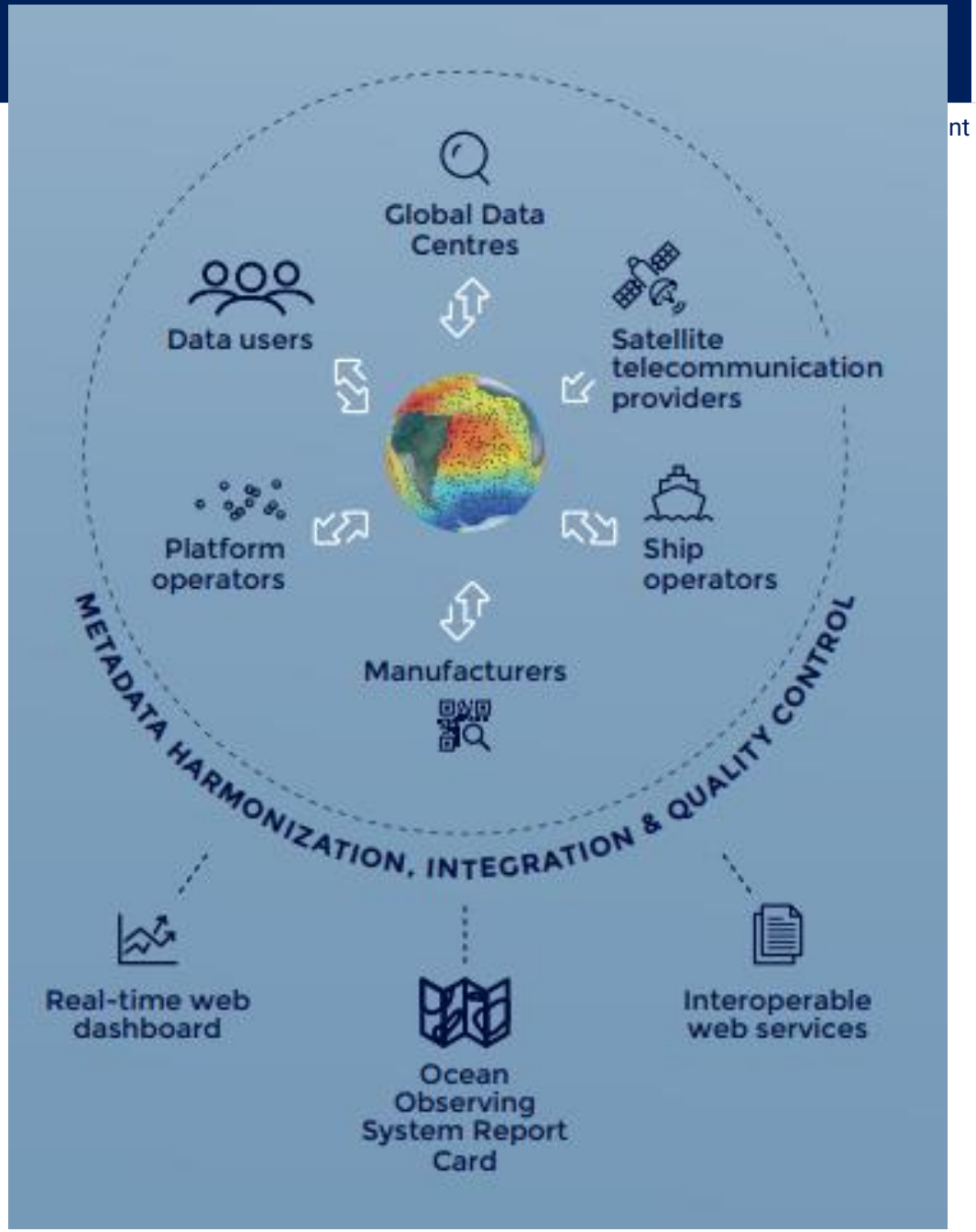
FRM – Quality Control and metadata

Machine searchable and accessible global metadata

Specification of full QC procedure and definition for route to FRM

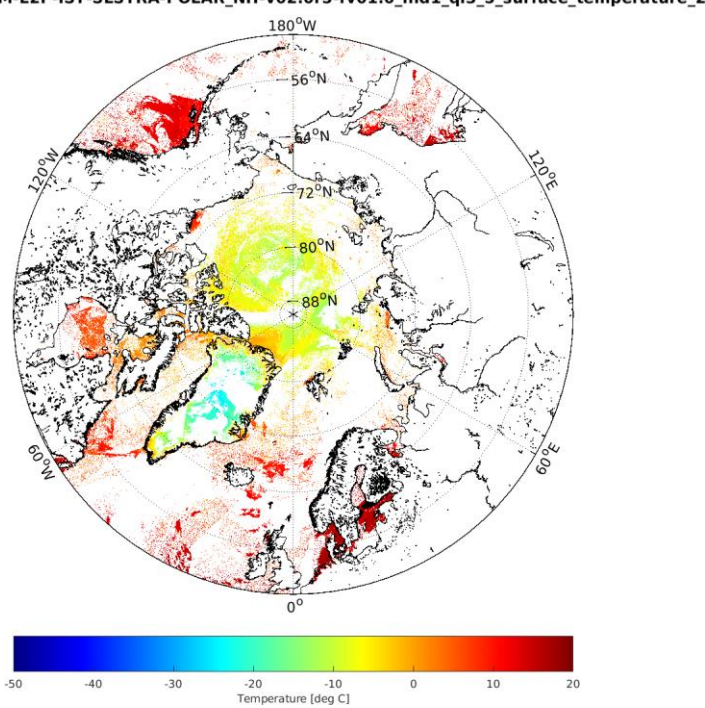
More details from Belbeoch et al, DBCP-38

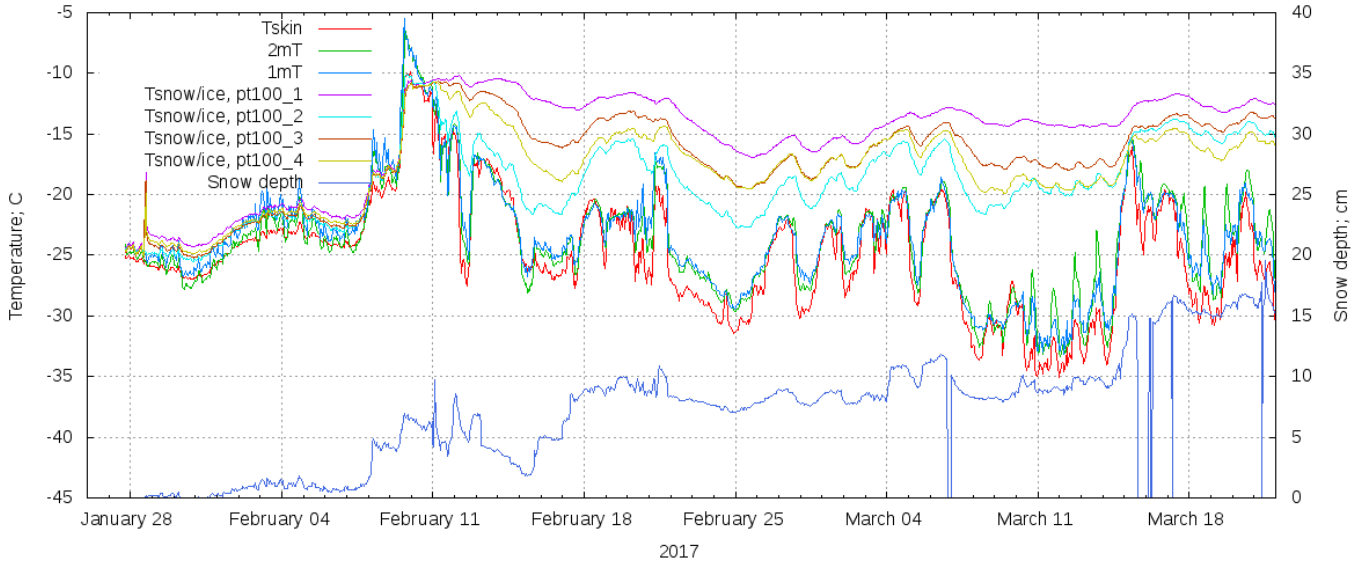




Sea-ice buoy design and prototype (DMI)

- Operational Sentinel-3 SLSTR sea-ice Surface Temperature products planned for 2024
- Demo satellite products available on WEkEO on request
- However, poor coverage of IST in situ observations in the high-latitudes limits the satellite IST algorithm development and validation
- Therefore, design and prototype in progress to provide Copernicus FRM over sea-ice
- Aim to better represent the snow-skin/ice surface temperature
- Need a high-quality, easy to deploy, sea-ice drifter in larger numbers
- Challenges: large vertical gradients, large diurnal variability
- Coordination with International Arctic Buoy Programme (IABP) and DBCP





Summary and outlook

- Continued use of all drifters by satellite Sea Surface Temperature and GHRSST community for validation and algorithm development (all DBCP drifters provide key reference dataset)

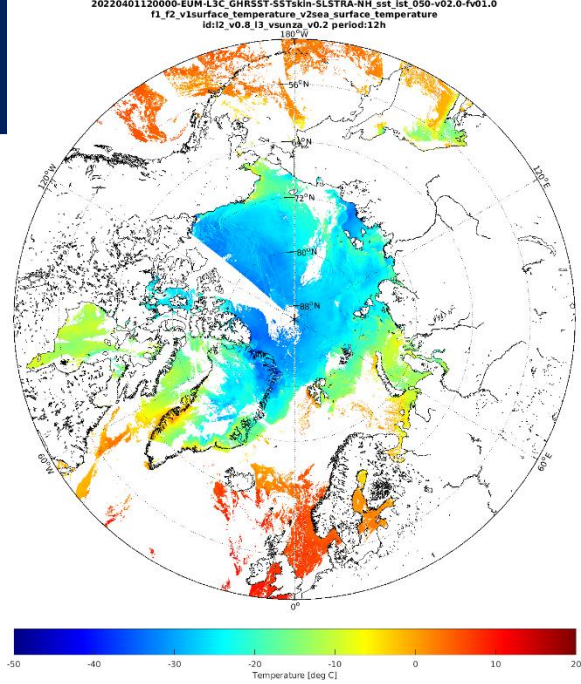
- Progress towards Fiducial Reference Measurements (FRM) of a sub-set of drifters continues with Copernicus TRUSTED activities for high-quality and climate SST validation

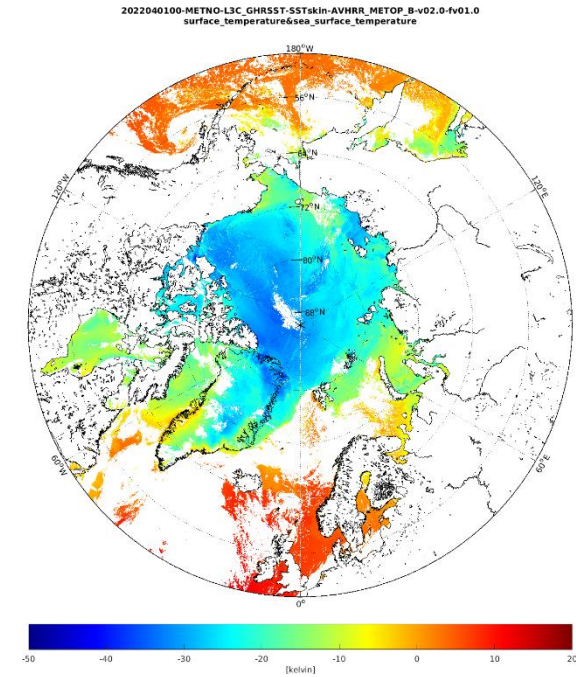
Next 3 years:

- Continuation of buoy deployments and measurements (further 75)
- Further definition of QC procedures and metadata storage and retrieval
- FRM standard for drifters in coordination with National Metrology Institutes
- Design and prototype of new sea-ice drifter for snow and ice surface temperature

Future plans

- Envisage a limited time continuation of Fiducial Reference Measurements for the Copernicus programme and Sentinel-3 validation. Contribution to SST FRMs by other agencies/NMS are however also needed in the future to augment the coverage and sustainability of these key measurements





https://www.eumetsat.int/TRUSTED

Acknowledgements

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Publications

Le Menn M., et al, 2019, Development of Surface Drifting Buoys for Fiducial Reference Measurements of Sea-Surface Temperature, Frontiers in Marine Science,6, https://doi.org/10.3389/fmars.2019.00578

Poli P., et al, 2019, The Copernicus Surface Velocity Platform drifter with Barometer and Reference Sensor for Temperature (SVP-BRST): genesis, design and initial results, Ocean, Sci., 15, 199 214, https://doi.org/10.5194/os-15-199-2019

Thank you!

Questions are welcome.

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