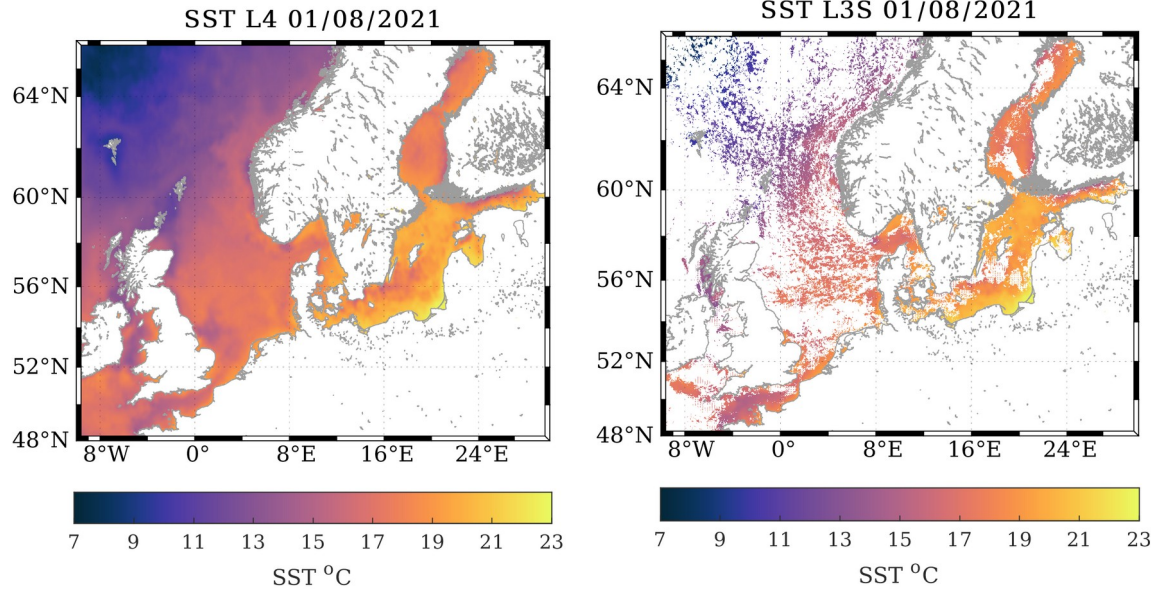


North and Baltic Sea GHRSSST- Compliant SST Products for the Copernicus Marine Service

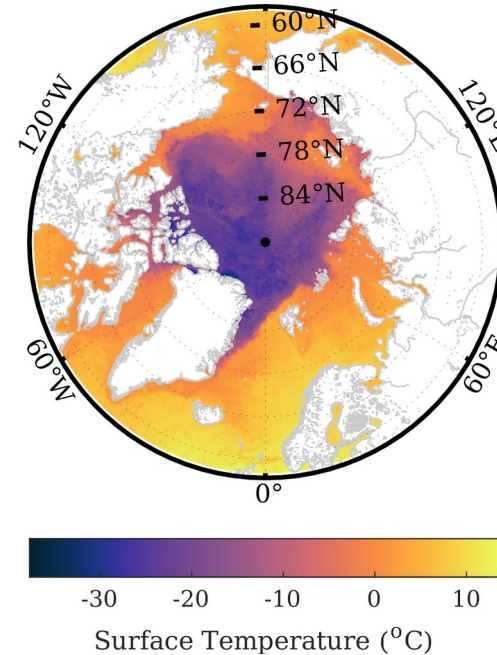
Ioanna Karagali, Magnus Barfod Suhr, Wiebke M. Kolbe, Pia Nielsen-Englyst, Jacob L. Høyer
Danish Meteorological Institute

GHRSSST Project Office funded by EU Copernicus

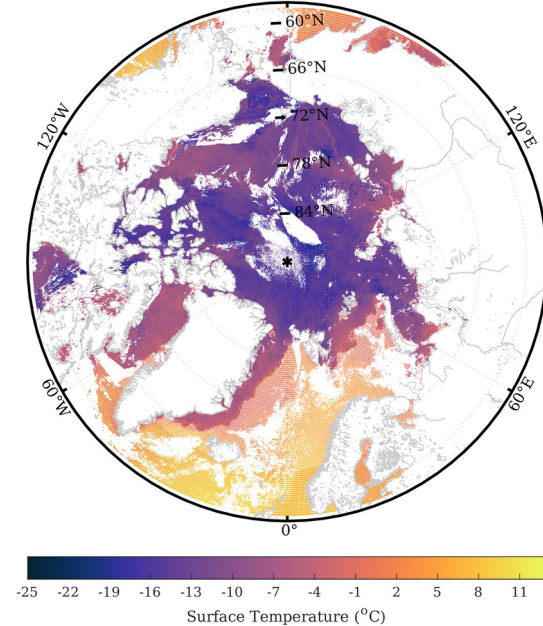
<https://www.ghrsst.org>



L4_NRT_011_008 180° 22/10/22



L3S_MY_011_021 180° 01/05/2021

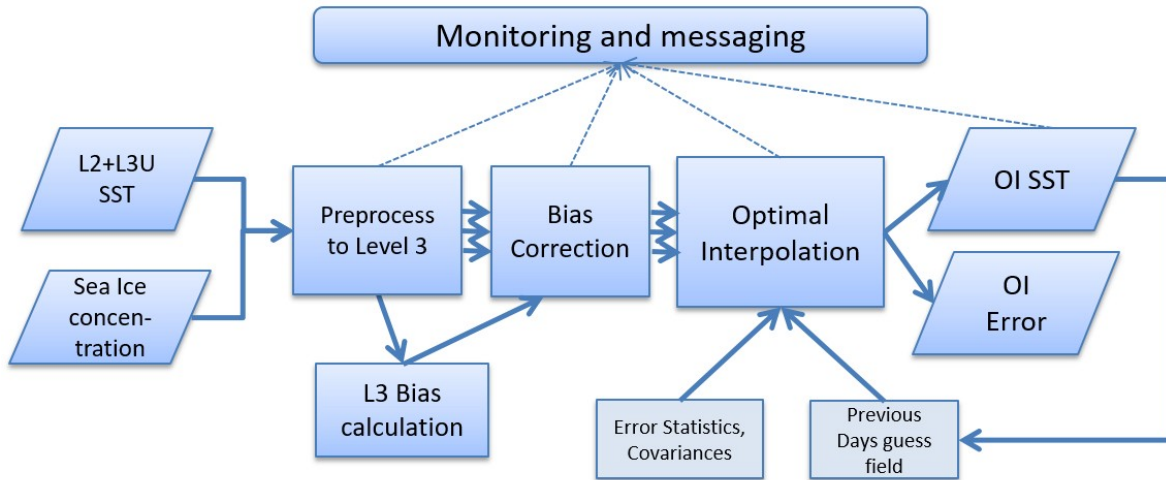


- Near-Real-Time (NRT) BAL SST L4 (010_007_b) 2016-
- NRT BAL SST L3S (010_032) 2019- <https://marine.copernicus.eu>
- **NRT BAL SST L4 DIU (010_040) 2022-**
- Multi-Year (MY) BAL SST L4 (010_016) 1982-2022
- **MY BAL SST L3S (010_021) 1982-2022**

- NRT ARC SST/IST L4 (011_008) 2019-
- MY ARC SST/IST L4 (011_016) 1982-2022
- **MY ARC SST/IST L3S (011_021) 1982-2022**

L4 BAL Products

- NRT BAL SST L4 010_007_b
 - 0.02 degrees
 - 2016 onward



- MY BAL SST L4 010_016
 - 0.02 degrees
 - 1982-2022
 - Regular temporal updates
 - ESA CCI, Copernicus C3S
 - Will be reprocessed in 2024 for v3 of ESACCI SST
- NRT DIU BAL L4 010_034
 - 0.02 degrees
 - 2022 onward
 - Hourly

Validation

- NRT BAL L4 010_007_b

In Situ		Bias	Standard deviation	RMS	No. observations
01/01/ - 30/10 2018	Moored Buoys	-0.02	0.53	-	1320
2021	Drifting Buoys	-0.005	0.318	0.318	97414
	Moored Buoys	0.067	0.526	0.530	90318

- MY BAL L4 010_016

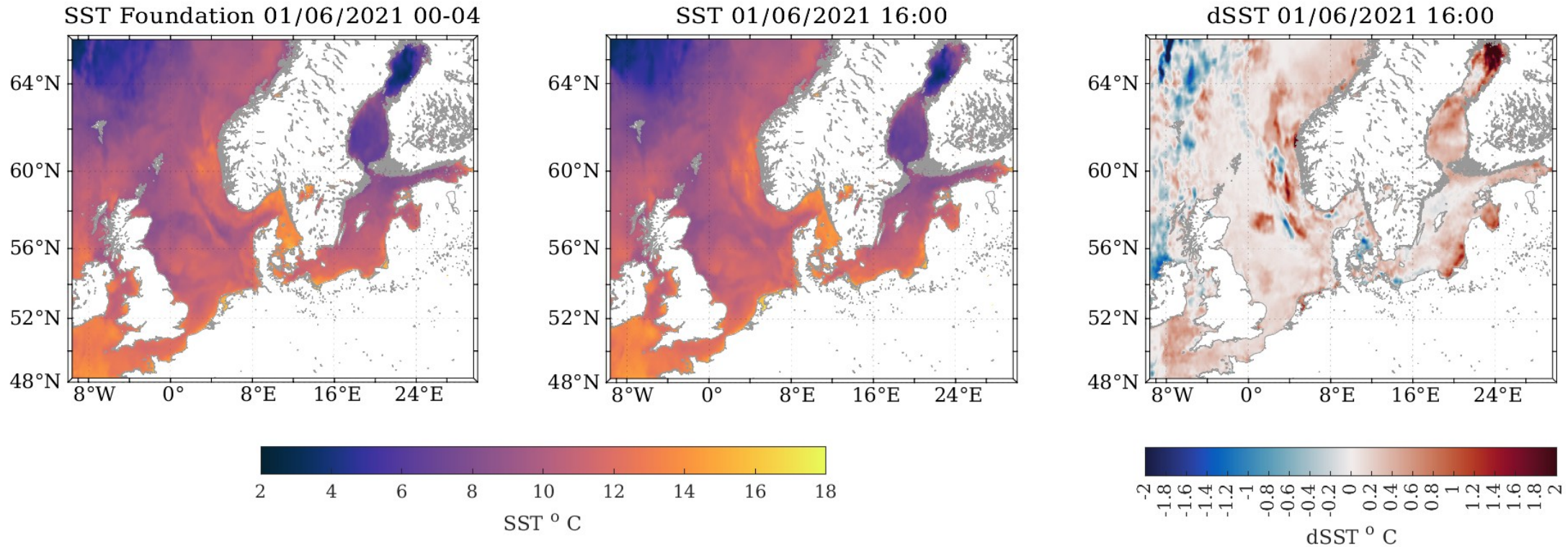
In Situ		Bias	Standard deviation	RMS	No. observations
1982-2021	Moored Buoys	-0.12	0.50	0.51	156629
	Drifting Buoys	-0.10	0.40	0.41	784180
	Ships	-0.21	0.85	0.88	3085376

- NRT DIU BAL L4 010_034

- Validation stats for 14-20, March 2024

In Situ	L4 Diurnal SST	Bias	Standard Deviation	Nobs
Drifting Buoys	Night-time	-0.17	0.54	59
	Day-time	-0.07	0.76	97
	All	-0.11	0.68	153

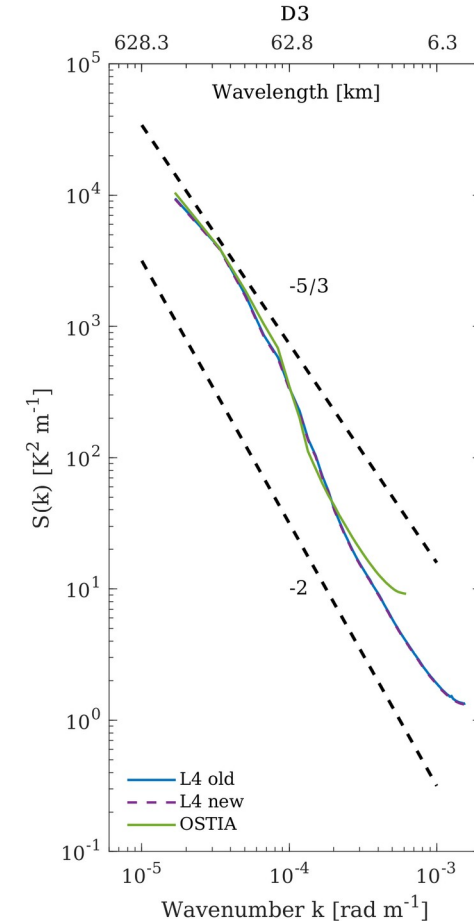
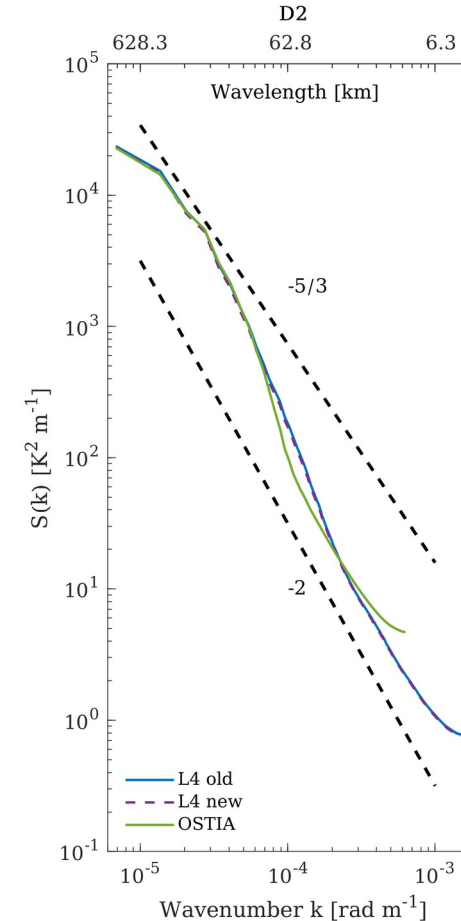
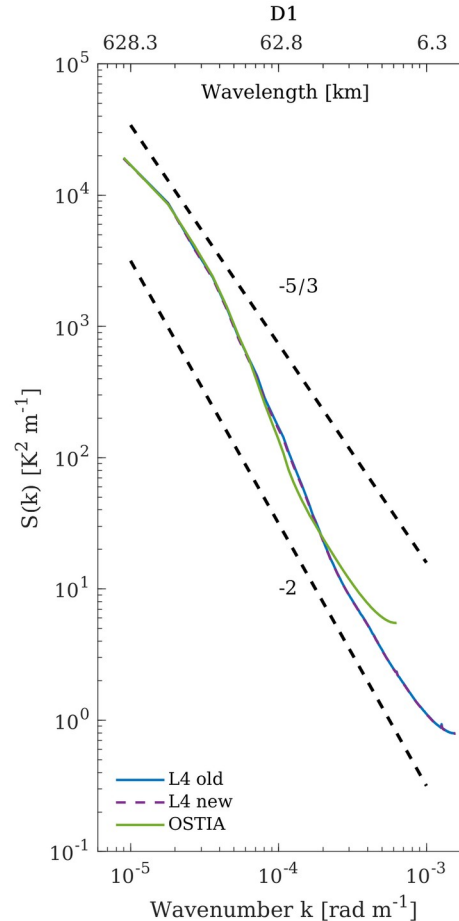
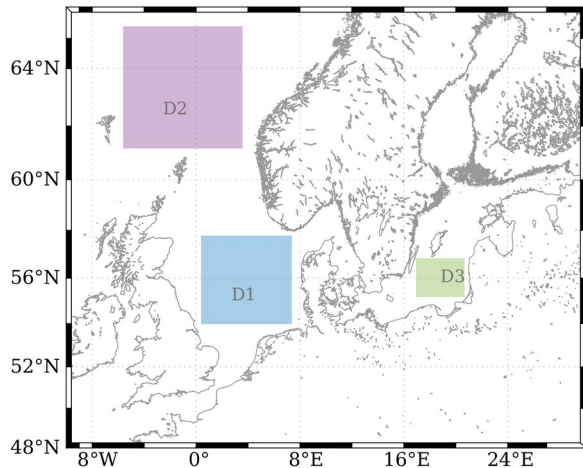
Diurnal warming



Example of night-time foundation (left), SST at 16:00 and dSST (SST16:00-SSTfoundation) for June 01, 2021.

NRT BAL L4 SST Spectra

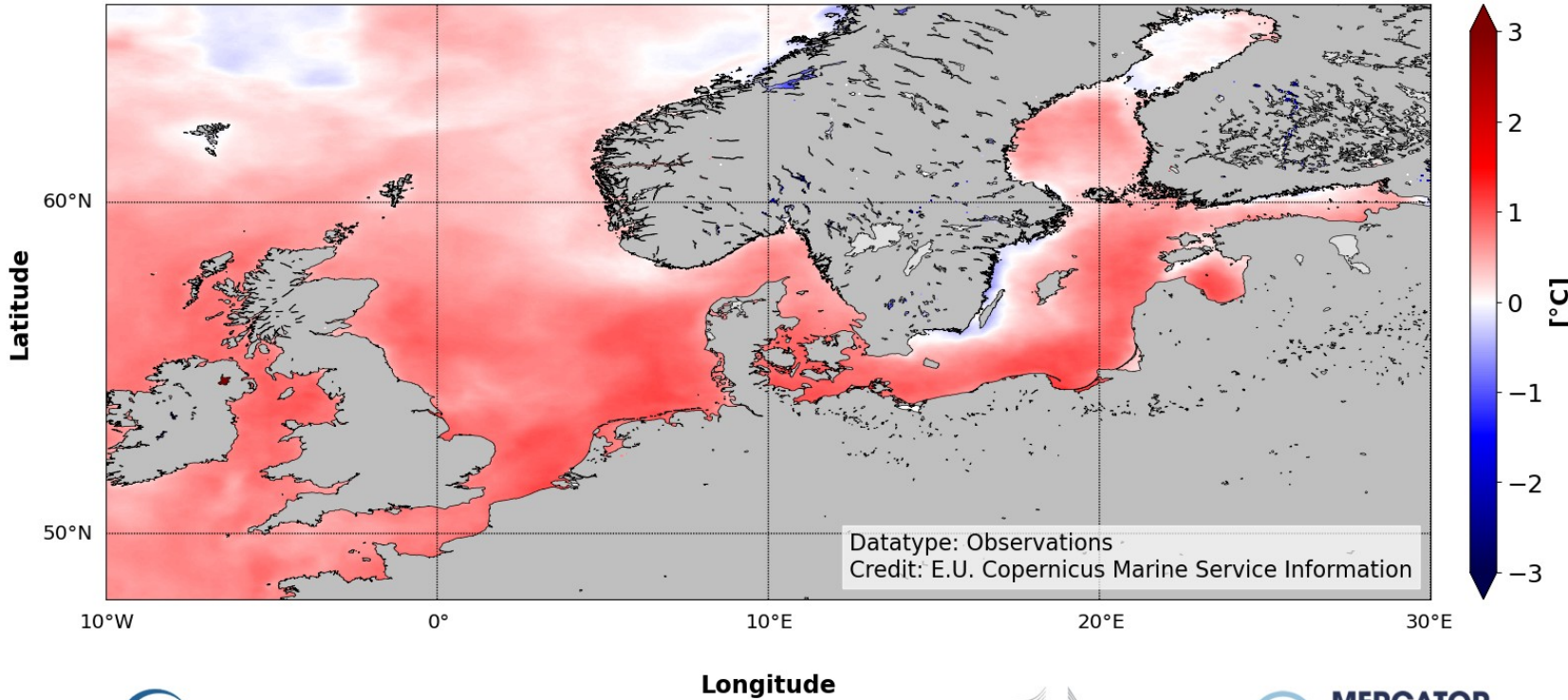
- Aim: assess effective spatial resolution
- 3 subdomains selected



Mean zonal (latitudinal) power spectra for 2021, as a function of wavenumber (k) for the 3 sub-domains, using the L4 product along with the OSTIA L4 NRT product (010_001).

Ocean Monitoring Indicators (OMI)

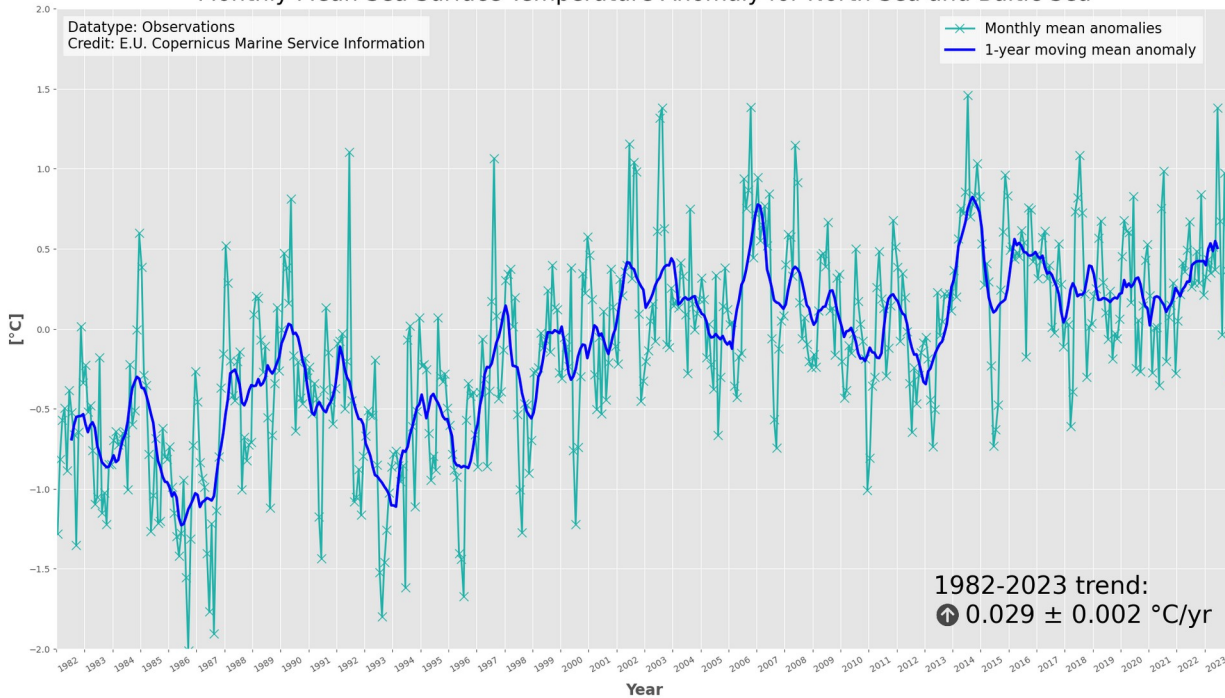
Annual Mean Sea Surface Temperature Anomaly for North Sea and Baltic Sea - 2023



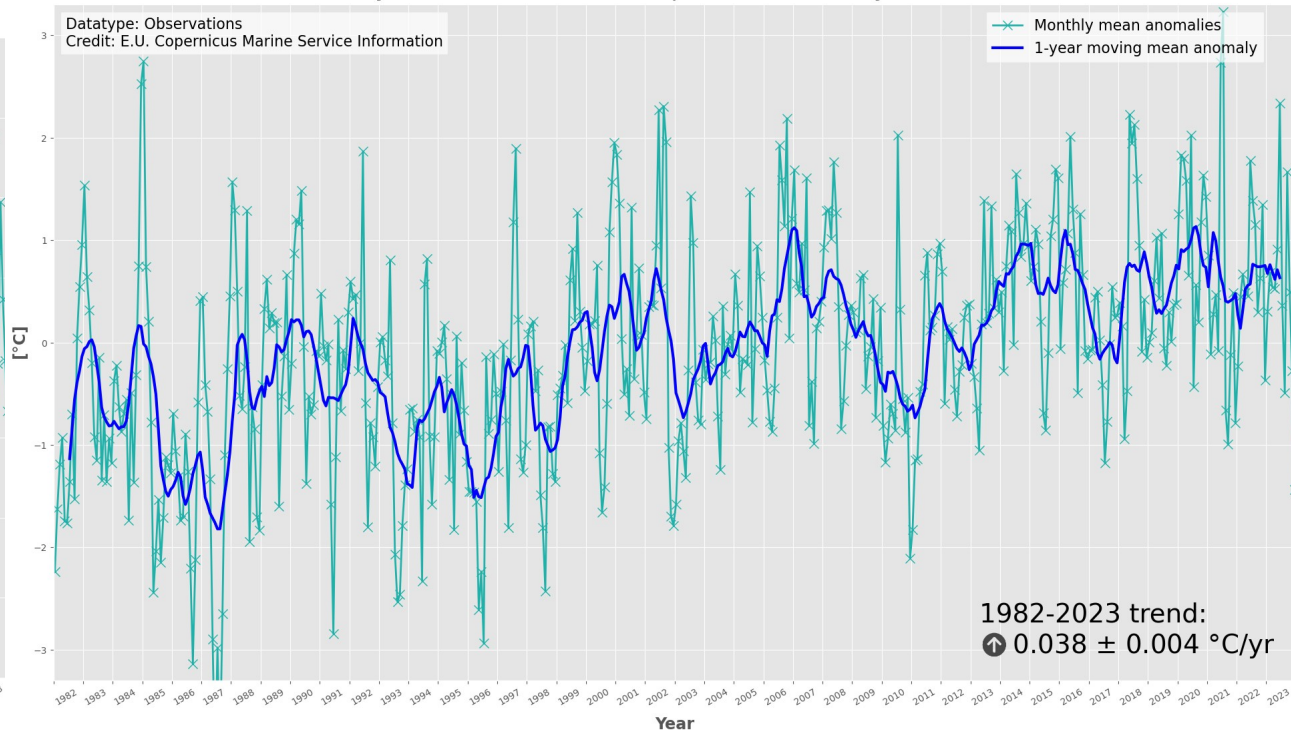
- Temperature anomalies relative to the 1991-2020 climatology
- Average anomaly: **$0.48 \pm 0.51^\circ\text{C}$**
- Baltic Sea basin (east of 9°E) average anomaly: **$0.84 \pm 0.41^\circ\text{C}$**

Ocean Monitoring Indicators (OMI)

Monthly Mean Sea Surface Temperature Anomaly for North Sea and Baltic Sea



Monthly Mean Sea Surface Temperature Anomaly for Baltic Sea



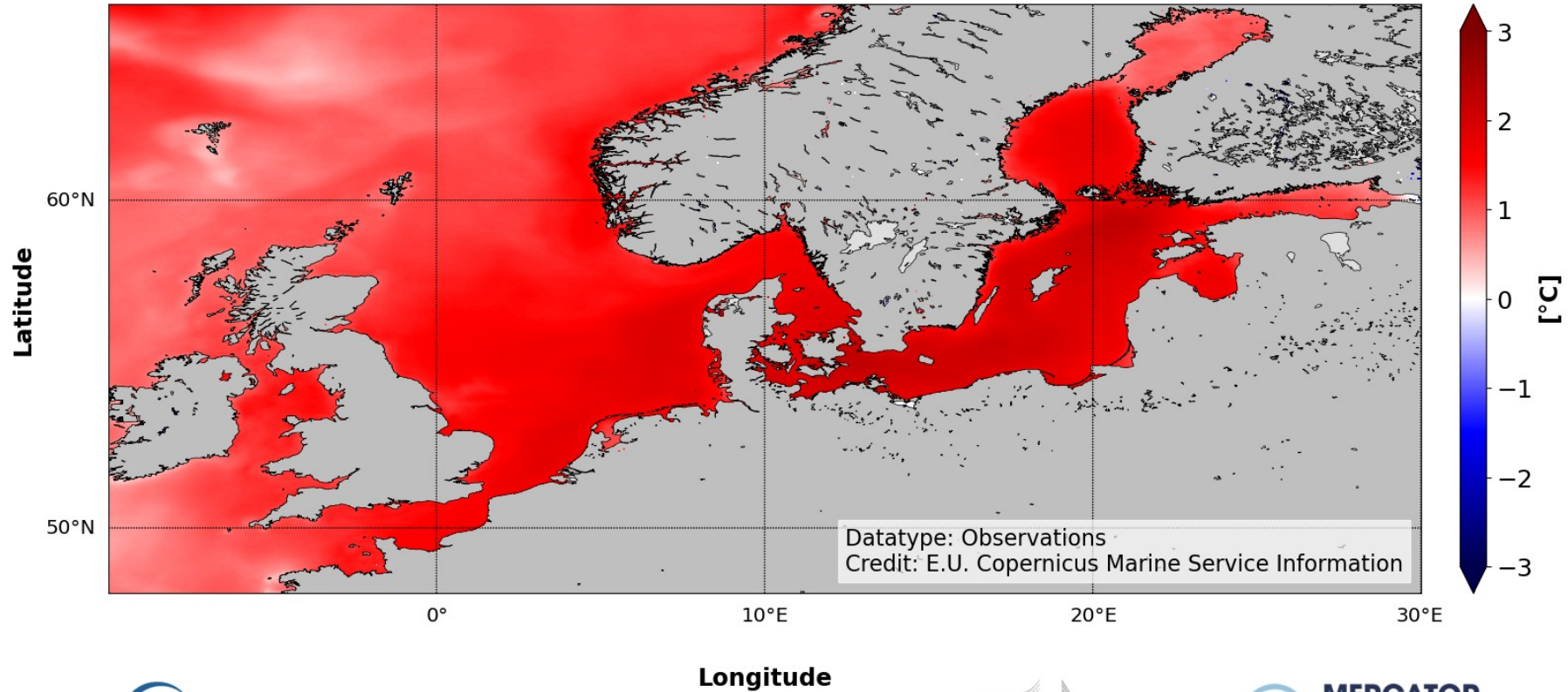
- Monthly mean and 1-year moving anomalies relative to the 1991-2020 climatology

- Average trend **0.029°C/year**
- Average warming **1.22 °C**

- Average trend for Baltic (east of 9°E) **0.038°C/year**
- Average warming for Baltic **1.57°C**

Ocean Monitoring Indicators (OMI)

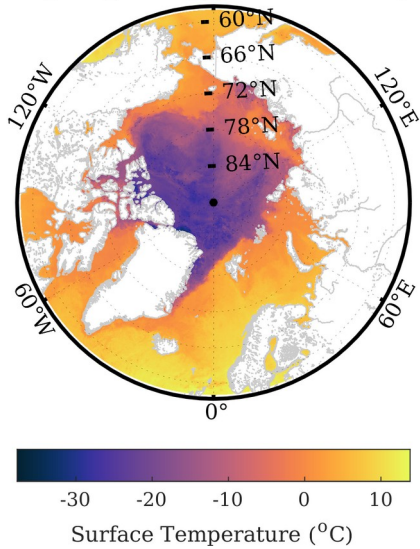
Sea Surface Temperature Trends for North Sea and Baltic Sea



Cummulative trends: rate of change per year/Nyears (1982-2023)

L4_NRT_011_008 180° 22/10/22

ARC SST/IST Products



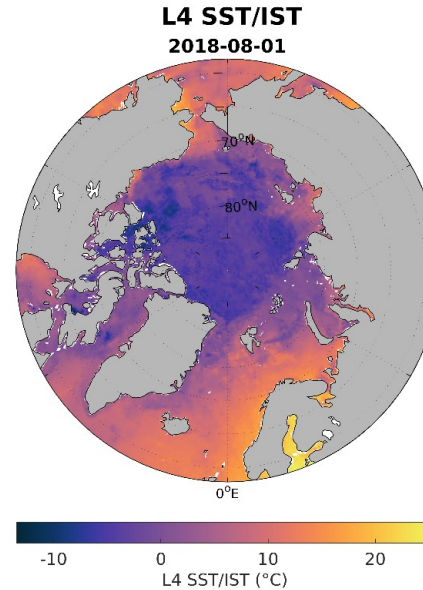
Daily NRT SST/IST

IST Validation 2019-2022

μ : -2.81, σ : 3.94
RMS: 4.84, Nobs: 16963

SST Validation 2016-2017

μ : -0.1, σ : 0.55
RMS: 0.56, Nobs: 22544



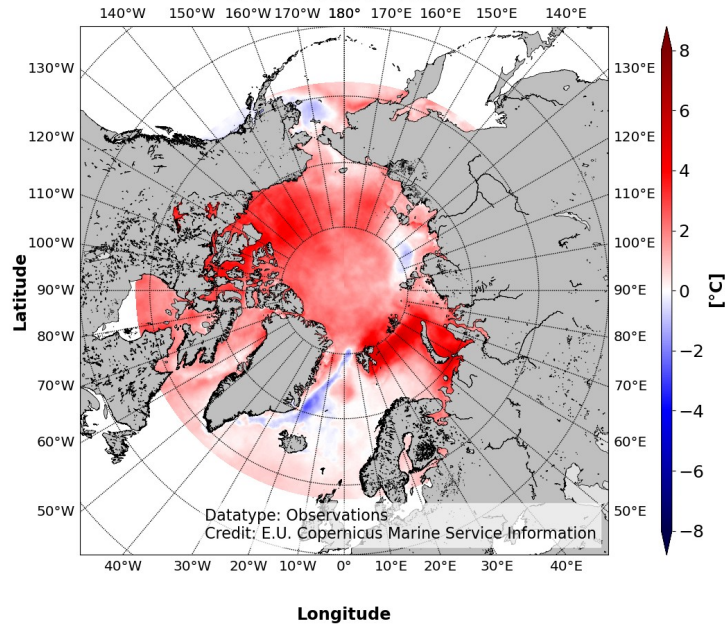
MY SST/IST*

Type	Parameter	Mean	Std	RMS	Nobs
Drifting buoys	SST (°C)	0.00	0.54	0.54	3062549
Moored buoys	SST (°C)	0.03	0.56	0.56	76052
Argo floats	SST (°C)	0.03	0.51	0.51	32953
NP drifting ice stations (T2m)	IST (°C)	-2.35	3.12	3.91	7665
Drifting buoys ECMWF (T2m)	IST (°C)	-3.21	3.34	4.63	55288
Drifting buoys CRREL (T2m)	IST (°C)	-2.87	3.36	4.42	22979
Icebridge KT-19 (IST, SIC >= 15%)	IST (°C)	1.52	3.12	3.48	36638

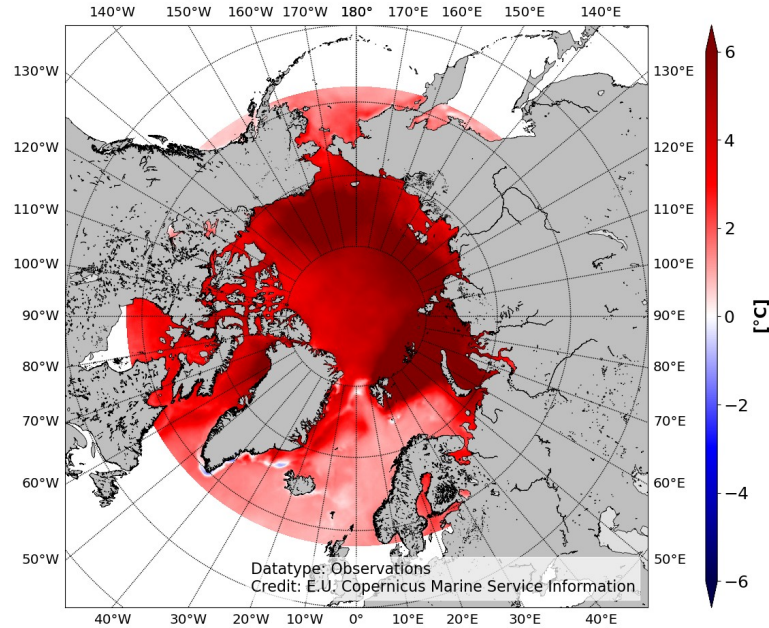
*Nielsen-Englyst P, et al. (2023): A combined sea and sea-ice surface temperature climate dataset of the Arctic, 1982-2021. Remote Sensing of Environment, 284, 2023, 113331.

Ocean Monitoring Indicators

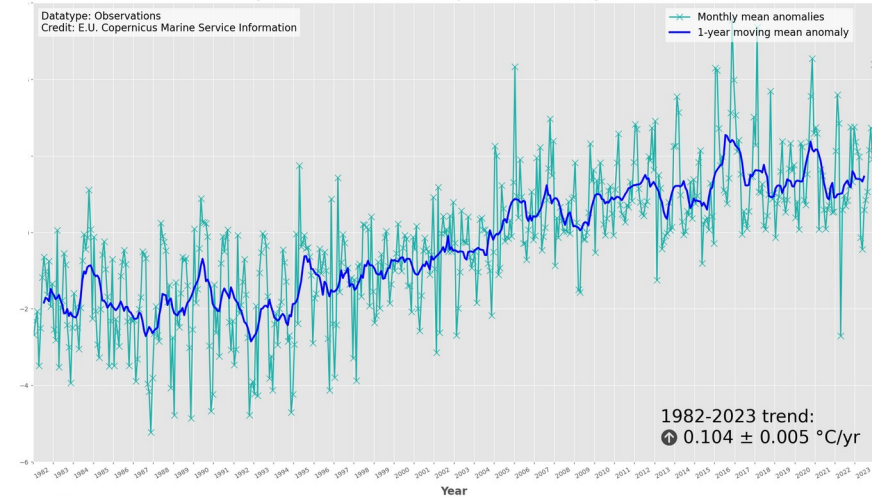
Annual Mean Surface Temperature Anomaly in the Arctic - 2023



Surface Temperature Trends in the Arctic 1982-2023



Monthly Mean Sea Surface Temperature Anomaly in the Arctic

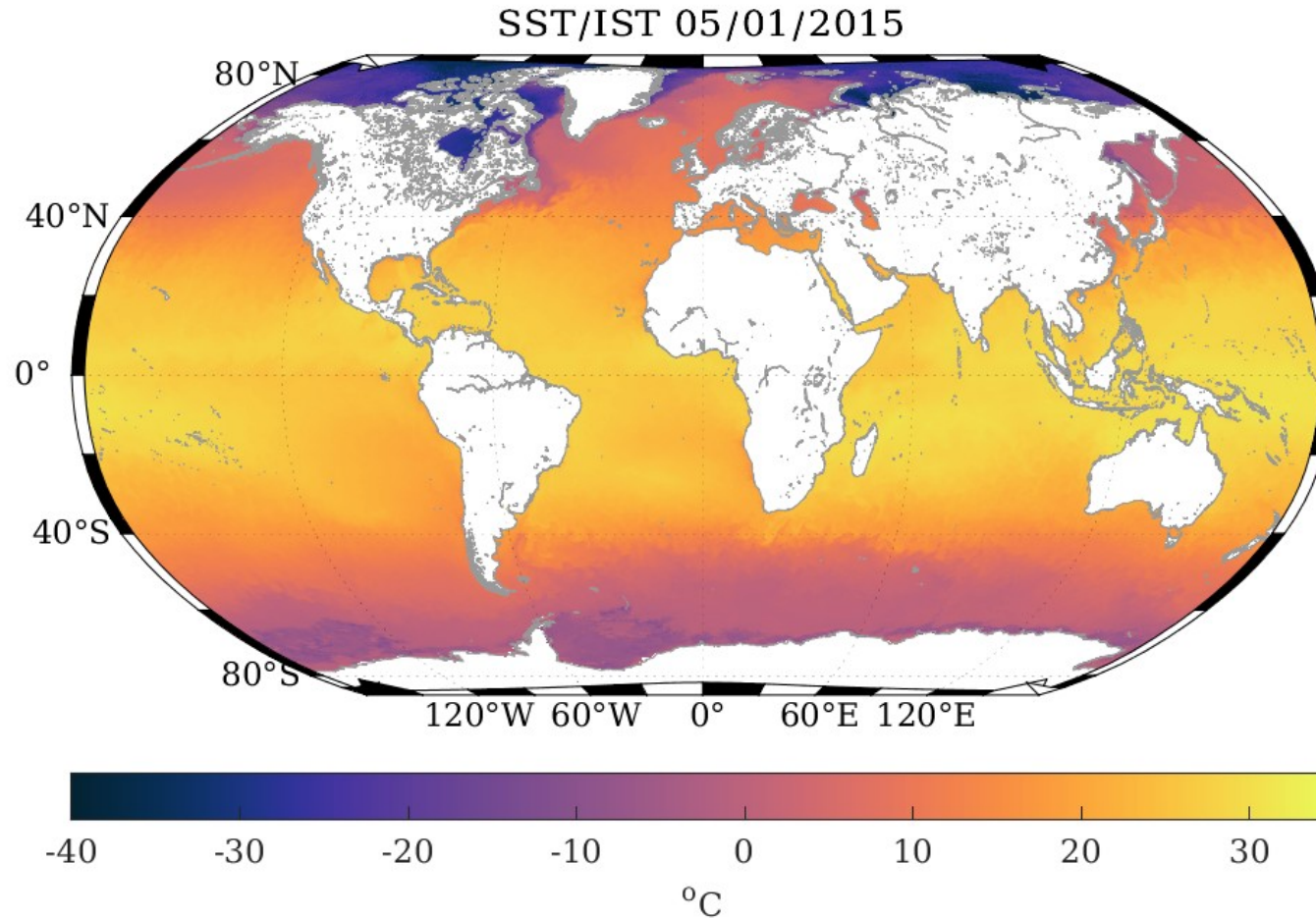


MY ARC SST/IST L4 (1982-2023)

- Average trend **0.104°C/year**
- Average warming **4.37 °C**

New C3S product: Global SST/IST

- Global L4 SST_{sub-skin}/IST_{skin} CDR at 0.05°, 1982-2024 to be released in 2024.



Conclusions

- DMI PU of Copernicus Marine Service for SST & IST products in the North/Baltic Sea & the Arctic Ocean.
- Products available as daily files @ Near-Real-Time and Multi-Year
- Based on L2/L3U SST & IST single-sensor products & a suite of HR SIC products.
- Near-zero biases, standard deviations of 0.5 °C for the SST component.
- High effective spatial resolution of NRT BAL L4 SST close to grid spacing of 0.02°
- Ocean Monitoring Indicators show alarming warming trends:
 - 0.03 °C/yr North/Baltic Sea
 - 0.126 °C/yr Arctic Ocean
- New hourly L4 SST product developed to support analysis of diurnal variability in the North & Baltic Sea.

Bonus

- Global daily L4 SST_{found} at 0.05° available

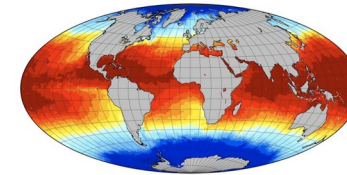
https://podaac.jpl.nasa.gov/dataset/DMI_OI-DMI-L4-GLOB-v1.0

GHRSSST Level 4 DMI_OI Global Foundation Sea Surface Temperature Analysis (GDS version 2) (DMI_OI-DMI-L4-GLOB-v1.0)

3 Publications Cited this Dataset
Citation metrics available for years (2014-2021)

Information	Coverage	Data Access	Documentation	Citation
Version	1.0			
Processing Level	4			
Start/Stop Date	2013-Apr-30 to Present			
Short Name	DMI_OI-DMI-L4-GLOB-v1.0			
Description	A Group for High Resolution Sea Surface Temperature (GHRSSST) Level 4 sea surface temperature analysis produced daily on an operational basis by the Danish Meteorological Institute (DMI) using an optimal interpolation (OI) approach on a global 0.05 degree grid. The analysis is based upon nighttime GHRSSST L2P skin and subskin SST observations from several satellites. The sensors include the Advanced Very High Resolution Radiometer (AVHRR), the Spinning Enhanced Visible and Infrared Imager (SEVIRI), the Advanced Microwave Scanning Radiometer 2 (AMSR2), the Visible Infrared Imager Radiometer Suite (VIIRS), and the Moderate Resolution Imaging Spectroradiometer (MODIS) on Aqua. An ice field from the EUMETSAT OSI-SAF is used to mask out areas with ice. This dataset			

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CLOUD ENABLED

Status: ACTIVE

Short Name:
DMI_OI-DMI-L4-GLOB-v1.0

Collection Concept ID:
C2036881727-POCLOUD

Spatial Coverage:
N: 90° S: -90°
E: 180° W: -180°

Access:

- Browse Granule Listing
- Search Granules

Capabilities: