# Met-Ocean data sets:
## climate, reanalysis, forecast and in situ data

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UCA Universidad de Cádiz

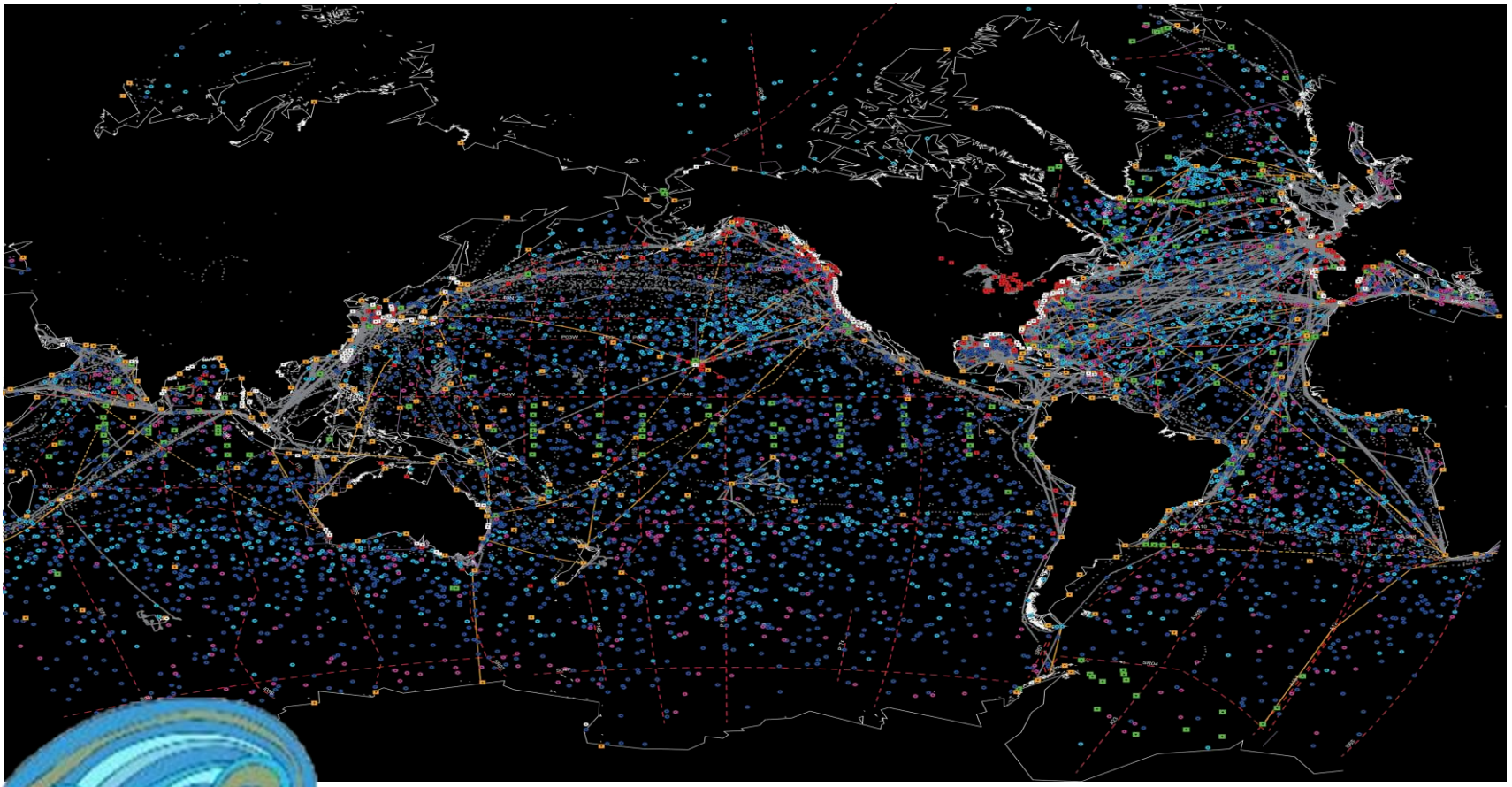
SEA EU European University of the Seas

# Contents

- Met-Ocean data types and characteristics
- Analysis, reanalysis and climatology
- Overview of some data sets
- Some CMEMS products description (PHYS and INSITU)
- Data lexicon: quality information and product user manual

# Metocean data

**Meteorology and ocean physics data. Part of the Earth System data.**



*Ocean observing system report card 2021*

At present a quite complete observing system (in situ and remote).

Not evenly distributed obs, fewer back in time.

We need a long and reliable record for:

✓Climate change

✓Ocean health

✓Forecast and warning

# Metocean data types (products)

MARINE DATA LITERACY COURSE

## Numerical Models

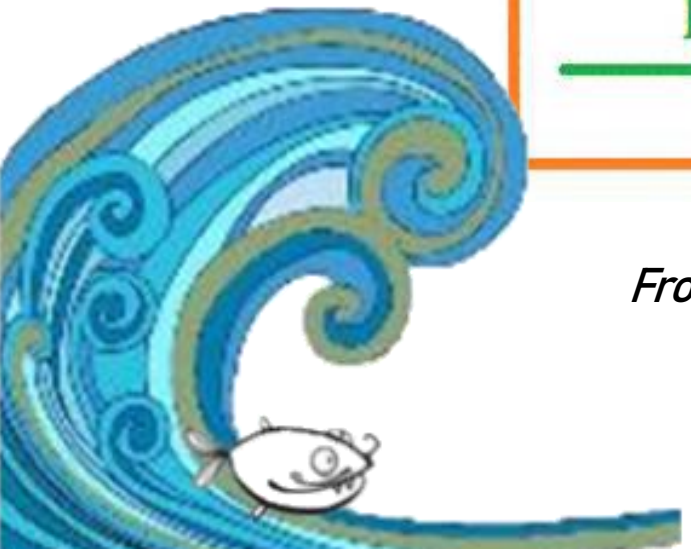
Hindcasting | Nowcasting | Forecasting

Past | Present | Future

## Data Assimilation= Model + Observations

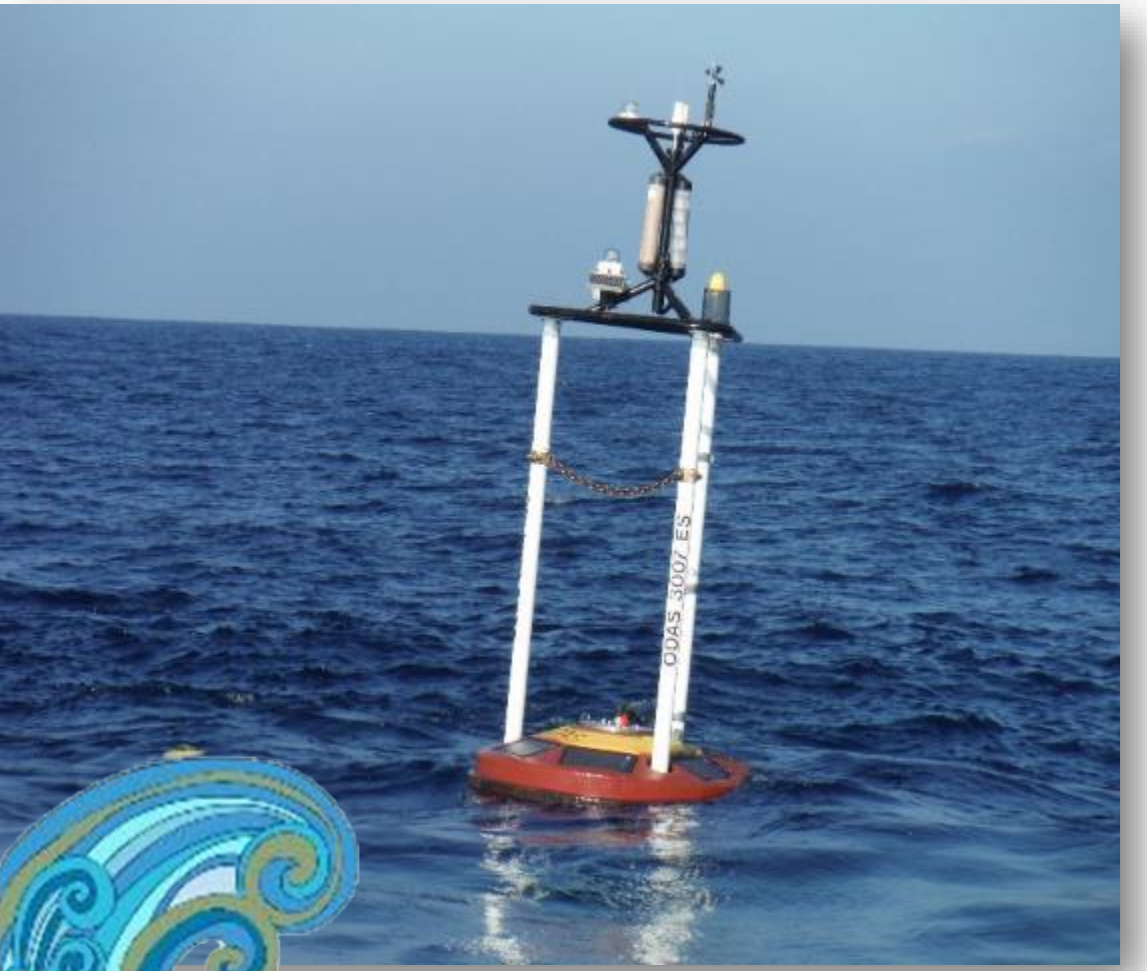
Re-Analysis | Analysis

Past | Present



*From Siva Reddy PhD Thesis (2015) DOI:10.13140/RG.2.1.4459.4326*

# Metocean data types (level of processing)




**Level 0**
- Unprocessed instrument data

**Level 1**
- Data processed to sensor unit

**Level 2**
- Derived geophysical variables (same resolution and location as L1)

**Level 3**
- Georeferenced data (gridded fields)

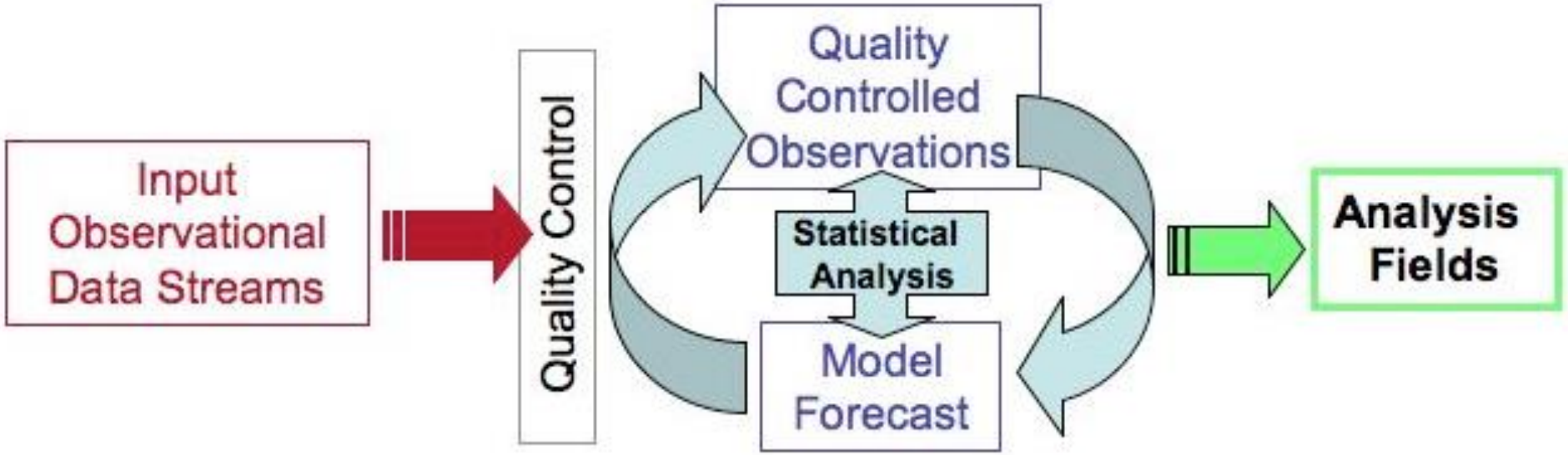
**Level 4**
- Model output or results from analysis of multiple lower level products, missing data gaps filled

# Re/analysis products

An **analysis** is a snapshot of the **state of the ocean** at any **given time**. It is done using **model data and observations** to provide a best fit produced **on the fly**.

An oceanographic **reanalysis** consists in modelling **the state of the ocean over a long period of time** (several years) while correcting it with the **best available past observations**.

*From the Blue Book Copernicus for a Sustainable Ocean*



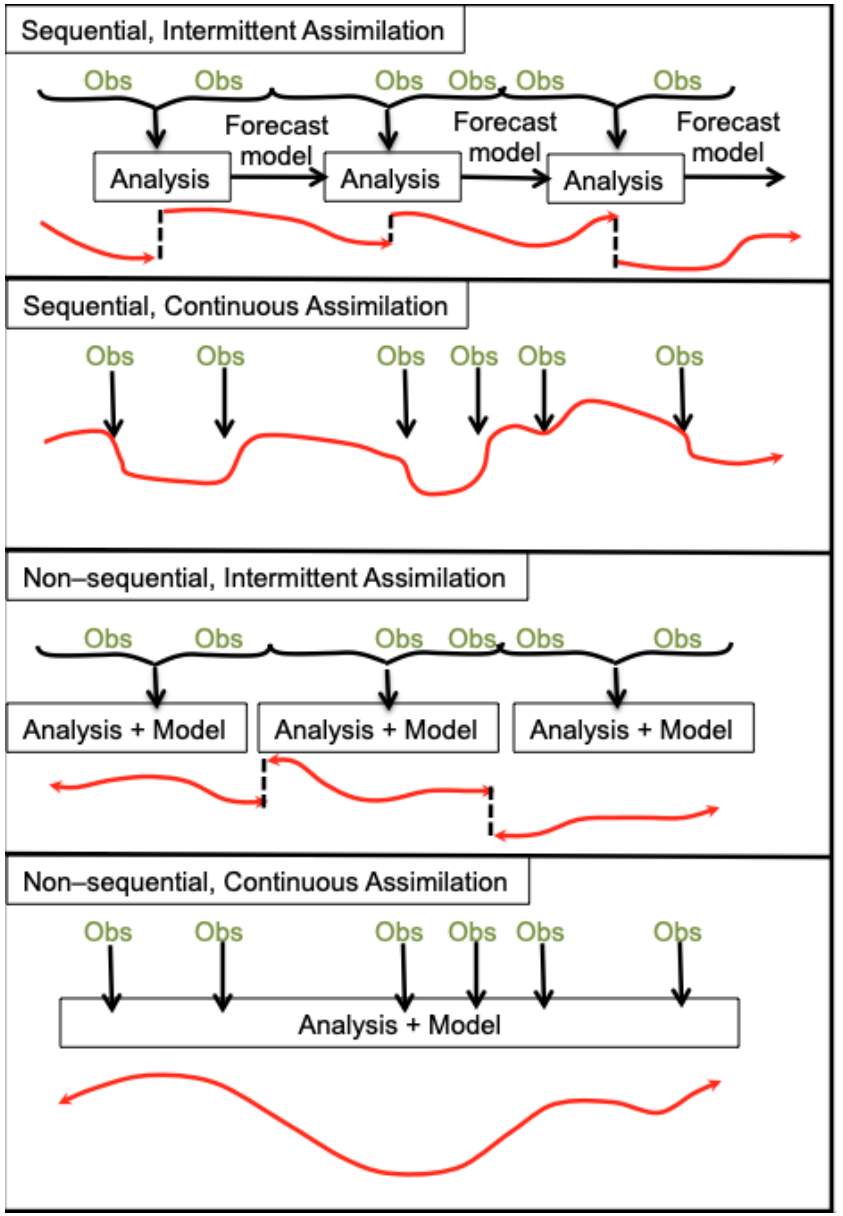

*From E. Kalnay, www2.atmos.umd.edu*

# Re/analysis products

All **past observations** are reprocessed keeping the numerical model and assimilation techniques **“frozen”** (without changes).

The result is an **analysis consistent in time**: a **reanalysis**.

However, **changes in observing system/platforms** may generate **“jumps”** in the reanalysis.

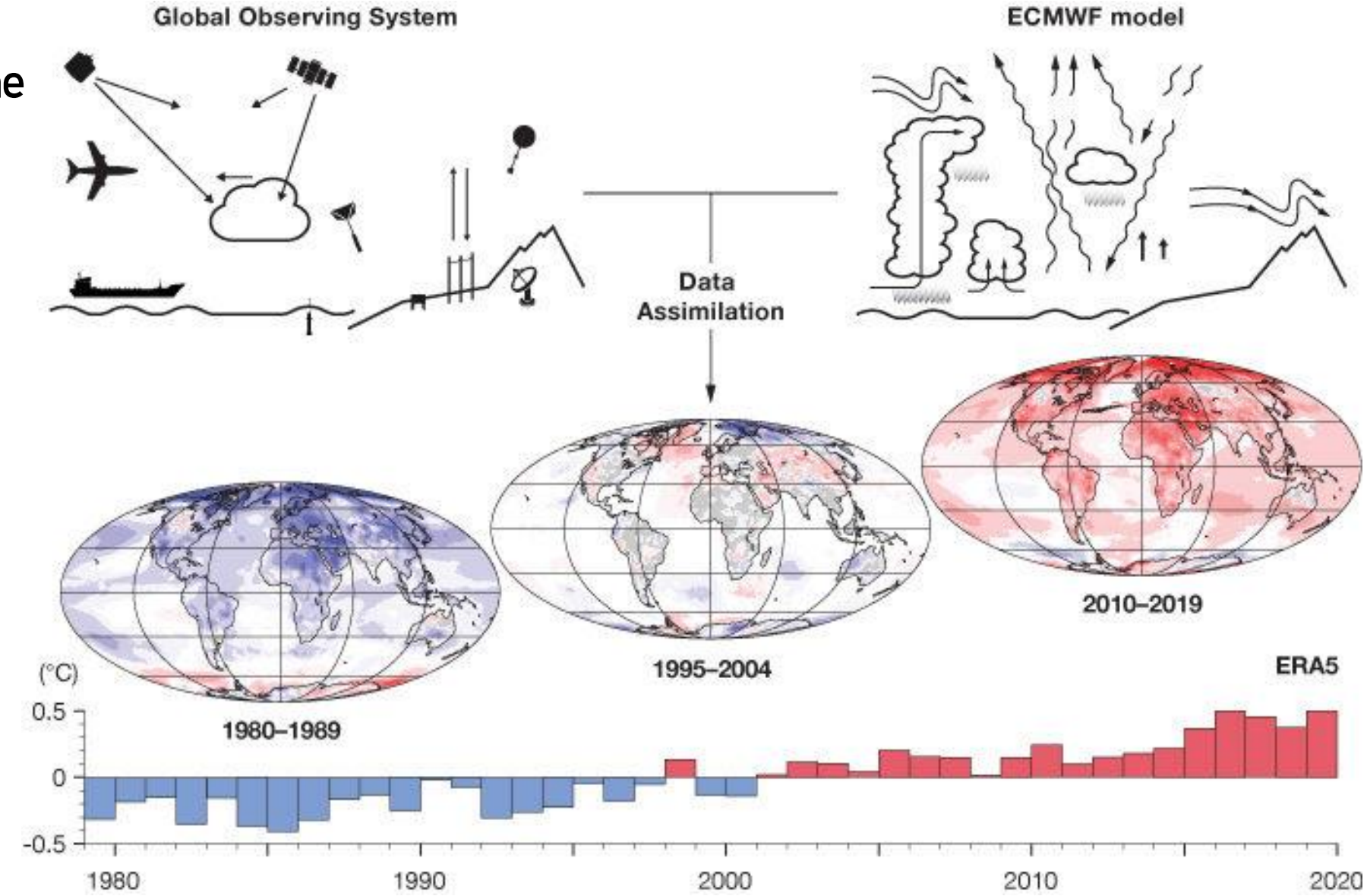



*Representation of four basic strategies for data assimilation as a function of time. Observations are made at different times and arrive at irregular times. Intermittent assimilation of observations induces step changes in the model analysis (red line) while continuous assimilation of observations gives smoother changes in the model analyses*
***https://confluence.ecmwf.int/display/FUG/Section+2.5+Model+Data+Assimilation%2C+4D-Var.***

# Re/analysis data

Reanalysis data provide the most complete picture currently possible of past weather and climate.

'Maps without gaps'.




https://www.ecmwf.int/en/about/media-centre/focus/2020/fact-sheet-reanalysis

# Re/analysis data: uncertainty

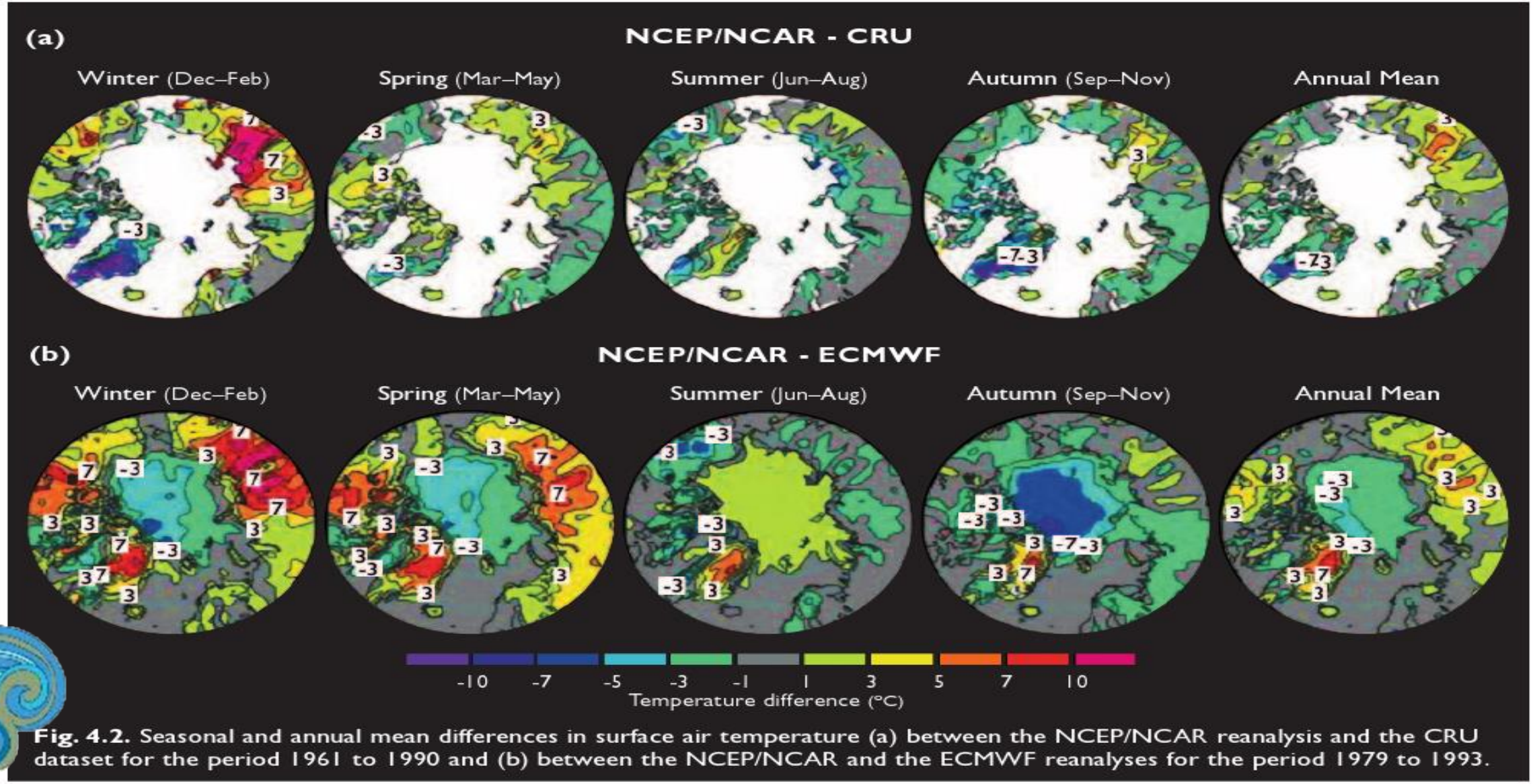
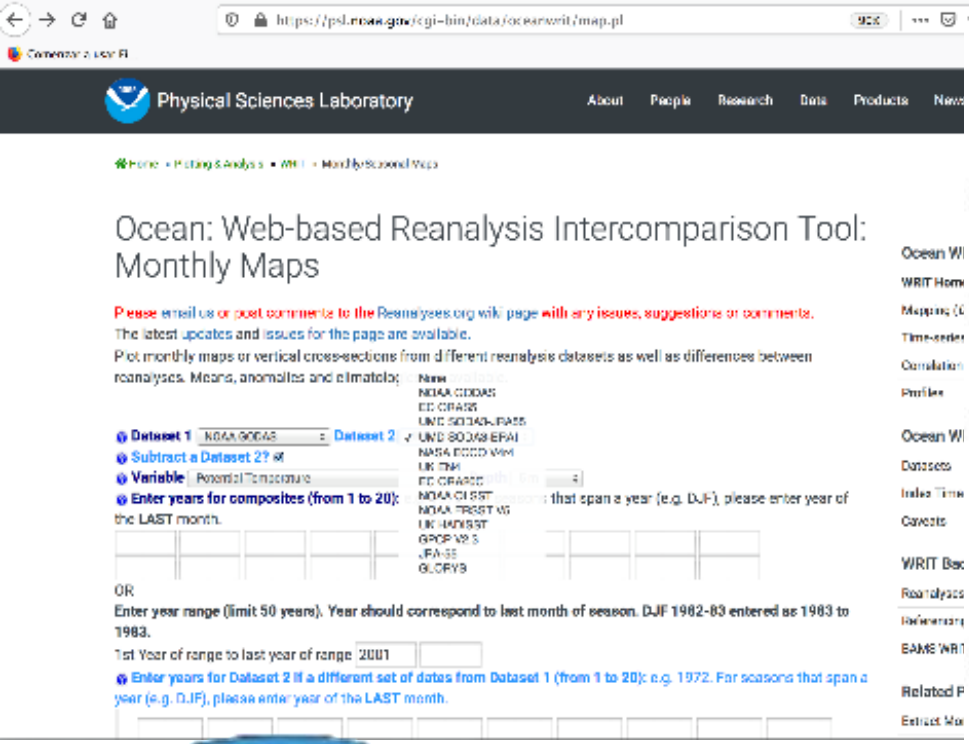


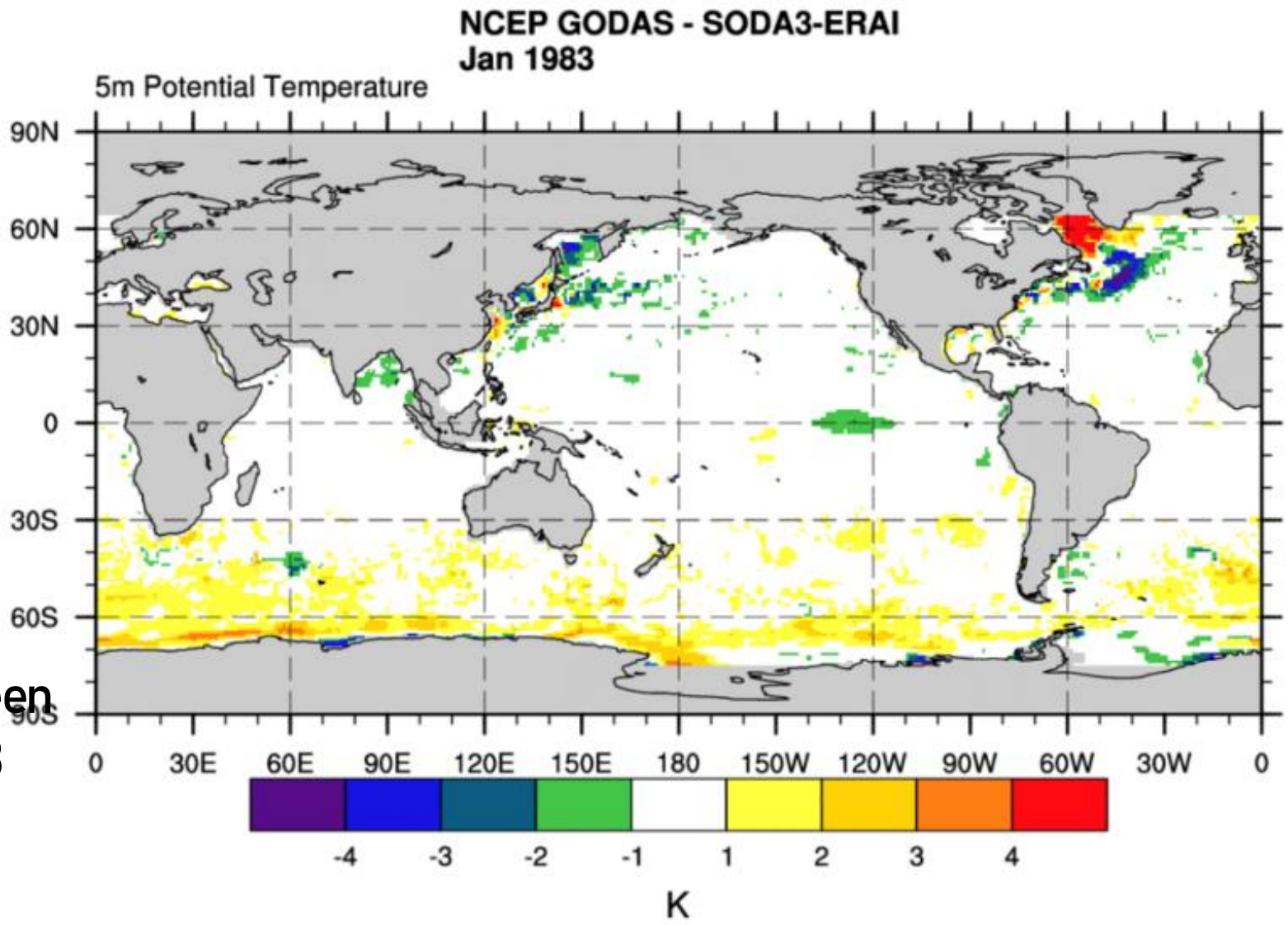

**Fig. 4.2.** Seasonal and annual mean differences in surface air temperature (a) between the NCEP/NCAR reanalysis and the CRU dataset for the period 1961 to 1990 and (b) between the NCEP/NCAR and the ECMWF reanalyses for the period 1979 to 1993.

ACIA Report 2004

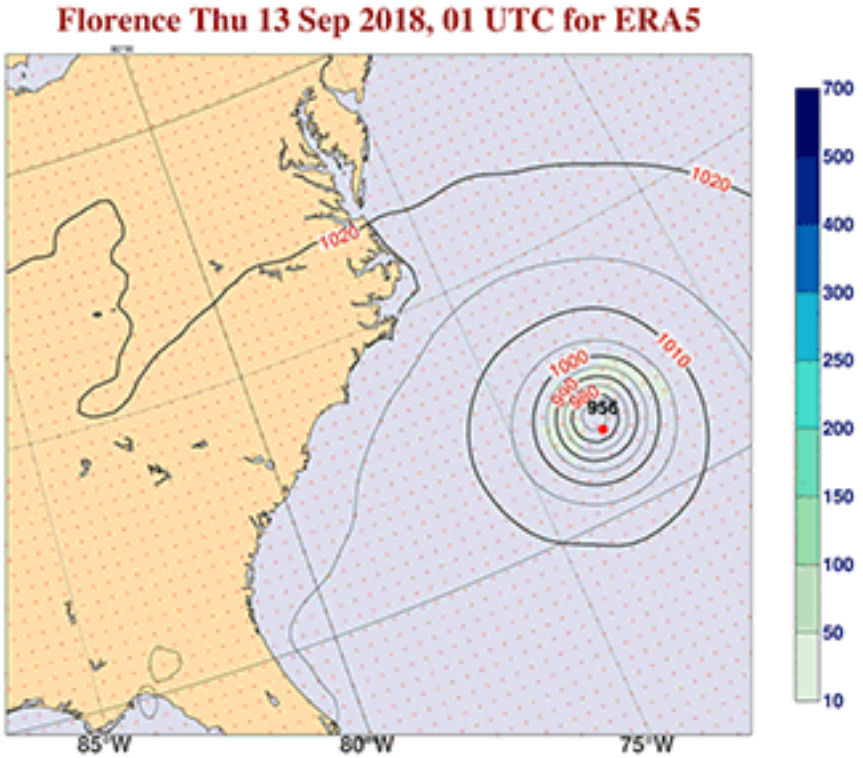
# Re/analysis data: uncertainty

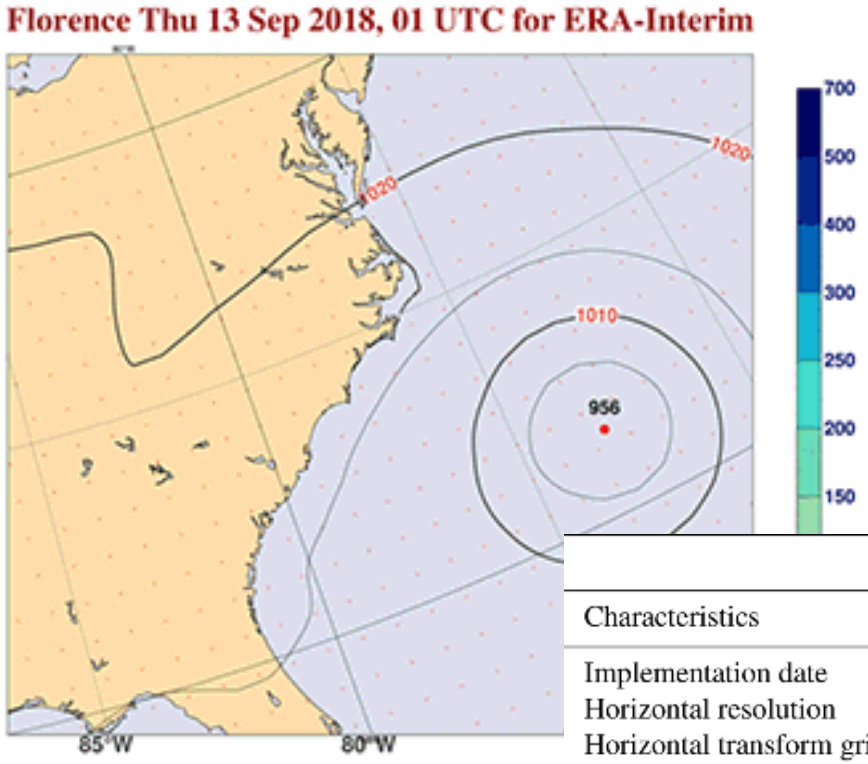



Differences between GODAS and SODA3 using NOAA WRIT



# Reanalysis data: improving accuracy




*From: https://www.ecmwf.int/en/about/media-centre/news/2018/ecmwfs-era5-reanalysis-soon-extend-back-1979*

| | ERA5 | ERA-Interim |
|---|---|---|
| Characteristics | | |
| Implementation date | 8 Mar 2016 | 12 Dec 2006 |
| Horizontal resolution | $T_L$636 (~ 31 km) | $T_L$255 (~ 79 km) |
| Horizontal transform grid[a] | 0.3° × 0.3° | 0.75° × 0.75° |
| Vertical resolution | 137 levels up to 0.01 hPa | 60 levels up to 0.1 hPa |
| Temporal resolution | Hourly | 6-hourly |
| IFS cycle[b] | 41r2 | 31r2 |
| Period covered | 1950–now | 1979–now |
| Reference | Hersbach and Dee (2016) | Dee et al. (2011) |
| Resource requirements | | |
| CPU time (s) | 3130 | 350 |
| Main memory (MB) | 5800 | 530 |
| Disk storage (GB) | 450 | 5.8 |

*From Hoffman et al. (2019) https://acp.copernicus.org/articles/19/3097/2019*

# Reanalysis data: Strengths and limitations

**Reanalysis data are often used to represent the "true state of the atmosphere/ocean according to observations."**

**Key strengths:**

- The data are multivariate, spatially and temporally complete, and gridded
- The data combine information from many sources (observations and models)
- The data set is physically and dynamically coherent, according to the models used

**In actual fact, reanalysis combines inaccurate and incomplete observations with imperfect models, using methods and procedures that are technically and scientifically complex.**

**Key weaknesses:**

- Changes in the observing system can cause changes in mean errors
- Mixing observations with models tends to violate conservation properties
- Uncertainties in the reanalysis data are difficult to understand and quantify

Dee (https://climatedataguide.ucar.edu/climate-data/atmospheric-reanalysis-overview-comparison-tables#Table)

# Reanalysis

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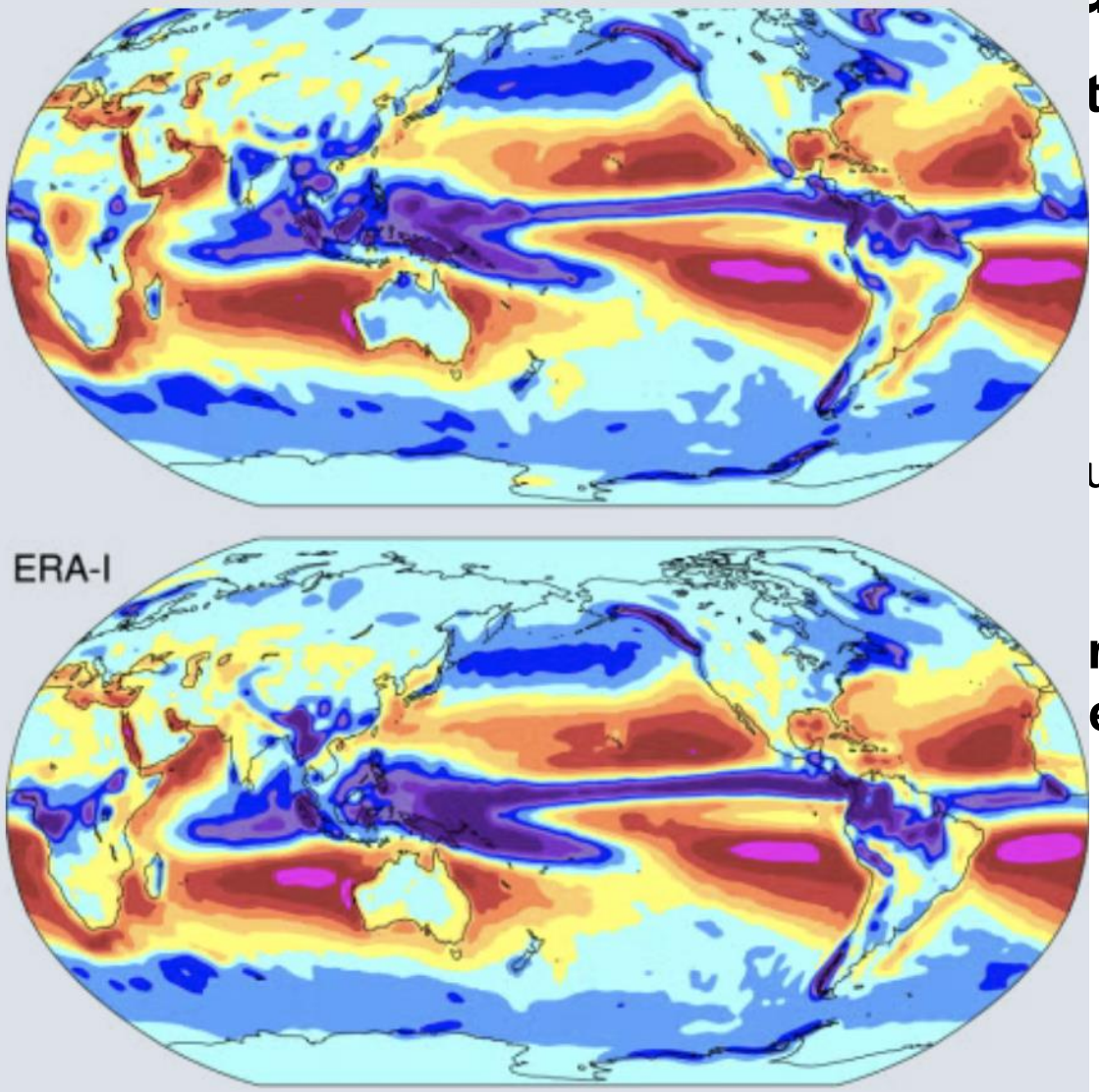
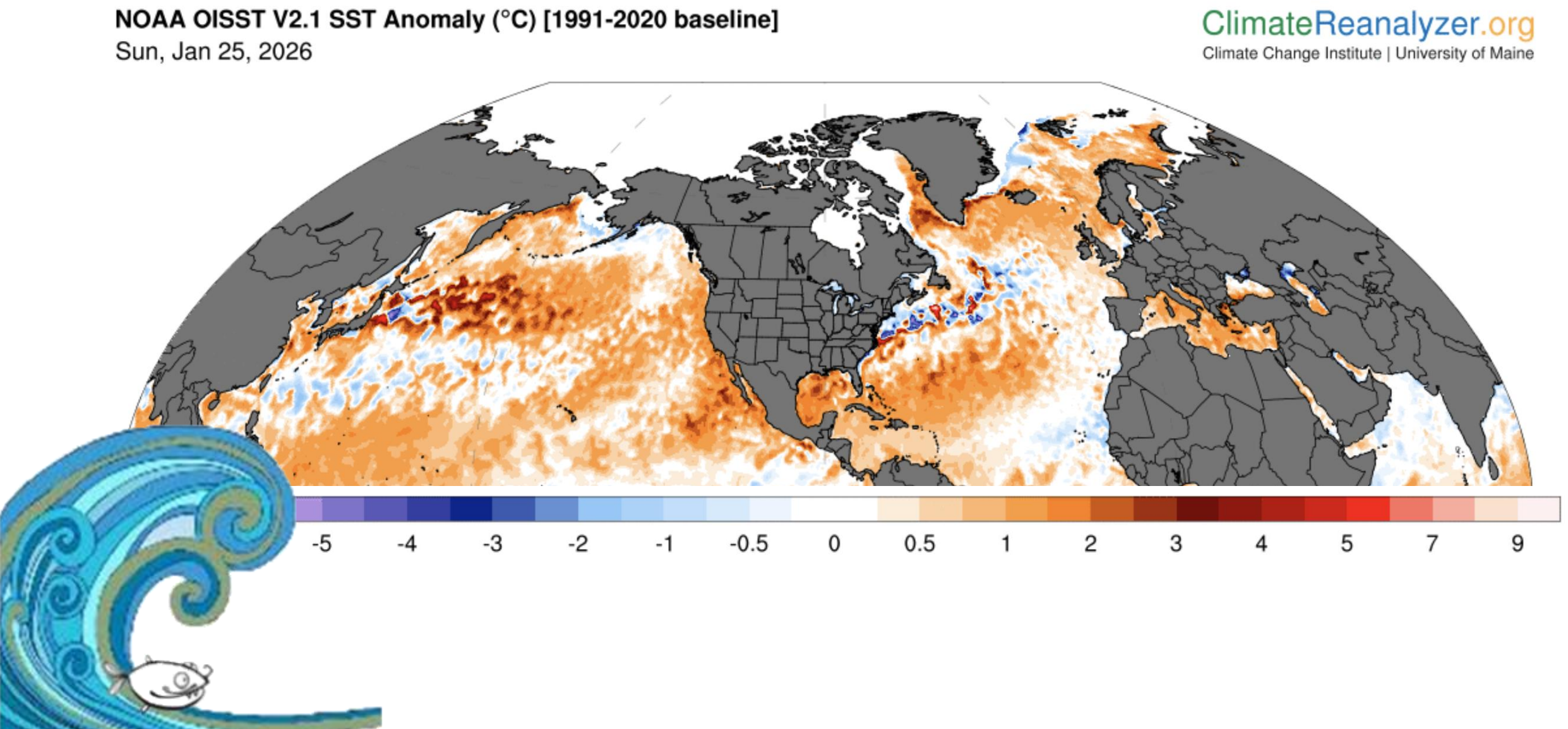



Evaporation minus Precipitation in MERRA (top) and ERA-Interim (bottom) based on Trenberth et al. (2011). (Contributed by J Fasullo)

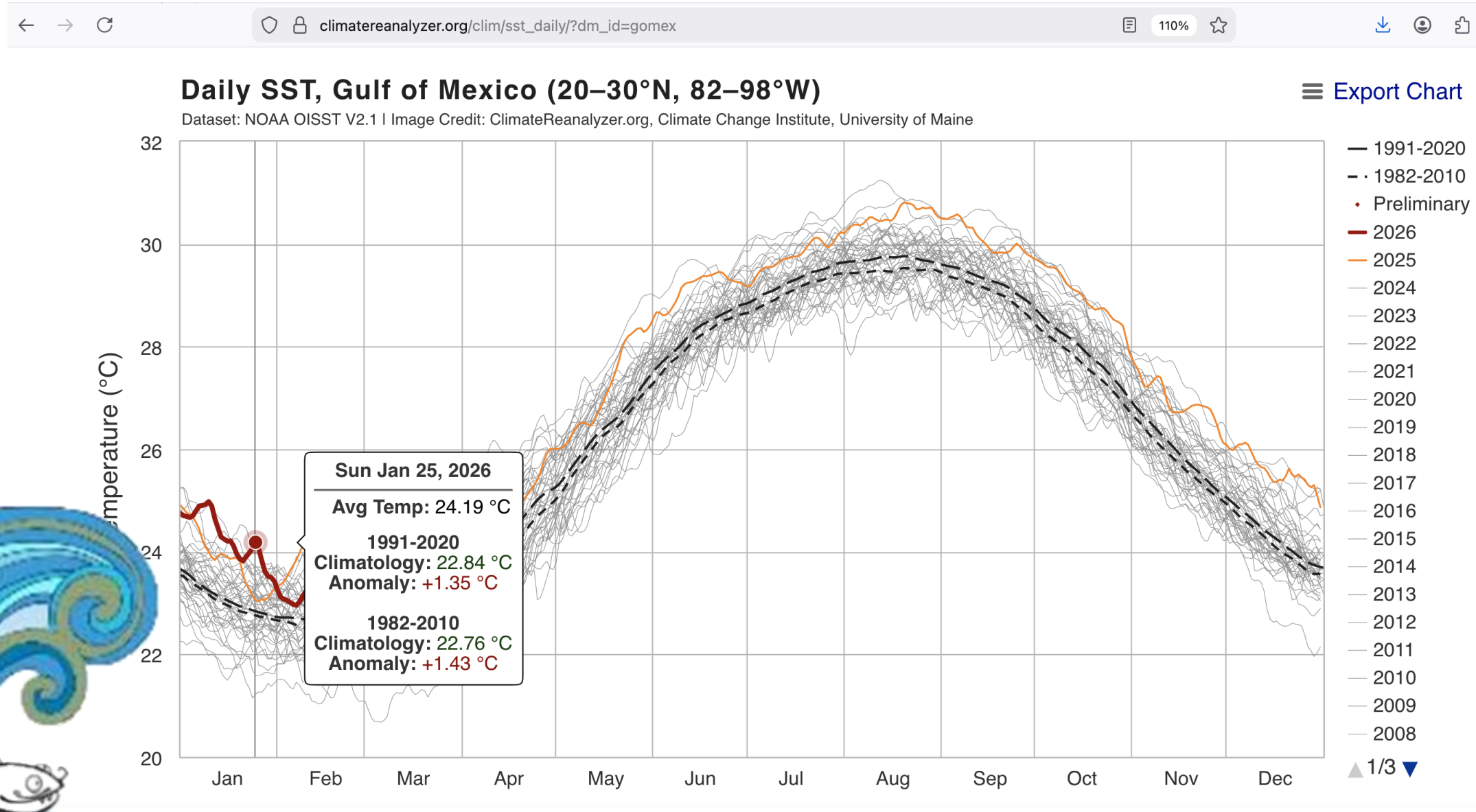
Dee (https://clima

# Re/analysis data: examples of applications

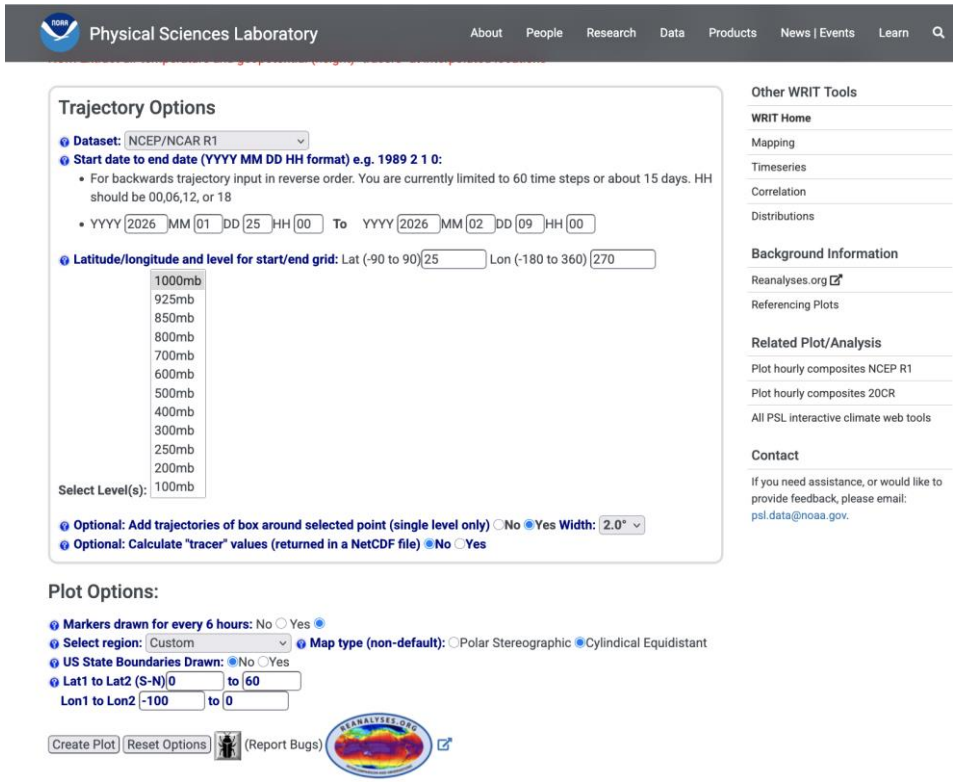
MARINE DATA LITERACY COURSE



# Re/analysis data: examples of applications



# Re/analysis data: examples of applications

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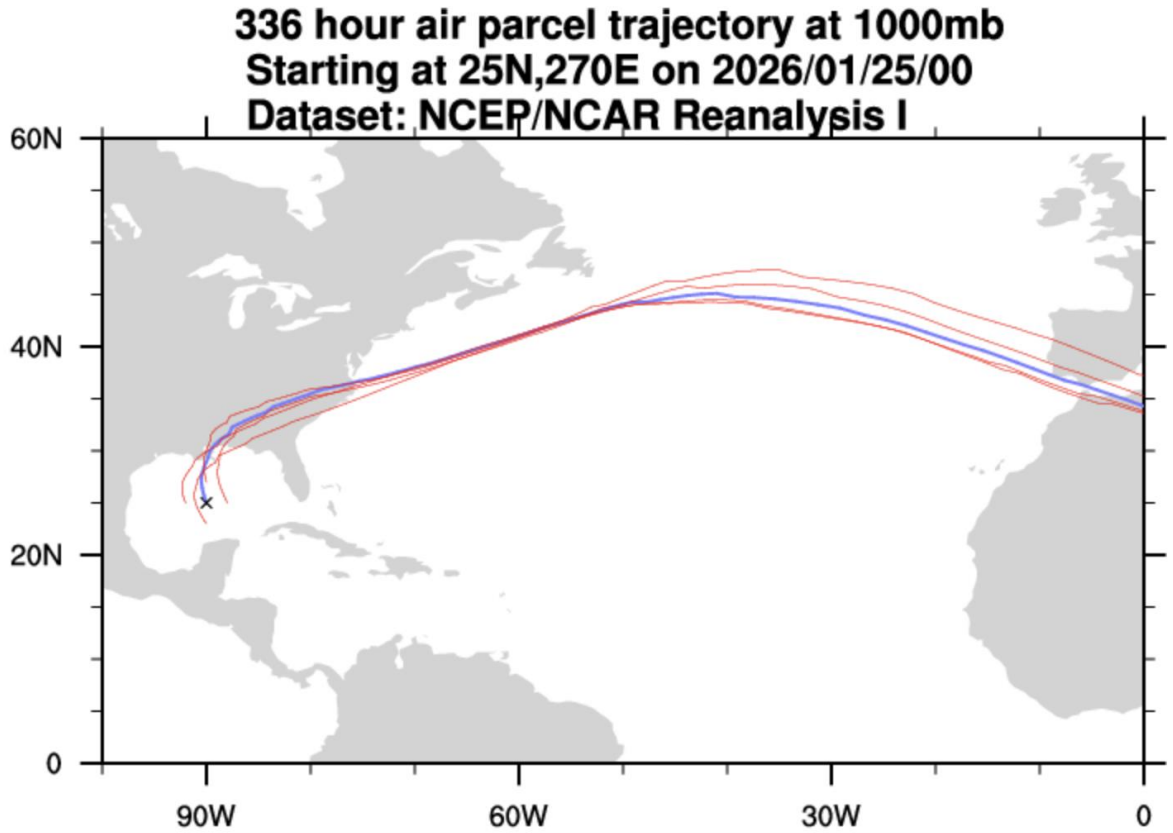
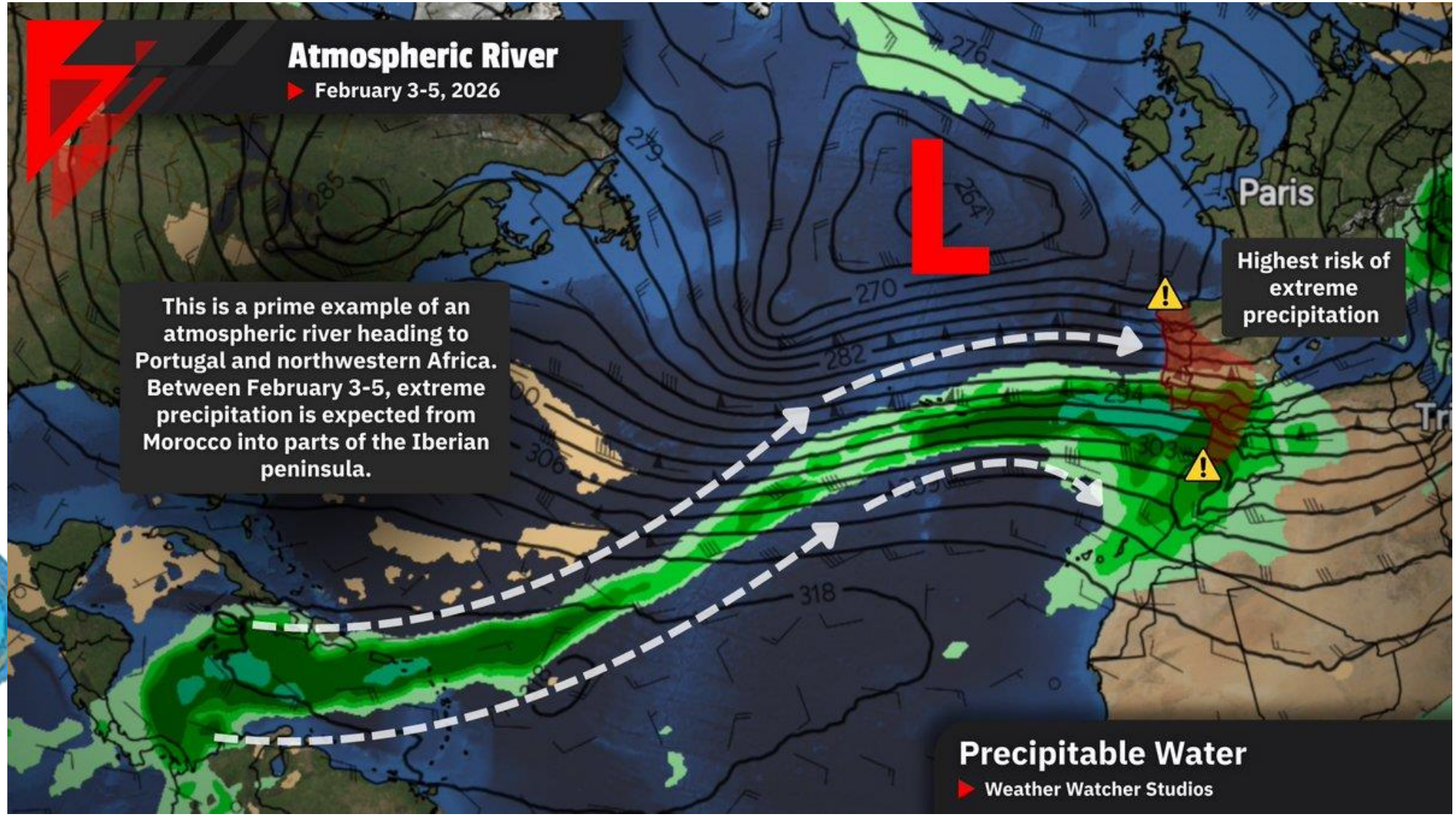


# Re/analysis data: examples of applications

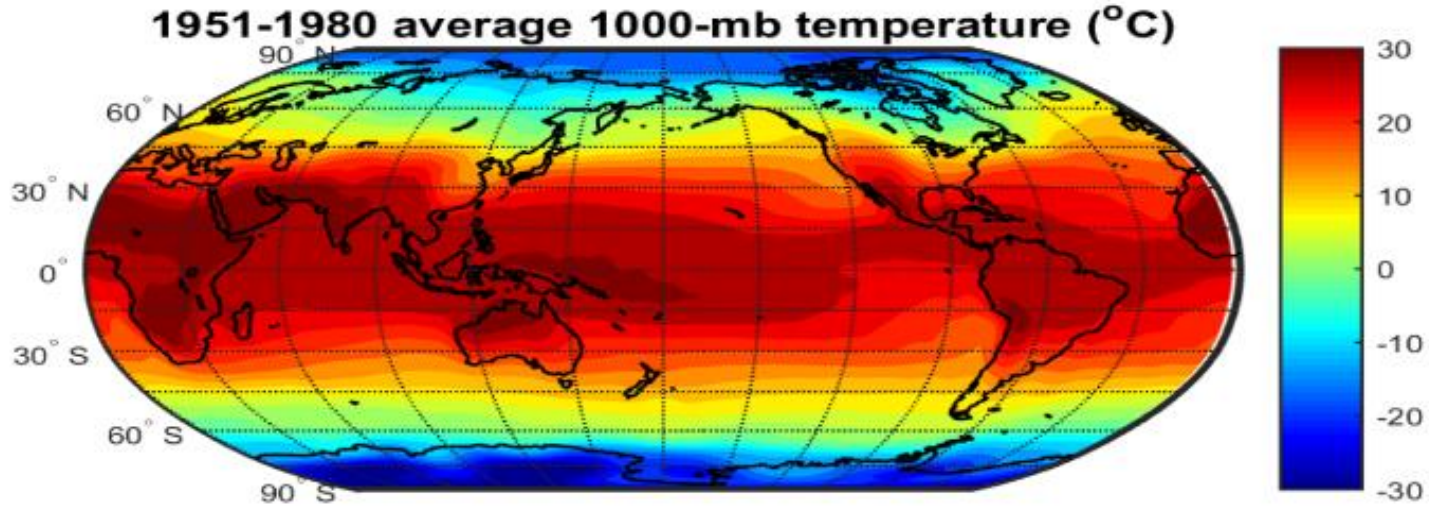


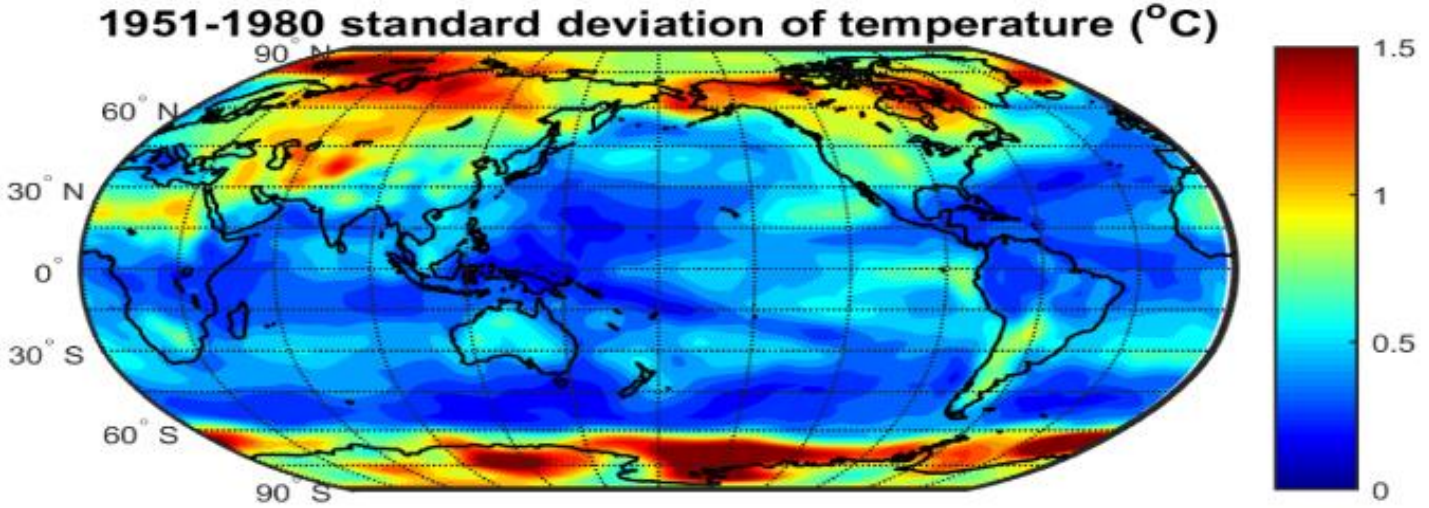
# Climatology data

Climate is the statistical ensemble of states occurring in the system Atmosphere-Ocean-Solid Earth in a period of several decades (Monin, 1979).

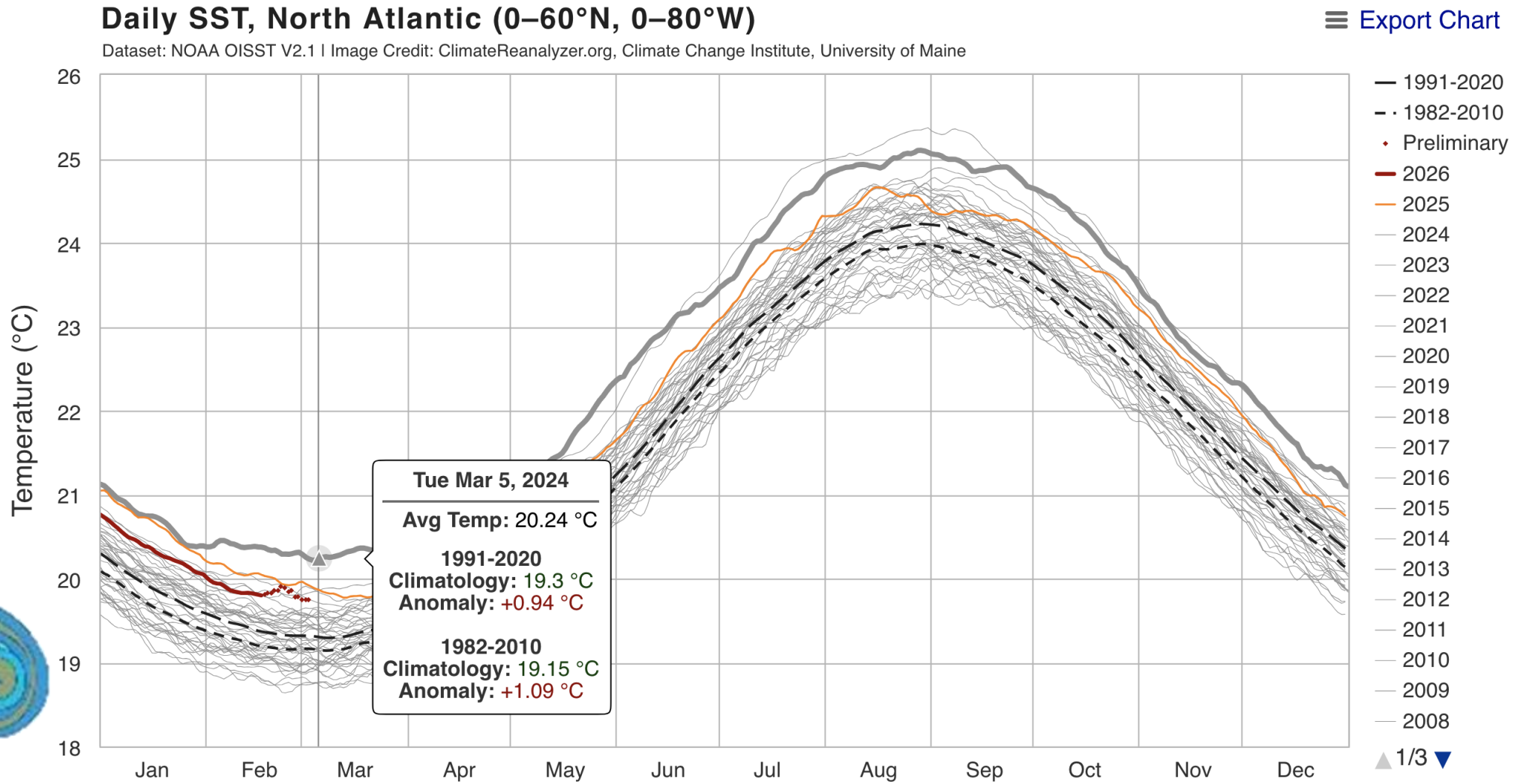
Climate may be defined as the multivariate, multiple-time probability distribution of status of the ocean-ice-atmosphere system (North et al. 1982).

**Climate normals**: Period averages computed for a uniform and relatively long period comprising at least three consecutive ten-year periods (WMO No-1203). Climate includes arithmetic **mean**, but it can also include values such as the **standard deviation**, percentile points, number of exceedances of a threshold or **extreme values**.

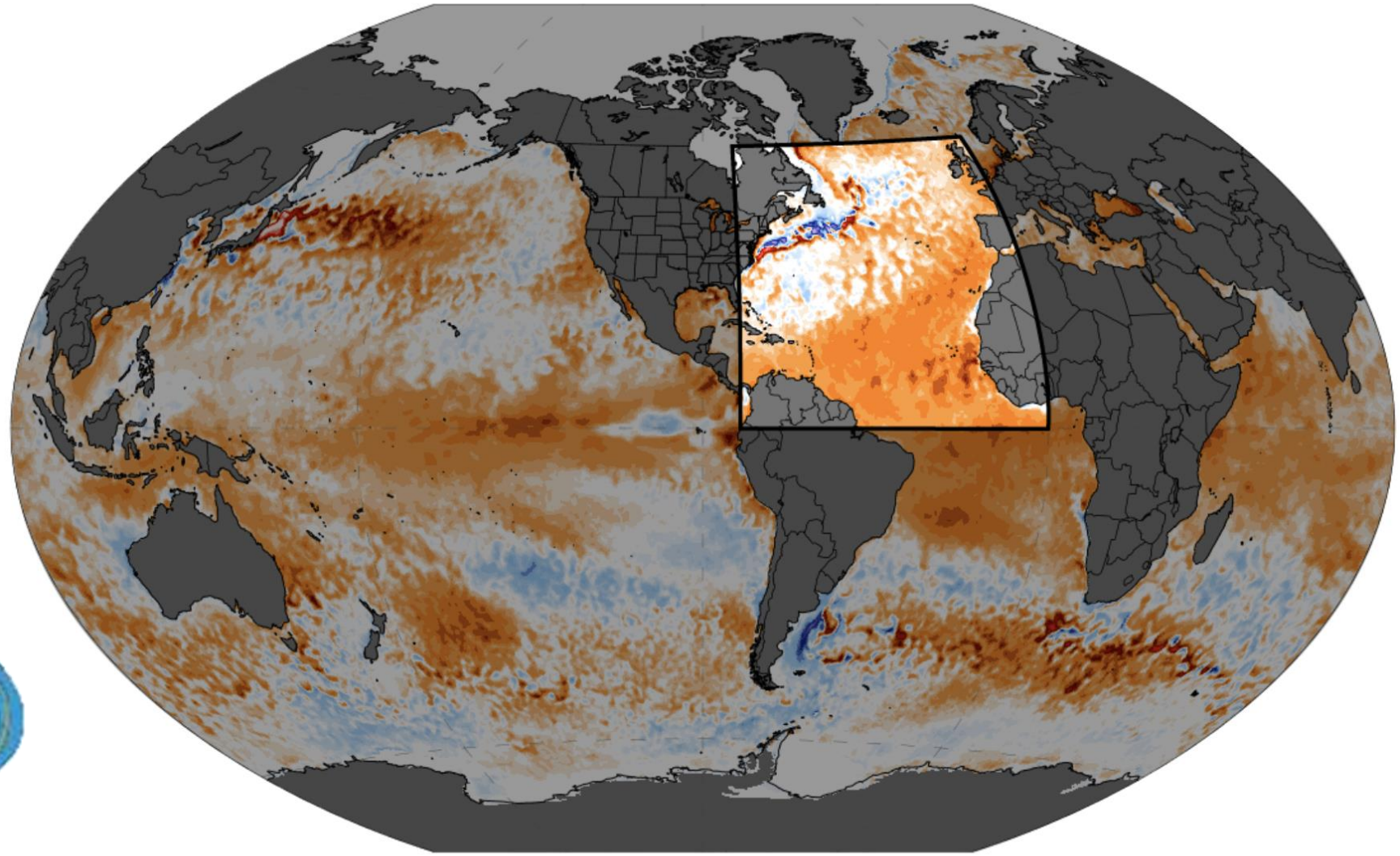


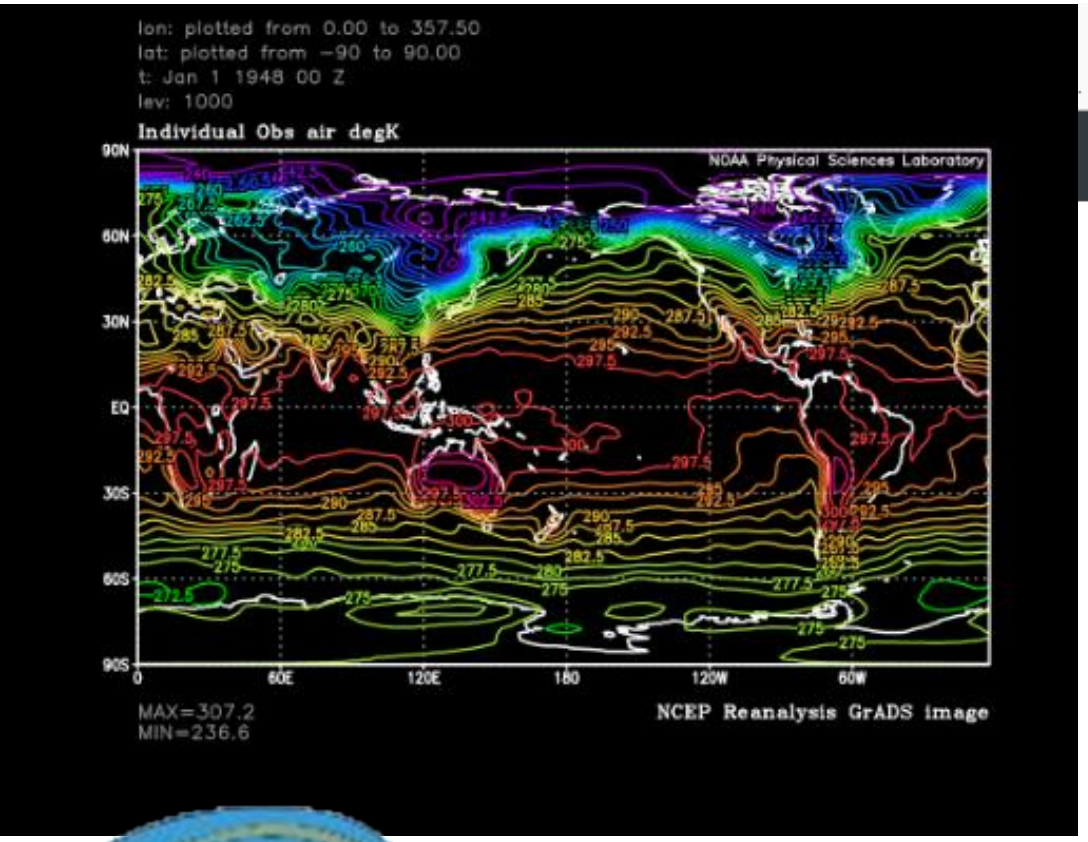
# Climatology from reanalysis



# Climatology from reanalysis



# NCEP/NCAR Reanalysis 1




Air temperature at Surface
(January 1st 1948)
Resolution 2.5° x 2.5°

https://psl.noaa.gov/data/gridded/data.ncep.reanalysis.html 80%

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**Brief Description:**

- NCEP/NCAR Reanalysis 1

**Temporal Coverage:**

- 4-times daily, daily and monthly values for 1948/01/01 to present
- Long term monthly means, derived from data for years 1981 - 2010

**Spatial Coverage:**

- Global Grids

**Levels:**

- 17 Pressure level and 28 sigma levels. N/A

**Update Schedule:**

- Daily

**We have separated the data documentation into seven sections:**

- Pressure level
- Surface
- Surface Fluxes
- Other Fluxes
- Tropopause
- Derived Data
- Spectral Coefficients

**Usage Restrictions:**

- None

**Detailed Description:**

- The NCEP/NCAR Reanalysis 1 project is using a state-of-the-art analysis/forecast system to perform data assimilation using past data from 1948 to the present. A large subset of this data is available from PSL in its original 4 times daily format and as daily averages. However, the data from 1948-1957 is a little different, in the regular (non-Gaussian) gridded data. That data was done at 8 times daily in the model, because the inputs

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NCEP/NCAR Reanalysis
N. American Regional Reanalysis

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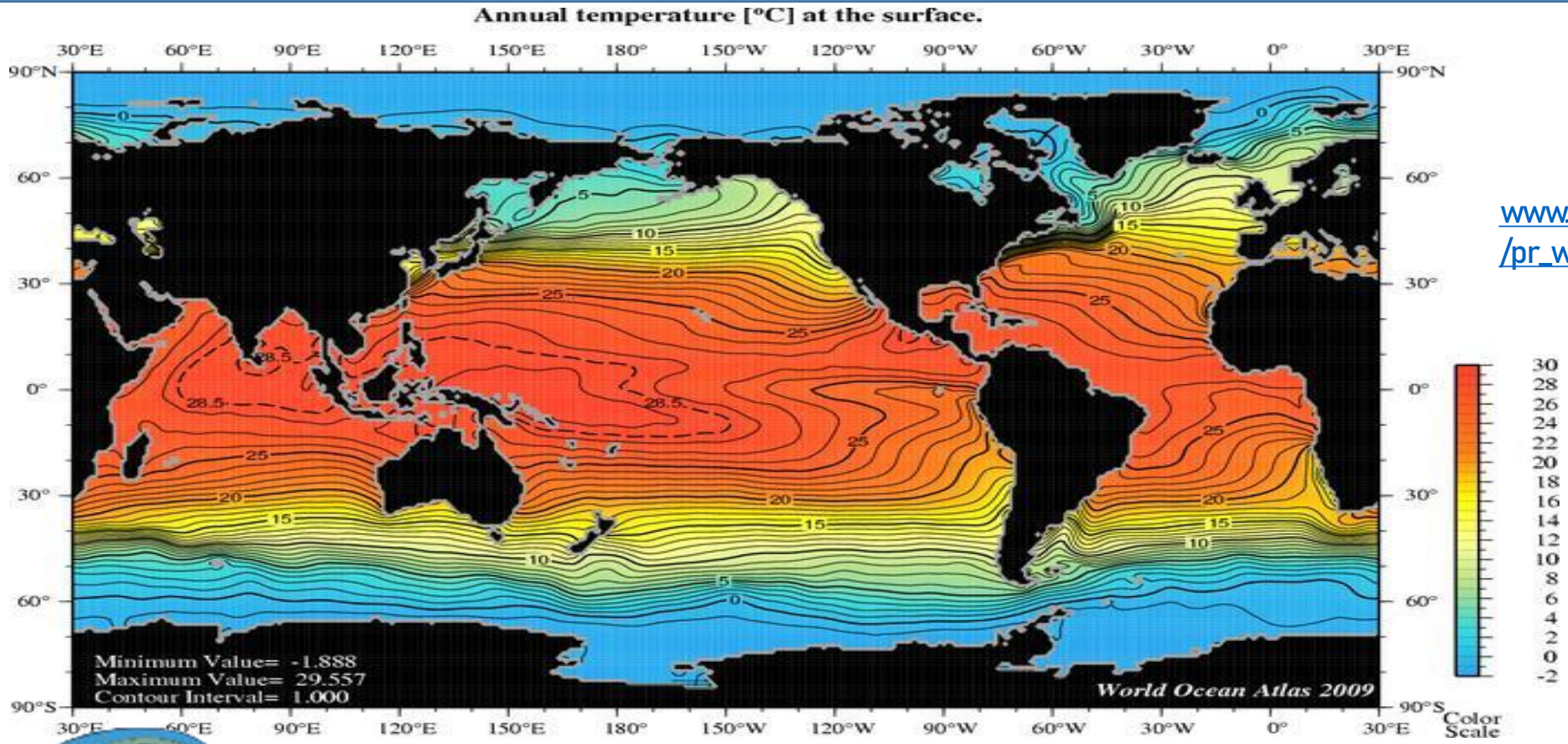
OPeNDAP Access

http://www.esrl.noaa.gov/psd/data/reanalysis/reanalysis.shtml

# World Ocean Atlas 2009 (WOA09)

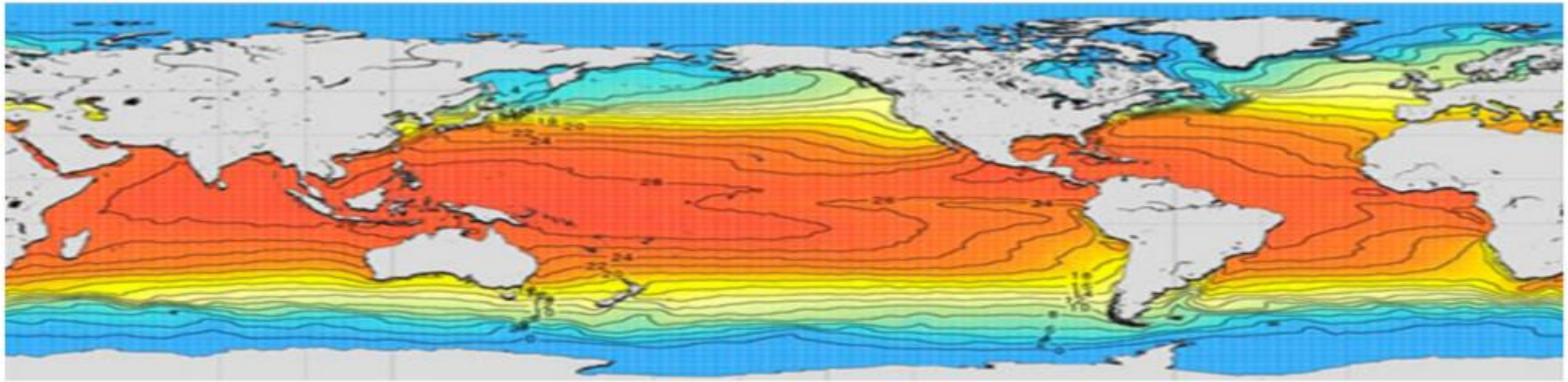



www.nodc.noaa.gov/OC5/WOA09/pr_woa09.html

World Ocean Atlas 2009 (WOA09) is a set of **objectively analyzed (1° grid)** climatological fields of **in situ temperature, salinity, dissolved oxygen, Apparent Oxygen Utilization** (AOU), **percent oxygen saturation, phosphate, silicate, and nitrate** at **standard depth levels** for **annual, seasonal, and monthly compositing periods** for the World Ocean. It also includes **associated statistical fields** of observed oceanographic profile data interpolated to standard depth levels on both 1° and 5° grids .

# World Ocean Atlas 2018 (WOA18)

## WORLD OCEAN ATLAS 2018 (WOA18)



The *WOA18* updates previous versions of the World Ocean Atlas to include approximately 3 million new oceanographic casts added to the World Ocean Database and renewed quality control.

This final version of WOA18 published in July, 2019 is replacing a prereleased version made available in September, 2018. The changes between the versions include:

1. For the first time the Animal mounted pinniped temperature profiles (APB) have been added improving coverage in high latitude areas.
2. A different Expendable Bathythermograph (XBT) correction (Cheng et al., 2014) has been employed.
3. A double XBT correction has been detected in pre-release version and fixed in final version.
4. All temperature and salinity climatological fields were re-calculated to account for these adjustments.

https://www.ncei.noaa.gov/access/world-ocean-atlas-2018/

# World Ocean Atlas 2023 (WOA23)

**Table 1b. Number of casts in the WOD product series**

| Dataset | NCEI (1974)[1] | NCEI (1991)[2] | WOA 1994 | WOD 1998 | WOD 2001 | WOD 2005 | WOD 2009 | WOD 2013 | WOD 2018 | WOD 2023 |
|---|---|---|---|---|---|---|---|---|---|---|
| OSD[3] | 425,000 | 783,912 | 1,194,407 | 1,373,440 | 2,121,042 | 2,258,437 | 2,541,298 | 3,115,552 | 3,233,155 | 3,256,037 |
| CTD[4] | n/a | 66,450 | 89,000 | 189,555 | 311,943 | 443,953 | 641,845 | 848,911 | 1,089,421 | 1,132,680 |
| MBT[5] | 775,000 | 980,377 | 1,922,170 | 2,077,200 | 2,376,206 | 2,421,940 | 2,426,749 | 2,425,607 | 2,426,301 | 2,426,245 |
| XBT | 290,000 | 704,424 | 1,281,942 | 1,537,203 | 1,743,590 | 1,930,413 | 2,104,490 | 2,211,689 | 2,334,267 | 2,360,444 |
| MRB[6] | n/a | n/a | n/a | 107,715 | 297,936 | 445,371 | 566,544 | 1,411,762 | 1,656,204 | 1,277,591 |
| DRB | n/a | n/a | n/a | n/a | 50,549 | 108,564 | 121,828 | 251,712 | 245,592 | 272,872 |
| PFL | n/a | n/a | n/a | n/a | 22,637 | 168,988 | 547,985 | 1,020,216 | 2,215,341 | 2,748,011 |
| UOR | n/a | n/a | n/a | n/a | 37,645 | 46,699 | 88,190 | 88,190 | 127,544 | 127,574 |
| APB | n/a | n/a | n/a | n/a | 75,665 | 75,665 | 88,583 | 1,713,132 | 1,871,303 | 2,056,367 |
| GLD | n/a | n/a | n/a | n/a | n/a | 338 | 5,857 | 103,798 | 1,665,453 | 2,968,167 |
| **Total casts** | **1,490,000** | **2,535,163** | **4,487,519** | **5,285,113** | **7,037,213** | **7,900,368** | **9,155,099** | **13,190,569** | **16,864,581** | **18,625,988** |
| Plankton | n/a | n/a | n/a | 83,650 | 142,900 | 150,250 | 218,695 | 242,727 | 245,059 | 245,059 |
| SUR[7] | n/a | n/a | n/a | n/a | 4,743 | 9,178 | 9,178 | 9,289 | 9,289 | 9,289 |

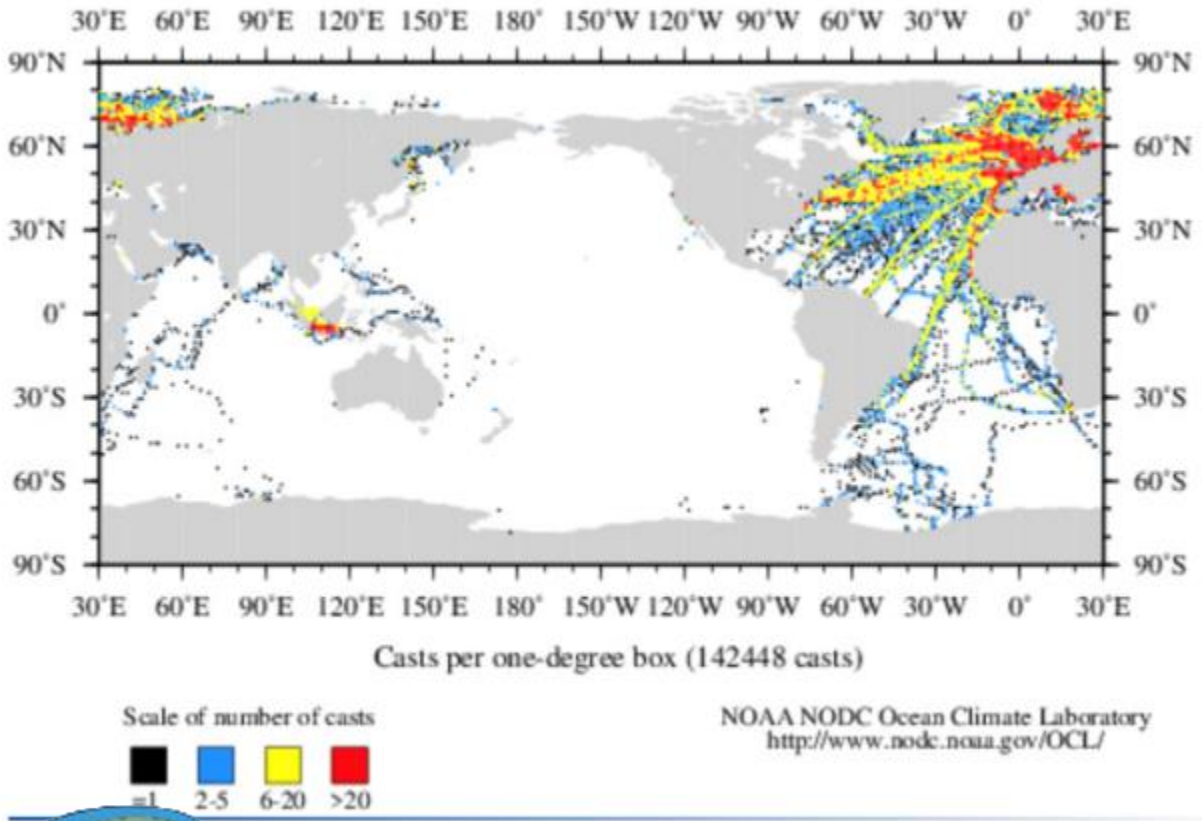
[1] Based on statistics from *Climatological Atlas of the World Ocean* (Levitus, 1982).
[2] Based on NODC Standard Product: Global ocean temperature and salinity profiles (2 disc set) (NCEI Accession 0098058).
[3] WOD23 OSD dataset includes data from 179,616 low-resolution CTD and 1,708 low-resolution XCTD casts.
[4] WOD23 CTD dataset includes data from 12,741 high-resolution XCTD casts.
[5] WOD23 MBT dataset includes data from: 2,340,323 MBT, 80,200 DBT and 5,659 Micro-BT casts.
[6] MRB data submitted under NCEI Accession 0063240 in WOD18 were recorded at the 15-min interval; in 2021 those data were re-converted as daily averages, the daily average profiles matched with the first unique station number each day, and the extra stations were removed, hence total of MRB record counts in WOD23 decreased.
[7] Surface data are represented differently from cast (profile) data in the database – all observations in a single cruise have been combined into one "cast" with zero depth, value(s) of variable(s) measured, latitude, longitude, and Julian year-day to identify data and position of individual observations.

https://www.ncei.noaa.gov/access/world-ocean-atlas-2023/

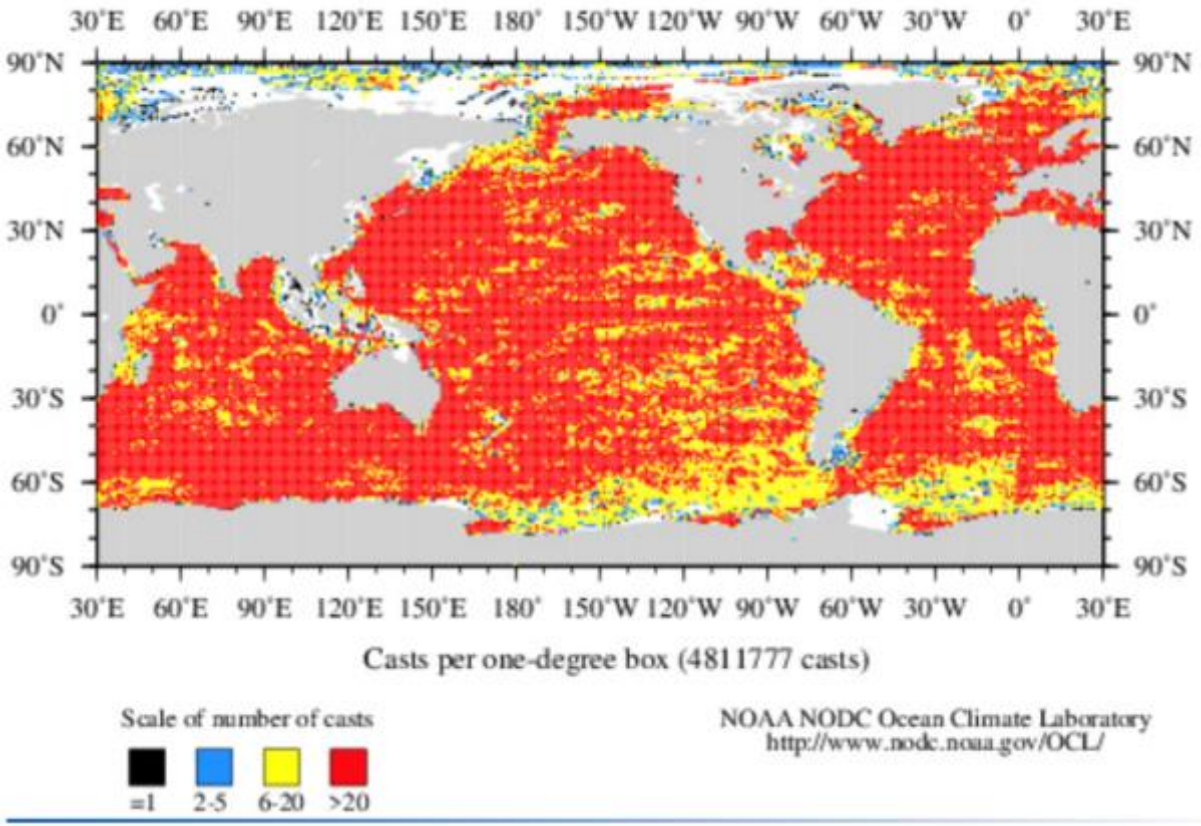
*Garcia et al., 2024*

# World Ocean Database 2018 (WOD18)

https://www.ncei.noaa.gov/access/world-ocean-database-select/dbsearch.html

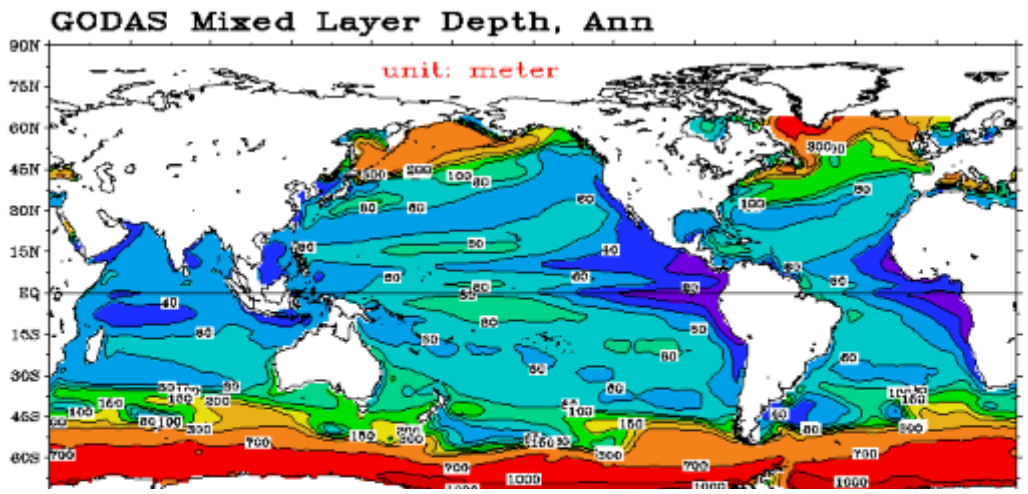


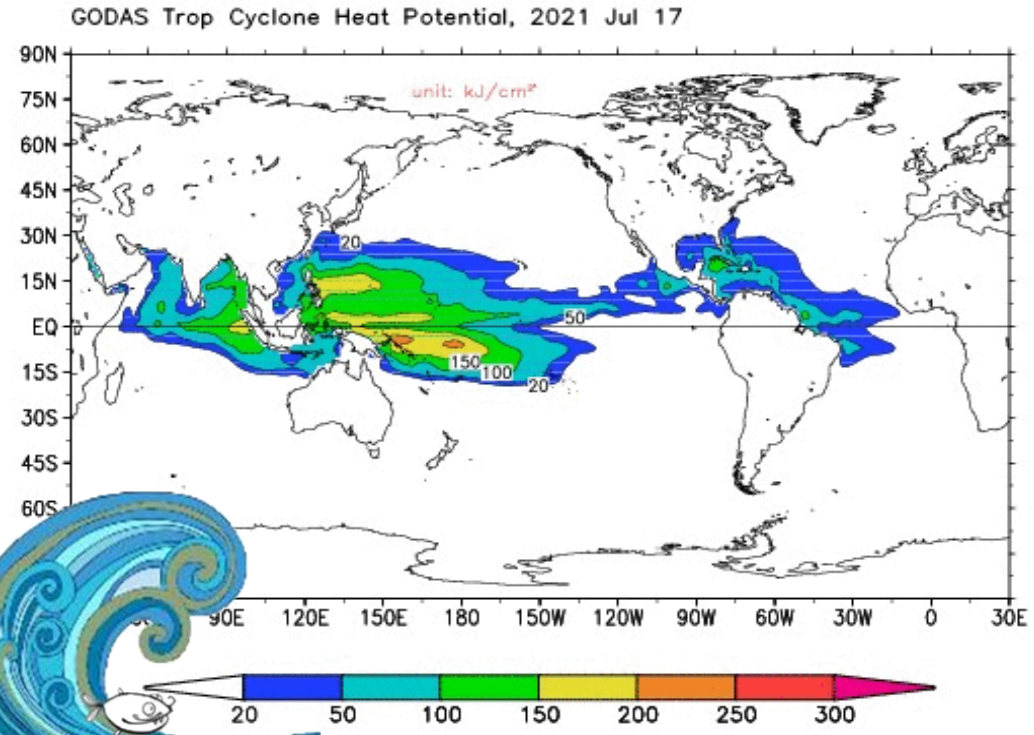

1910-1920




2010-2020

# NCEP Global Ocean Data Assimilation System (GODAS)




https://www.cpc.ncep.noaa.gov/products/GODAS/

National Weather Service

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Coastal upwelling

Binary Data
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Monthly in NetCDF
Other formats

# NCEP Global Ocean Data Assimilation System (GODAS)

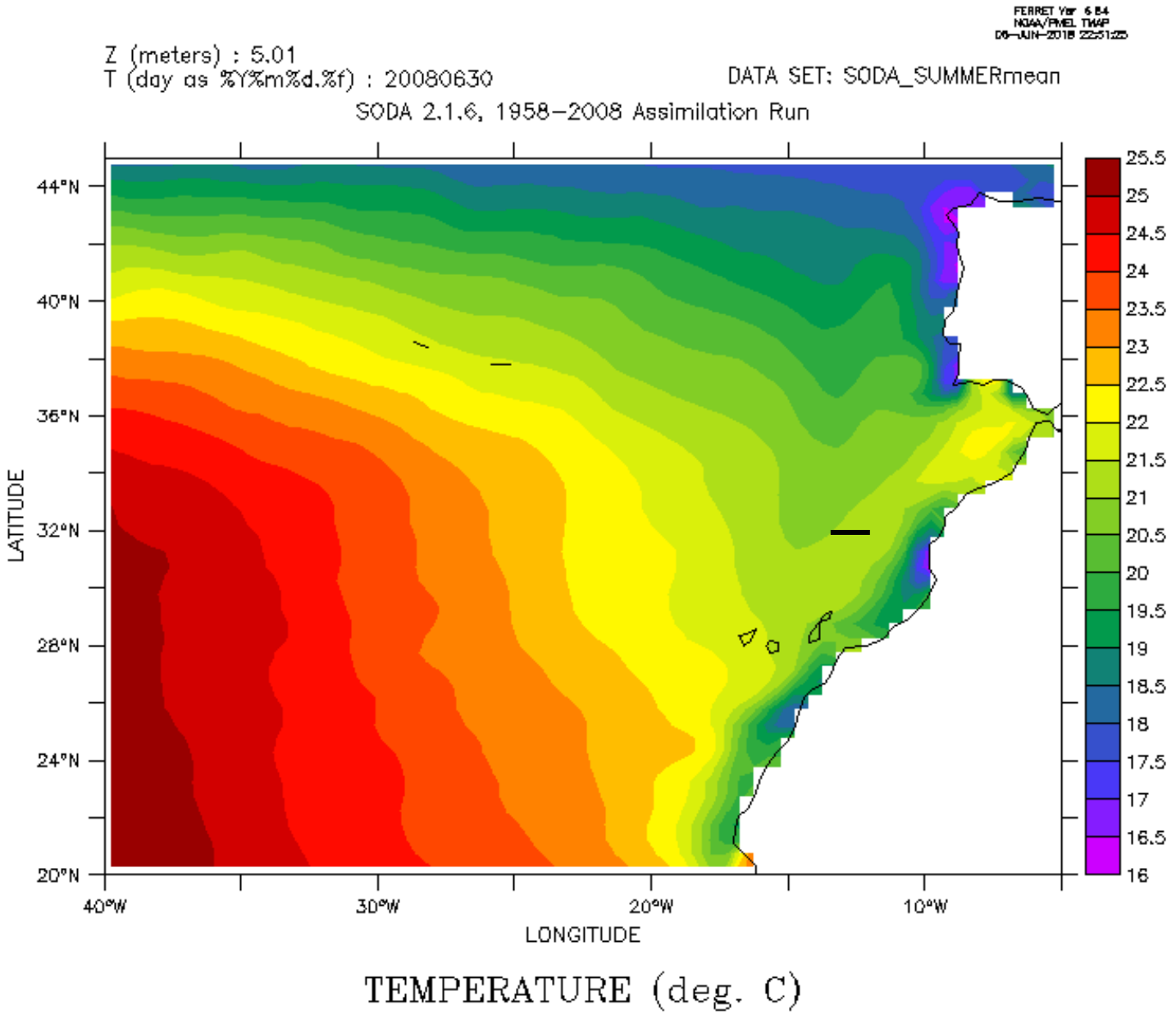
**GODAS depends on continuous real-time data from the Global Ocean Observing System. This project is to deliver routine ocean monitoring products, and is being implemented by CPC in cooperation with NOAA Global Ocean Monitoring and Observing (GOMO)**

- Introduction
- Climatology (1982-2004): Plots Animations
- Monthly products (1979-present): Plots Animations
- Pentad products (past 3 months): Plots Animations
- Coastal upwelling: Plot
- Ocean reanalysis for downloading: Monthly Pentad
- Validations against observations
- Links to other ocean analysis data

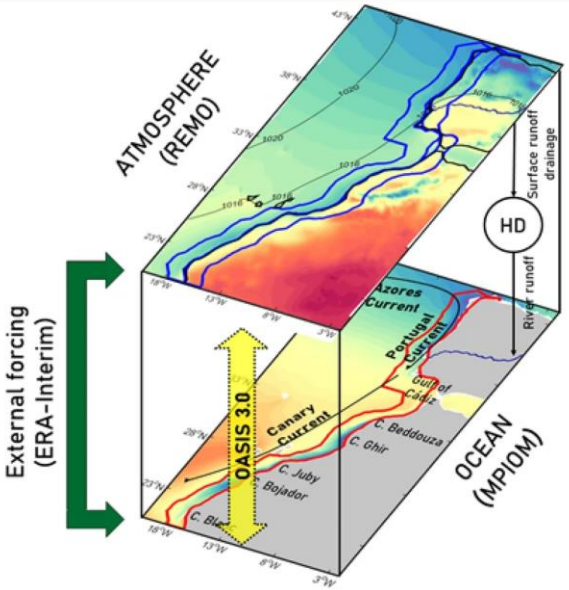
## Monthly Ocean Briefing

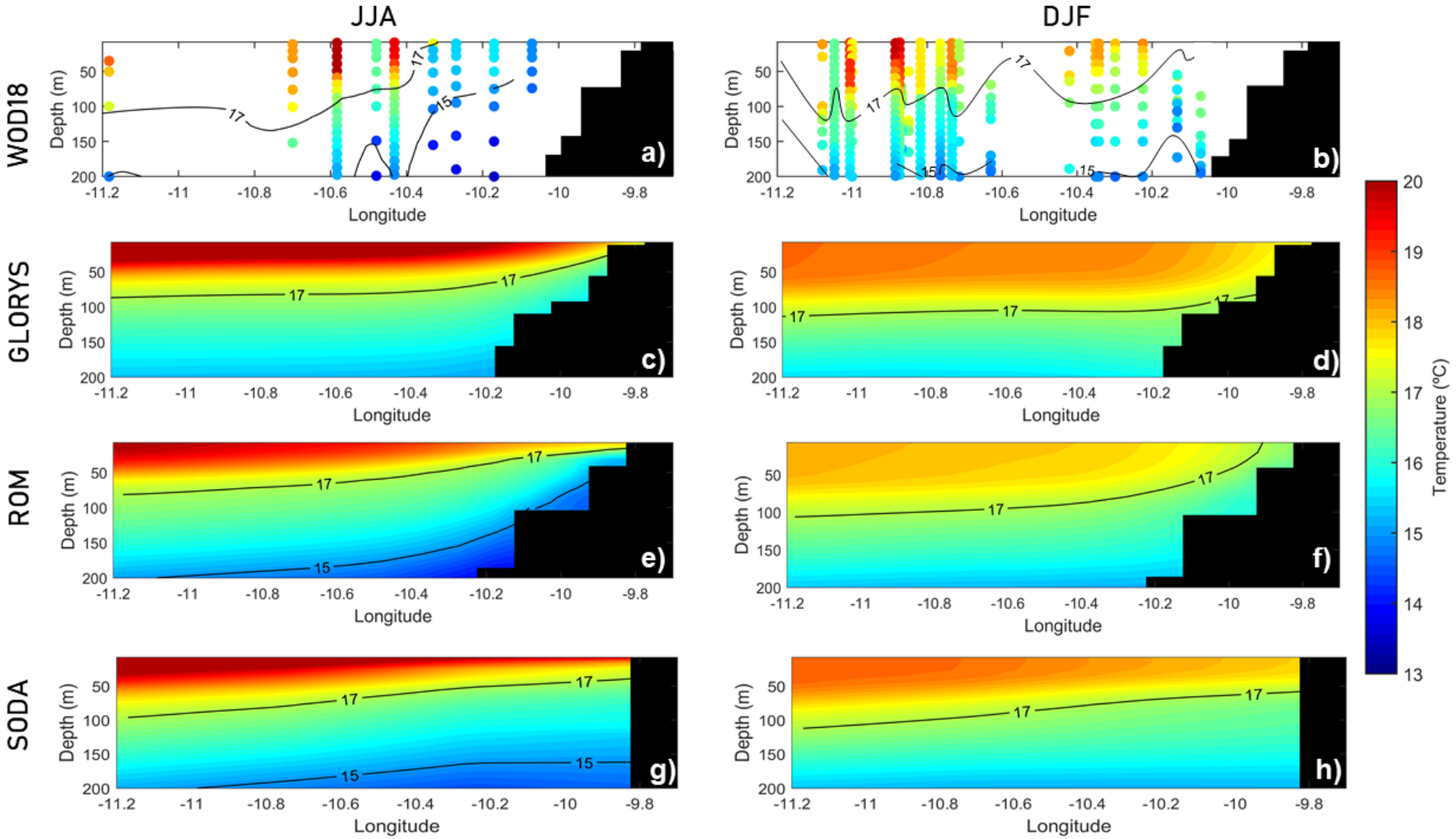
# Simple Ocean Data Assimilation (SODA)

**Model:** GFDL MOM5/SIS1
**Resolution:** Horizontal 0.25° (28 km at Equator). 50 vertical levels, uper layer at 10 m depth
**Period and time resolution:** 1871-2008 (monthly), 1980-2017 (5 days)
**Assimilated data:** WOD09 T&S, ICOADS 2.5 SST
**Forcings:** 20CRv2 for wind stress and bulk formulae
https://www.soda.umd.edu/



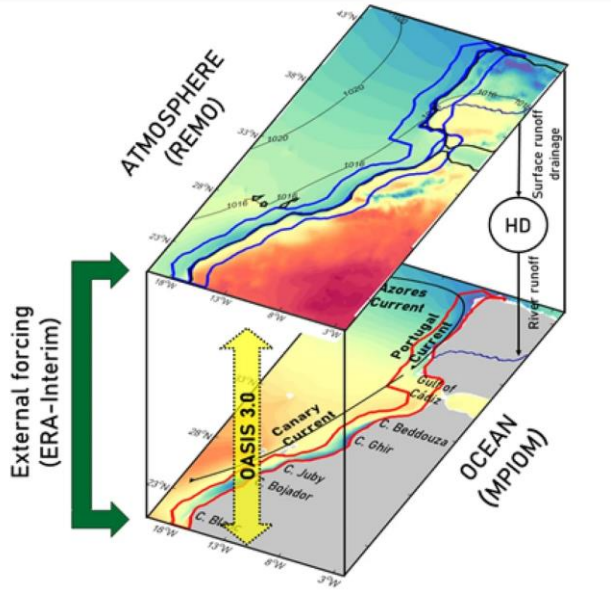
# Insitu data, models and reanalysis




Temperature (°C) transect for JJA (left) and DJF (right) in Cape Ghir (1980–2012) for WOD18 (**a**, **b**), GLORYS (**c**, **d**), ROM (**e**, **f**) and SODA (**g**, **h**). Vázquez et al. (2021)

# Insitu data (WOD) , models and reanalysis




https://www.ncei.noaa.gov/access/world-ocean-database-select/bin/dbsearch.pl

**QUERY RESULTS:**

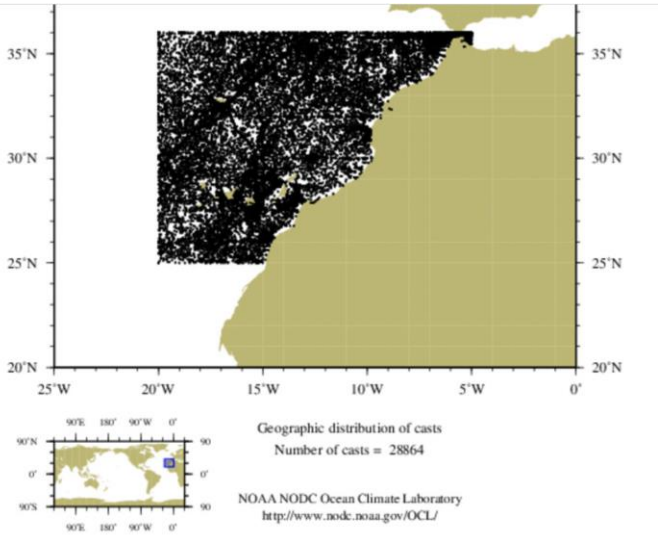
VIEW DATA DISTRIBUTION PLOT | CRUISE LIST

*Please, CLICK ONLY ONCE, it may take a while before results are shown.*

**The cast count for your request is:**

| | |
|---|---|
| 9147 | OSD casts |
| 2798 | CTD casts |
| 0 | XBT casts |
| 0 | MBT casts |
| 9754 | PFL casts |
| 0 | DRB casts |
| 1643 | MRB casts |
| 0 | APB casts |
| 0 | UOR casts |
| 610 | SUR cruises |
| 4912 | GLD casts |
| 28864 | TOTAL casts |

Full (expanded) file size estimate (128.9 MB)




**COPY OF YOUR SEARCH CRITERIA:**

GEOGRAPHIC COORDINATES: *Longitude* from -20.0000 to -5.0000; *Latitude* from 36.0000 to 25.0000
DATASET: OSD,CTD,XBT,MBT,PFL,DRB,MRB,APB,UOR,SUR,GLD
MEASURED VARIABLES (must): Temperature, Salinity
MEASURED VARIABLES (extract): Temperature, Salinity

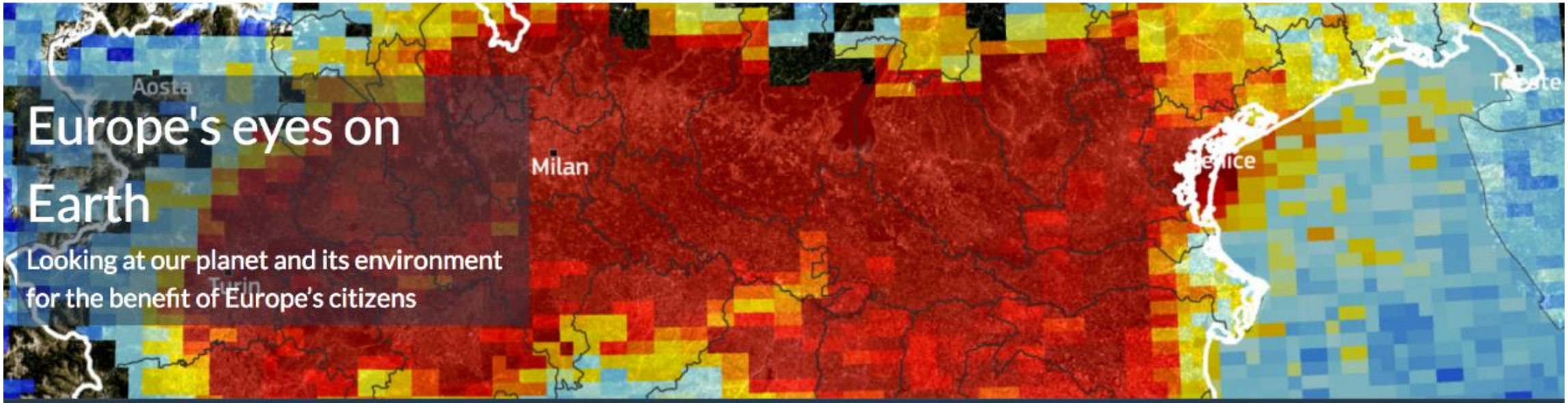
**To get data for specific cruise(s) or accession(s):**

**1.** Place check mark in front of any number of cruises and/or accessions,

**2.** Press SUBMIT CRUISE/ACCESSION button and return to the main database search page.

COLUMN DEFINITIONS

| # | Cruise Reference | Institute | Platform | #Casts | Accession# | Start Date | End Date | Orig. Cruise ID |
|---|---|---|---|---|---|---|---|---|
| 1 | GB012547 | 89 | 8747 | 78 | 0071062 | 1/ 1/1873 | 5/30/1873 | n/a |
| 2 | GB012548 | n/a | 8747 | 32 | 0126754 | 6/13/1873 | 7/27/1873 | NODC-0000-0 |
| 3 | DE011764 | n/a | 296 | 44 | 0000505 | 7/ 7/1874 | 10/18/1874 | NODC-0000-0 |
| 4 | SU007937 | 455 | 6584 | 209 | 9400170 | 11/26/1886 | 5/18/1889 | n/a |
| 5 | SU000000 | 89 | n/a | 89542 | 0071062 | 10/ 1/1894 | 7/28/1990 | n/a |




## Copernicus Services

Atmosphere | Marine | Land | Climate Change | Security | Emergency

# Copernicus Marine Environment Monitoring Service

MARINE DATA LITERACY COURSE

CMEMS -An operational European service by European experts to offer the best worldwide information on Marine Environment based on observations and models


Domains: Global and 8 regional domains





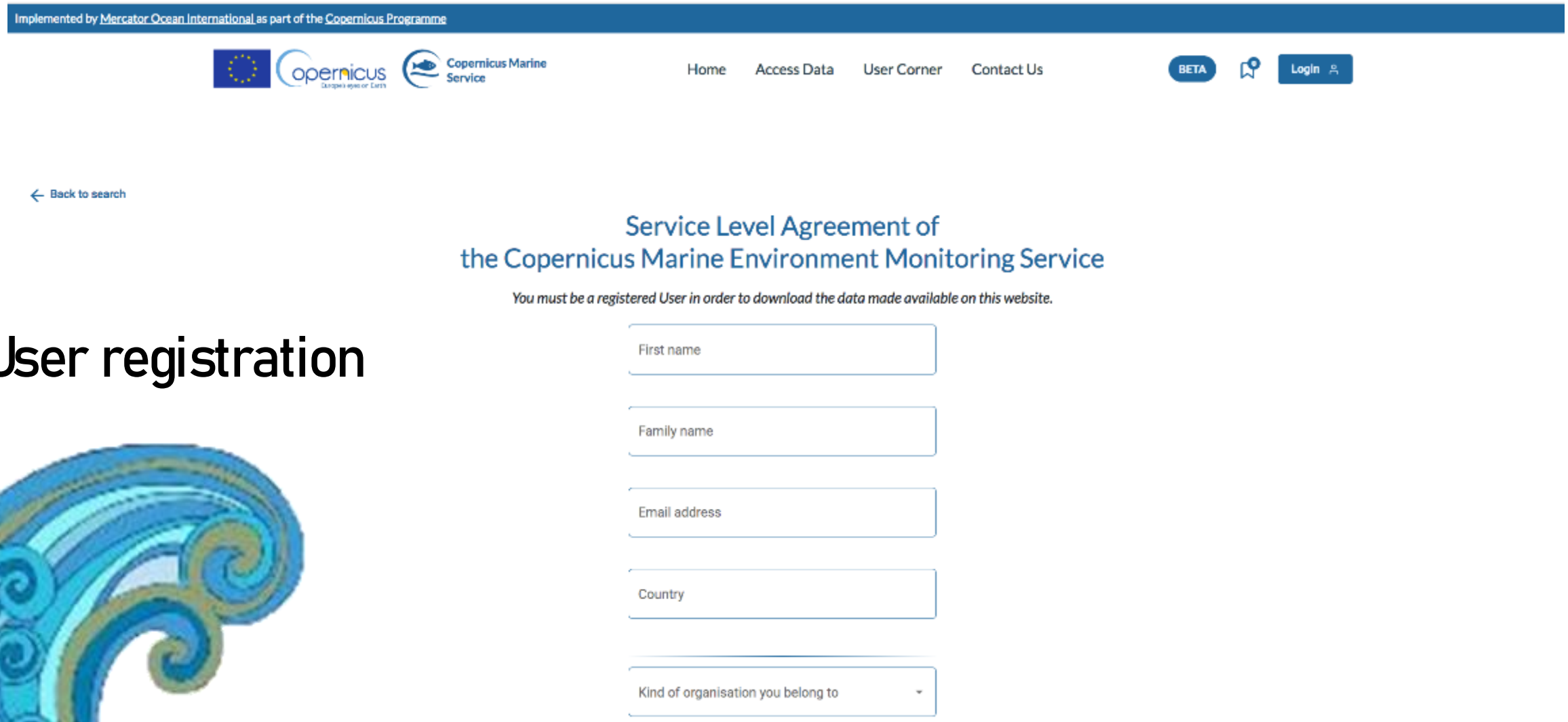








# Copernicus Marine Environment Monitoring Service




## User registration

https://resources.marine.copernicus.eu/registration-form

# Copernicus Marine Environment Monitoring Service

MARINE DATA LITERACY COURSE

Resources | News | Press | Events | Contact | REGISTER | Type... | English

Copernicus Europe's eyes on Earth | Copernicus Marine Service

Services | Opportunities | Access Data | Use Cases | User Corner | About


Home > Access data

## Explore terabytes of ocean data at all different user levels

DATA

### OCEAN PRODUCTS

Ocean product catalogue, to download or visualize data across nearly 15 variables, including hindcast, current and forecast data

TRENDS

### OCEAN CLIMATE TRENDS

Monitoring the health of the ocean.
Ocean Monitoring Indicators
Ocean Climate Portal

EXPERTISE

### OCEAN STATE REPORT

Extensive annual analysis on the state of the ocean over nearly 20 years and severe/notable annual events

TRACK

### OCEAN IN SITU

Track in situ technology deployed in the ocean through our In Situ TAC Dashboard

EXPLORATION

### OCEAN VISUALISATION

Dive into our 4D digital oceans through our 3 visualisation tools for beginner, intermediate and advanced users

QUALITY

### PRODUCT QUALITY DASHBOARD

Explore our monthly scientific performance and product quality information updates.

POLICIES

### OCEAN PRODUCTS FOR MSFD

Together with EMODnet, we provide relevant data for the Marine Strategy Framework Directive (MSFD)

INFOGRAPHICS

### DATA IN A NUTSHELL

Dive into our data offer for the Blue (physical), White (sea ice), and Green (biogeochemical) ocean

# Copernicus Marine Environment Monitoring Service



## User Corner



### Help Center & FAQ

Have a question about our services? Find everything gathered in one intuitive place online.

### User Notification Service

Check or subscribe to learn about planned maintenance, updates and the latest developments.

### Product Roadmap

Need to plan ahead? Explore our timeline of upcoming service developments and improvements.

### E-Learning

Access our tutorials online, accompanied by videos, code, and more.

### Product Quality

Explore our monthly performance and product quality information updates.

### Data in a nutshell

Dive into our data offer for the Blue (physical), White (sea ice), and Green (biogeochemical) ocean

### Service Commitments & Licence

Transparency is needed to create trust and value: see a summary of key points associated with our service.

### User Feedback & Needs Platform

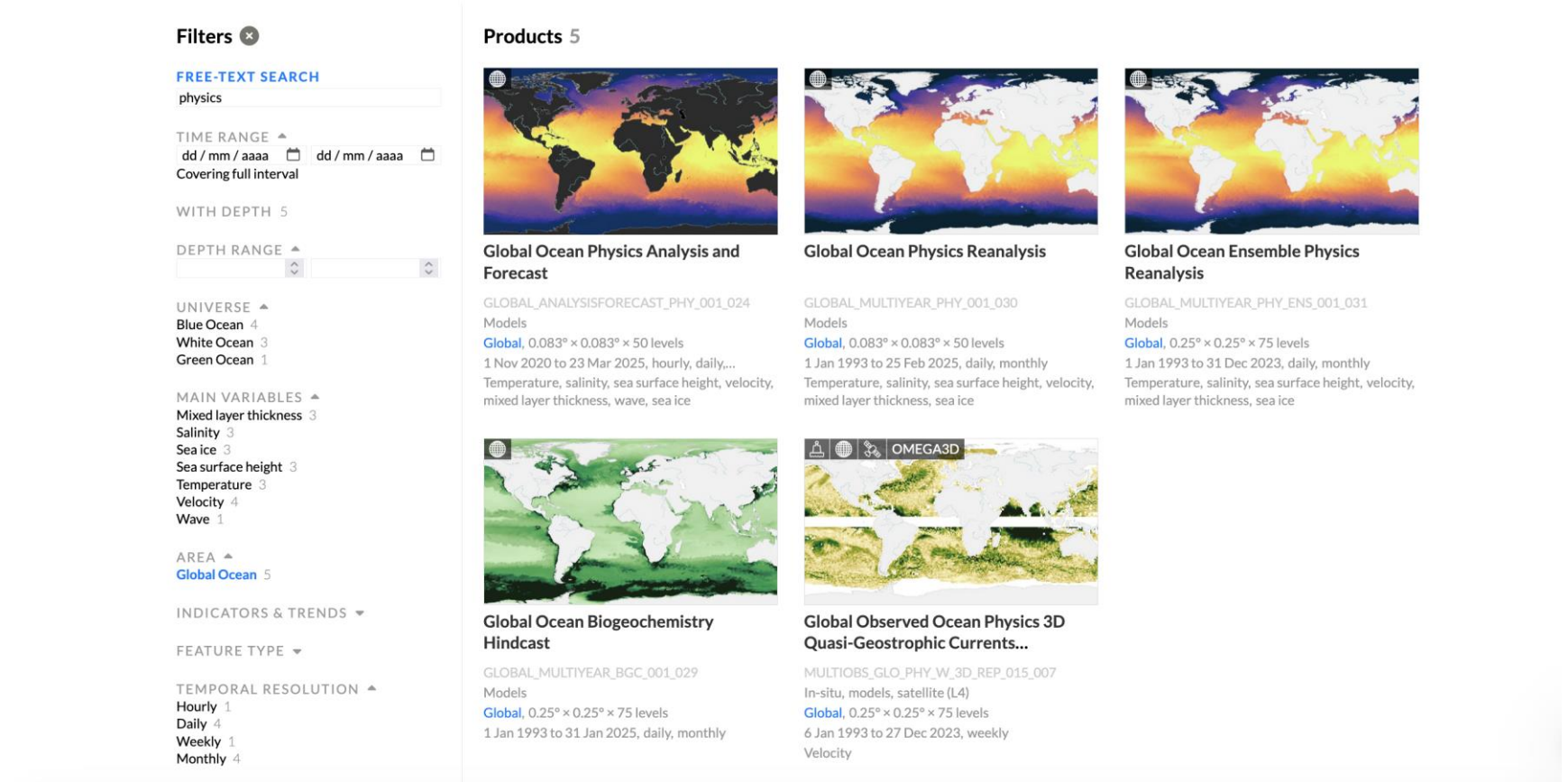
Ideas ? We are listening! This is your space to share suggestions, needs, and help shape the future of the Copernicus Marine Service.

# Copernicus Marine Environment Monitoring Service

MARINE DATA LITERACY COURSE

Searching the catalogue:

- Keyword
- Domain
- Time period
- Variables




Product

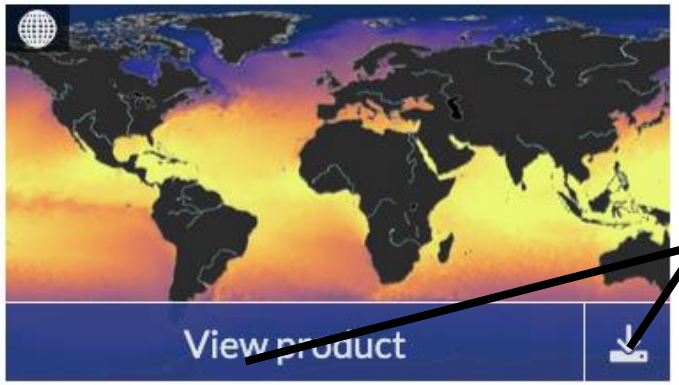
Datasets

Parameters

Resolution and coverage limited by:

- computing power
- storage capacity

# We select one of the products...




DOWNLOAD

VIEW

**Global Ocean Physics Analysis and Forecast**

GLOBAL_ANALYSISFORECAST_PHY_001_024

Models

Global, 0.083° × 0.083° × 50 levels

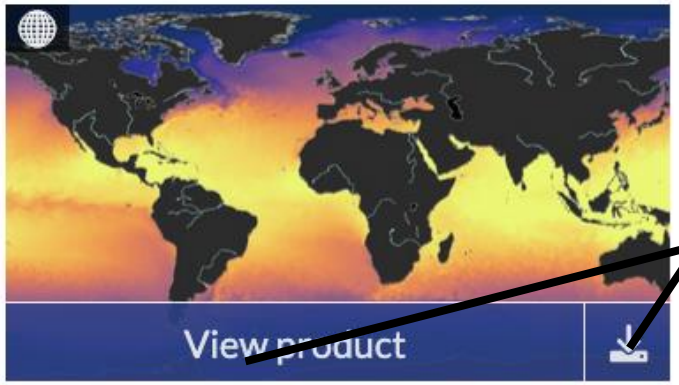
1 Nov 2020 to 23 Mar 2025, hourly, daily,...

Temperature, salinity, sea surface height, velocity, mixed layer thickness, wave, sea ice

## Classification

| | |
|---|---|
| **Full name** | Global Ocean Physics Analysis and Forecast |
| **Product ID** | GLOBAL_ANALYSISFORECAST_PHY_001_024 |
| **Source** | Numerical models |
| **Spatial extent** | Global Ocean · Lat -80° to 90° · Lon -180° to 179.92° |
| **Spatial resolution** | 0.083° × 0.083° |
| **Temporal extent** | 1 Nov 2020 to 23 Mar 2025 |
| **Temporal resolution** | Hourly · Daily · Monthly |
| **Elevation (depth) levels** | 50 |
| **Processing level** | Level 4 |
| **Variables** | Sea water potential temperature (T) · Sea surface temperature anomaly (SST) · Sea water potential temperature at sea floor (TOB) · Sea water salinity (S) · Sea water potential salinity at sea floor (S) · Sea surface height above geoid (SSH) · Change in sea surface height due to change in air pressure (SSH) · Tidal sea surface height above mean sea level (SSH) · Eastward sea water velocity (UV) · Northward sea water velocity (UV) · Sea surface wave stokes drift x velocity (UV, VSDXY) · Sea surface wave stokes drift y velocity (UV, VSDXY) · Upward sea water velocity (UV) · Surface sea water x velocity (UV) · Surface sea water y velocity (UV) · Surface sea water x velocity due to tide (UV) · Surface sea water y velocity due to tide (UV) · Ocean mixed layer thickness defined by sigma theta (MLD) · Sea ice thickness (SIT) · Eastward sea ice velocity (SIUV) · Northward sea ice velocity (SIUV) · Surface snow thickness (SNOW) · Age of sea ice (SIAGE) · Sea ice albedo (SIALB) · Sea ice surface temperature (IST) · Cell thickness · Change in sea floor height above reference ellipsoid due to ocean tide loading · Global average sea level change due to change in ocean mass · Global average steric sea level change · Model level number at sea floor · Ocean dynamic sea level · Sea binary mask · Sea floor depth below geoid · Sea ice area fraction · Sea ice speed · Sea water pressure at sea floor |
| **Feature type** | Grid |
| **Blue markets** | Polar Environment Monitoring · Policy & Governance · Education · Public Health & Recreation · Science & Innovation · Extremes & Hazards & Safety · Coastal Services · Natural Resources & Energy · Trade & Marine Navigation |
| **Projection** | Equirectangular |
| **Data assimilation** | Sea Level · Sea Ice Concentration and/or Thickness · SST · In-Situ TS Profiles |
| **Update frequency** | Daily – *12:00 UTC; 15th day of month at 12:00 UTC* · Monthly |
| **Format** | NetCDF-3 · NetCDF-4 |
| **Originating centre** | Mercator Océan International |
| **Last metadata update** | 26 November 2024 |

# We select one of the products...




DOWNLOAD

VIEW

**Global Ocean Physics Analysis and Forecast**

GLOBAL_ANALYSISFORECAST_PHY_001_024

Models

Global, 0.083° × 0.083° × 50 levels

1 Nov 2020 to 23 Mar 2025, hourly, daily,...

Temperature, salinity, sea surface height, velocity, mixed layer thickness, wave, sea ice

Copernicus Marine Service

Services Opportunities Access Data Use Cases User Corner About

# Global Ocean Physics Analysis and Forecast

Home > Marine Data Store > Product

- Description
- Notifications
- Data access
- Contact

DOCUMENTATION

- User Manual
- Quality Information Document
- Synthesis Quality Overview
- Product Quality Dashboard
- Roadmap
- Licence
- How to cite

DOI

10.48670/moi-00016

## Overview

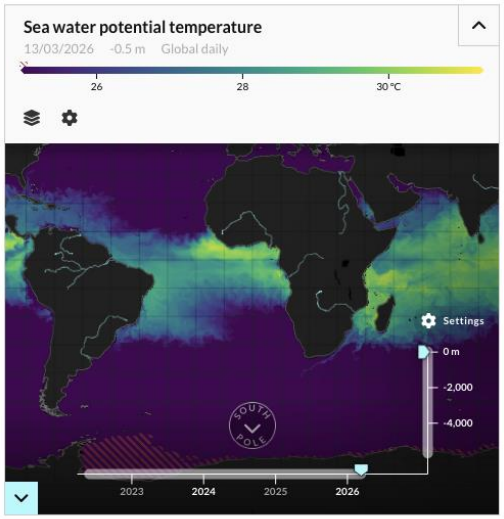
The Operational Mercator global ocean analysis and forecast system at 1/12 degree is providing 10 days of 3D global ocean forecasts updated daily. The time series is aggregated in time in order to reach a two full year's time series sliding window.

This product includes daily and monthly mean files of temperature, salinity, currents, sea level, mixed layer depth and ice parameters from the top to the bottom over the global ocean. It also includes hourly mean surface fields for sea level height, temperature and currents. The global ocean output files are displayed with a 1/12 degree horizontal resolution with regular longitude/latitude equirectangular projection.

50 vertical levels are ranging from 0 to 5500 meters.

This product also delivers a special dataset for surface current which also includes wave and tidal drift called SMOC (Surface merged Ocean Current).

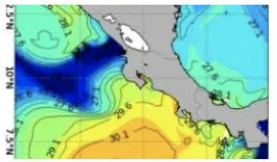
**DOI (product):**
https://doi.org/10.48670/moi-00016




Explore in MyOcean Pro

## Use cases


IBISAR web service in support to search and rescue operations



Coastal marine safety in Costa Rica

Addressing marine pollution from oil spills with effective dispersion modelling

Show 81 more cases

# We select one of the datasets of the product (we can download or view it) ...

MARINE DATA LITERACY COURSE

## Global Ocean Physics Analysis and Forecast

Home > Marine Data Store > Product

- Description
- Notifications
- Data access
- Contact

DOCUMENTATION

- User Manual
- Quality Information Document
- Synthesis Quality Overview
- Product Quality Dashboard
- Roadmap
- Licence
- How to cite

DOI

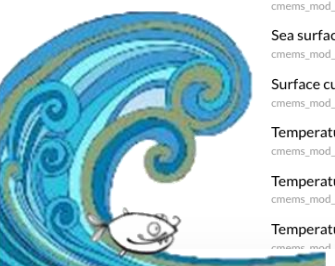
10.48670/moi-00016

### Data access and mapping services

There are multiple ways to download data from this product:

- If you prefer a graphical tool, click on the top-right button: .
- **Subset**: The most intuitive graphical approach for subsetting data in time, space and/or variables. For a programming approach (*WCS-like*), prefer the Copernicus Marine Toolbox: CLI or Python API.
- **Files**: The fastest graphical approach to get original files (*FTP-like*). For a programming approach, prefer the Copernicus Marine Toolbox: CLI or Python API.
- **Maps**: The standard mapping service for GIS approach (QGIS or similar tools).
- If you are looking for a lazy-loading data access (*xarray/OPeNDAP-like*), copy the dataset ID and use it with the Copernicus Marine Toolbox: Python API.

| Dataset | Temporal extent | Subset | Files | Maps |
|---|---|---|---|---|
| Hourly<br>cmems_mod_glo_phy_anfc_0.083deg_PT1H-m | 01/06/2022–15/03/2026 | Form | Browse | WMTS |
| Daily<br>cmems_mod_glo_phy_anfc_0.083deg_P1D-m | 01/06/2022–14/03/2026 | Form | Browse | WMTS |
| Monthly<br>cmems_mod_glo_phy_anfc_0.083deg_P1M-m | 01/06/2022–01/01/2026 | Form | Browse | WMTS |
| Currents, 6-hourly<br>cmems_mod_glo_phy-cur_anfc_0.083deg_PT6H-i | 01/06/2022–15/03/2026 | Form | Browse | WMTS |
| Currents, daily<br>cmems_mod_glo_phy-cur_anfc_0.083deg_P1D-m | 01/06/2022–14/03/2026 | Form | Browse | WMTS |
| Currents, monthly<br>cmems_mod_glo_phy-cur_anfc_0.083deg_P1M-m | 01/06/2022–01/01/2026 | Form | Browse | WMTS |
| Salinity, 6-hourly<br>cmems_mod_glo_phy-so_anfc_0.083deg_PT6H-i | 01/06/2022–15/03/2026 | Form | Browse | WMTS |
| Salinity, daily<br>cmems_mod_glo_phy-so_anfc_0.083deg_P1D-m | 01/06/2022–14/03/2026 | Form | Browse | WMTS |
| Salinity, monthly<br>cmems_mod_glo_phy-so_anfc_0.083deg_P1M-m | 01/06/2022–01/01/2026 | Form | Browse | WMTS |
| Sea level, hourly<br>cmems_mod_glo_phy_anfc_merged-sl_PT1H-i | 01/09/2022–15/03/2026 | Form | Browse | WMTS |
| Sea surface temperature anomaly, daily<br>cmems_mod_glo_phy_anfc_0.083deg-sst-anomaly_P1D-m | 01/11/2022–14/03/2026 | Form | Browse | WMTS |
| Sea surface temperature anomaly, monthly<br>cmems_mod_glo_phy_anfc_0.083deg-sst-anomaly_P1M-m | 01/09/2022–01/01/2026 | Form | Browse | WMTS |
| Surface currents, hourly<br>cmems_mod_glo_phy_anfc_merged-uv_PT1H-i | 01/11/2020–14/03/2026 | Form | Browse | WMTS |
| Temperature, 6-hourly<br>cmems_mod_glo_phy-thetao_anfc_0.083deg_PT6H-i | 01/06/2022–15/03/2026 | Form | Browse | WMTS |
| Temperature, daily<br>cmems_mod_glo_phy-thetao_anfc_0.083deg_P1D-m | 01/06/2022–14/03/2026 | Form | Browse | WMTS |
| Temperature, monthly<br>cmems_mod_glo_phy-thetao_anfc_0.083deg_P1M-m | 01/06/2022–01/01/2026 | Form | Browse | WMTS |



## Global Ocean Physics Analysis and Forecast

Home > Marine Data Store > Product > Download

Download | Automate | Browse files | ~ 11.83 MB

### Dataset

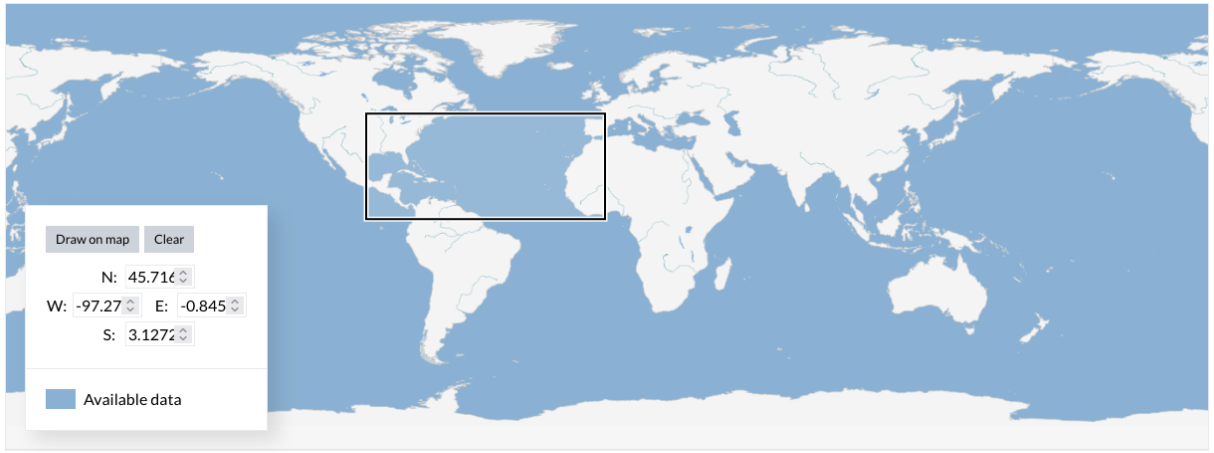
**Product identifier** GLOBAL_ANALYSISFORECAST_PHY_001_024
**Product name** Global Ocean Physics Analysis and Forecast
**Dataset** *Please choose one of the datasets in this product:*
Hourly · cmems_mod_glo_phy_anfc_0.083deg_PT1H-m

### Variables*

Add all | Clear all

- Eastward sea water velocity *uo* [m/s]
- Northward sea water velocity *vo* [m/s]
- Sea surface height above geoid *zos* [m]
- Sea water potential temperature *thetao* [°C]
- Sea water salinity *so* [/ $10^3$]

### Area of interest



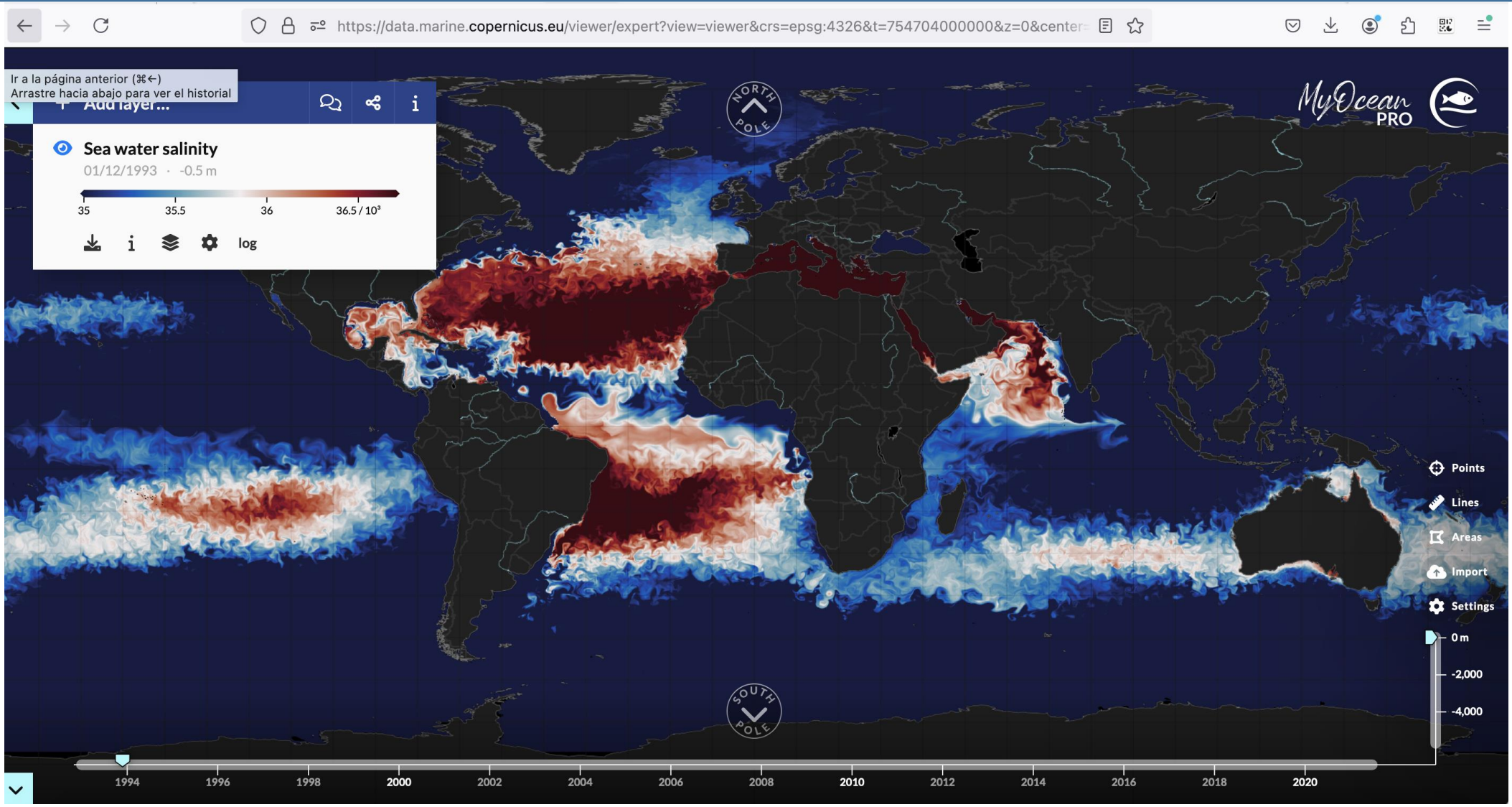

### Date range

Use defaults | Clear

*Choose start and end times at least partly within this range: 01/06/2022, 00:00 → 14/03/2026, 23:00*

**From** 14 / 03 / 2026 , 23 : 00
**To** 14 / 03 / 2026 , 23 : 00

# We view one parameter from one of the datasets of the product ...




USE THE “EXPLORE DATA BUTTON” OR GO TO VISUALIZATION AND UPLOAD THE DATA SET

# You can use the Copernicus Visualization tools (from beginner level to expert!) …

## Ocean data visualisation tools

Home > Access data > Visualisation tools

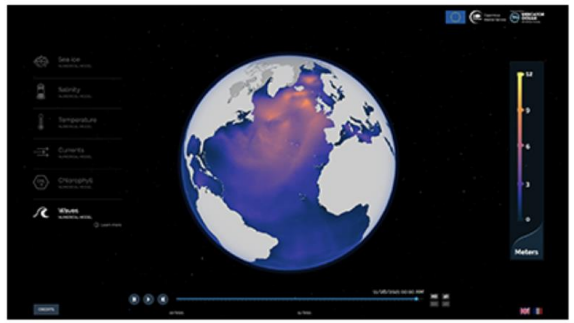
We offer a variety of ocean visualisation tools that allow visitors at all different user levels to dive into our digital oceans and explore.

Below are our main tools for beginner, intermediate and advanced users, respectively. See the table below to learn about their different features.

In order to access the full features of the viewers you need to be a registered user of the Copernicus Marine Service. Register today, by clicking here; it's free and quick!

**MYOCEAN LEARN**

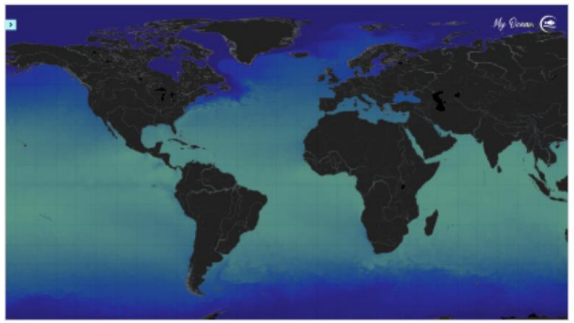
**(BEGINNER) GLOBE**



**Understand key variables**

**MYOCEAN LIGHT**

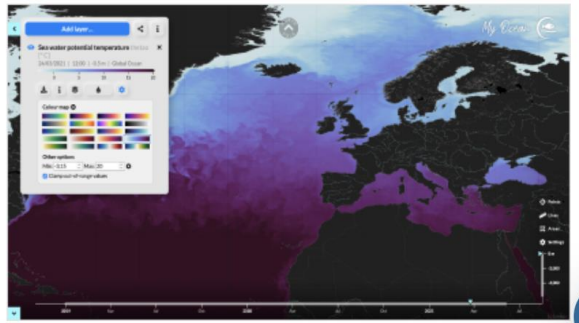
**(INTERMEDIATE) PLANISPHERE**



**Access key variables**

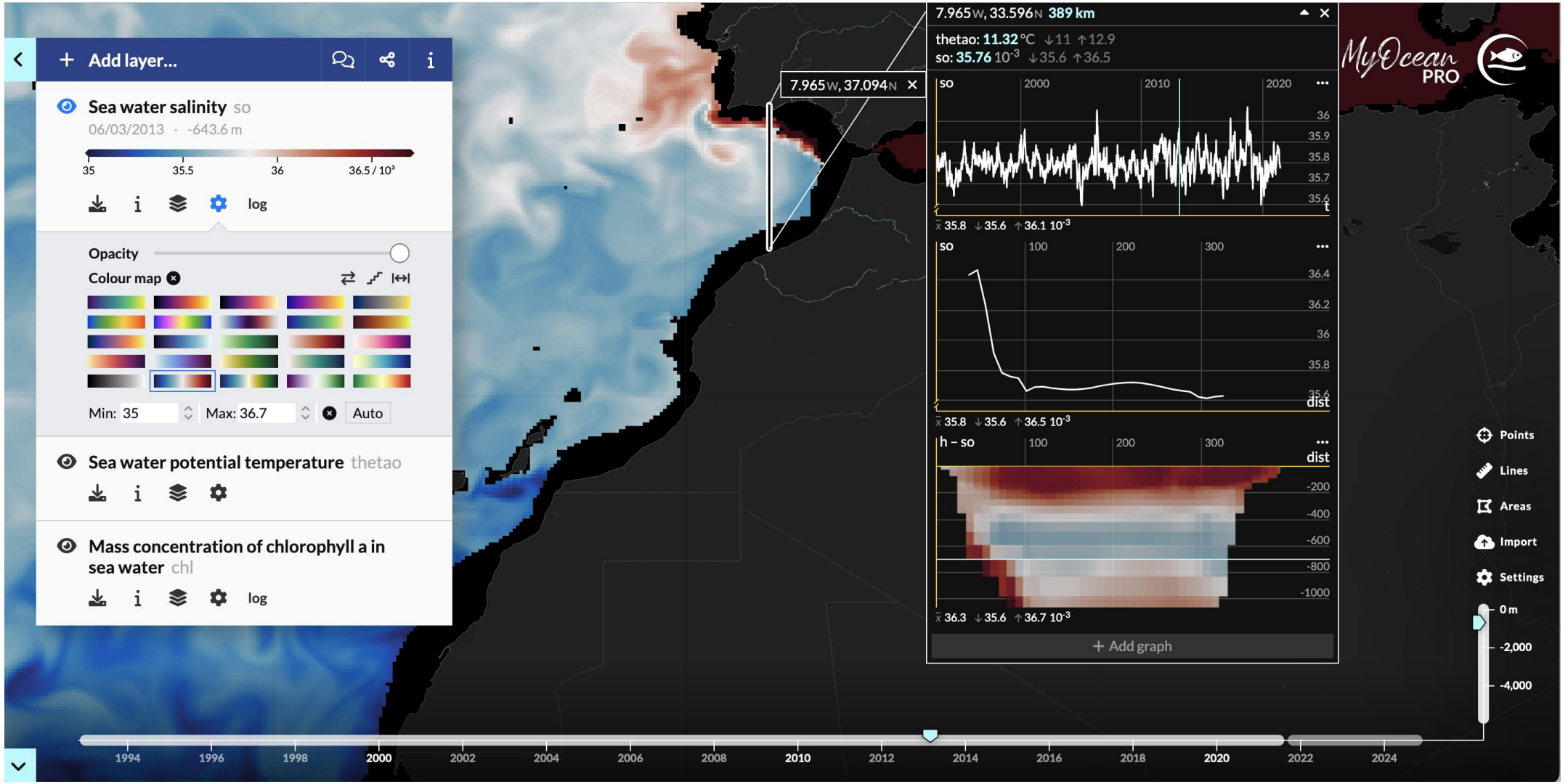
**MYOCEAN PRO**

**(EXPERT) PLANISPHERE**

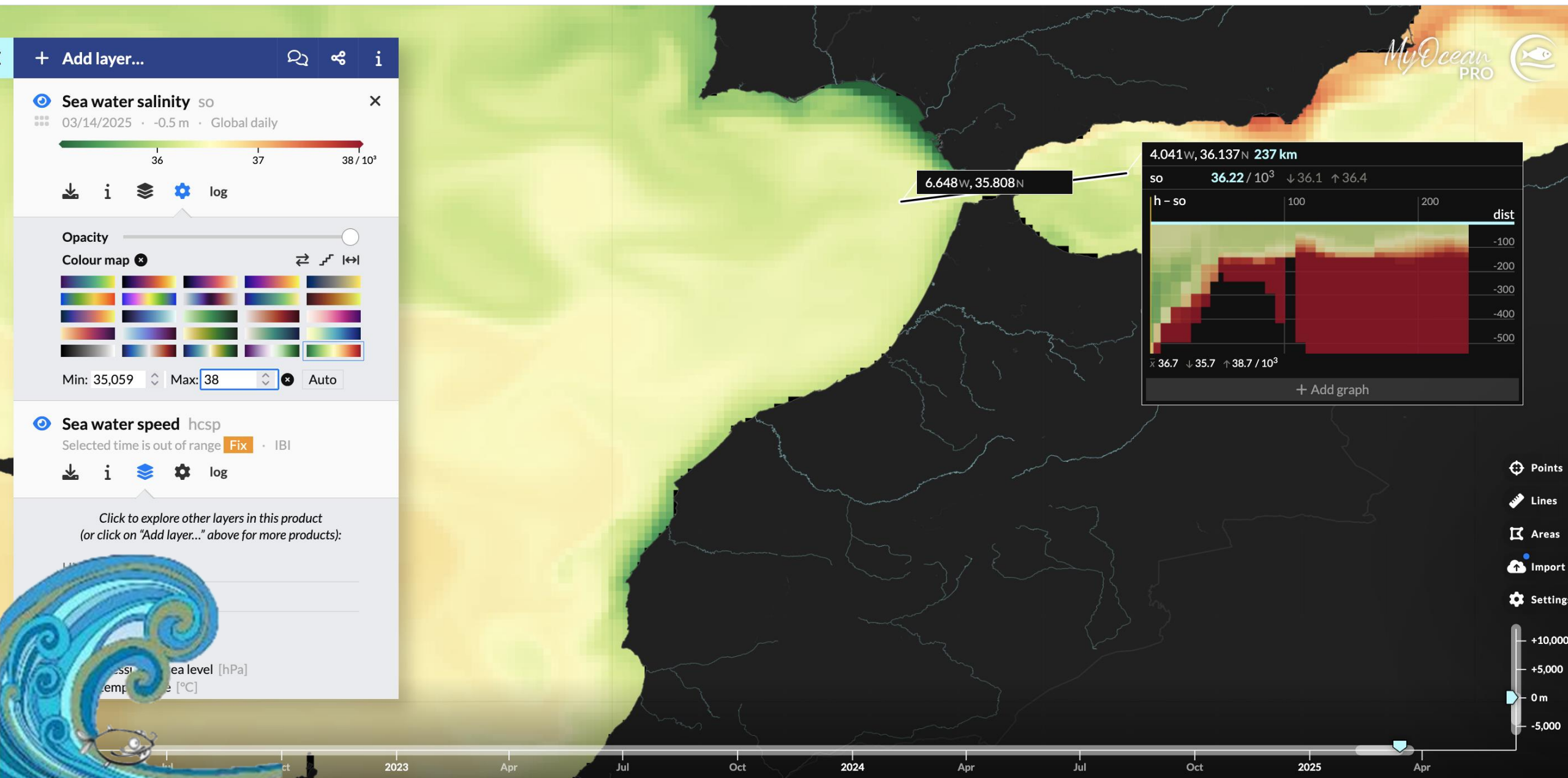


**Access full catalogue**

# You can use the Copernicus Visualization tools (from beginner level to expert!) ...



# We view one parameter (layer) from one of the datasets of the product ...



# PRODUCT USER MANUAL (PUM)

COPERNICUS MARINE SERVICE PRODUCT USER MANUAL

PRODUCT USER MANUAL

For the GLOBAL Ocean Sea Physical Analysis and Forecasting Products

GLOBAL_ANALYSIS_FORECAST_PHY_001_024

Issue: 1.7

tributors: S. Law Chune , L.Nouel, E. Fernandez, Corinne Derval, M.Tressol, R. Dussurget

val Date : MAY 2021

CHANGE RECORD

| Issue | Date | § | Description of Change | Author | Validated By |
|---|---|---|---|---|---|
| 1.1 | 21/09/2016 | All | initial version | L.NOUEL | Y Drillet |
| 1.2 | 19/09/2017 | All | Addition of static and monthly datasets – Reformatting to follow new template | E. Fernandez | L. Nouel |
| 1.3 | 26/04/2018 | II.3 | Addition of Information on SSH | C. Derval | C. Derval |
| 1.4 | 18/01/2019 | | Addition of a new dataset of 3 merged : general circulation, tides & waves | S. Law Chune | C. Derval |
| 1.5 | 19/11/2019 | | Addition of new datasets for instantaneous data | M. Tressol | |
| 1.6 | 01/07/2020 | IV | Nomenclature description & FTP download behaviour. | M. Tressol | C. Derval |
| 1.7 | 03/05/2021 | | 10D forecast for SMOC | C. Derval | C. Derval |

CONSTANTLY UPDATED: EVOLVING SYSTEM, IMPROVING SERVICES

# PRODUCT USER MANUAL (PUM)

MARINE DATA LITERACY COURSE

**TABLE OF CONTENTS**



Full description and how to use it

| Dataset: global-analysis-forecast-phy-001-024--hourly-merged-uv | | |
|---|---|---|
| **Variables** | Zonal and Meridional Velocities for :<br>- Oceanic general circulation : (uo,vo)<br>- Tide currents (utide, vtide)<br>- Current from waves (ustokes, vstokes)<br>- Total current (utotal, vtotal) | |
| | **Analysis** | **Forecast** |
| **Update frequency** | Daily | Daily |
| **Available time series** | 1st April 2016 up to real-time | 10-days forecast |
| **Target delivery time** | Daily at 12pm (noon) UTC | Daily at 12pm (noon) UTC |
| **Temporal resolution** | 1-hourly instantaneous | 1-hourly instantaneous |
| **Number of vertical levels** | 1 | |
| **global-analysis-forecast-phy-001-024-3dinst-thetao** | | |
| **Variables** | - Temperature | |
| | **Analysis** | **Forecast** |
| **Update frequency** | Daily | Daily |
| **Available time series** | 1st January 2019 up to real-time | 48 hours forecast |
| **Target delivery time** | Daily at 12pm (noon) UTC | Daily at 12pm (noon) UTC |
| **Temporal resolution** | 6-hourly instantaneous | 6-hourly instantaneous |
| **Number of vertical levels** | 50 | |

One product may have several datasets, each of which may have several parameters

# QUALITY INFORMATION DOCUMENT (QUID)

COPERNICUS
MARINE ENVIRONMENT MONITORING SERVICE

## QUALITY INFORMATION DOCUMENT

### QUALITY INFORMATION DOCUMENT

**For Global Sea Physical Analysis and Forecasting Product**

**GLOBAL_ANALYSIS_FORECAST_PHY_001_024**

**Issue:** 2.1

**Contributors** :J-M. LELLOUCHE, O. LEGALLOUDEC, C.REGNIER, B. LEVIER, E. GREINER, M.DREVILLON

**Quality Assurance Review Group** : 30/04/2019

### CHANGE RECORD

| Issue | Date | § | Description of Change | Author | Validated By |
|---|---|---|---|---|---|
| 1.0 | 23/09/2016 | All | Creation of the document for CMEMS V2.3 | M. Drevillon | Y. Drillet |
| 2.0 | 19/10/2016 | | Correction after review | J. M. Lellouche | Y. Drillet |
| 2.1 | 01/01/ 2019 | SI, | Merging of the document to include SMOC dataset | S. Law Chune | Mercator Ocean |

### I.2 Executive summary

The quality of the Global high resolution system and GLO_HR products has been assessed using one year of the hindcast. The headline results for each of the variables assessed are as follows.

#### *I.2.1 Temperature and salinity*

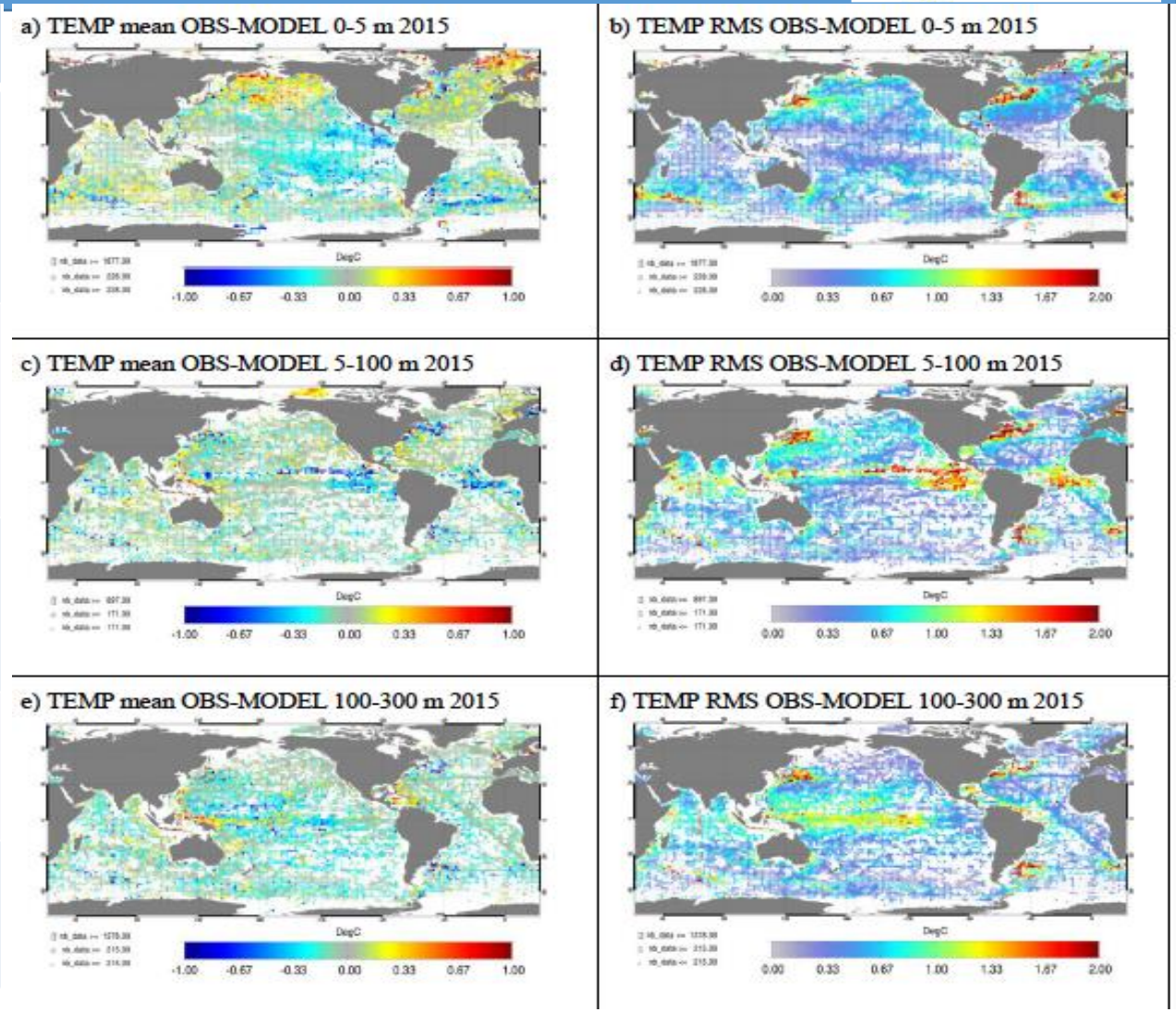
The systems description of the ocean water masses is very accurate on average and departures from in situ observations rarely exceed 0.5 K and 0.1 psu. In the thermocline, RMS errors reach 1 K and 0.2 psu. In high variability regions like the Gulf Stream or the Agulhas Current, or the Eastern Tropica Pacific, RMS errors reach more than 2 K and 0.5 psu locally.

CONSTANTLY UPDATED: ASSESSMENT LEADS TO PRODUCT IMPROVEMENT

# QUALITY INFORMATION DOCUMENT (QUID)

MARINE DATA LITERACY COURSE

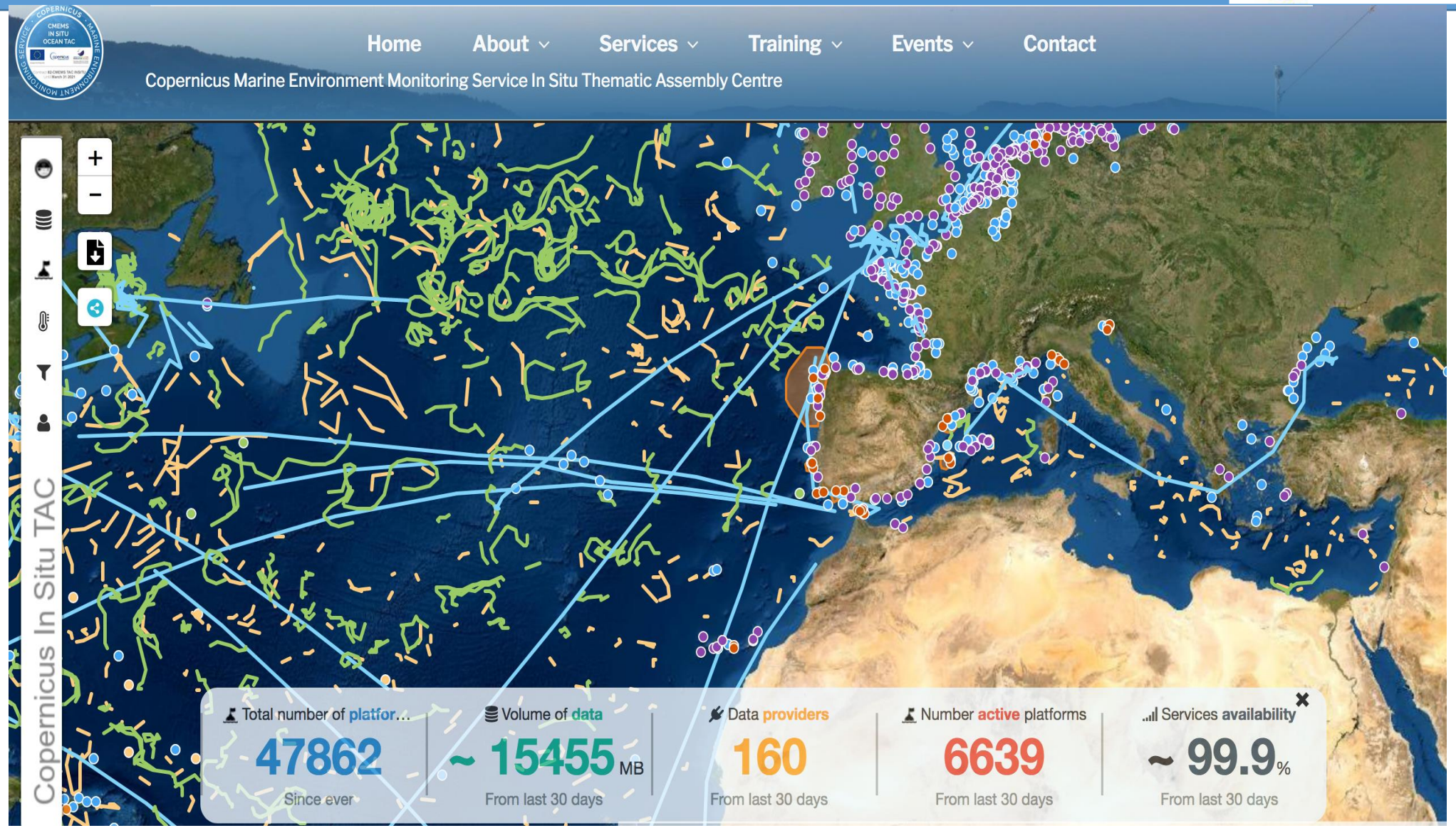
| variable | Region | Type of metric | MERSEA/GODAE classification | Reference observational dataset |
|---|---|---|---|---|
| 3D temperature | Global, and regional basins | Residual Error=obs-model<br>Time evolution of RMS error on 0-500m<br>Vertical profile of mean error. | CLASS4 | CMEMS:<br>CORIOLIS T (z) profiles |
| 3D salinity | Global, and regional basins | Residual Error=obs-model<br>Time evolution of RMS error on 0-500m<br>Vertical profile of mean error. | CLASS4 | CMEMS:<br>CORIOLIS S(z) profiles |
| Sea level anomaly (SLA) | Global, and regional basins | Residual Error=obs-model<br>Time evolution of RMS and mean residual error | Data assimilation statistics | CMEMS:<br>On track AVISO sla observations from Jason3, Saral Altika and Cryosat |
| Sea surface height | At tide gauges (Global but near coastal regions) | Residual Error=model-obs<br>Time series correlation and RMS error | CLASS4 | Tide gauges sea level time series from GLOSS, BODC, Imedea, WOCE, OPPE and SONEL |
| Sea Surface Temperature SST | Global, and regional basins | Residual Error=obs-model<br>Time evolution of RMS and mean error | Data assimilation statistics | CMEMS:<br>OSTIA SST |




Assessment metrics for different variables, using a large set of observations and reference climatologies

# CMEMS IN SITU TAC

- Data filtering:
  Domain
  Platform
  Parameter
  Time period
- Platform info
- Download
- Data view
- Screenshot from 2023




http://www.marineinsitu.eu/dashboard/

# CMEMS IN SITU TAC

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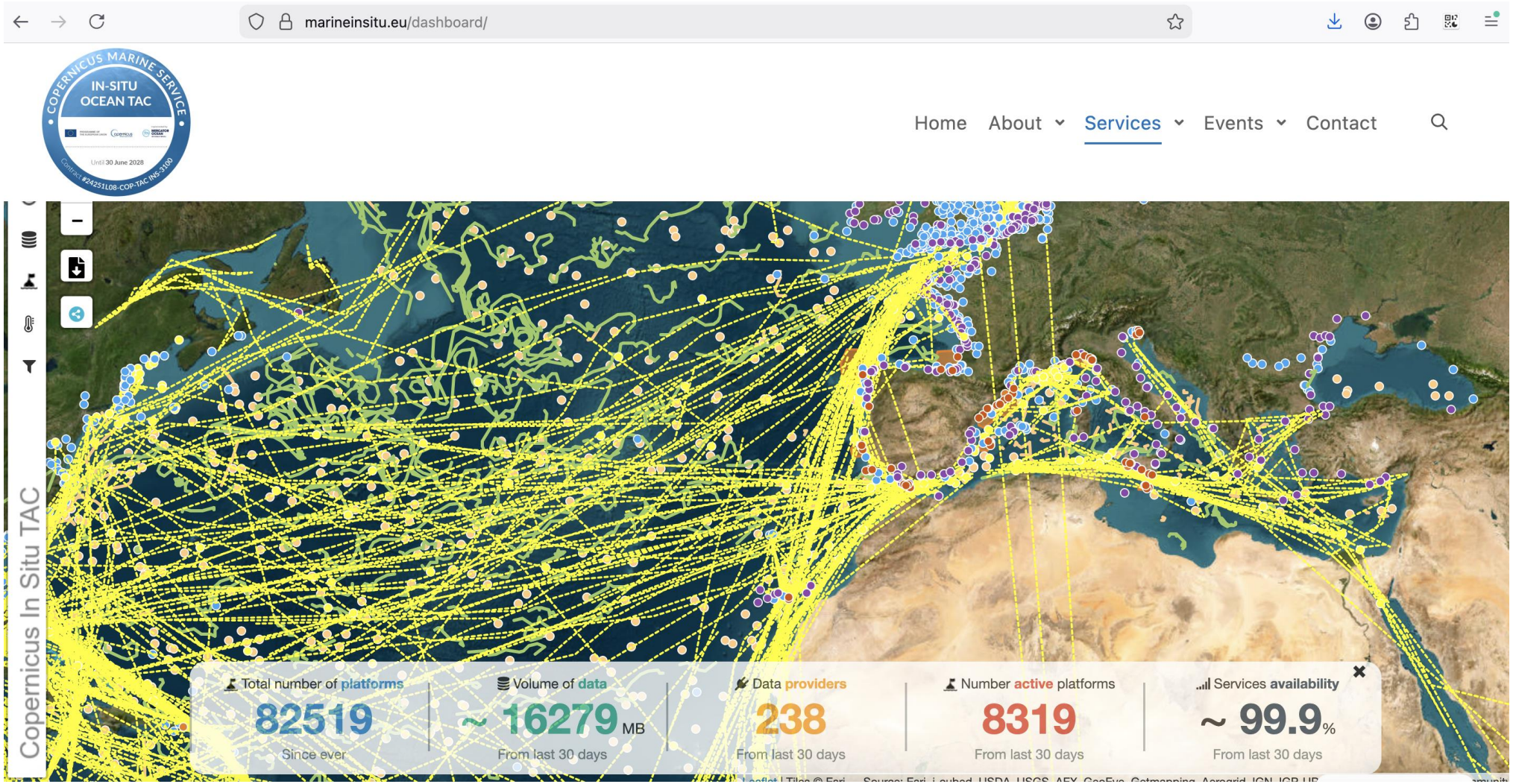
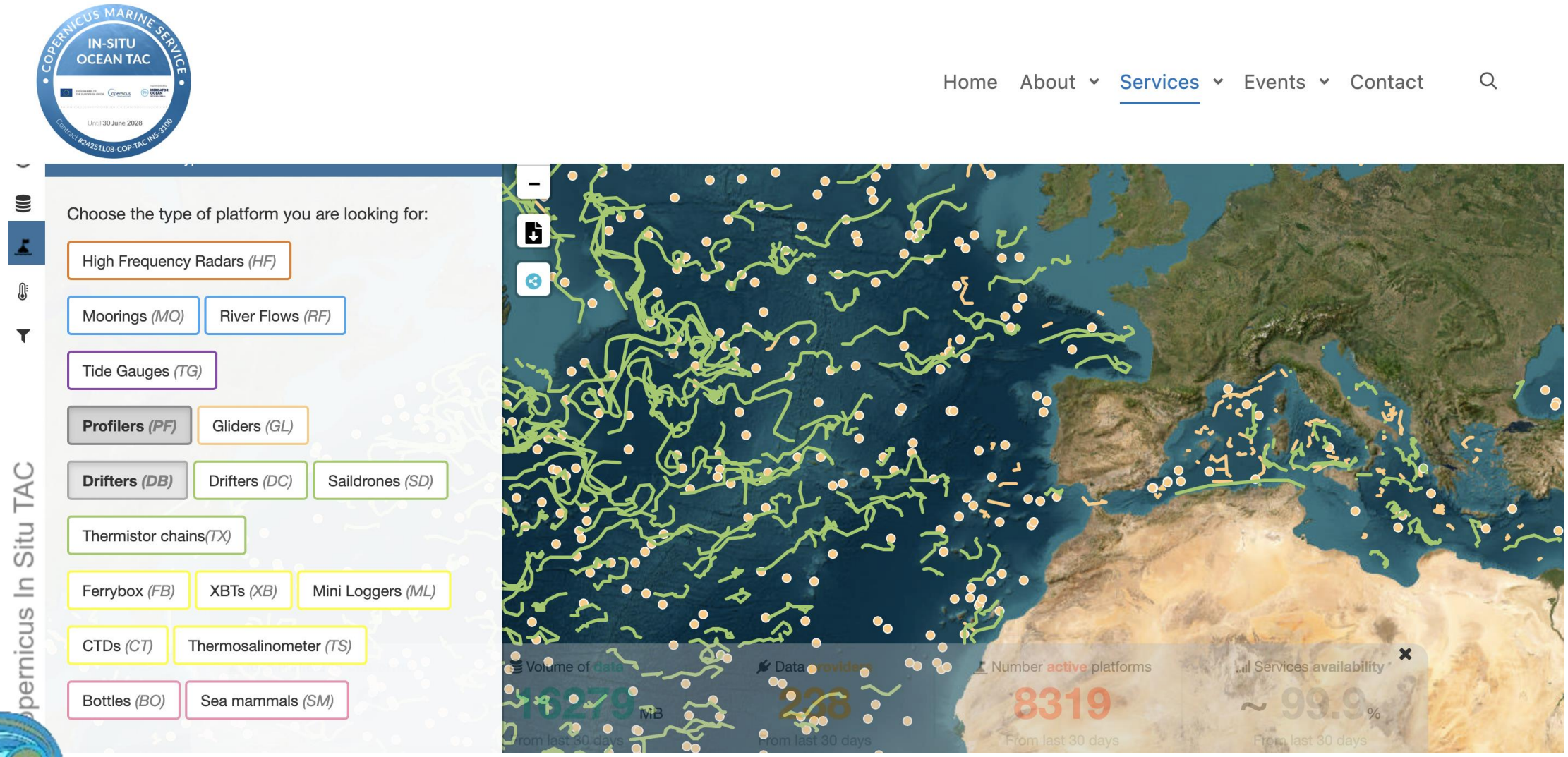
  Platform
  Parameter
  Time period
- Platform info
- Download
- Data view
- Screenshot from 2026



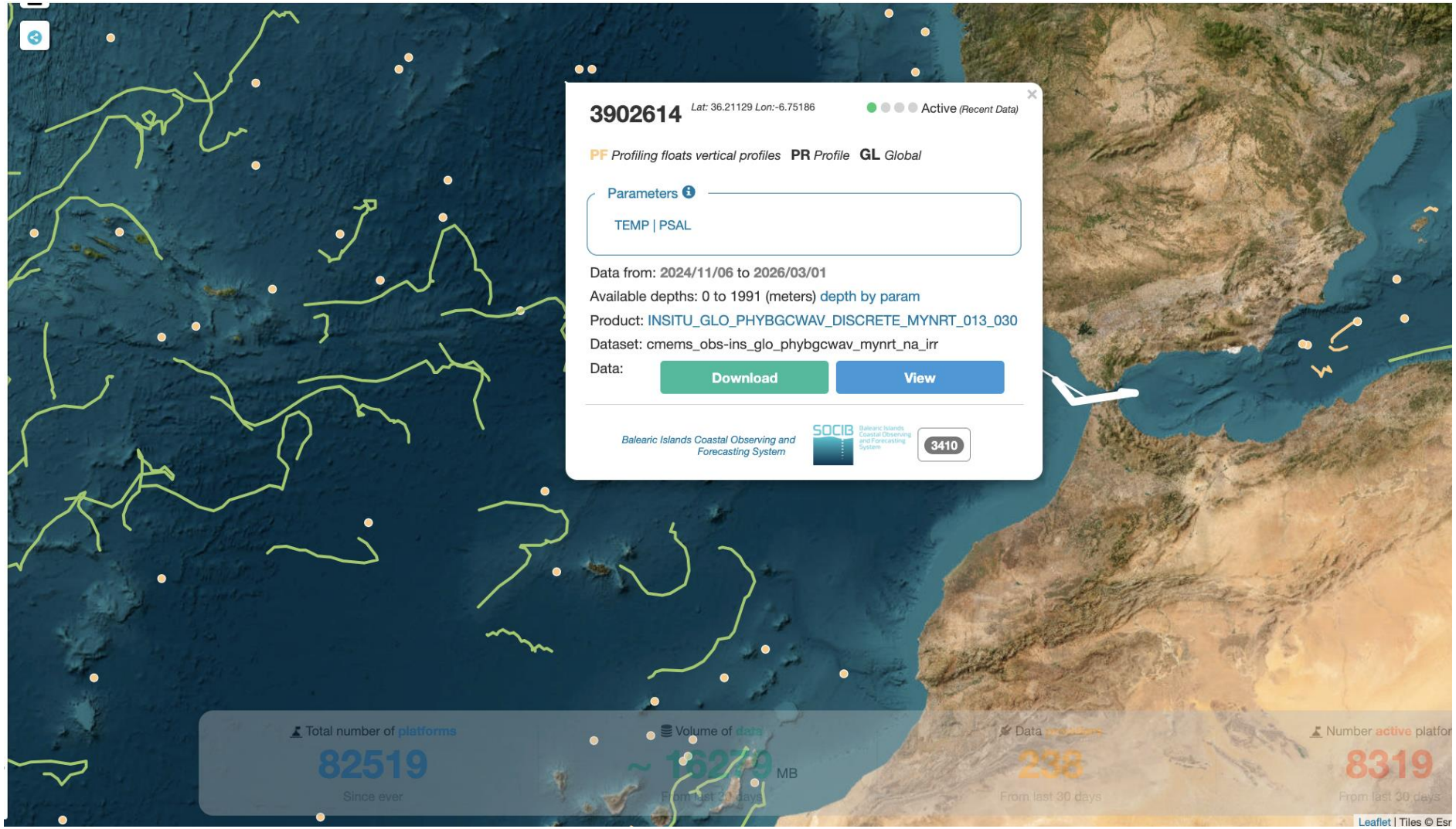

http://www.marineinsitu.eu/dashboard/

# CMEMS IN SITU TAC



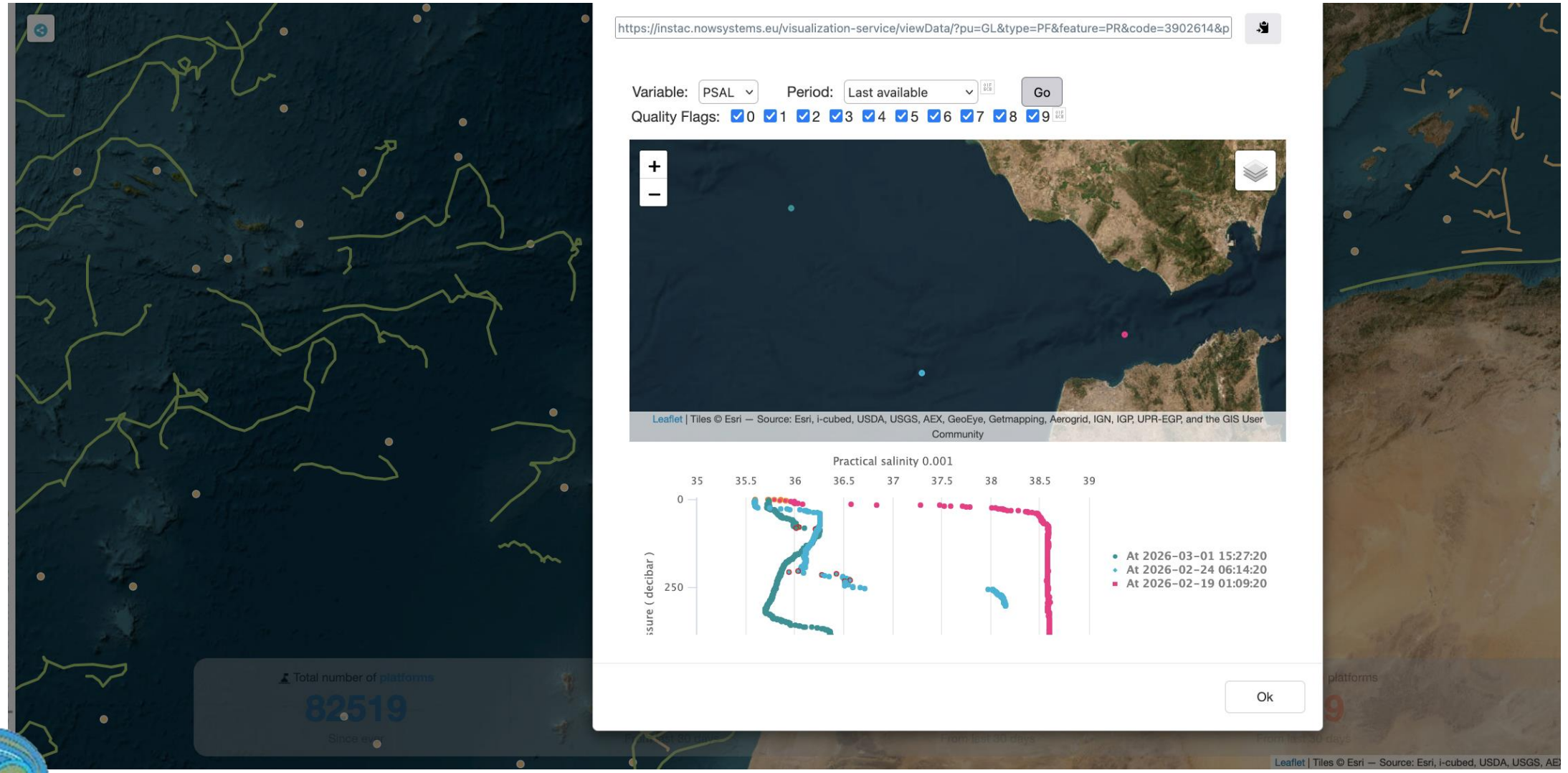

Selecting observation platforms

# CMEMS IN SITU TAC




Selecting observation platforms

# CMEMS IN SITU TAC




Selecting observation platforms

# CMEMS IN SITU TAC

## IN SITU TAC ORGANIZATION Leader: Ifremer / France

**Management & Operations**
7 Regions

| | |
|---|---|
| Global: | Ifremer / France |
| Arctic: | IMR / Norway |
| Baltic: | SMHI / Sweeden |
| NWS: | BSH / Germany |
| IBI: | Puertos del Estado / Spain |
| MED: | HCMR / Greece |
| Black Sea: | IOBAS / Bulgaria |

**Scientific Expertise Cross Cutting**

| | |
|---|---|
| Product Quality: | Oceanscope-PdE-IMR |
| Multi Year: | SOCIB-OceanScope-PdE |
| BGC assim.: | IMR |

**System Evolution**

| | |
|---|---|
| HF Radar: | AZTI-CNR-SOCIB |
| Carbon Data: | UIB |
| BGC assessment: | IMR-HCMR-SYKE |
| Monitoring: | SOCIB-PdE-HCMR |

Figure 2.1 : The In Situ TAC components.

Multiple platforms

International and regional organizations

NRT (Near Real Time) products

REP (Reprocessed) of delayed mode products

*From CMEMS-INS-QUID-013-030-036.pdf*

# CMEMS IN SITU TAC

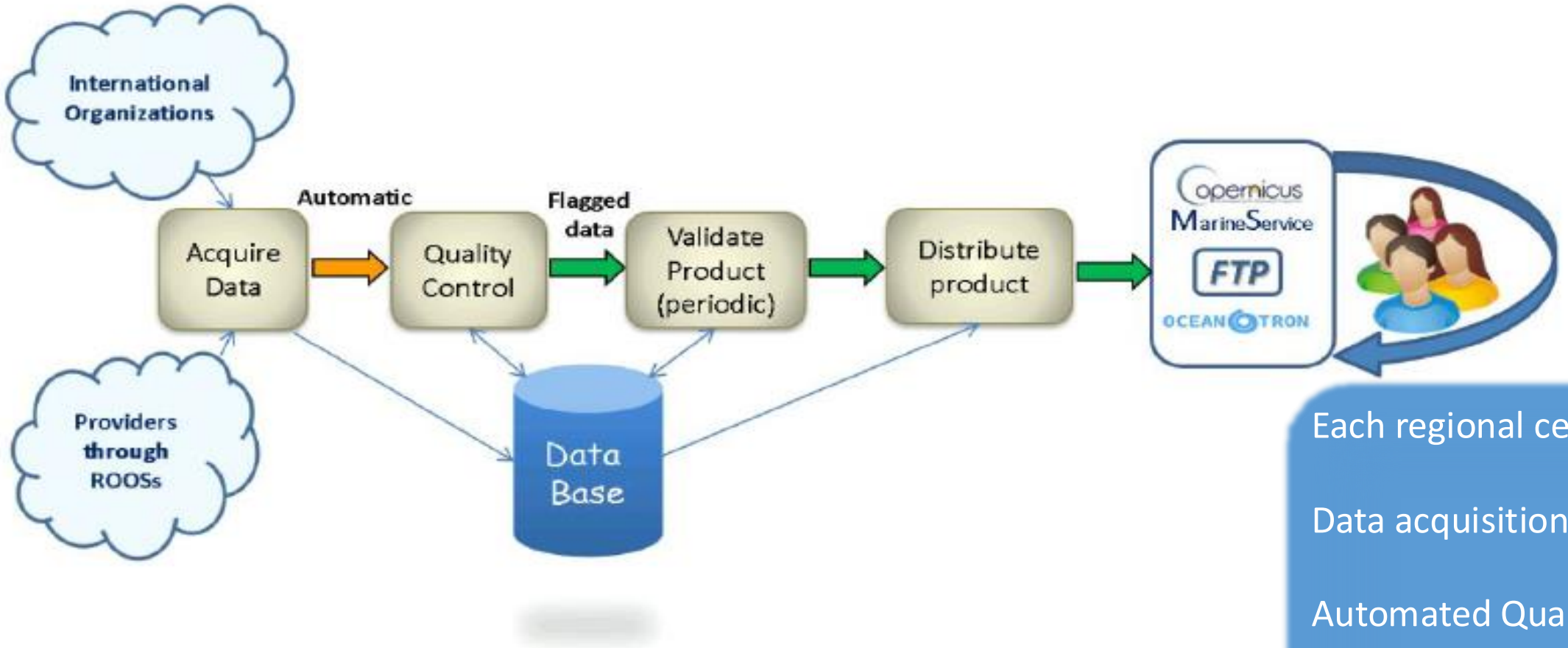



Figure 2.2: Functions implemented by the In Situ TAC components

Each regional center:

Data acquisition

Automated Quality Control

Product validation

Product distribution

*From CMEMS-INS-QUID-013-030-036.pdf*

# QUALITY CONTROL: 2 STEPS

MARINE DATA LITERACY COURSE

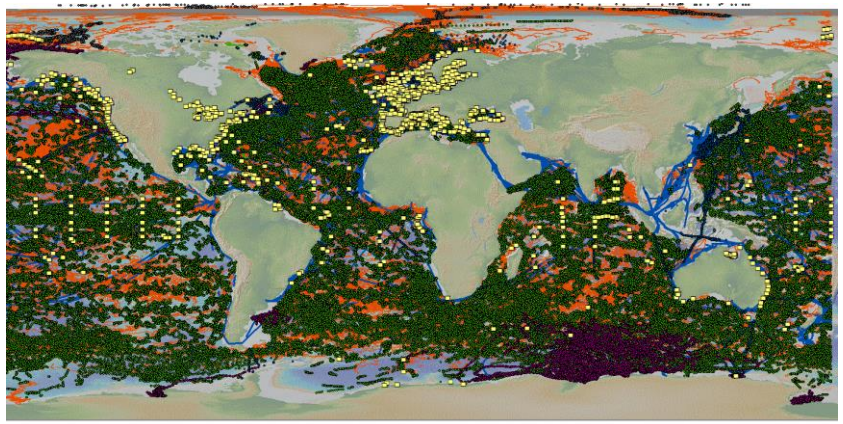
## STEP 1: Automated NRTQC

| Code | Meaning | Comment |
|---|---|---|
| 0 | No QC was performed | - |
| 1 | Good data | All real-time QC tests passed. |
| 2 | Probably good data | These data should be used with caution |
| 3 | Bad data that are potentially correctable | These data are not to be used without scientific correction. |
| 4 | Bad data | Data have failed one or more of the tests. |
| 5 | Value changed | Data may be recovered after transmission error. |
| 6 | Value below detection/quantification | The level of the measured phenomenon was too small to be quantified/detected by the technique employed to measure it. The accompanying value is the quantification/detection limit for the technique or zero if that value is unknown |
| 7 | Nominal value | - |
| 8 | Interpolated value | Missing data may be interpolated from neighbouring data in space or time. |
| 9 | Missing value | - |

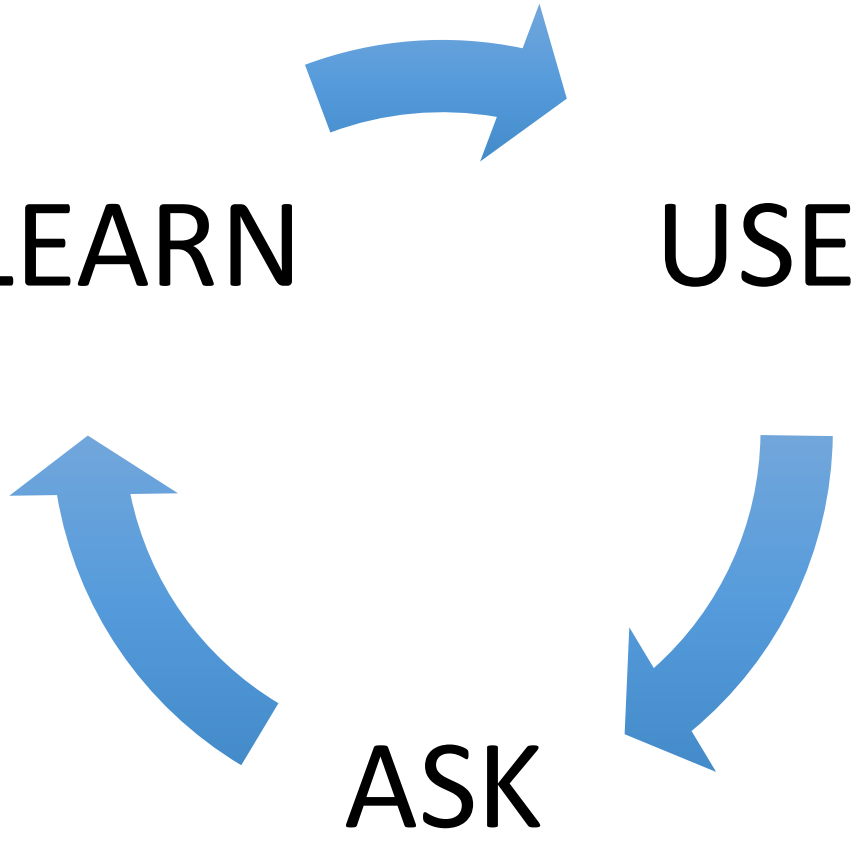
Table 4 Quality control flags.

## STEP 2: REP: Area dependent metrics, including

1. Visual quality control.
2. Comparison to a reference climatology.
3. Objective analysis and residual analysis.
4. Assessment of drifter data.



*From CMEMS-INS-QUID-013-030-036.pdf*

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