



# Copernicus Marine Environment Monitoring Service (CMEMS)

Rosalia Santoleri  
on behalf of CMEMS team



Marine Monitoring

Consiglio Nazionale delle Ricerche



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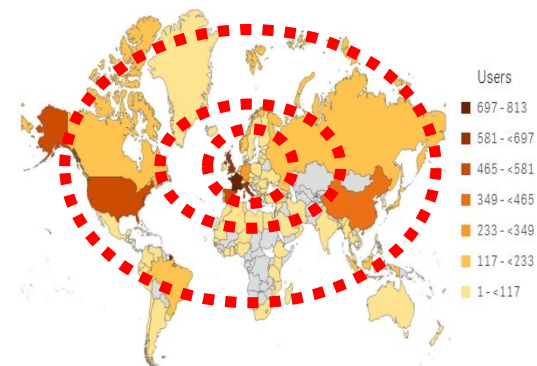




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# Introduction

The Copernicus Marine Environment Monitoring Service (CMEMS) provides **regular and systematic reference information on the physical state, variability and dynamics of the ocean and marine ecosystems** for the global ocean and the European regional seas with a **free open access to the datasets**.



More than **12 000 subscribers** (~ + 200 new subscribers/month)

Downloads (2017) : **290 000+**

Downloaded Volume (2017) : **371 Tb,**

User satisfaction (2017) : **4,7/5**



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# The Copernicus Marine Service: drivers

## •Support a sustainable ocean and blue growth

Coastal Environment, Marine policies and public information, Marine operation and Safety, Marine Pollution, Research, Climate, New Services.

## •Provide pioneering solutions

Operational and scientifically assessed, Worldwide and European-wide coverage, long-term sustainability, thousands of users.

## •Provide Open and easy access to marine data

Open and free data policy, network of producers throughout Europe, Modular organization, Common standards, Single point of access.



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HERGATOR OCEAN



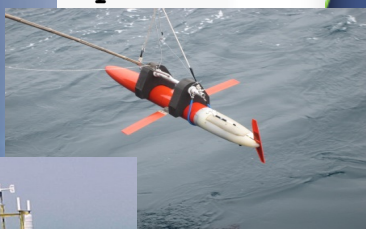
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# The Copernicus Marine Service

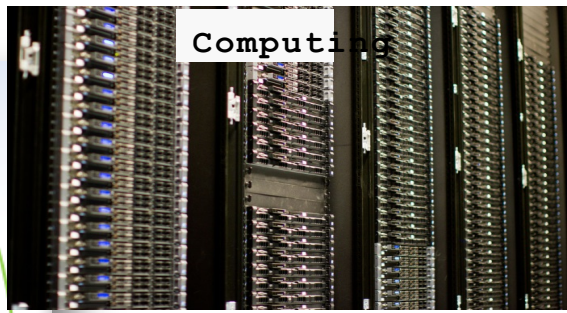
Mercator Ocean entrusted by the European Commission to implement the Copernicus Marine Service, with the support of an extended network



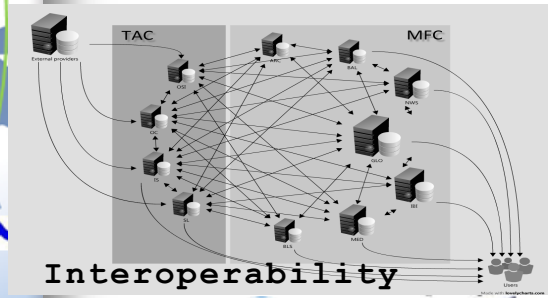
Space data



In-situ  
data



Computing



Interoperability  
Protocols





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# CMEMS Products



- 1. Global
- 2. Arctic
- 3. Baltic
- 4. NWS
- 5. IBI
- 6. Med Sea
- 7. Black Sea

## Global ocean and the European basins

★ InSitu, Satellite Observations,  
Modelling products

★ Physical & Biogeochemical  
variables

★ Long time series (25 years)

★ Real time products

A unique catalogue online.

Full OPEN and FREE service for  
any application related to Ocean  
& Seas.



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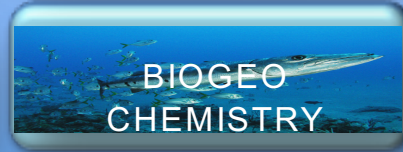




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# The Copernicus Marine Service: products

## 6 ESSENTIAL OCEAN VARIABLES



**Reanalysis**  
10 to 45 years

**Real-Time**  
Daily Hourly

**Forecast**  
2 to 10 days



**~ 160  
Products**

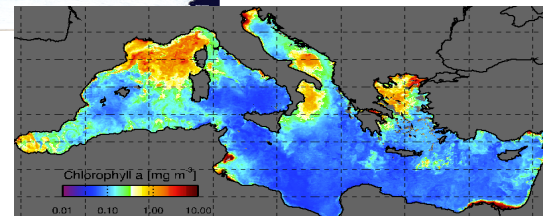
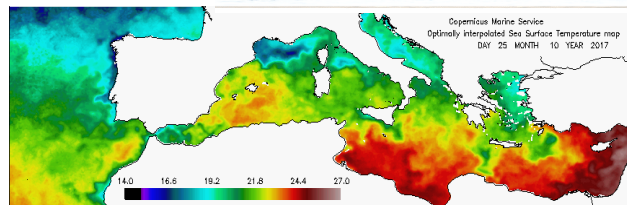
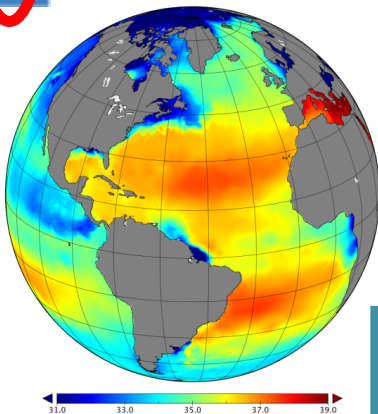
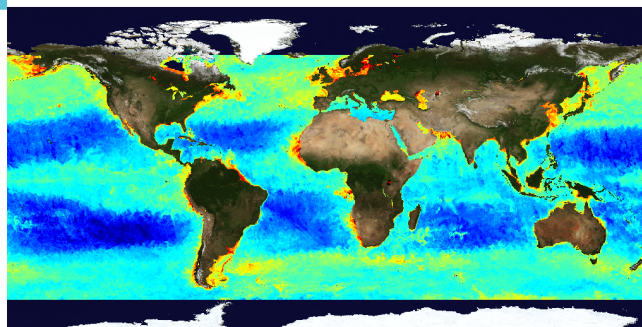
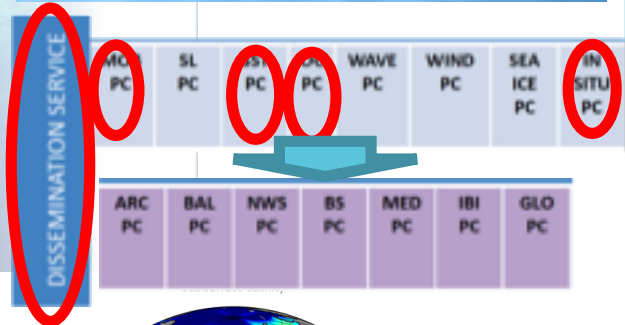


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# Copernicus Marine Environmental Service: System

CMEMS is a System of Systems composed by:

- **8 Thematic Assembling Centres (TACs)** for observation
- **7 Modelling Forecasting Centres (MFC)**
- **1 Dissemination Service** (archiving all the data and disseminating the products to the users)



CNR leads: Ocean Colour, SST, Dissemination Service  
CNR is partner in: Multi-OBS (SSS) & In Situ (HF radar)



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# The Copernicus Marine Service

ESA; EUMETSAT;  
Direct agreement  
with other space  
agencies

L1 / L2  
Space  
data

CMEMS  
Thematic Assembly Centers

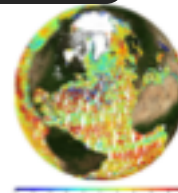
SL  
OC  
SST  
SI  
WAVE  
WIND  
MOB  
In Situ (INS)

CMEMS  
Monitoring and Forecast Centers

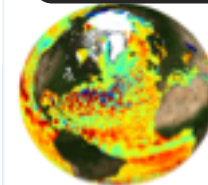


- 1 Global
- 2 Arctic
- 3 Baltic
- 4 NWS
- 5 IBI
- 6 Med Sea
- 7 Black Sea

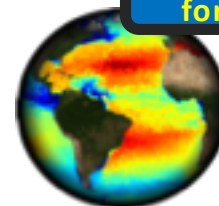
L3  
Products



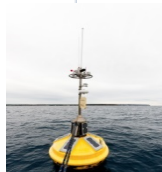
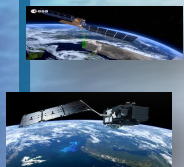
L4  
Products



Analysis and  
forecasts



In situ  
observations







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S e a S u r f a c e T e m p e r a t u r e

# Sea Surface Temperature

in

# CMEMS



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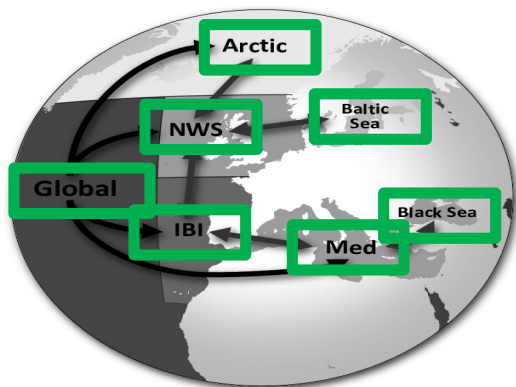
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# Sea Surface Temperature



Satellite Observation products

SEA SURFACE TEMPERATURE (SST)

L3 and L4

NRT and Reprocessing

Source: SST-TAC

In Situ Observation products

TEMPERATURE (T)

From - 6000 m to surface

NRT and Reprocessing

Source: INSITU TAC

Model products

TEMPERATURE (T)

From - 6000 m to surface

Forecast, NRT and Reanalysis

Source: MFCs

# Sea Surface Temperature Thematic Assembly Centre



## Main roles

**Leader: B.Buongiorno Nardelli (CNR)**  
 Deputy: A.Pisano (CNR)

MultiYear Product Expert: S. Good (Metoffice)

Product Quality Expert: E. Autret (Ifremer)

Earth Observation Expert: R.Santoleri (CNR)

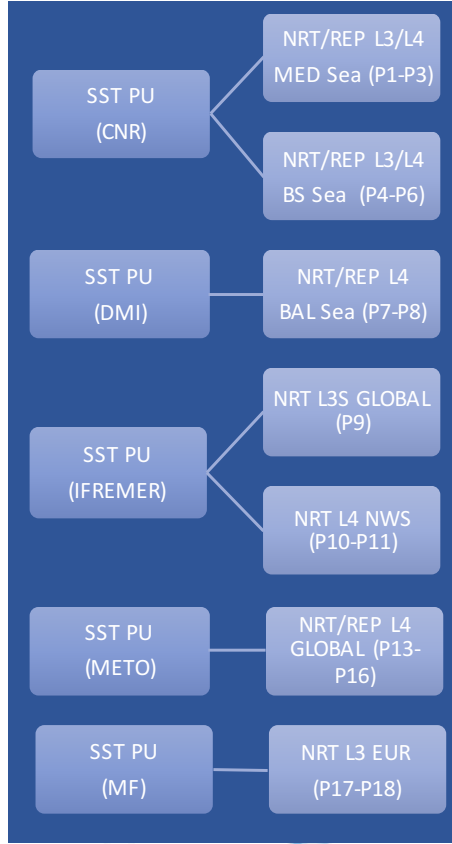
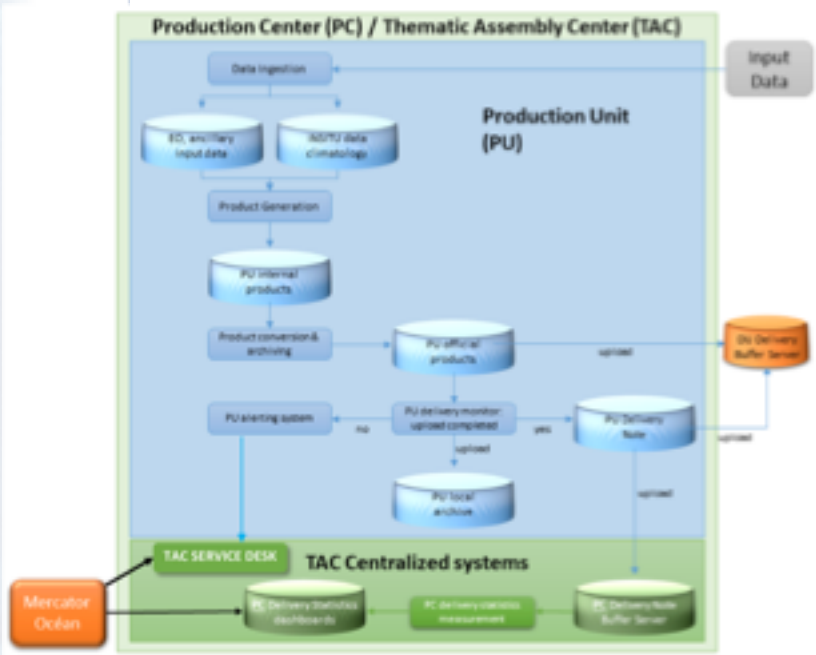
	Acronym	Name	Country	Resp.
1	CNR	National Research Council	Italy	Coordination Data production
2	DMI	Danish Meteorological Institute	Denmark	Data production
3	IFREMER	French Research Institute for Exploitation of the Sea	France	Data production
4	MET	Norway Norwegian Meteorological Institute	Norway	Service Desk
5	METO	Met Office	UK	Data production
6	MF	Météo-France	France	Data production





# How SST TAC production is carried out

A distributed processing system based on **Production Units** with specific competences and operational expertises



Processing includes **routine monitoring of Product Quality**

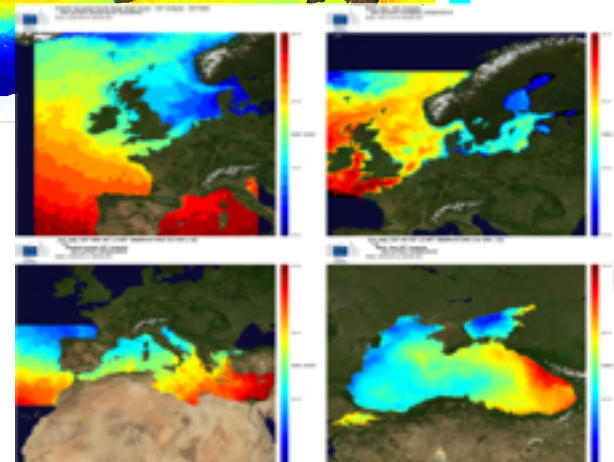
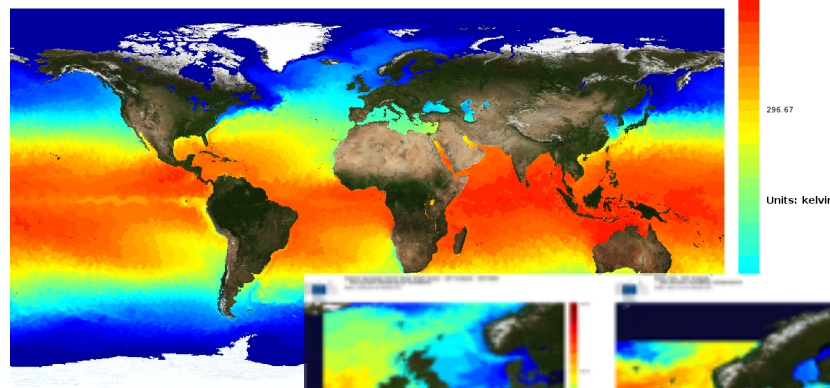


# What SST TAC is providing

ID	Title
P1	Black Sea - High Resolution and Ultra High Resolution L3S Sea Surface Temperature
P2	Black Sea High Resolution and Ultra High Resolution Sea Surface Temperature Analysis
P3	Black Sea - High Resolution L4 Sea Surface Temperature Reprocessed
P4	Mediterranean Sea - High Resolution and Ultra High Resolution L3S Sea Surface Temperature
P5	Mediterranean Sea High Resolution and Ultra High Resolution Sea Surface Temperature Analysis
P6	Mediterranean Sea - High Resolution L4 Sea Surface Temperature Reprocessed
P7	Baltic Sea- Sea Surface Temperature Analysis
P8	Baltic Sea- Sea Surface Temperature Reprocessed
P9	Global Ocean Sea Surface Temperature L3 Observations
P10	Atlantic European North West Shelf Ocean - ODYSSEA Sea Surface Temperature Analysis
P11	Atlantic European North West Shelf Seas - High Resolution L4 Sea Surface Temperature Reprocessed (1982-2012)
P12	Global Ocean OSTIA Sea Surface Temperature and Sea Ice Analysis
P13	Global Ocean Sea Surface Temperature Multi Product Ensemble (GMPE)
P14	Global Ocean OSTIA Diurnal Skin Sea Surface Temperature
P15	Global Ocean OSTIA Sea Surface Temperature and Sea Ice Reprocessed
P16	ESA SST CCI reprocessed sea surface temperature analyses
P17	European Ocean- Sea Surface Temperature Mono-Sensor L3 Observations
P18	European Ocean- Sea Surface Temperature Multi-Sensor L3 Observations

## State-of-the-art portfolio covering the Global Ocean and the European Regional Seas

- **Near Real Time (NRT) L3/L4**
- **Multi-Year (reprocessed) L4 dataset**

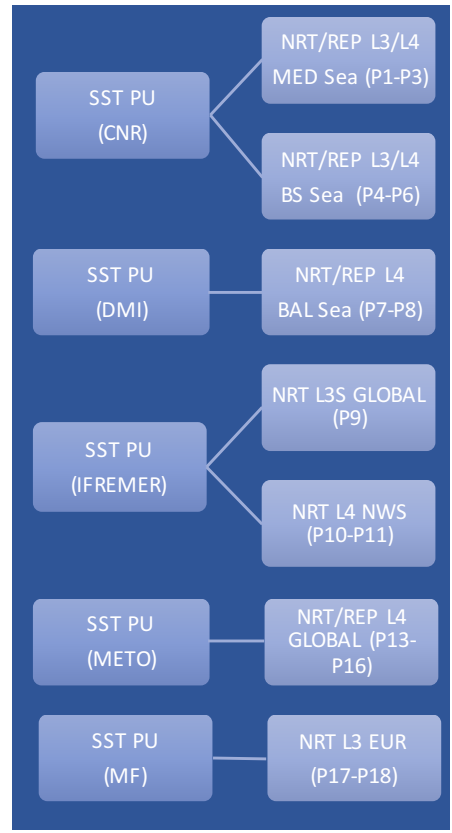




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# SST TAC Products

ID	Product reference	Title
P1	SST_BS_SST_L3S_NRT_OBSERVATIONS_010_013	Black Sea - High Resolution and Ultra High Resolution L3S Sea Surface Temperature
P2	SST_BS_SST_L4_NRT_OBSERVATIONS_010_006	Black Sea High Resolution and Ultra High Resolution Sea Surface Temperature Analysis
P3	SST_BS_SST_L4_REP_OBSERVATIONS_010_022	Black Sea - High Resolution L4 Sea Surface Temperature Reprocessed
P4	SST_MED_SST_L3S_NRT_OBSERVATIONS_010_012	Mediterranean Sea - High Resolution and Ultra High Resolution L3S Sea Surface Temperature
P5	SST_MED_SST_L4_NRT_OBSERVATIONS_010_004	Mediterranean Sea High Resolution and Ultra High Resolution Sea Surface Temperature Analysis
P6	SST_MED_SST_L4_REP_OBSERVATIONS_010_021	Mediterranean Sea - High Resolution L4 Sea Surface Temperature Reprocessed
P7	SST_BAL_SST_L4_NRT_OBSERVATIONS_010_007_b	Baltic Sea- Sea Surface Temperature Analysis
P8	SST_BAL_SST_L4_REP_OBSERVATIONS_010_016	Baltic Sea- Sea Surface Temperature Reprocessed
P9	SST_GLO_SST_L3S_NRT_OBSERVATIONS_010_010	Global Ocean Sea Surface Temperature L3 Observations
P10	SST_NWS_SST_L4_NRT_OBSERVATIONS_010_003	Atlantic European North West Shelf Ocean - ODYSSEA Sea Surface Temperature Analysis
P11	SST_NWS_SST_L4_REP_OBSERVATIONS_010_023	Atlantic European North West Shelf Seas - High Resolution L4 Sea Surface Temperature Reprocessed (1982-2012)
P12	SST_GLO_SST_L4_NRT_OBSERVATIONS_010_001	Global Ocean OSTIA Sea Surface Temperature and Sea Ice Analysis
P13	SST_GLO_SST_L4_NRT_OBSERVATIONS_010_005	Global Ocean Sea Surface Temperature Multi Product Ensemble (GMPE)
P14	SST_GLO_SST_L4_NRT_OBSERVATIONS_010_014	Global Ocean OSTIA Diurnal Skin Sea Surface Temperature
P15	SST_GLO_SST_L4_REP_OBSERVATIONS_010_011	Global Ocean OSTIA Sea Surface Temperature and Sea Ice Reprocessed
P16	SST_GLO_SST_L4_REP_OBSERVATIONS_010_024	ESA SST CCI reprocessed sea surface temperature analyses
P17	SST_EUR_SST_L3C_NRT_OBSERVATIONS_010_009_b	European Ocean- Sea Surface Temperature Mono-Sensor L3 Observations
P18	SST_EUR_SST_L3S_NRT_OBSERVATIONS_010_009_a	European Ocean- Sea Surface Temperature Multi-Sensor L3 Observations





- **Coordinated activity at TACs &MFCs level by CMEMS PQWG**
- **Validation is a continuous and ongoing activity needed to characterize the accuracy and quality of the delivered SST products**
- **Each SST PU performs routine, predefined, validation on NRT products**
- **Validation metrics and statistics are automatically generated during operational processing in accordance with CMEMS PQWG guidelines.**
- **Routine validation is performed by comparison of operational SST products against independent in situ observations whenever possible, or failing that, less qualitative comparisons such as against climatologies**
- **The information is made available to the users through QQuality Information Document (QUID) and the CMEMS webpage:**
- **<http://marine.copernicus.eu/services-portfolio/scientific-quality/>**

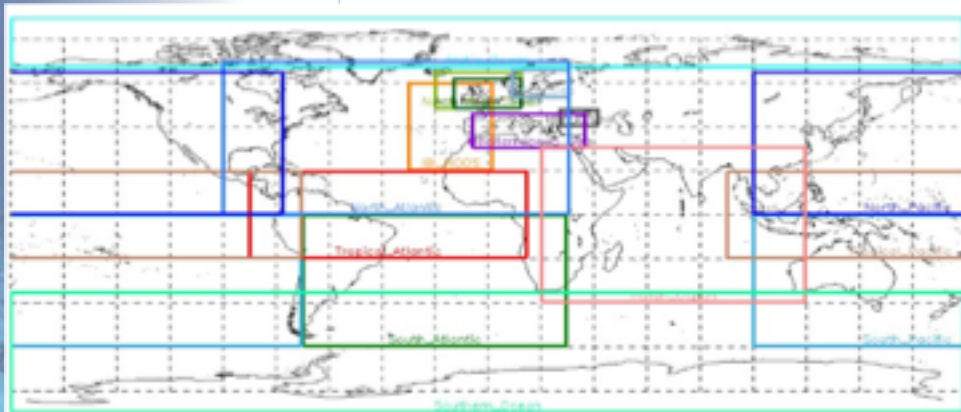




# PRODUCT QUALITY: SST assessment

- Argo is the reference sensor of choice
- these are not used (at least in OSTIA), so are an independent reference data
- drifting buoy matchups are also available, although these are not independent
- Produce statistics for various regions of the globe
- Bias, rms and standard deviation of differences
- Observation minus background or observation minus analysis can also provide useful information

**Assessment of SLSTR data has been ongoing at each PU**

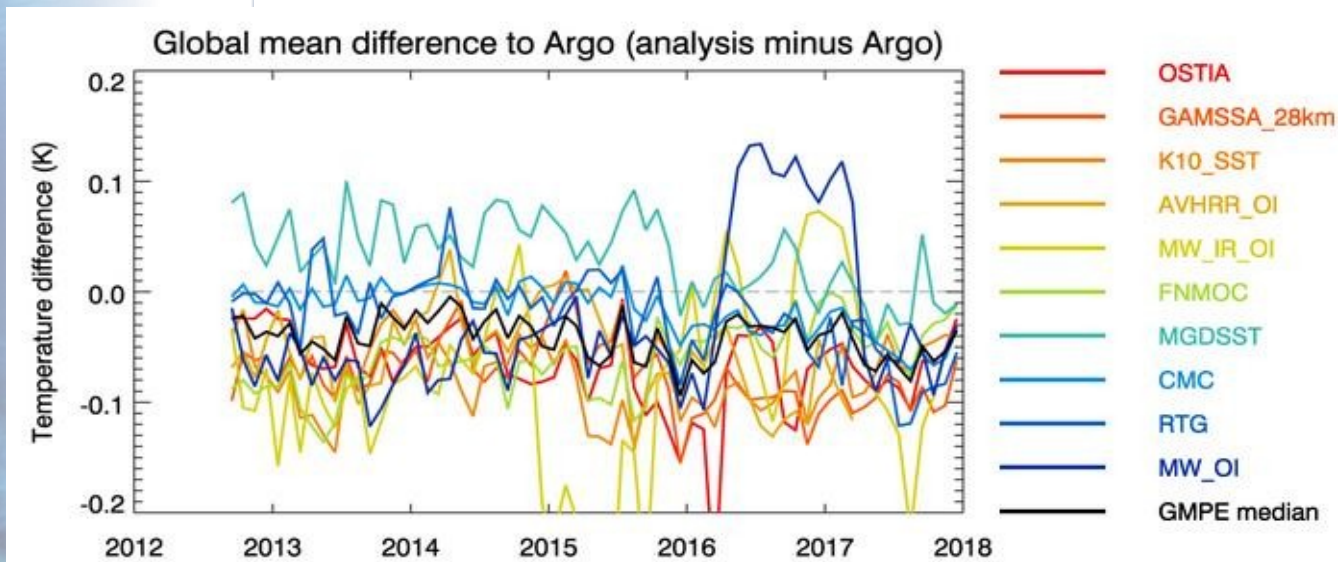






# S S T P R O D U C T Q U A L I T Y

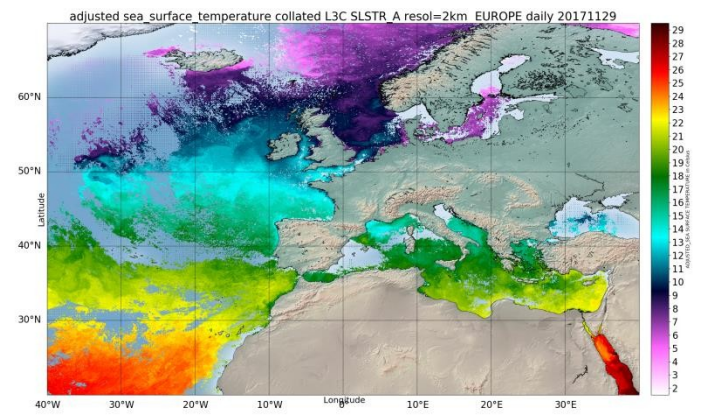
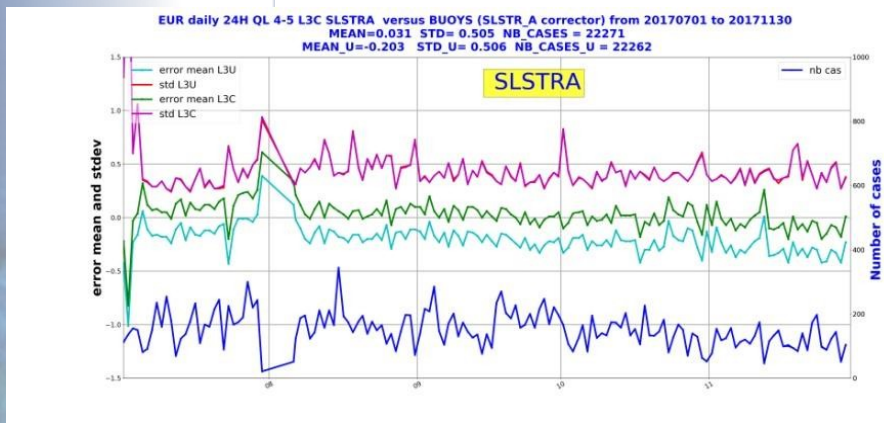
- The GMPE (GHRSSST-PP Multi Product Ensemble) is used to compare SSTs and gradients between different global products - in principle it could be applied to regional areas
- In 2017 the GMPE was expanded to include new/updated versions of analyses (DMI OI, MUR, G1SST, CMC 0.1°, OSPO night)





# Ingestion of SLSTR in the SST-TAC

- Since January 2017 all the SST-TAC PUs were involved into evaluation and validation SLSTR with the aim to:
  - provide feedback to Eumetsat team in charge of validation of SLSTR
  - prepare the ingestion of SLSTR to the CMEMS L3S and L4 Processing chains
  - SLSTR is already ingested in operational mode in some of CMEMS products (eg. Mediterranean & Black Sea)

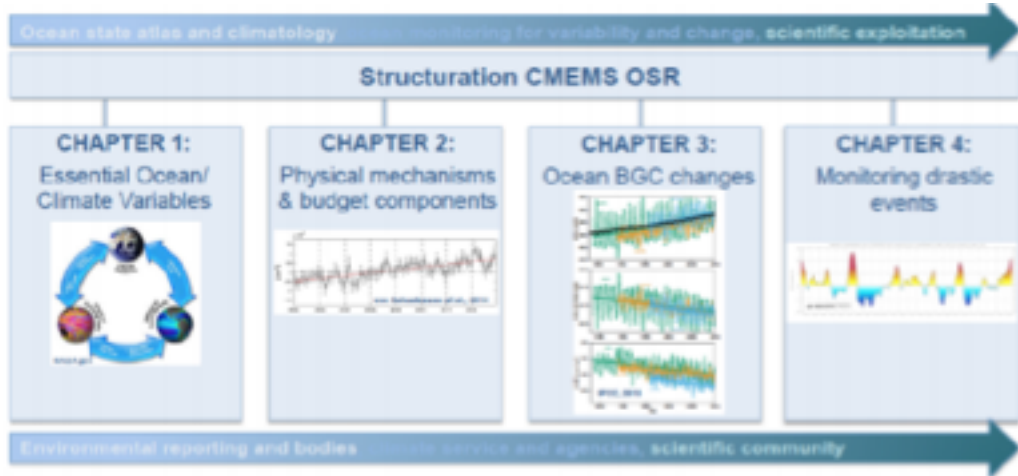




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# Ocean Monitor Indicators & Ocean State Report

- The CMEMS consistent and operational time series of physical and biogeochemical ocean parameters from ocean reanalyses of ocean observing systems (in situ, satellite) variables (covering the period 1993 up to now) are used for:
  - The Implementation of **Ocean Monitoring Indicators**
  - the CMEMS annual **Ocean State Report**



OSR 2016 published in 2017 in JOO  
OSR 2017 will be available ASAP



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# THE OCEAN STATE REPORT

... provides a state-of-the-art assessment of the state of the global ocean and European regional seas



- |          |             |
|----------|-------------|
| 1 Global | 5 IBI       |
| 2 Arctic | 6 Med Sea   |
| 3 Baltic | 7 Black Sea |
| 4 NWS    |             |

For ocean scientific community as well as for policy and decision makers.

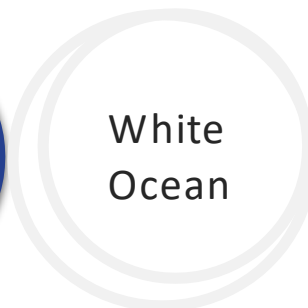
... draws on expert analysis



80 experts

... provides

- a 4-D view
- a view from above
- a view directly from the interior



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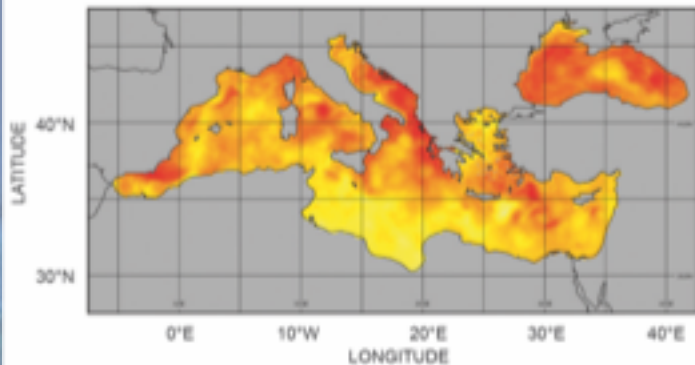
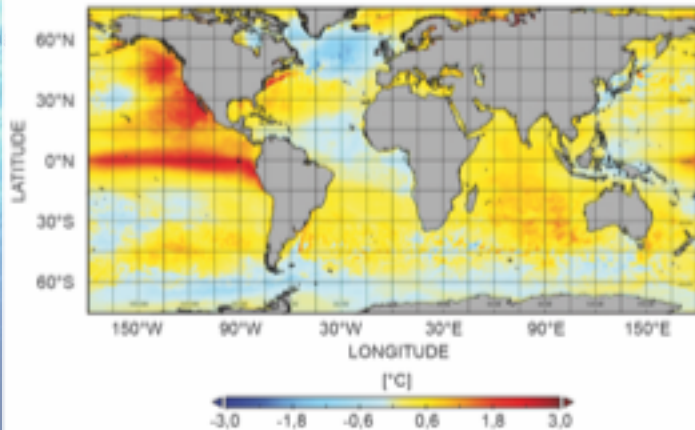




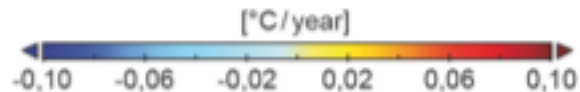
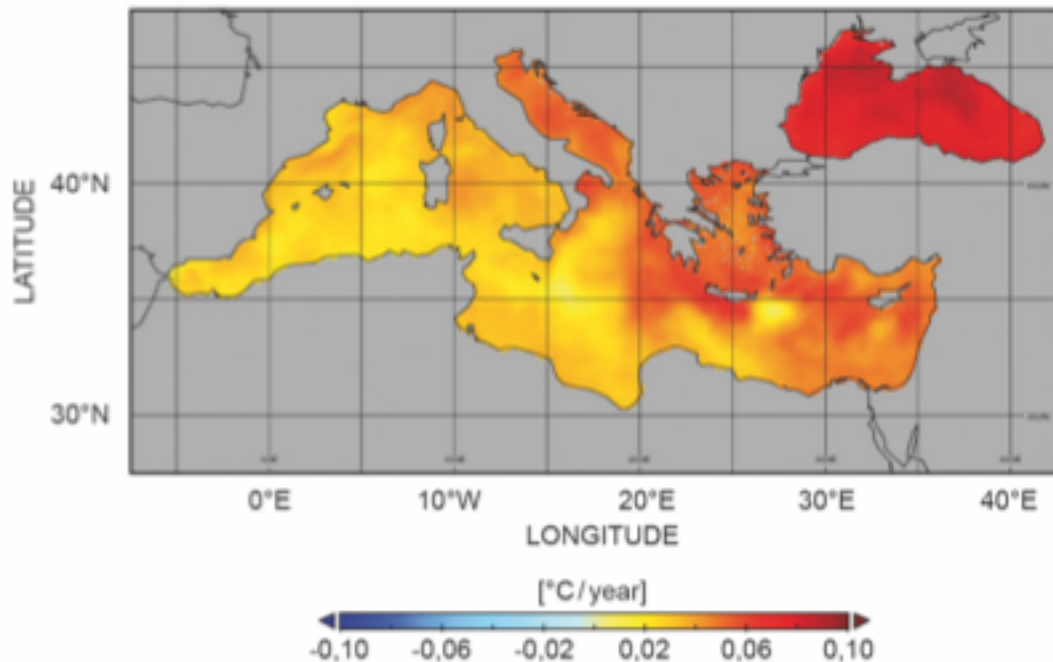


Data: 1993-2015

2015 Sea Surface Temperature anomaly [°C]



1993 - 2015 Sea Surface Temperature trend



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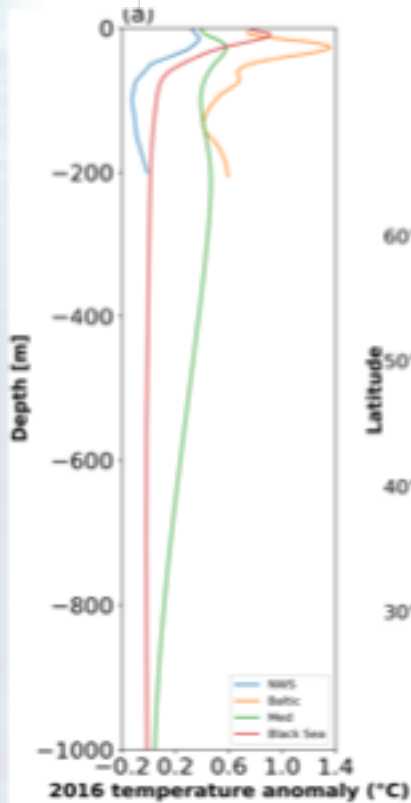


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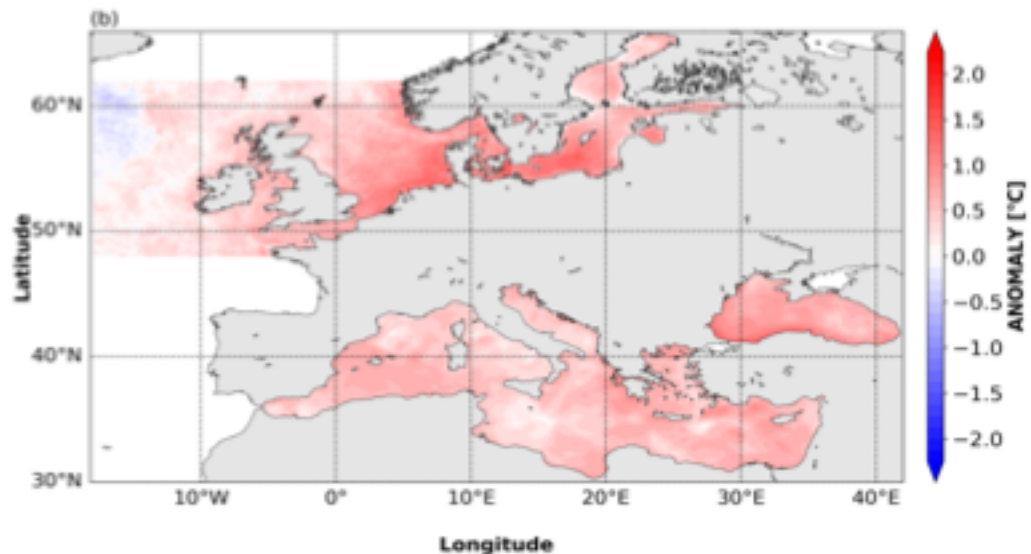




## Temperature anomaly profiles in 2016



## Annual surface temperature anomalies in 2016 relative to 1993 – 2014 climatology



In 2016 SSTs were warmer than the climatology ( $> 1^{\circ}\text{C}$ )  
Anomalous Heating extends up to 50 m of depth



## Integration of new sensors

- Highest priority (common to all PUs): Sentinel 3A (already ongoing), Sentinel 3B
- Then: JPSS-1, GMI, VIIRS, AMSR2, Himawari 8, GOES-R

## Evolution of processing algorithms/New products

- Improved interpolation techniques/configurations: effective resolution optimized background errors (METO), algorithms (IFREMER)
- New regional L4 products resolving the diurnal cycle (DMI, CNR)
- New regional L4 over NWS+IBI (IFREMER), new L4 over EUR (MF)

## Upgrade of Multi-Year processing and implementation of OMI

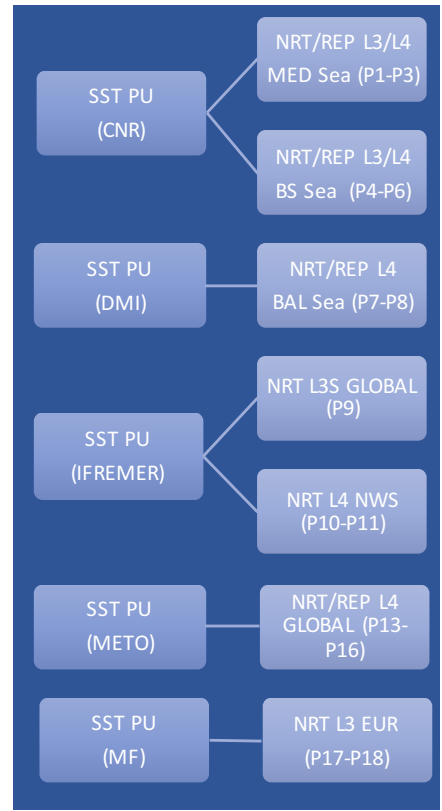
- Major effort to provide homogeneous and accurate regional and global REP products taking advantage of the planned regular release schedule of upstream high quality climatic records by ESA CCI/C3S initiatives





# The new SST TAC Products (2018-2020)

ID	Description	PU	Year
P19	New daily L4 NRT over the NWS+IBI area (substitutes P10)	IFREMER	2018
P20	New daily L4 REP over the NWS+IBI area (substitutes P11)	IFREMER	2018
P21	New daily L4 NRT EUR product	MF	2019
P22	New diurnal NRT L4 over the Baltic Sea	DMI	2020
P23	New diurnal NRT L4 over the MED	CNR	2020
P24	New diurnal NRT L4 over the BS	CNR	2020
P25	New daily L4 EUR REP product	MF	2020
P26	New daily L3S BAL NRT product	DMI	2019







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*Thanks for Your attention*



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