

The Copernicus Marine Environment Monitoring Service and the role of altimetry

Mercator Ocean
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Implemented by



The European Copernicus Programme



SATELLITES
(S1, S3, S6/Jason-CS)
+ Jason-2, Jason-3



IN SITU



SERVICES



MARINE

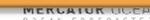
ATMOSPHERE

LAND

SECURITY

EMERGENCY

CLIMATE

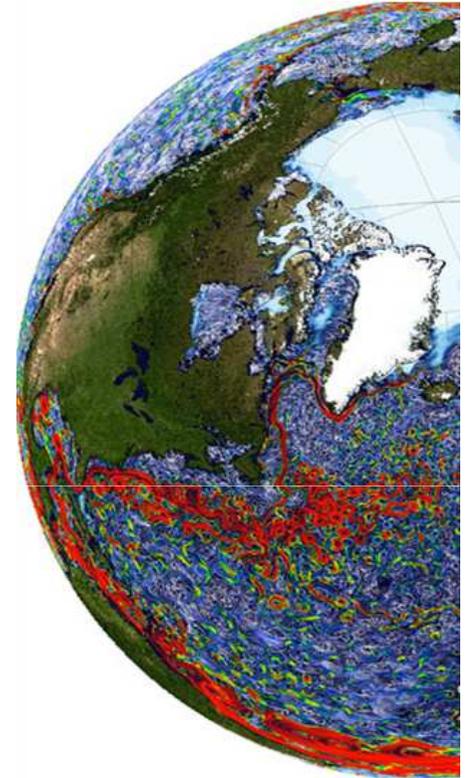


The Copernicus Marine Service – Vision

“A world-leading marine environment and monitoring service, supporting blue growth and the blue economy, for maritime safety, effective use of marine resources, healthy waters, informing coastal and marine hazard services, and supporting climate services”

Core European service / global and European regional marine products. Free and open data access to all products.

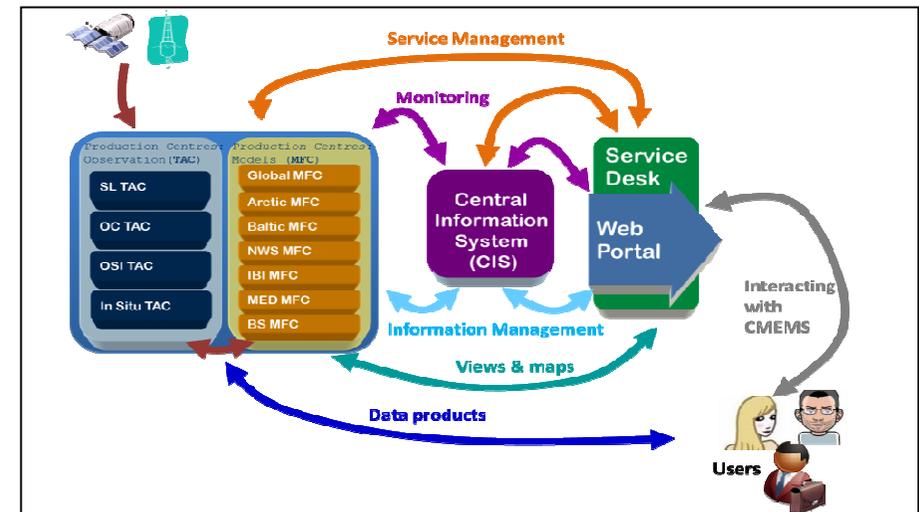
Public/private downstream services and applications build on and develop with CMEMS => foster market development and development of the blue economy.



The Copernicus Marine Environment Monitoring Service

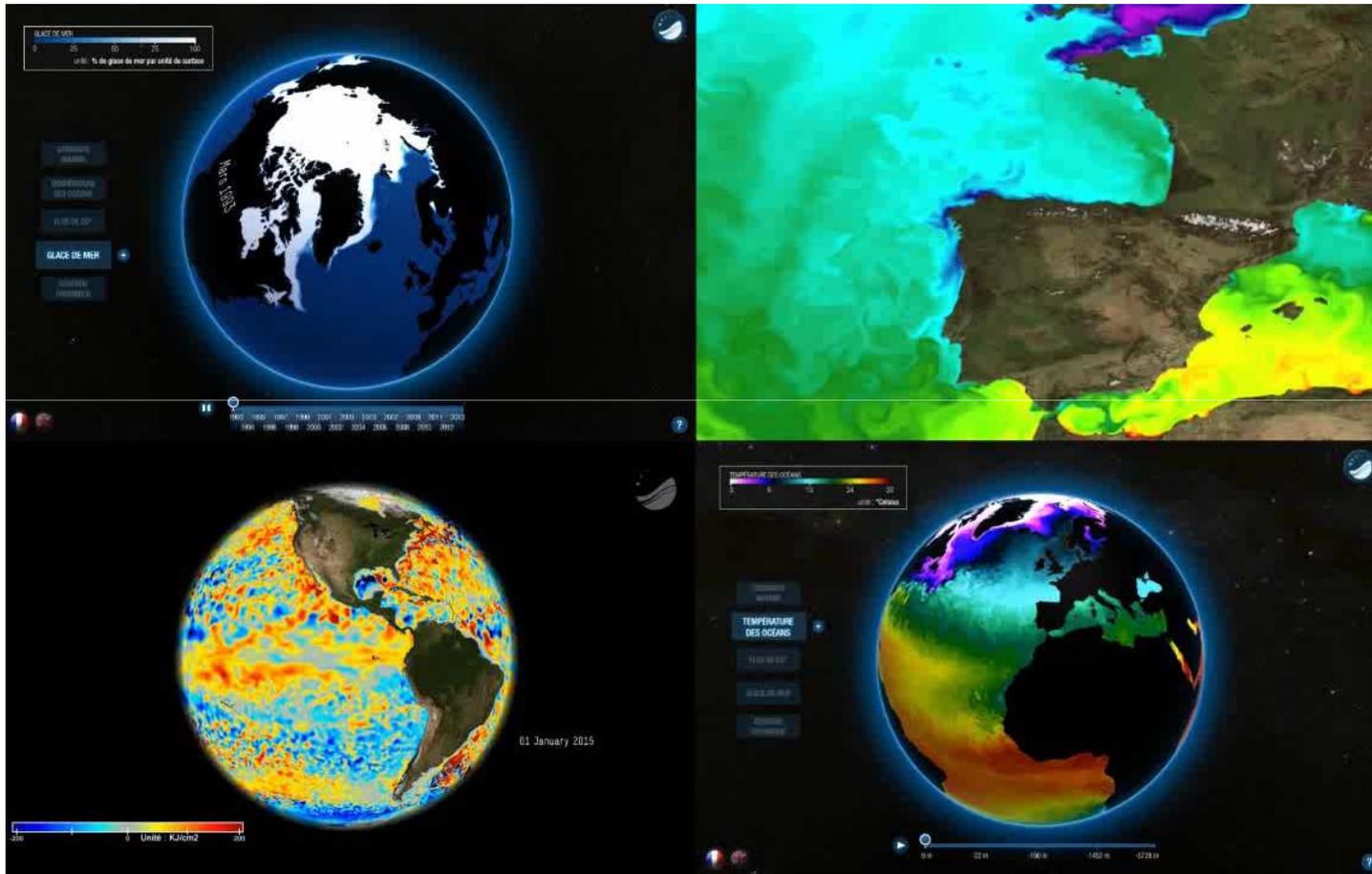
An EU Marine Service with a clear ambition

- **Operational** and **scientifically assessed**
- **Observations** (satellite, in-situ) and **models** (analyses/forecasts)
- **Physics** (e.g. sea level, currents, temperature, sea ice) and **Biogeochemistry** (e.g. oxygen, primary production, nutrients)
- A **network** of European producers
- A **unique catalogue: Worldwide** and **European-wide** coverage
- A **central information system** to search, view, download products and monitor the system
- A **service desk** to support users who relies on a network of technical & marine experts
- **Generic** to serve a **wide range of downstream applications**. More than **7500 users**



Copernicus Marine Service

An integrated information



MULTIPLE SOURCES OF INFORMATION

OBSERVATIONS
(SATELLITES AND
IN-SITU) AND
MODELS

GLOBAL AND
REGIONAL

PHYSICS AND
BIOGEOCHEMISTRY

REAL-TIME AND
REANALYSES
(LAST 30 YEARS)

Areas of benefits



Coastal & marine environment



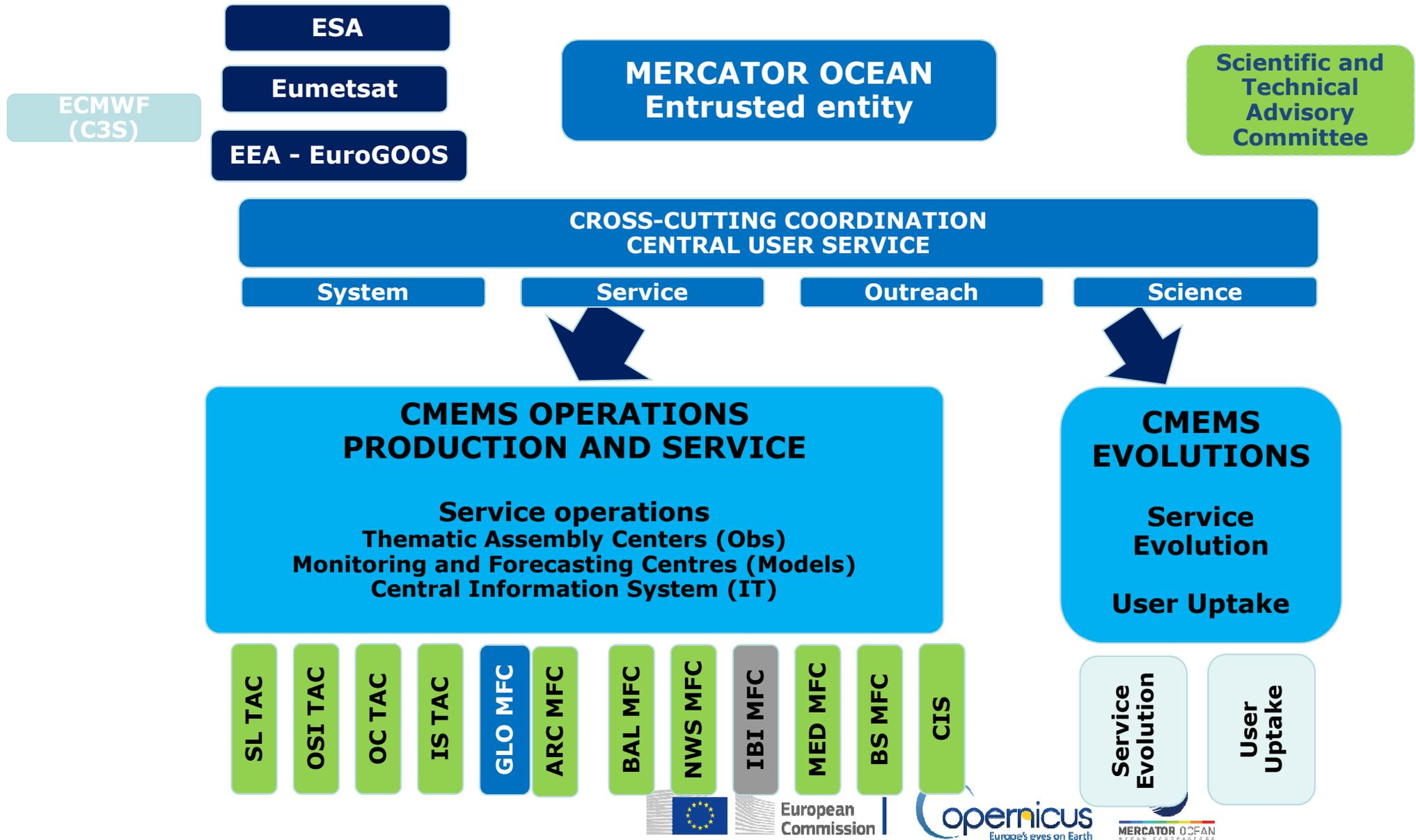
Marine resources

Weather, climate & seasonal forecasting



Maritime safety

Copernicus Marine Service organisation



ESA

Eumetsat

EEA - EuroGOOS

ECMWF
(C3S)

MERCATOR OCEAN
Entrusted entity

Scientific and
Technical
Advisory
Committee

CROSS-CUTTING COORDINATION
CENTRAL USER SERVICE

System

Service

Outreach

Science

CMEMS OPERATIONS
PRODUCTION AND SERVICE

Service operations
Thematic Assembly Centers (Obs)
Monitoring and Forecasting Centres (Models)
Central Information System (IT)

CMEMS
EVOLUTIONS

Service
Evolution
User Uptake

SL TAC

OSI TAC

OC TAC

IS TAC

GLO MFC

ARC MFC

BAL MFC

NWS MFC

IBI MFC

MED MFC

BS MFC

CIS

Service
Evolution

User
Uptake



European
Commission



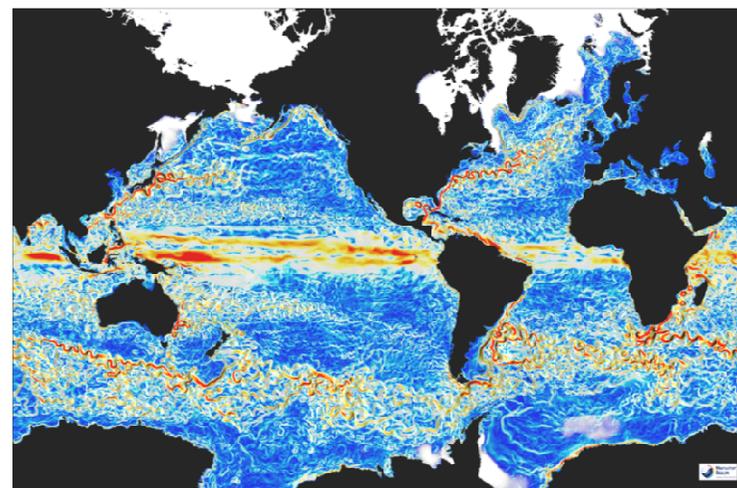
MERCATOR OCEAN
OCEAN FORECASTERS

Altimetry and the Copernicus Marine Service

- **Unique and fundamental role** of satellite altimetry for ocean analysis and forecasting.
- The Jason series provides **very high quality data to reference/intercalibrate** the other missions.
- **Essential** together with in-situ data (e.g. Argo) for the **ocean climate monitoring that CMEMS provides**.
- Many of our applications require a **high resolution description and forecast of the ocean state** (e.g. marine pollution, ship routing, search and rescue, offshore industry). Model resolution (1/12° global, 1/36° regional).
- Requirement is for at least 3 to 4 altimeters.
- **Critical importance and complementary role of Sentinel 3A & 3B** and future interleaved tandem phase of **Jason-2**.



El Niño/La Niño monitoring with the global Mercator Ocean/CMEMS reanalysis system



Global 1/12° analysis and forecasting system

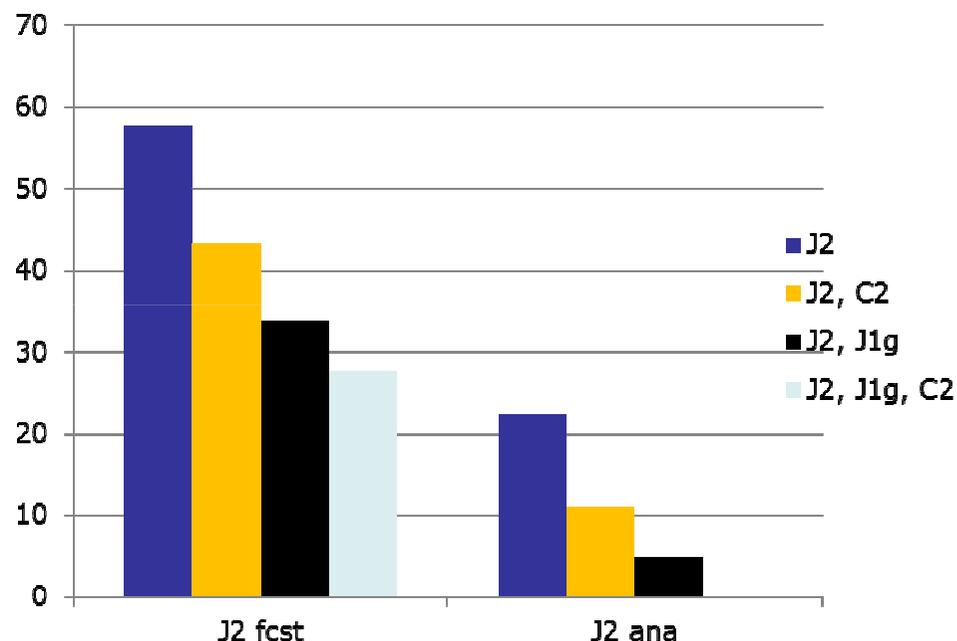


The role of high resolution altimetry (1)

Observing System Evaluation (OSE) carried out with the 1/12° North Atlantic Mercator Ocean data assimilation system (Remy et al., 2016)

Impact of assimilating different altimeter missions (Jason-2, Jason-1 GM, Cryosat-2).

Compared to the three altimeter configuration, assimilating only two altimeters increases the forecast errors by 10 to 20 % and assimilating only one altimeter increases the forecast error by more than 30%.



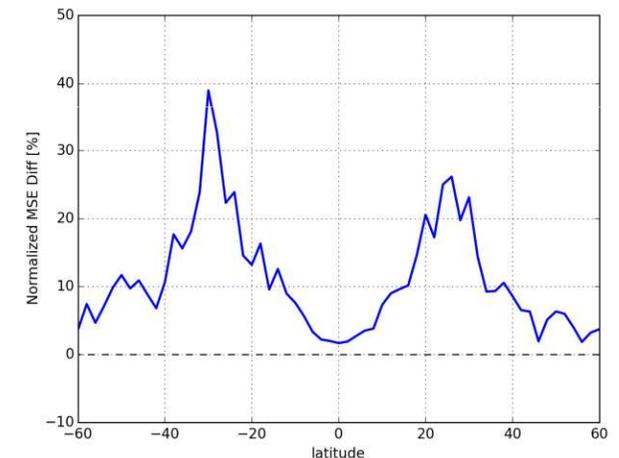
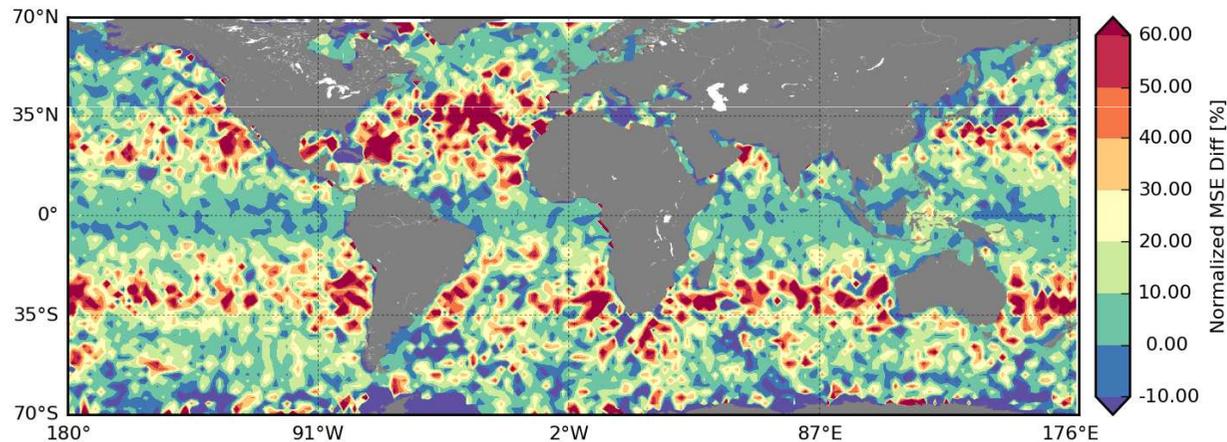
Errors in percentage of variance reduction compared to the best configuration, i.e. analyses when all altimeter data sets are assimilated.



The role of high resolution altimetry (2)

Impact of a 4th altimeter in the Mercator Ocean 1/12° global system

Performance of CMEMS high resolution systems is highly dependant on the availability of multiple altimeter missions. At least 4 altimeters required (with « optimized » configurations).



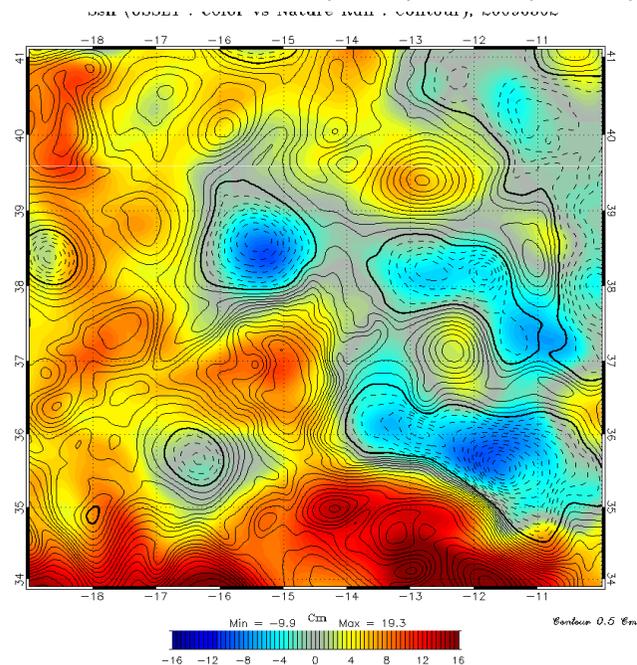
Reduction of 7 day Sea Level forecast errors (forecast skill) (in %) when moving from three to four altimeters (Hamon et al., 2016).

Future altimeter observations and the Copernicus Marine Service

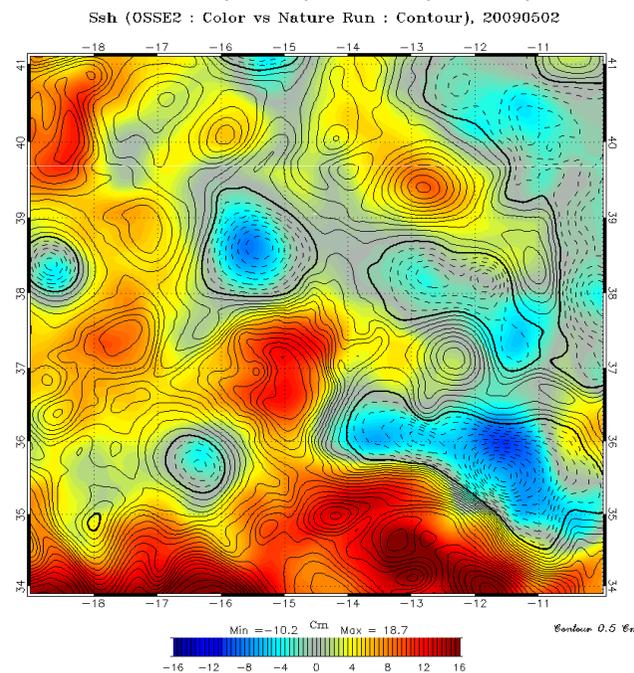
Today requirements: at least 4 altimeters. **Longer term requirements : (much) higher resolution.** Model resolution likely to increase by a factor 3 for the post 2020 time period to better represent upper ocean dynamics.

A series of Swath altimeters and conventional altimeters ?

3 Conventional altimeters (colors), Truth (contour)



SWOT (colors), Truth (contour)



OSSEs in the IBI regional model (North East Atlantic)

Nature Run (truth) 1/36° assimilated in a 1/12° model (Benkiran et al., 2016)



Conclusion

- **Fundamental role of satellite altimetry for ocean analysis and forecasting**
- **Reference mission : Long term continuity is ensured thanks to Jason-3 and the future Jason CS/Sentinel 6. A major step forward.**
- **Multiple altimeters are mandatory** to describe and forecast ocean currents at fine scale. **At least 4 altimeters** in optimized orbits (for oceanography) required.
- Essential role of **Jason-2 in its interleaved orbit.**
- **Much higher resolution required for the post 2020 time period.** Swath and conventional altimeters.

