Copernicus Marine Service

COPERNICUS MARINE 8th GENERAL ASSEMBLY

Blue Ocean observations/satellite

Production Centers achievements & plans

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Copernicus Marine Service

PROGRAMME OF THE EUROPEAN UNION

Copernicus Europe's eyes on Earth

implemented by MERCATOR OCEAN INTERNATIONAL

Blue Ocean TACs in Copernicus Marine Service

Objective of Satellite TACs collect and process all available satellite observations to:

- support the MFCs with data required for assimilation and validation;
- provide useful observational data products, ready to use, to value-adding and end-users

TACs products are Multi-mission …

- TAC products are Multi-mission products including core missions, third party missions, opportunity missions
- Use of products delivered by Ground Segments (calibrated and validated products) in strong link with space agencies
- Processing steps include Cross calibration before multi-mission/multi-sensor processing

…and user oriented :

- Real-Time/Near real Time constraints are important for many applications
- Re-processing is also very important: Long time series for e.g. climate applications, ocean circulation studies, etc
- Global and Regional Products are distributed: Regional tuning of processing to better serve coastal/regional applications

The 5 « Blue Ocean » TACS

From Eumetsat/ ESA/CNES

Surface wind and stress
from scatterometers

Koninklijk Nederlands Meteorologisch Instituut
Ministerie van Infrastructuur en Waterstaat

Waves
SWH from altimeters
Swell spectra from SAR images

CLS
cnes

Sea Level & geostr. current
from altimeters

CLS
imedea
cnes

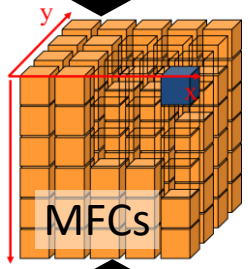
SST
from infrared & microwaves

National Research Council of Italy
Ifremer
Norwegian Meteorological Institute
The Danish Meteorological Institute

Multi OBS
Surface fields (SSS, Currents), 3D fields T/S, vertical velocity

CLS
cnes
Ifremer
LSCE
National Research Council of Italy
LOV
IMEV

Assimilation



Assessment

Applications

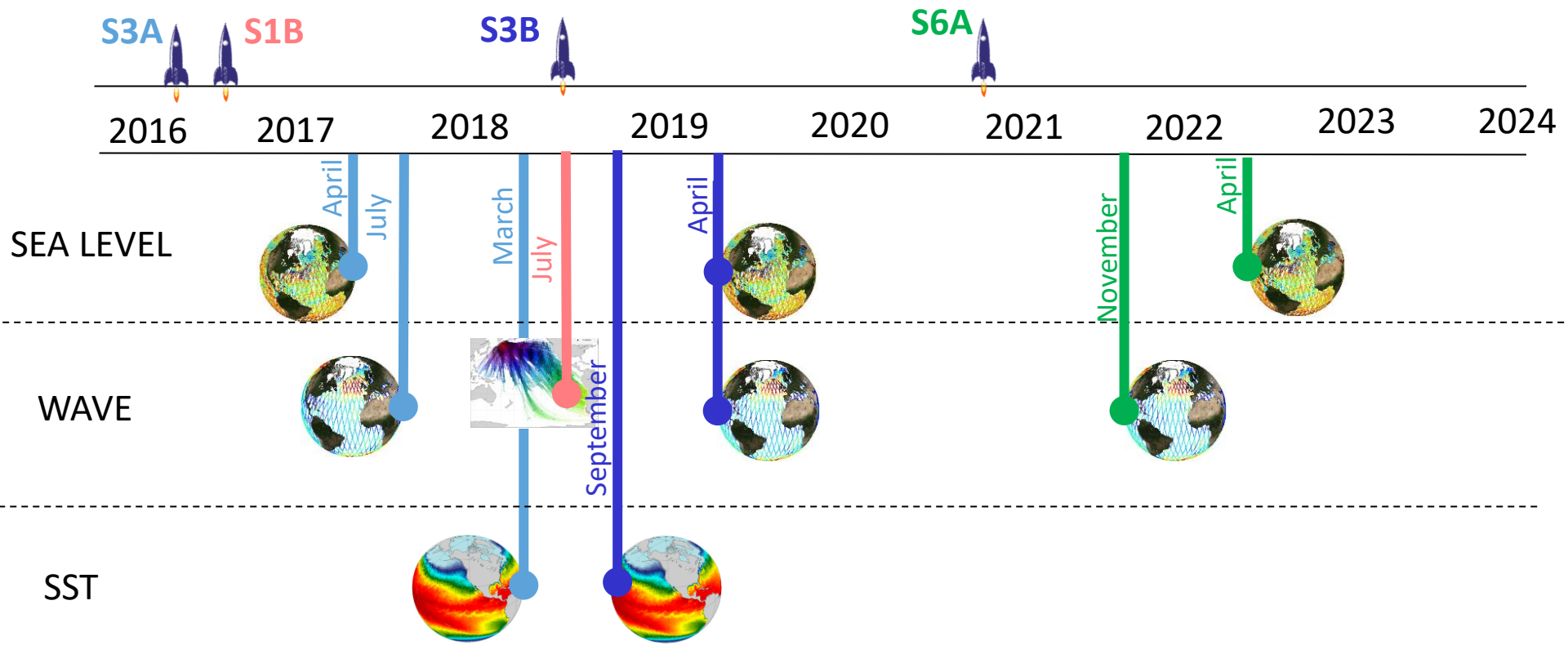
External users

~60 people involved in the TACs activities. Few of them are considered as “experts” of the different physical fields & products

Copernicus Marine Service

Upstream EO data (Sentinel) integration

Sentinel missions - Upstream EO data used for L3/L4 production a/o validation



Sentinel missions contribution

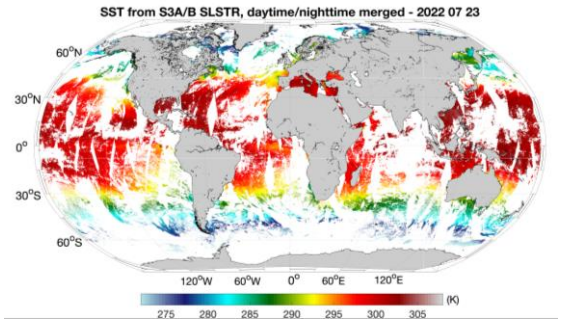
High quality measurement

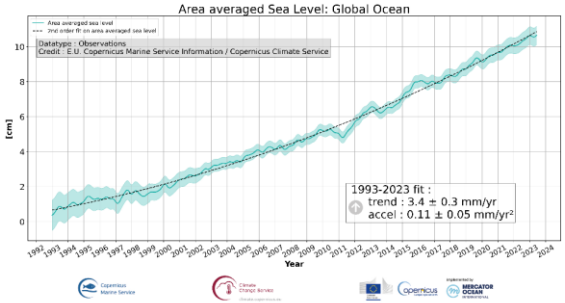
Low residual noises for SAR measurement for Sea level and Waves

➔ Along-track (L3) sea level improved observing capability compared to conventional LRM measurement (Sea level observable wavelegnths reduced by 15 to 30% compared to Jason-3)

➔ Use the full posting-rate altimeter measurement (20Hz) for sea level and waves

High resolution Temperature Radiometer measurements for SST (1km spatial resolution)





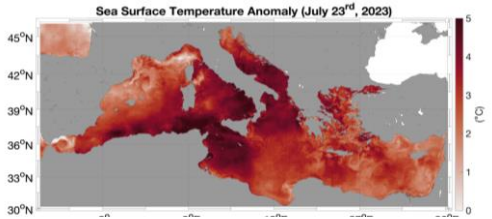
Sentinel reference missions

- Sentinel-6A HR reference for Sea Level
- Sentinel-6A LR reference for Wave, combined with in situ measurements
- Sentinel-3A reference for SST

➔ **Ensure the stability of Sea Level, Wave and SST at climatic scales**

Contribution of Sentinels missions to the gridded (Level-4) production

- The 2 interleaved couples (S6+J3N and S3A+S3B) optimized for mesoscale sampling. They contribute for nearly 65% to the L4 sea level product in low latitude (< 60°).
- Sentinel-3 contribution is **essential in Arctic**
- Sentinel-3 missions **significantly improve the quality and spatial coverage** of SST



Exceptional Mediterranean MHW event (2022-2023) detected in the MED SEA SST product

Opportunity & collaborative missions

Additionally to the Sentinels, TACs also ingest opportunity and collaborative missions :

- European: SWOT-nadir, Cryosat-2, Meteosat, Metop-A/B/C, ERS-1/2, SMOS, …
- US: NOAA, Suomi NPP, MODIS, GOES, QuikSCAT, VIIRS/NOAA, SMAP, …
- Chinese: HaiYang-2A, HaiYang-2B, HaiYang-2C, HaiYang-2D, Himawari, SHIZUKU (GCOM-W1), CFOSAT
- Indian: OceanSat-2, Oceansat-3, ScatSat-1, Altika

➔ **The link between TACs and space agencies is crucial** to ensure and maintain the contribution of the different opportunity/collaborative missions

	Number of satellite used	
	for MY production	For NRT production
WIND	7	6
WAVE	7	10
SST	20	13
SL	15	8
MOB	2 (+L4 products used)	

and in situ measurements :

- Drifters, ADCP, ARGO T/S profiles

2023 service upgrades

Main objectives

➔ Answer to users needs (MFCs & external users)
➔ Improve the observation of
- fine-scale e/o high frequency structures/processes in open ocean
- Signal and dynamic in coastal areas

➔ valorize and promote our products through OSR

Higher resolution

How ?:
- Improved processing/methodology
- Improved upstream (e.g. new Arctic SSS climatology; winds; alti 20Hz)
- Use new upstream (SMAP)

SSS/SSD MYNRT (015_013): from 1/4° to 1/8° and from weekly to daily

2D Surface currents MYNRT (015_003): from 3-hour (6-hour) in REP (NRT) to hourly fields.

SST Baltic (010_007_b): improvement of the effective spatial resolution

SL NRT (008_044): Start L3 prod with **~1km** (5Hz) posting-rate (instead of conventional ~7km) for global ocean

SWH NRT (Demo): Updated version with **~1km** (5Hz) posting-rate and associated uncertainties

WIND NRT (012_002 & 012_004): L3 & L4 coastal coverage & quality improved

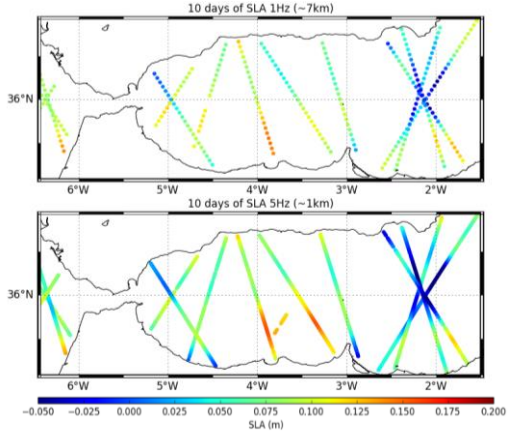
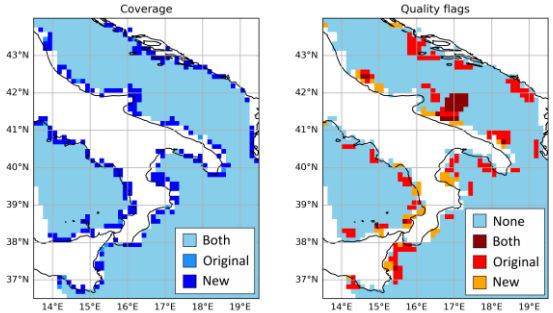


Illustration of L3 5Hz vs 1Hz SLA product

Illustration of coastal improvement for WIND products



Improve quality

Quality improved

How ?:
- Improved processing/methodology
- improved upstream (e.g. SSS/SSD)
- Use new upstream (SWOT-nadir; MetOP-c; CFOSAT/SWIM)

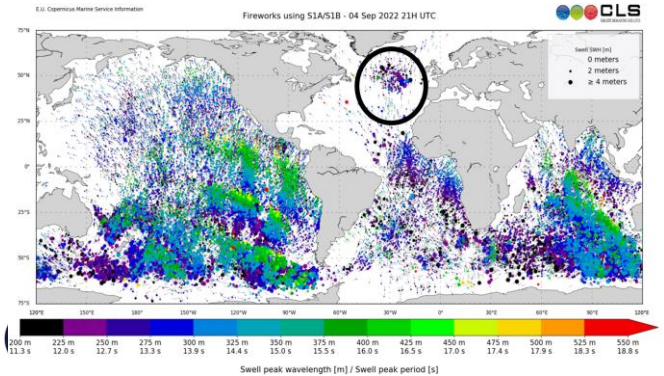
SL NRT (008_044 & 008_059): L3 1Hz (~7km) processing change to benefit from new upstream 20Hz; use SWOT nadir measurements → 8 altimeters in the constellation

SL NRT (008_046 & 008_60): L4 benefits from new SWOT-nadir measurement

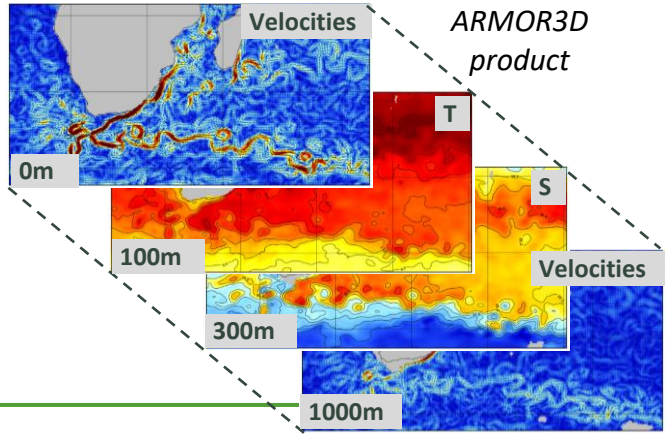
ARMOR 3D MYNRT (015_012): benefit from SSS/SSD upstream change

SST NRT -010_...): integration of MetOp-C AVHRR into all global and regional NRT products (BAL already integrated) → 13 satellite radiometers in the constellation

SPC NRT (014_004): L4 benefits from CFOSAT/SWIM measurements → 10 altimeters in the constellation



SPC wave product



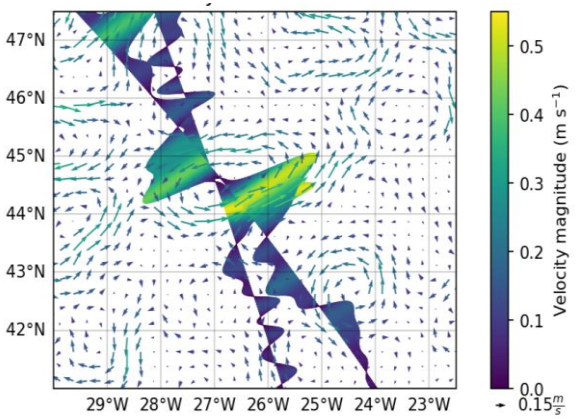
Additional products/variables

2D Surface currents MYNRT (015_003): New variable for geostrophy & Ekman components and related uncertainties

SST L3S Global & Atlantic (010_010 & 010_037): 6 New datasets : multi-resolution layers with respect to the sensor class (IR Polar Orbiting, IR Geostationary and Microwave)

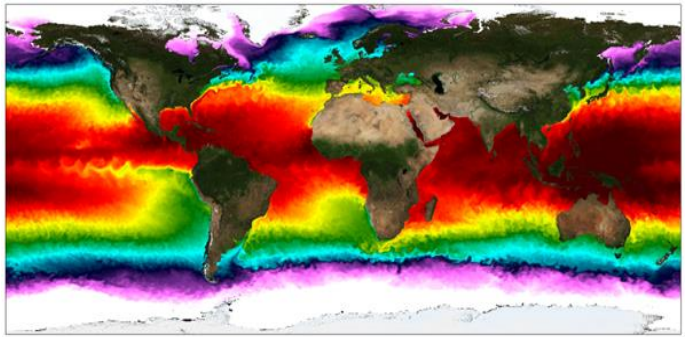
SST L4 Global (010_043): new L4 NRT product Odyssea for global ocean at 0.10°x0.10 resolution grid: daily, gap-free.

SL NRT (008_044 & 008_059): new variables for geostophic current in cross-track direction

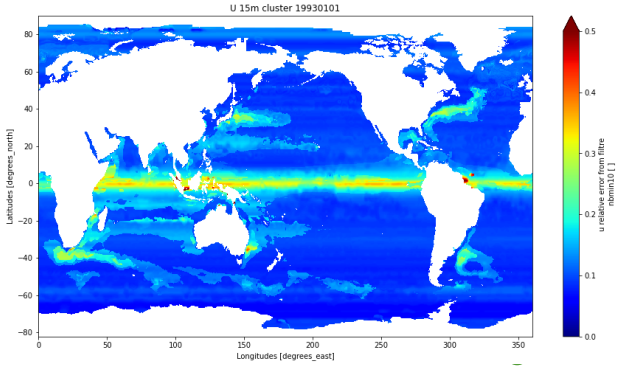


Example of across-track current for S3A and J3N (background : geostrophic currents from L4)

Odyssea NRT L4



2D surface currents :15m U uncertainties 01/01/1993



MY series completed

- Regular forward temporal extensions for different MY products & OMIs
- Specific temporal extensions / reprocessing :
  - **WIND L3:** Reprocessed datasets for ERS-1, ERS-2, QuikSCAT and Oceansat-2
  - **WIND L4:** Backward extension to 1999 using bias corrections based on QuikSCAT
  - **SST L3S:** release of a new Odyssea global ocean Multi-Year L3S product (daily, 1/10°x1/10°), from 1982 to present

Contribution to OSR#8

Blue Ocean TACs contribute to OSR#8:

- Chap 1: contribution in 2 sections (Sea level rise; extreme winds)
- Chap 2 : lead 1 section (extreme wave events)
- Chap 4: lead 1 section (Gulfstream activity) + contribution to 1 section (deep water formation and phytoplankton bloom in the Cretan area)

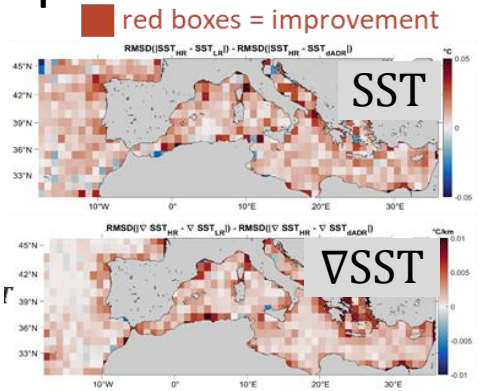
2024 major Perspectives

Improve temp. & Space resolution

Improve quality

Higher resolution & quality improved

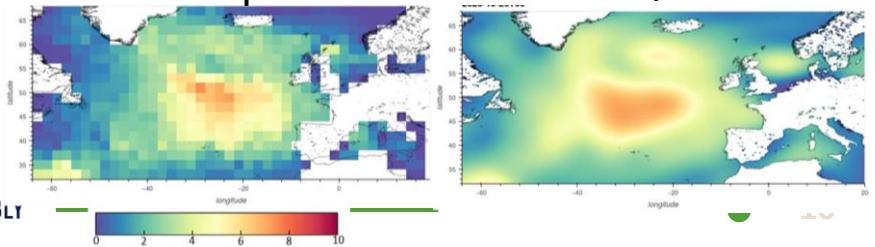
ARMORD 3D_MYNRT (015_012): from 1/4° to 1/8° and from weekly to daily
SSS MYNRT (015_015): use SMAP upstream
SST NRT (010_004): Regional MED product. Improvement of effective resolution & SST gradients accuracy thanks to AI based methodology
SST NRT (010_007_7/_032): Regional Baltic products improved with new land mask and ice estimation
SL NRT (008_046 & 008_060): improved L4 effective spatial resolution using a new multi-scale mapping methodology (MIOST)
SWH MY (014_007): increase spatial resolution to 0,5 (instead of 2°); use new multiscale mapping methodology (MIOST)
SWH NRT (014_003): use new multiscale mapping methodology (MIOST)
SPC NRT (014_002 and 014_004): use new upstream (CNES L2)



Example of expected quality improvement for SST in Med Sea

Current product

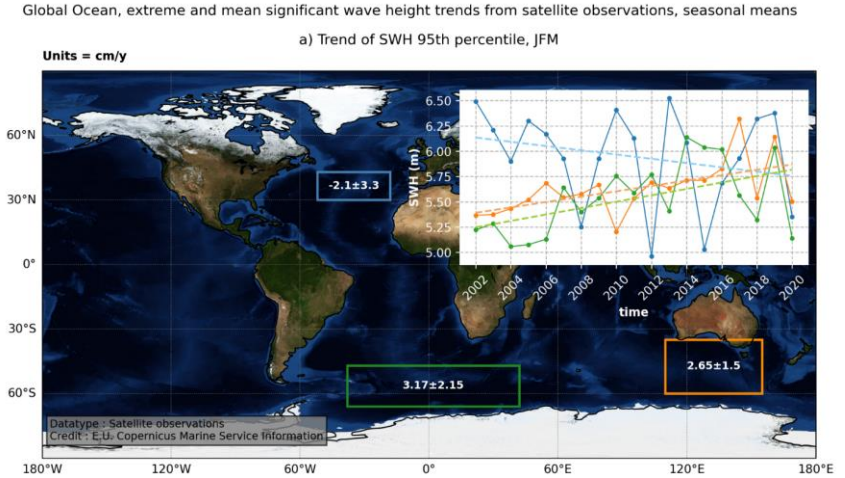
Future product



Example of expected spatial resolution improvement for SWH): case of the storms Claràn & Domingos [2023/10/26]

Additional products/variables

SST MY (010_044): new Odyssea L4 product for global ocean: 0.10°x0.10° resolution grid from 1982 to present.
WIND NRT (012_100-104): 5 new demo products for the European seas providing high-resolution SAR winds derived from Sentinel-1A at 1km
WIND NRT (012_002): new L3 dataset for Oceansat-3 OSCAT measurements
SPC NRT (014_009): new L3 product giving SWH full spectrum with CFOSAT measurements
SWH OMI: new OMI mean and extreme of SWH winter and summer values in three oceanic regions from 2002 to 2020 and their trends
2D Surface currents MYNRT (015_003): new tidal signal from Fes2022 atlas (and related uncertainties)
ARMOR3D MYNRT (015_012): new climatological monthly uncertainties of T and S
SL MY (008_068): new monthly mean datasets for Europe area



Example of new SWH OMI: trend of the extreme significant wave height (seasonal means)

MY series reprocessed

SST (010_...): full reprocessing (1982-present) of all MY products based on ESACCI SST v.3.0

WIND (012_006;003): hourly and monthly L4 extended backward to 1994 using scatterometer observations from ERS-1 and ERS-2

SL (008_...): full reprocessing of all MY L3 & L4 for Global and Europe areas (1993-present) using new altimeter standards (DT-2024) & new mapping methodology (MIOST)

ARMOR3D (015_012): full reprocessing with higher special & temporal resolution (from 1/4° to 1/8° and from weekly to daily)

OMEGA 3D (015_007): Full reprocessing with benefit from improved 2D surface current; change upstream (ERA5 instead for ERA-interim); improved algo/methodology

Conclusions

Summary

Blue ocean TACs:

- 5 TACs; 10 institutions; ~60 people involved
- 39 satellites/sensors used in NRT production (51 for MY) + different in situ measurements
- 57 products on the catalogue in 2023 (-3% vs 2022) + 28 OMIs
- 64 products in 2024 (+12% vs 2023) / 258 datasets + 29 OMIs

2023:

- 52 (91%) products upgraded
- 15 datasets added to the catalogue
- + 3 new sensors used in NRT

2024:

- 51 (79%) products upgraded
- 16 datasets added to the catalogue

Copernicus Marine Service