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IBIRYS: a Regional High-Resolution Reanalysis (physical and biogeochemical) of the last 30 years (1993-2023) over the European Northeast Shelf

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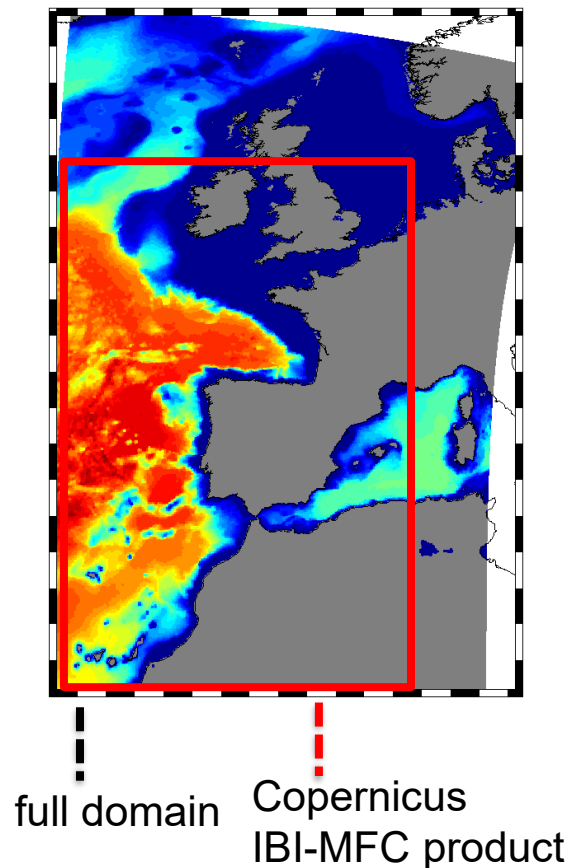
- Introduction
 - Physical model
 - description
 - Assessment (SSH, SST, S, T)
 - Biogeochemical model
 - description
 - Assessment (CHL-a, O₂)
 - Summary
-

Introduction

- **MOI** has developed an regional ocean reanalysis (physics and biogeochemistry) in the framework of the **Copernicus Marine Service**
 - In Copernicus, the Atlantic -Iberian-Biscay-Irish- Monitoring and Forecasting Centre (**IBI MFC**) is in charge of the production and dissemination of the reanalysis (PHY, BIO and WAV)
 - **Consortium members:** NOW systems, Meteo-France, CESGA
 - The reanalysis is regularly updated since 2015. In the new release (November 2025), the resolution of the physics and bio models is increased from $1/12^\circ$ to **$1/36^\circ$**
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Description of the model (PHY)

- Based on IBI-MFC NRT forecast system
- **NEMO3.6** at $1/36^\circ$ horizontal resolution and 50 vertical levels (z^*)
- Data **assimilation** system: Mercator SAM2V2
 - Along-track SLA
 - SST (L3)
 - Temperature and salinity profiles
- Atmospheric forcing: **ERA5**
- Forcing at boundaries and initial conditions: global reanalysis **GLORYS12**
- Rivers from Copernicus in-situ TAC, national websites and Ehype model

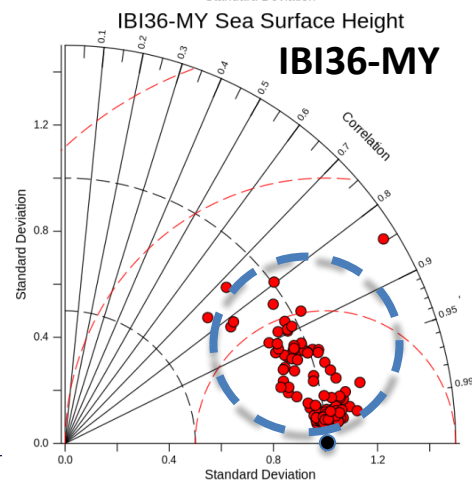
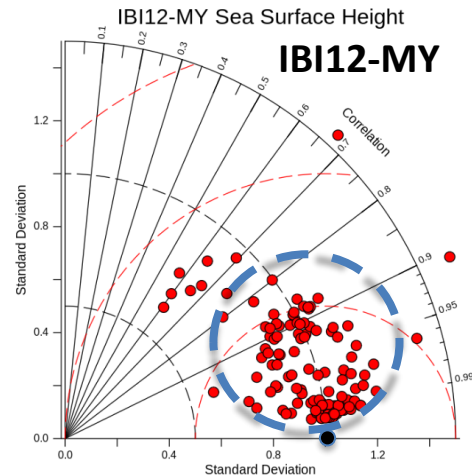
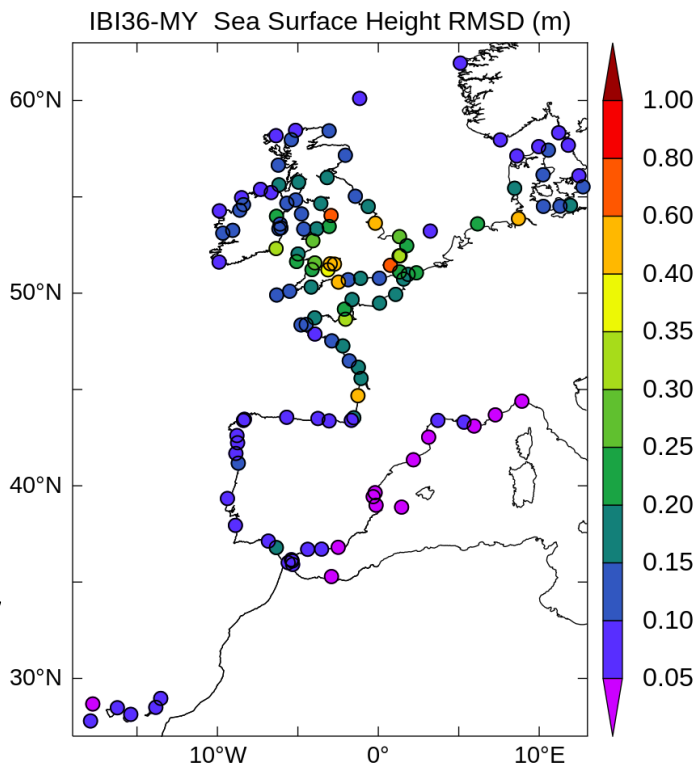


Assessment (PHY)

Total sea level
Comparisons to tide
gauges for the period
1993-2022 (depending of
each tide gauge)

RMSD lower than 10 cm
South of 45°N, higher
values in tidal sea

Improvement with the new
reanalysis

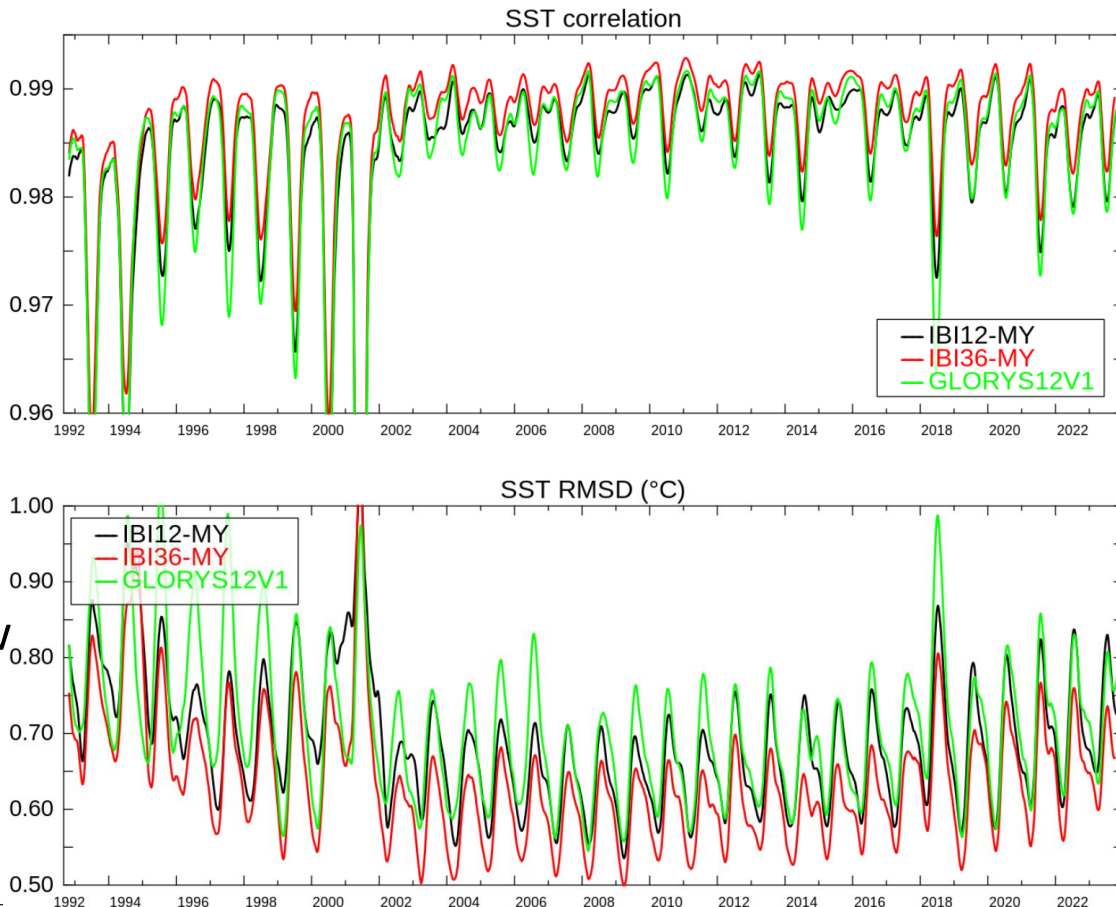


SST correlation and RMSD compared to satellite (domain averaged)

Seasonal cycle with lower/higher correlation/RMSD in summer

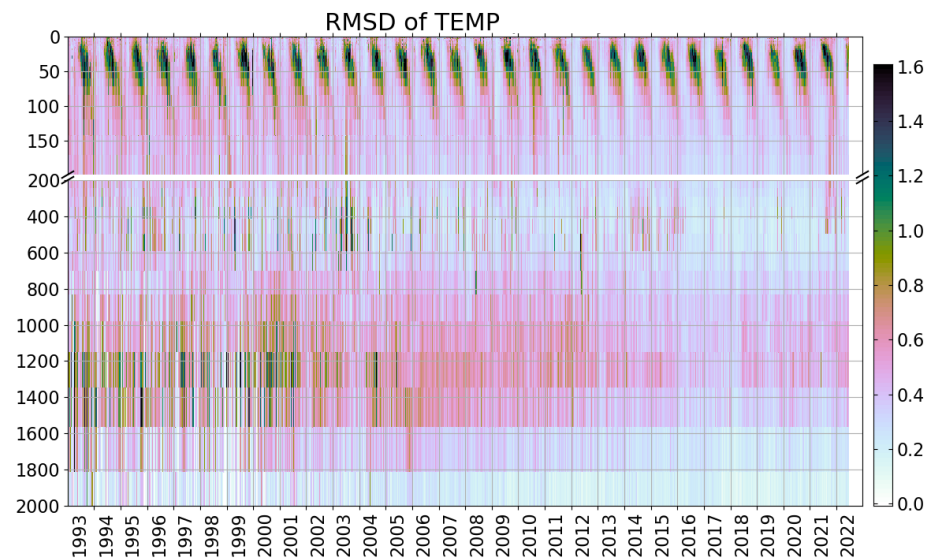
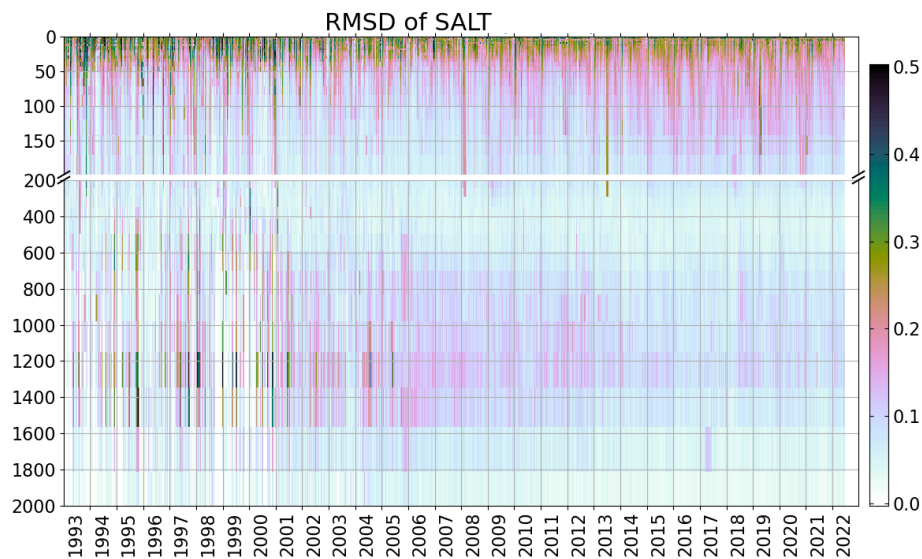
Improvement with the new reanalysis

Daily satellite L3S SST:
SST_ATL_PHY_L3S_MY_010_038



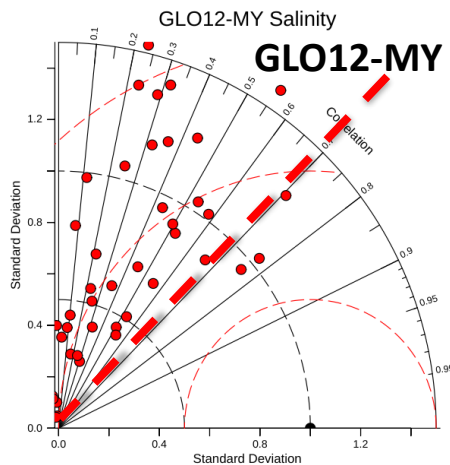
RMSD of salinity and temperature (domain averaged) compared to in-situ profiles (after assimilation)

Higher values near surface and at the depth of Mediterranean water



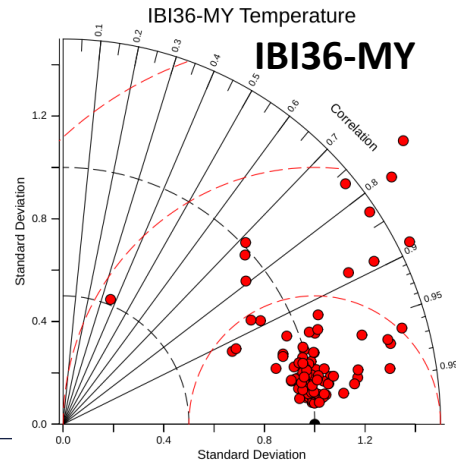
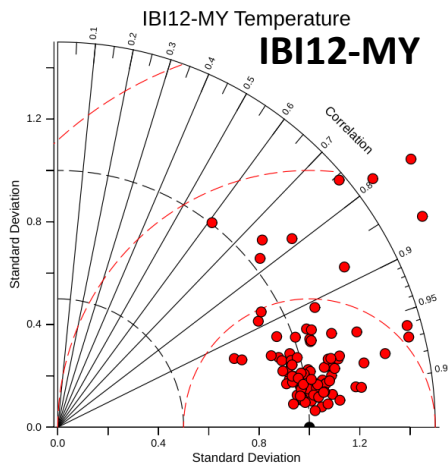
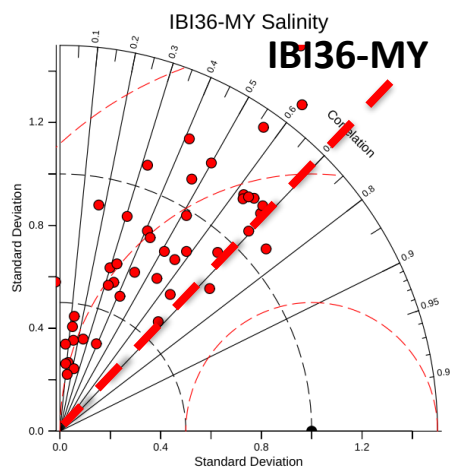
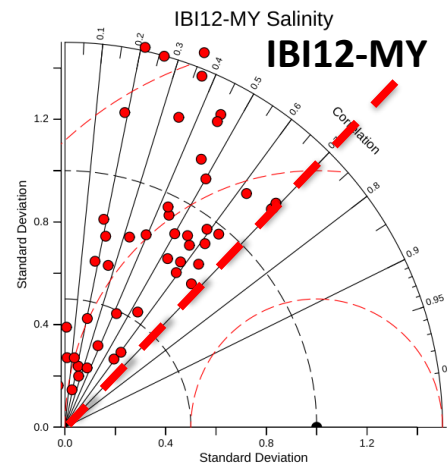
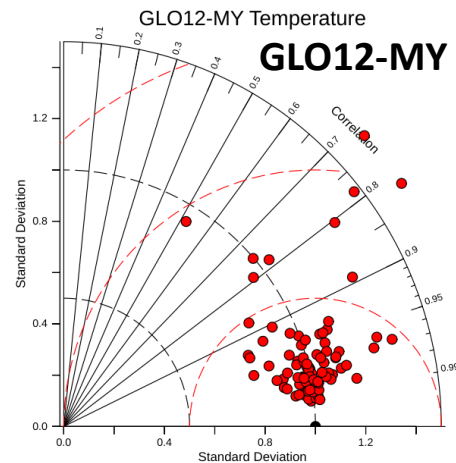
Salinity

Slight
improvement with
the new reanalysis



Temperature

Improvement
with the new
reanalysis

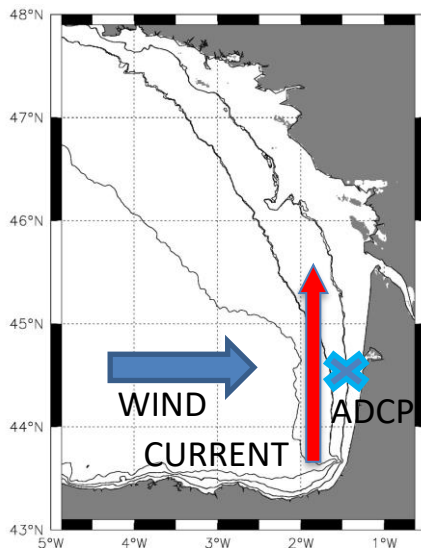


Bay of Biscay coastal jet

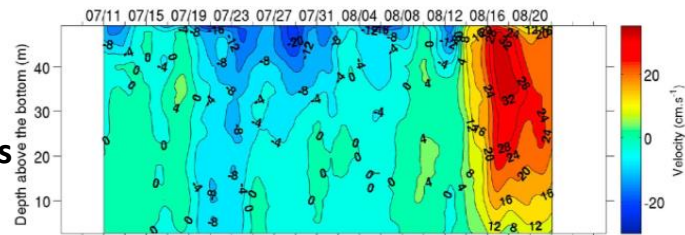
Batifoulie et al (2012):

Observations of poleward coastal jets along the Aquitaine shelf, associated with increase of the bottom temperature.

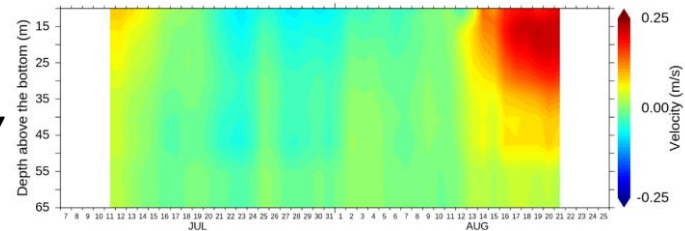
The triggering mechanism is due to downwelling situation along the Spanish coast induced by westerlies winds.



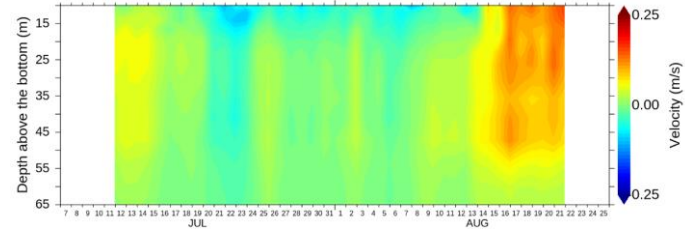
Observations



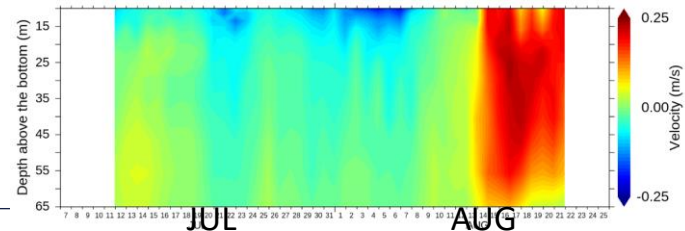
GLO12-MY



IBI12-MY

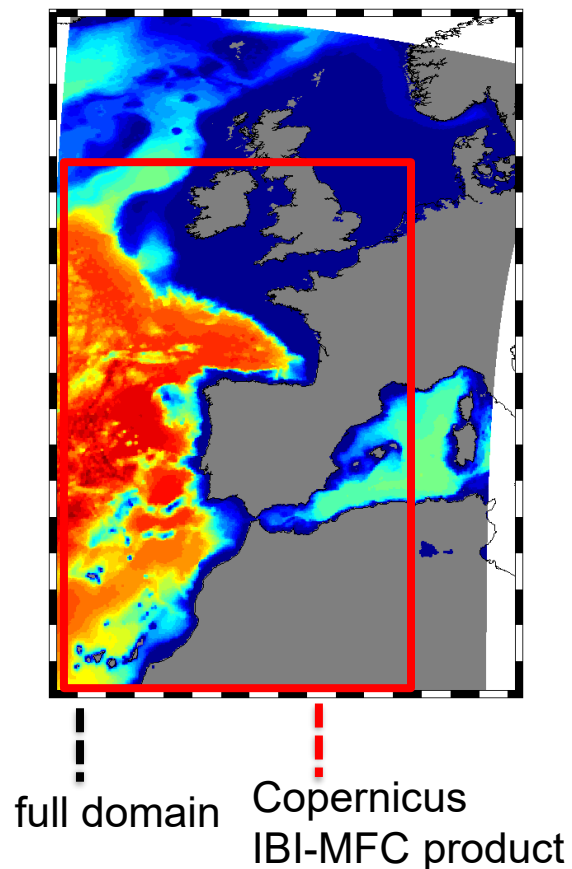


IBI36-MY



Description of the system (BGC)

- **PISCESv2** ocean model at $1/36^\circ$ and 50 vertical levels
- **Online coupling** (1-way) with physical model
- **BIOMER4** global forecast model at boundaries (climatology before 2008) and correction of carbon trends
- River discharges: inputs of nutrients (Global News 2 + additional NO_3 , PO_4 , Si) modulated by river flow
- Permanent burial : Organic Matter deposition to the sediment is function of a bottom shear stress Critical value
- Atmospheric pCO_2 and dust from CAMS (interannual 2D fields)
- No assimilation

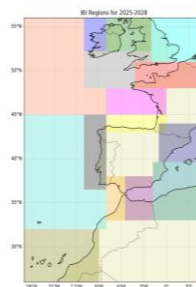
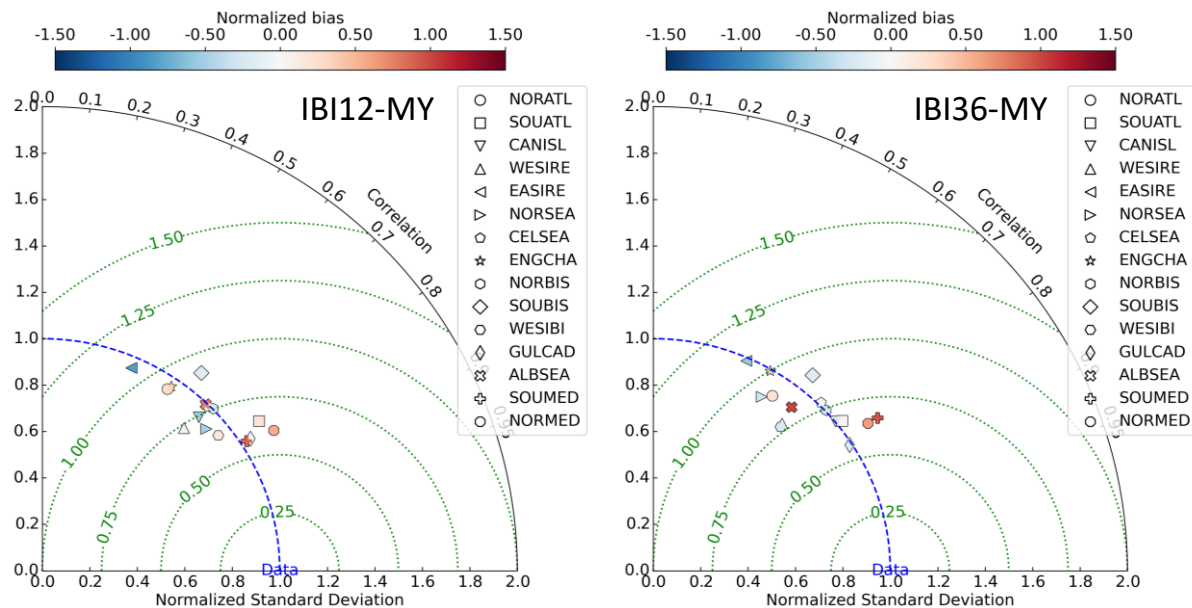


Assessment (BGC)

Chlorophyll-a
(mg Chl m⁻³)
Comparison to
Satellite OC
Monthly fields 1998-
2023

Statistics by region
(stats on log(chl), 3D
fields)

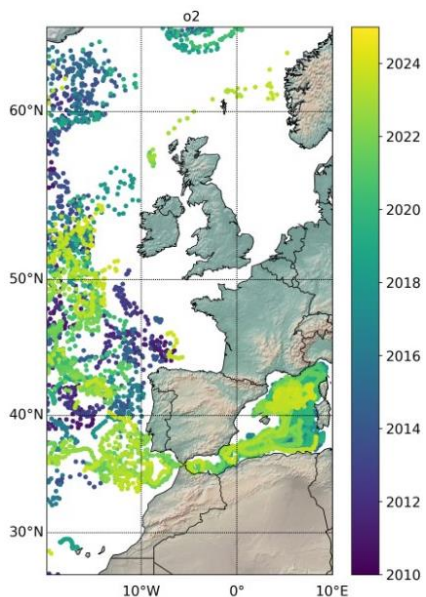
Satellite OC: Monthly L4 satellite chlorophyll
OCEANCOLOUR_ATL_BGC_L4_MY_009_118
OCEANCOLOUR_MED_BGC_L4_MY_009_144



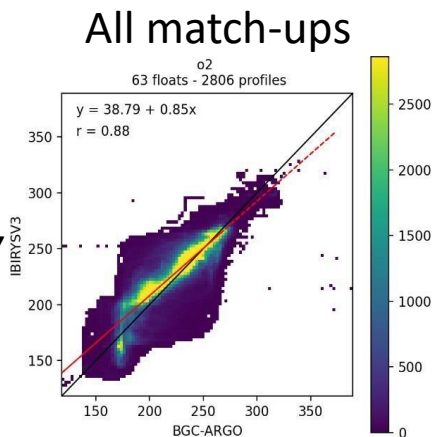
New MY product:

- similar performance to OC satellite data
- similar representation of temporal/spatial variability

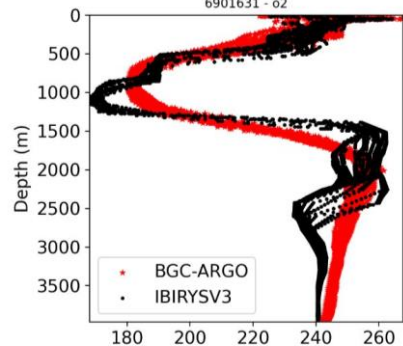
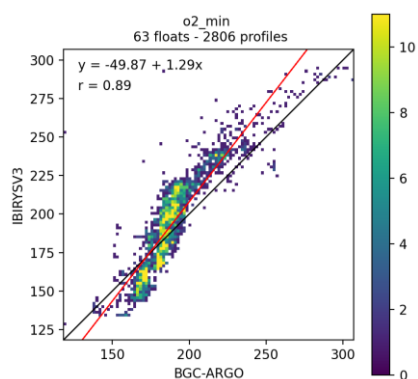
Oxygen ($\mu\text{mol kg}^{-1}$) Comparison to BGC- Argo Focus on North Atlantic



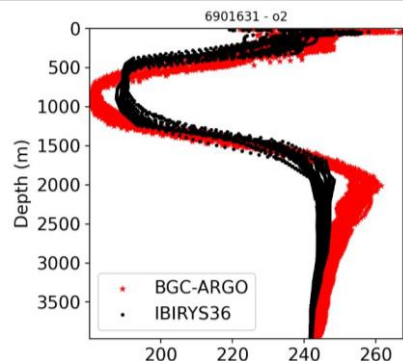
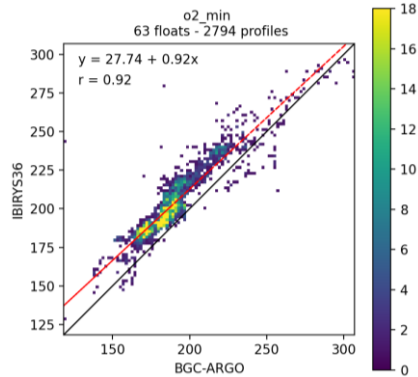
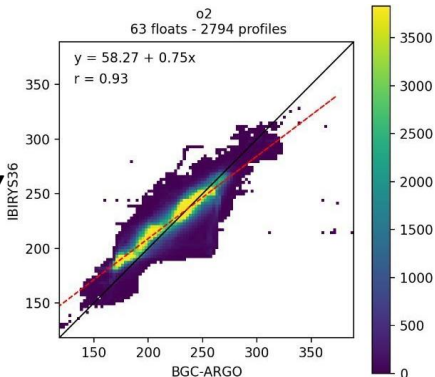
IBI12-MY



O2 minimum



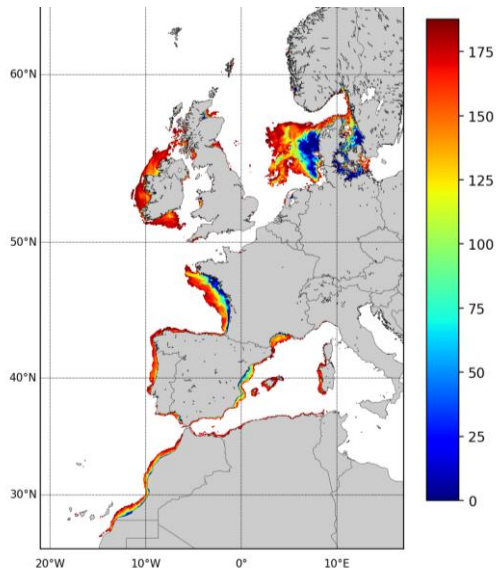
IBI36-MY



New MY product: → clear improvement of O2 vertical distribution, position and value of oxygen minimum on the North Atlantic, especially west of the Strait of Gibraltar and Portugal

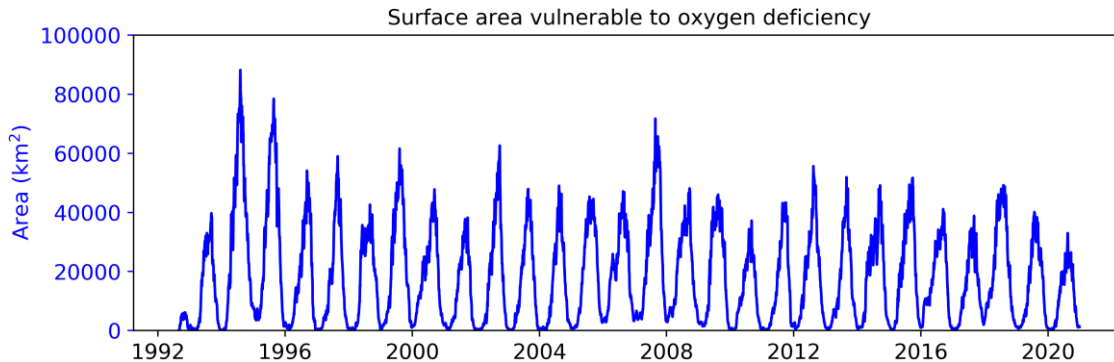
Monitoring the areas vulnerable to oxygen deficiency from the IBI Reanalysis

Spatial distribution of areas vulnerable to oxygen deficiency



Lowest concentration (below the defined threshold) simulated during the simulation (1993-2023)

Seasonal evolution of vulnerable surface areas (km²)



Winter : No vulnerable areas

waters well oxygenated due to strong mixing

Summer: Maximum surface area of 85 000 km² deoxygenated conditions in the coastal waters of the north-west European shelf

As identified by OSPAR (2013), Ciavatta et al. (2016), Breitburg et al. (2018)

The New MY product could be used to monitor vulnerability of the North-west European shelf to oxygen deficiency !

Summary

- The IBI reanalysis has been updated with increased horizontal resolution
 - The period 1993-2023 has been produced
 - The new reanalysis shows good scores compared to observations and previous and global reanalyses
 - Better scores for SSH or SST
 - Better scores for Oxygen
 - The reanalysis will be in Copernicus Catalog in November 2025
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