Assessing the impact of BGC-Argo data assimilation into the Copernicus operational model system of the Mediterranean Sea biogeochemistry

Gianpiero Cossarini, Carolina Amadio, Anna Teruzzi, Laura Feudale, Giorgio Bolzon, Stefano Salon

National Institute of Oceanography and Applied Geophysics – OGS , Trieste, Italy

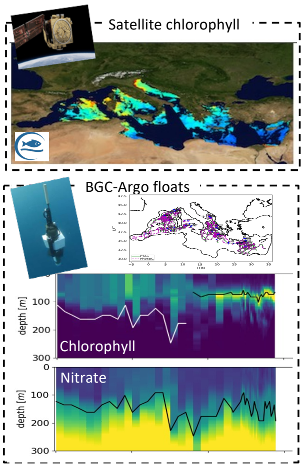
29 JUNE – 1 JULY 2022
EuroSea/OceanPredict
Workshop on Ocean Prediction and Observing

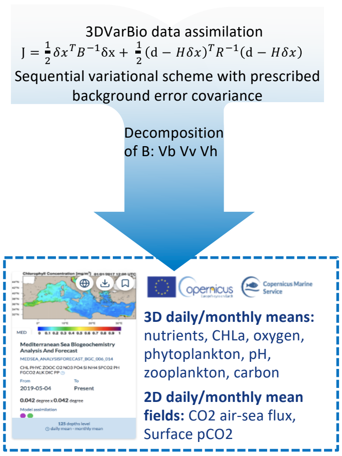
The biogeochemical analysis and forecast system of the Mediterranean Sea (MedBFM)

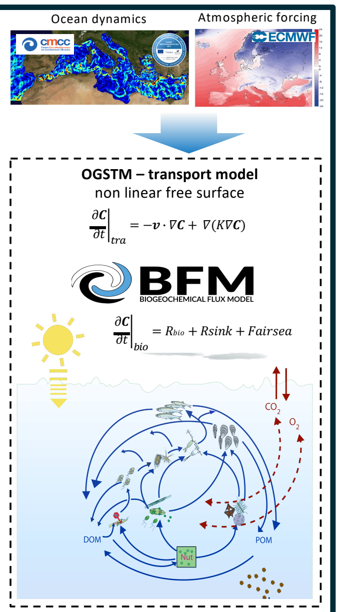
In the framework of the **Copernicus Marine Service** (marine.copernicus.eu), the operational NRT analysis and forecast system for the Mediterranean Sea biogeochemistry (MedBFM) consists of the coupled transport model (OGSTM) and **Biogeochemical Flux Model (BFM)** and the variational data assimilation (**3DVarBio**) for ocean color satellite and BGC-Argo observations.

Tracers transport and biogeochemistry are forced by ocean dynamics produced by the Copernicus Mediterranean physical model (NEMO–OceanVar at CMCC). MedBFM has a resolution of 1/24° horizontally and 125 Z* vertical levels and produces 7 days of analysis and 10 days of forecast.

Setup of MedBFM includes: ECMWF MWP analysis and forecast; nutrients and carbon input from 38 rivers (runoff higher than 50 m^3/s); nutrients air deposition; CO2 air-sea exchange forced by atmospheric pCO2; open boundary conditions in the Atlantic Ocean and at the Dardanelles Strait from Word Ocean Atlas, GLODAP and EMODNet datasets.

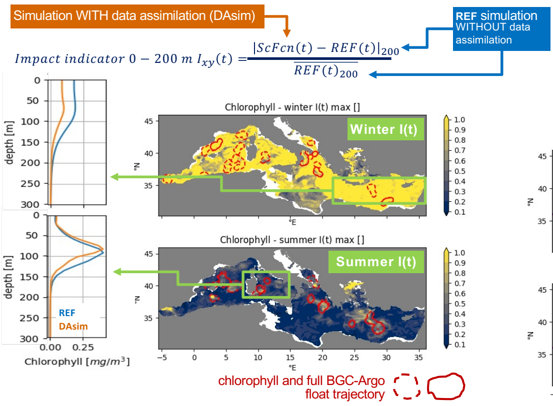




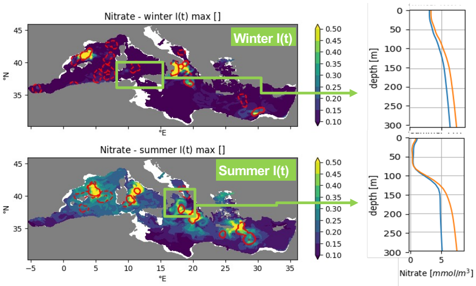


Cossarini et al., 2019; Teruzzi et al., 2021

Impact of BGC-Argo and Ocean Color satellite assimilation



An impact indicator I(t) is calculated for each assimilation date and each grid point. I(t) quantifies how much the assimilated run (DAsim) deviates from a reference (REF) simulation.
Maps of normalised seasonal median of the impact indicator values (yellow indicates high impact) and simulated profiles for chlorophyll and nitrate in winter and summer.



BGC-Argo and ocean color data assimilation are complementary. Satellite observations are influential in winter/early spring when surface phytoplankton blooms occur, BGC-Argo profiles have notable (even if local) impacts on the vertical structure of nutrients and phytoplankton mostly in summer.

The impacts of multi-variate profile assimilation are directly linked to the sampling frequency and dimension of the BGC-Argo network.

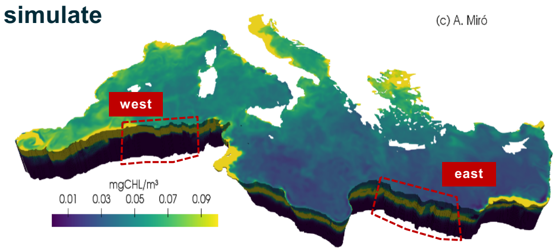
Improving model capability to simulate vertical biogeochemical dynamics

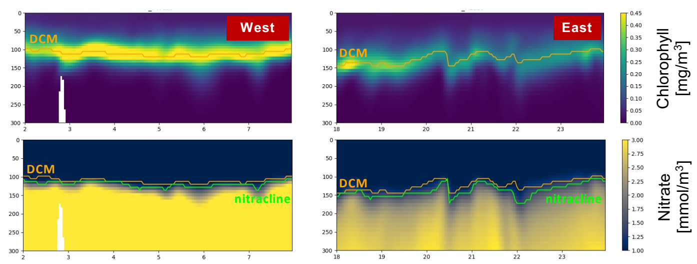
The simulation with assimilation shows that, in the western Mediterranean, the DCM is shallower, more intense, and less thick and occurs at higher light intensity with higher nutrient uptake by phytoplankton than in the eastern Mediterranean. Correspondingly, the nitracline and the phosphocline are shallower, steeper and narrower.

Moving eastward, the DCM, nutricline and productivity features change by as much as 50%, which indicates that the Mediterranean Sea has relatively variable conditions despite being a small semi-enclosed basin.

Different light extinction factors and nutrient concentrations in the bottom layer contribute to generate the simulated zonal gradient of DCM and nutricline depths and shapes.

Results of the simulation that integrated BGC-Argo floats and satellite observations provide a validated 3D description of Mediterranean Sea biogeochemistry (3D field of chlorophyll).
West-to-East sections of chlorophyll and nitrate during summer showing the depths of deep chlorophyll maximum and nitracline (colored lines)





Developments under evaluation

Assimilation of BGC-Argo oxygen profiles to exploit the availability of the most common sensor mounted in BGC-Argo floats (100-150 profiles per month). Up to 20% of Mediterranean domain shows marked impacts after assimilation. Testing the assimilation of pseudo-observations of nitrate, phosphate, chlorophyll reconstructed with an upgrade of the Canyon-Med Neural Network based on a new training with the EMODNet data collection. Combining the assimilation of BGC-Argo data and pseudo-observations reconstructed from Argo temperature, salinity and oxygen allows to maximize the impact of the float network.

Cossarini, G., Mariotti, L., Feudale, L., Mignot, A., Salon, S., Taillandier, V. and D'Ortenzio, F. (2019). Towards operational 3D-Var assimilation of chlorophyll Biogeochemical-Argo float data into a biogeochemical model of the Mediterranean Sea. Ocean Model. 133, 112–128. doi: 10.1016/j.ocemod.2018.11.005

Teruzzi, A., Bolzon, G., Feudale, L., and Cossarini, G. (2021). Deep chlorophyll maximum and nutricline in the Mediterranean Sea: emerging properties from a multi-platform assimilated biogeochemical model experiment. Biogeosciences, 18, 6147–6166. https://doi.org/10.5194/bg-18-6147-2021