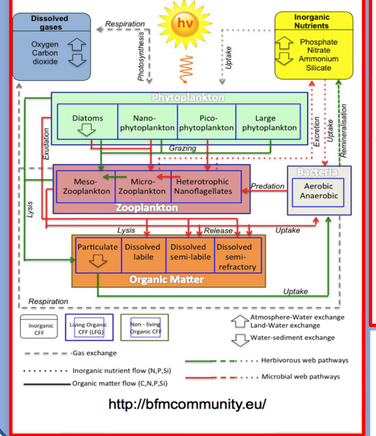
The Forecasting Model of the Environmental Dynamics of the North Adriatic Sea Structure and Preliminary Results

Isabella Scroccaro[1], Marco Zavatarelli[1], Tomas Lovato[2], Piero Lanucara[3]

[1]University of Bologna, Department of Physics and Astronomy, Viale Berti Pichat, 8 – 40127 Bologna, Italy
[2]CMCC Foundation - Euro-Mediterranean Center on Climate Change, Viale Berti Pichat, 6 – 40127 Bologna, Italy
[3]CINECA, SCAI Department, Via dei Tizii, 6/B – 00185 Rome, Italy

Introduction In the framework of the European Project H2020 "ODYSSEA" (Operating a network of integrated observatory systems in the Mediterranean SEA, http://odysseaplatform.eu/) a forecasting modeling system of the coupled physical and biogeochemical conditions of the North Adriatic Sea (figure 1) is under development. The modeling system consists of the on-line coupling of the European general circulation model NEMO (Nucleus for European Modeling of the Ocean, https://www.nemo-ocean.eu/), with the marine biogeochemical model BFM (Biogeochemical Flux Model, bfm-community.eu/). The biogeochemical component of the model includes the simulation of the biogeochemical processes of both water column and sediments and their coupling (see figure 2).



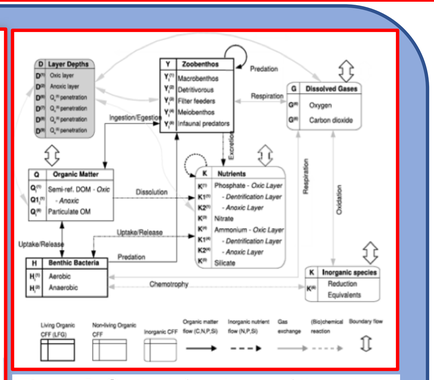
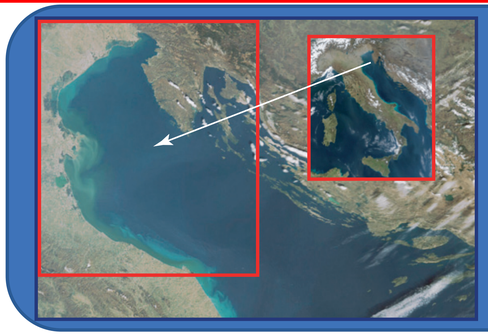


Figure 2. On the left, scheme of the pelagic state variables and interactions of the BFM. Above, scheme of the benthic state variables and benthic interactions of BFM.



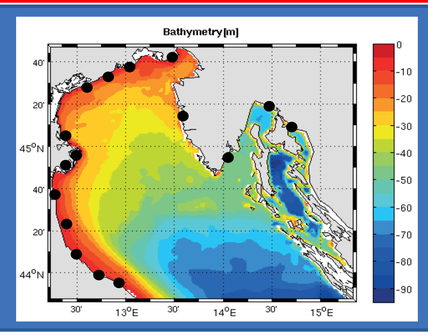


Figure 1. On the left, the map of the case study of the North Adriatic Sea, defined whithin the red line.

On the right, the model domain with the bathymetry and the location of the riverine inputs (black points).

Hardware Support for the simulations - Galileo and Marconi KNL (CINECA)

Yearly simulations have been carried out on 2 CINECA supercomputers systems:
1) A2 partition of Tier0 Marconi system, characterized by many-cores processors Intel Knights Landing (KNL) and a maximum computing power of about 11 Pflops.
2) GALILEO Tier1 system, equipped with Intel Xeon E5-2697 v4 (Broadwell) nodes, OPA interconnets.

Implementation of the Modeling System of the Environmental Dynamics of the North Adriatic Sea

The system is implemented with a horizontal resolution of about 800 m and a vertical resolution of 2 m, in z coordinates. The atmospheric forcing consists of forecasts and analyses from national and international meteorological centers. The river supplies of fresh water and nutrient salts consider the daily runoff of the Po river, while climatological values are taken into account for the other rivers within the study area. The open boundary conditions of the modeling system come from the Copernicus Marine Environment Monitoring Service (CMEMS, http://marine.copernicus.eu/). Initial concentration of BFM state variables come from BFM-POM Adriatic Sea simulation (res. O(2km)).

Sea Surface Temperature

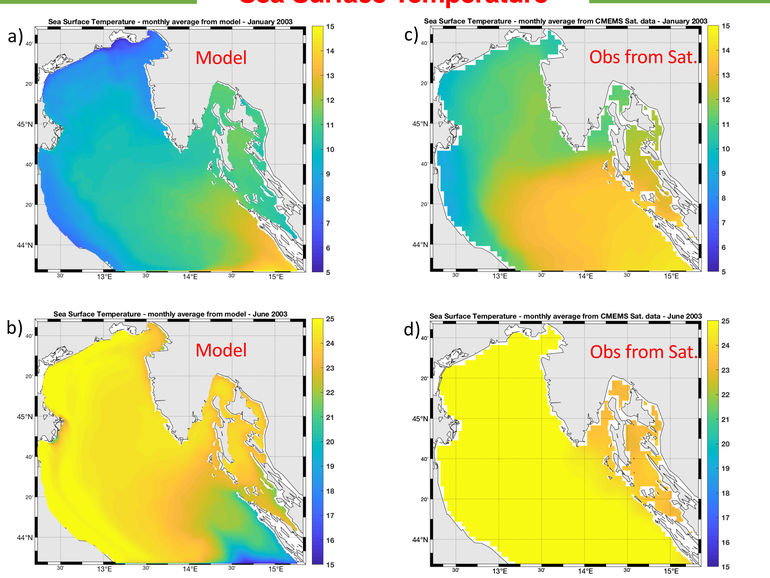


Figure 3. Maps of ***Sea Surface Temperature*** in °C – monthly average for January and June 2003. a) and b) Model results; c) and d) satellite data from CMEMS.

Chlorophyll-a

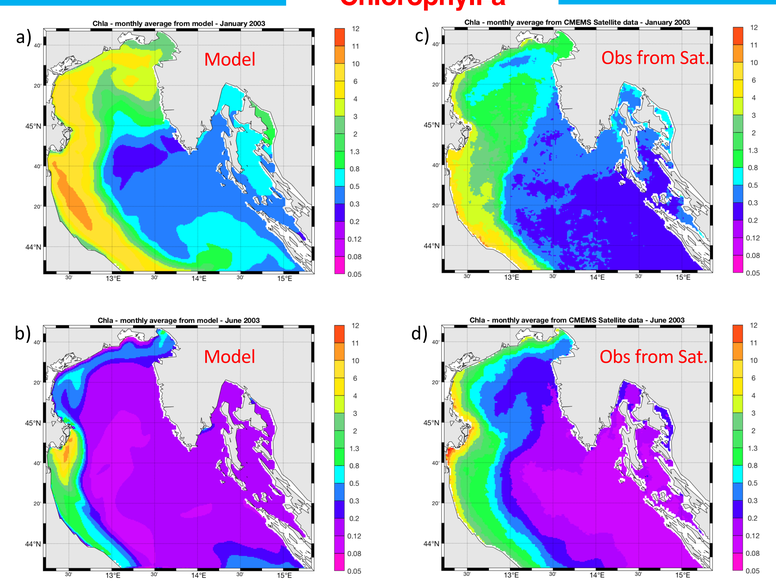


Figure 4. Maps of ***surface Chlorophyll-a*** in mg Chl/m^3– monthly average for January and June 2003. a) and b) Model results; c) and d) satellite data from CMEMS.

Benthic state variables

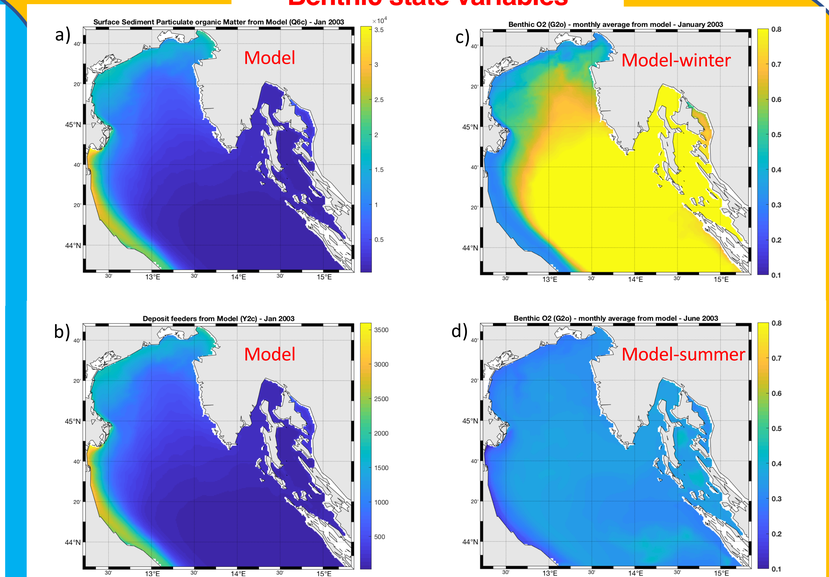


Figure 5. Maps of distribution: a) ***surface sediment particulate organic matter*** (mg C/m^2) - January 2003; b) ***deposit filter feeders*** (mg C/m^2) - January 2003; c) and d) ***benthic oxygen*** (mmol O$_2$/m^2) in January and June 2003.

Preliminary Results In figures 3, 4 and 5 some examples of preliminary results are presented, carried out in «hindcasting mode» for the year 2003, for chlorophyll a, sea surface temperature and some benthic state variables. Preliminary results indicate that the distributions of the pelagic biogeochemical state variables (see figures 3 and 4) are in reasonably good agreement with remote observations; also the benthic state variables concentrations are simulated in line with the known characteristics of the North Adriatic benthic ecosystem. In particuar, the seasonal variability of the benthic oxygen concentration (see figure 5) shows clearly the strong impact of the water column stratification (winter to summer) on the temporal dynamics of such state variable.

Final Considerations and Future Developments In this work, the model is run for the first time with an explicit benthic-pelagic coupling. Some preliminary results obtained from hindcast simulations of recent years are shown in comparison with observations from satellite platforms, for sea surface temperature and chlorophyll-a. The operational forecasting system is foreseen to be ready in the next months.

Aknowledgments *This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 727277.*