The CADEAU directive-oriented downstream coastal service: integration of the Italian water quality dataset and a model downscaling of the Mediterranean CMEMS

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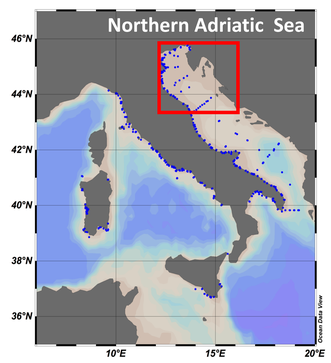

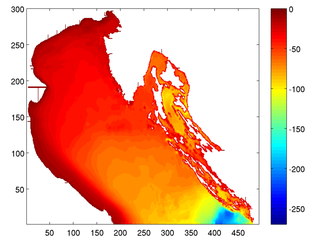

Fig. 1. Study area (left) and model domain and bathymetry (right). The model has a horizontal resolution of 1/128° (~850 × 600 m), with 27 vertical levels and 19 main freshwater sources (rivers).

1 - CONTEXT: EU PRESCRIPTIONS FOR THE MARINE ENVIRONMENT

EU countries are requested to comply with many **EU Directives** with respect to **coastal and marine environment** (e.g., WFD, UWWTD, BWD, MSFD).
Such Directives either prescribe **threshold values** to comply with, or define **environmental targets** and specify **assessments** and **actions** to reach them.

2 - THE CADEAU SERVICE: A DOWNSTREAM APPLICATION OF CMEMS

CADEAU is a **downstream application** in **support** of the application of the EU prescriptions. It aims to operationally produce an **annual bulletin** reporting the **marine environmental state** and the **water quality** in the **Northern Adriatic Sea** (CMEMS Mediterranean Sea region, Fig. 1).
The service (Demonstration 32-DEM-L5) is applied to the **Italian coastal area**, since it is one of the most sensitive sites of the Adriatic, where **eutrophication** and **marine resources exploitation** both influence and depend on the **quality** of the marine ecosystem.

3 - METHODS: IMPLEMENTATION OF THE SERVICE

The system is based on the high-resolution (**1/128°**), **coupled MITgcm-BFM model** [*1,2*] (Fig. 2 and 3). The model is initialized and driven by the **downscaling** of the products (hydrodynamics and biogeochemistry) provided by **CMEMS**.
The CADEAU **products** are designed to supply information on the **space-time distributions** of the major parameters related to **water quality** and they will be **publicly delivered** through a dedicated **web-portal**:
http://www.bio.isprambiente.it/cadeau/
The **annual bulletin** includes various derived products, such as:

- dynamics and characteristics of **ocean currents**
- concentration and dynamics of **biogeochemical variables** (nutrients, chlorophyll, dissolved oxygen)
- **dispersion of pollutants** around the areas of the discharge points (rivers and UWWTP outfalls)

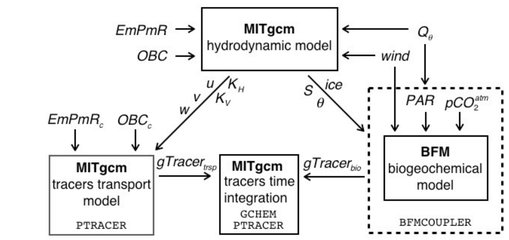

Fig. 2. Description of the MITgcm-BFM coupling and interfaces among the different components. Q_θ: heat fluxes; *EmPmR* ($EmPmR_c$): water (matter) fluxes; *OBC* (OBC_c): open boundary condition for hydrodynamic (biogeochemical) variables; *S*, θ, *u*, *v*, *w*, *ice*, K_h and K_v: hydrodynamic variables; *PAR*, *wind* and pCO_2^{atm}: forcing variables for the biogeochemical model.

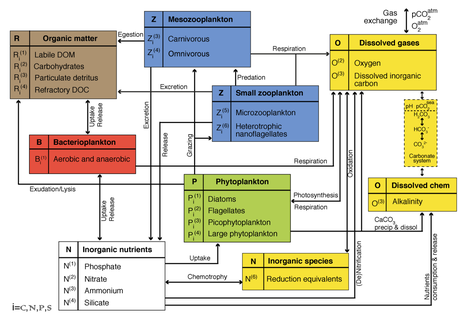

Fig. 3. BFM model: scheme of the functional interactions among the biogeochemical variables [*3*]

4 - PRELIMINARY PRODUCTS AND RESULTS

Two experimental datasets have been created (Fig. 4): **1** – ***in-situ* samplings** of physical, biological and chemical parameters (**110 stations**); **2** – urban wastewater treatment plants (**UWWTP)** discharges (not shown). The sampling data have also been analysed to obtain a **synoptic view** of the dataset and to check the spatial and temporal distribution of the *in-situ* measurements (Fig. 4a).
The **integration** of the numerical model and the experimental dataset has been tested successfully (Fig. 4, 5): the numerical results reproduces the **interannual variability** of the main hydrodynamic and biogeochemical properties of the northern Adriatic Sea, **filling the spatial and temporal gaps** of the experimental dataset.

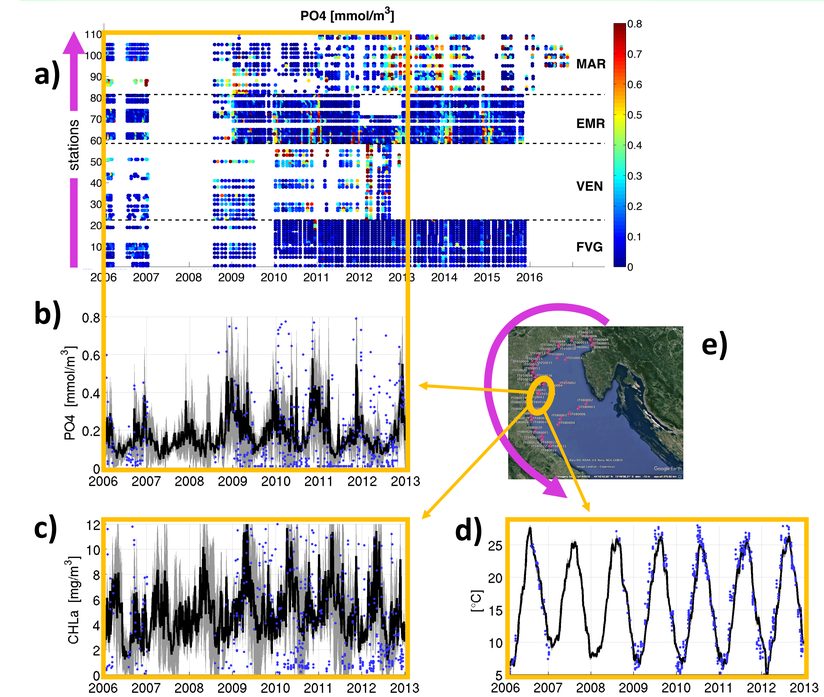

Fig. 4. Example of spatial and temporal distribution of *in-situ* measurements of phosphate (a). The stations are ordered by administrative divisions (FVG, VEN, EMR, MAR), following the coastline in the CCW direction, starting from north (e). Comparison of measured (**dots**) and modelled (lines) time series of phosphate (b), chlorophyll (c) and temperature (d) in the area indicated by the **ellipse** (e).

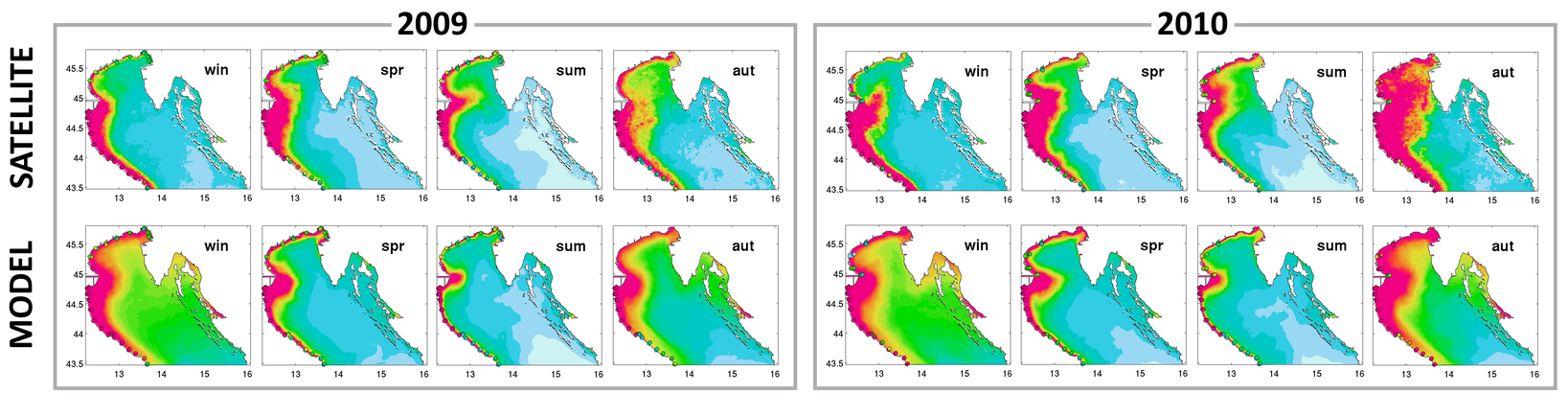

Fig. 5. Measured (top) and modelled (bottom) surface chlorophyll in 2009 and 2010 (seasonal averages). The coloured dots represent the *in-situ* measurements sampled in the stations shown in figure 4e.

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