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3D coupled physical-biogeochemical modelling of the Bay of Marseille: role of the physical forcing on the modulation of natural and anthropogenic nutrient inputs

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The Bay of Marseille is a contrasted environment: whereas the Bay is under strong and various anthropogenic inputs, this ecosystem remains to this day overall oligotrophic. However, during special events as rivers floods with intrusion of the Rhone River plume in the Bay, values of biogeochemical indicators are approaching those of an eutrophic environment. The aim of this work (sustained by GIRAC, MASSILIA and METROC projects) was to develop, validate, and use a three-dimensional physical-biogeochemical coupled model, in order to better understand the role of the physical forcing on the modulation of natural and anthropogenic nutrient inputs. Here, we will particularly focus on the determination and the hierarchization of the different nutrient sources.

The initial biogeochemical model (Faure et al, 2010a) was modified in order to introduce a new parameterization specific on the NW Mediterranean Sea ecosystem, and to add the sensitivity of zooplankton grazing formulation to the temperature. This new model version (ECO3M-MASSILIA) was coupled 'online' with the 3D hydrodynamic MARS3D model, in the nested model configuration RHOMA (Pairaud et al., 2011). Realistic 3D simulations were performed using atmospheric forcing from the high resolution MM5 model. The different sources of nutrients introduced into the coupled model were the Rhone River, urban rivers, anthropogenic(waste) inputs and benthic diffusive fluxes.

Results highlighted the complexity of the different forcings in this area, especially the role of physical forcing. Using such a complex coupled model permitted therefore to evaluate the modulation and the hierarchization of each specified input and their impacts on the biogeochemical functioning of this ecosystem. As an example, we showed that in some case rich nutrients water issued from Rhone River reached Marseille coastal area (Rhone River intrusion). On the other hand, winds created strong upwelling events, responsible of nutrients inputs in surface layer which could lead to an increase of primary production, especially in spring and summer. At last, the impact of urbans rivers and anthropogenic inputs remained quite minor, except in areas close to points of discharge, and during floods events.

In the future, these models could therefore be used as a decision-making tool for coastal managers, especially in order to prevent eutrophication processes. In addition, forcing a chemical contaminant (PCB) model with this physical-biogeochemical coupled model outputs is also under development. This contaminant model could allow studying the terrestrial inputs to the sea, the offshore export and the propagation of these contaminants in the foodweb.

References

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