Geophysical Research Abstracts
Vol. 18, EGU2016-9119-1, 2016
EGU General Assembly 2016

Modelling of the impact of the Rhone River N:P ratios over the NW Mediterranean planktonic food web

Elena Alekseenko (1), Melika Baklouti (2), and François Carlotti (2)

(1) People's Friendship University of Russia, Moscow, Russia (lena.alekseenko@gmail.com), (2) Aix-Marseille University, University of Toulon, CNRS/INSU, IRD, MIO, UM 110

The origin of the high N:P ratios in the Mediterranean Sea is one of the remaining important questions raised by the scientific community. During the last two decades it was observed that the inorganic ratio NO_3:PO4 ratio in major Mediterranean rivers including the Rhone River has dramatically increased, thereby strengthening the P-limitation in the Mediterranean waters (Ludwig et al, 2009, The MerMex group, 2011) and, as a result, increasing the anomaly in the ratio NO_3:PO4 of the Gulf of Lions (GoL) and in all the western part of NW Mediterranean.

The N:P ratios in seawater and in the metabolic requirements for plankton growth are indeed of particular interest, as these proportions determine which nutrient will limit biological productivity at the base of the food web and may select plankton communities with distinct biogeochemical function (Deutsch &Weber, 2012). In this context, an in the same spirit as the study of Parsons & Lalli (2002), an interesting question is whether high NO_3:PO4 ratios in sea water can favor dead-end gelatinous food chains to the detriment of chains producing fish or direct food for fish . More generally, we aim at characterizing the impact of changes in the NO_3:PO4 ratio on the structure of the planktonic food web in the Mediterranean Sea.

Coupled physical-biogeochemical modeling with the Eco3M-MED biogeochemical model (Baklouti et al., 2006a,b, Alekseenko et al., 2014) coupled with the hydrodynamic model MARS3D (Lazure&Dumas, 2008) is used to investigate the impact of Rhone River inputs on the structure of the first levels of the trophic web of the NW Mediterranean Sea. The fact that the model describes each biogenic compartment in terms of its abundance (for organisms), and carbon, phosphorus, nitrogen and chlorophyll (for autotrophs) contents means that the intracellular quotas and ratios of each organism can be calculated at any time. This provides information on the intracellular status of organisms, on the elements that limit their growth and ultimately enhances our understanding of the functioning of this planktonic food-web.

The present work consisted in running two different scenarios (low and high NO_3:PO4 in the Rhone River). The lower ratio is the one presently found in the Rhône river outputs while the higher ratio is twice the lower one.The study focused on a one-year period (2010) since the model outputs during this period have already been partially validated (Alekseenko et al., 2014).

At this stage, we first explore the spatial and temporal dynamics of the carbon stocks, in living and non-living compartments as well as related carbon fluxes. Results showed that, after one year of simulation, the change in NO_3:PO4 of Rhone River mostly impacts organisms in the shelf zone of GoL, and especially the lowest trophic levels during the spring phytoplankton bloom. The increase in NO_3:PO4 decreases primary production and bacterial production rates, thereby decreasing food availability for zooplankton which population growth decreases. During the spring phytoplankton bloom period, the decrease in Chl-a induced by the high NO_3:PO4 Rhone ratio has an order of value comparable to the Chl-a mean level observed in the GoL. In the case of the scenario with high NO_3:PO4 ratio, bacterial production increases after the spring bloom, what, in turn, increases the development of ciliates. The impact of NO_3:PO4 scenarios on the mesozooplankton and jellyfish compartments considered in the model is overall low after a one-year simulation, but, probably due to their longer life cycle comparing to smaller organisms, this should be investigated at longer time scales.

Acknowledgements

The present research is a contribution to the Labex OT-Med (n_ ANR-11-LABX-0061) funded by the French Government «Investissements d'Avenir» program of the French National Research Agency (ANR) through the A*MIDEX project (n_ ANR-11 IDEX-0001-02). The work is also partially supported by the grant of Russian Foundation for Basic Research (RFBR) n°16-35-00526.

References

1. Alekseenko E., Raybaud V., Espinasse B., Carlotti F., Queguiner B., Thouvenin B., Garreau P., Baklouti M. (2014) Seasonal dynamics and stoichiometry of the planktonic community in the NW Mediterranean Sea: a 3D modeling approach. Ocean Dynamics IN PRESS. http://dx.doi.org/10.1007/s10236-013-0669-2
2. Baklouti M, Diaz F, Pinazo C, Faure V, Quequiner B (2006a) Investigation of mechanistic formulations depicting phytoplankton dynamics for models of marine pelagic ecosystems and description of a new model. Prog Oceanogr 71:1–33
3. Baklouti M, Faure V, Pawlowski L, Sciandra A (2006b) Investigation and sensitivity analysis of a mechanistic phytoplankton model implemented in a new modular tool (Eco3M) dedicated to biogeochemical modelling. Prog Oceanogr 71:34–58
4. Deutsch, C. and Weber, T. (2012) Nutrient ratios as a tracer and driver of ocean biogeochemistry. Annual Review of Marine Science, 4:113-141
5. Krom MD, Herut B, Mantoura RFC (2000) Nutrient budget for the Eastern Mediterranean: implications for phosphorus limitation. Limnol Oceanogr 49(5):1582–1592
6. Lazure P, Dumas F (2008) An external-internal mode coupling for a 3D hydrodynamical model for applications at regional scale (MARS). Adv Water Resour 31(2):233–250
7. Ludwig, W., Dumont, E., Meybeck, M., Heussner, S. (2009). River discharges of water and nutrients to the Mediterranean and Black Sea: Major drivers for ecosystem changes during past and future decades? Progress in Oceanography 80, pp. 199-217
8. Parsons, T. R., and Lalli, C. M. (2002) Jellyfish population explosions: Revisiting a hypothesis of possible causes. La Mer 40: 111–121.
9. The MerMex Group, Durrieu de Madron X, Guieu C, Sempéré R, Conan P, Cossa D, D'Ortenzio F, Estournel C, Gazeau F, Rabouille C, Stemmann L, Bonnet S, Diaz F, Koubbi P, Radakovitch O, Babin M, Baklouti M, Bancon-Montigny C, Belviso S, Bensoussan N, Bonsang B, Bouloubassi I, Brunet C, Cadiou J-F, Carlotti F, Chami M, Charmasson S, Charrière B, Dachs J, Doxaran D, Dutay J-C, Elbaz-Poulichet F, Eléaume M, Eyrolles F, Fernandez C, Fowler S, Francour P, Gaertner JC, Galzin R, Gasparini S, Ghiglione J-F, Gonzalez J-L, Goyet C, Guidi L, Guizien K, Heimbürger L-E, Jacquet SHM, Jeffrey WH, Joux F, Le Hir P, Leblanc K, Lefèvre D, Lejeusne C, Lemé R, Loÿe-Pilot M-D, Mallet M, Méjanelle L,Mélin F, Mellon C, Mérigot B, Merle P-L, Migon C, Miller WL, Mortier L, Mostajir B, Mousseau L, Moutin T, Para J, Pérez T, Petrenko A, Poggiale J-C, Prieur L, Pujo-Pay M, Pulido-Villena, Raimbult P, Rees AP, Ridame C, Rontani J-F, Ruiz Pino D, Sicre MA, Taillandier V, Tamburini C, Tanaka T, Taupier-Letage I, Tedetti M, Testor P, Thébault H, Thouvenin B, Touratier F, Tronczynski J, Ulses C, Van Wambeke F, Vantrepotte V, Vaz S, Verney R (2011) Marine ecosystems' responses to climatic and anthropogenic forcings in the Mediterranean. Prog Oceanogr 91:97–166