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PCB modeling in the Gulf of Lions using a 3D coupled model

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Polychlorobiphenyls (PCBs) are synthetic chlorinated organic compounds, which were widely used in many industrial materials. These compounds are persistent, bioaccumulable and toxic for living organisms. The riverine and atmospheric fluxes are the major routes of entry for these chemicals into marine ecosystems, where they are now embedded in natural biogeochemical cycles (Lohmann et al. 2007). Because of bioaccumulation and biomagnification processes in food webs, even nowadays, these compounds may attain dangerous concentration levels especially in the top predators including marine mammals. The contamination of marine biota by PCBs in Mediterranean has also become a matter of concern as the concentrations in some species are at levels putting them at risk for significant biological effects. This may pose potential human health risks in commercial edible species (Carpenter 2006).

Planktonic populations play a key role in the trophic food webs in marine ecosystems by the mobilisation and transfer of energy and organic matter towards higher trophic levels. This work aims at a better understanding of the role of plankton in the transfer of PCBs to higher trophic levels in the Gulf of Lions (Mediterranean) by coupling of biogeochemical, ecological and hydrodynamical processes.

Modeling is a powerful tool for coupling processes of different disciplines and scales. The recent development of 3D hydrodynamic, hydrosedimentary and biogeochemical models in the Mediterranean (André et al, 2005,2009, Ulses et al, 2008, Dufois et al, 2008, Auger et al, 2011), enables feasibility testing of coupling these models with transfer processes of chemical contaminants. The lack of detailed observations in the sea and the significant uncertainty on contaminants inputs prevent from a proper validation of such modeling tests. However, these tools are very useful to assess the influence of fast processes on the transfer of contaminants to bioaccumulative species. Sensitivity analysis also enables to identify key parameters and assumptions which control contamination pathways in the Gulf of Lions.

Thus, this work is based on coupling such complex biogeochemical model (Eco3M), with a PCBs transport model and a model of hydrodynamics (MARS3D) in order to test a scientific exploration tool for the assessment of PCB dispersion in space and time in the Gulf of Lion and of their transfer to zooplankton via biogeochemical processes. In this work we estimate PCB budgets and fluxes into the Gulf of Lions between the different species of PCB, namely: dissolved total, available dissolved, particulate, biosorbed on plankton, assimilated by zooplankton, which are governed by different processes, such as: adsorption/desorption (equilibrium partitioning), bacteria and plankton mortality, zooplankton excretion, grazing, mineralization, volatilization.

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