MASSILIA PROJECT - MODELLING OF THE BAY OF MARSEILLE: IMPACT OF THE ANTHROPOGENIC SUPPLY ON THE MARINE COASTAL ECOSYSTEM

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Abstract

In the framework of sustainable development, the anthropogenic impact of large coastal cities on the marine ecosystem is a key issue. This project aimed to improve our knowledge in marine ecosystem response to the anthropogenic supplies (from rivers, sewage outflows and atmosphere) from large cities. In particular, the goal is to underline how the physical forcing decreases or increases the anthropogenic impact on the coastal ecosystem and the assessment of the chemical contaminant (PCB) inputs (from city to sea) and exports (from mid-sea to open sea).

Keywords: North-Western Mediterranean, Coastal models, Coastal processes, Eutrophication, Pollution

The density of contaminant-generating industries of the city of Marseille is highly representative of large modern Mediterranean cities. Marseille was thus chosen for the development of numerical tools, based on the coupling of a hydrodynamic model [1], a sedimentary model, a biogeochemical model [2] and a model of chemical contamination (PCB). The coastal area off Marseille is characterized by numerous physical and biogeochemical forcing, as shown on Figure 1. The physical forcing are: wind induced upwelling and downwelling, eddies, intrusion of the Northern Current, wind vertical mixing or stratification by heat fluxes. The biogeochemical inputs come from the Rhone River, the urban rivers in case of rainfall, the Waste Water Treatment Plant (WWTP) inputs, the sediment and atmospheric inputs and the biogeochemical characteristics of large-scale waters surrounding the Marseille area.

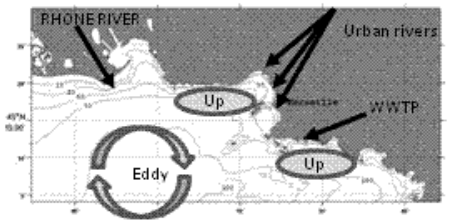

Fig. 1. Study Site of the Massilia Project - Physical processes and Anthropogenic and Natural Inputs

The approach was to study realistic typical and extreme events observed during the years 2007 and 2008. The status of typical or extreme of each event was determined in comparing with statistics on the 2001-2008 period. We used numerical tools to address following questions: i) what are the respective contributions of the physical forcing in the modulation of the oligotrophic level of this coastal ecosystem submitted to strong anthropogenic supplies? ii) What is the influence of extreme events, which frequency increases with global warming (floods, storms, heat events), on the changes in the first trophic level (phytoplankton) in the Bay of Marseille? iii) Are the chemical contaminant (PCB) inputs from the city to the sea off Marseille, stocked inside the coastal marine area or exported to the open sea?

Mistral wind events induced two spots of upwelling with a strong upwards vertical velocity (maximum of 5 $m.s^{-1}$ during an upwelling event in 2008's November) [1]. The area impacted by ascent of deep water was characterized by low temperature and high nutrient concentrations. These nutrient concentrations induced an increase in chlorophyll-a concentrations in the upwelling spot and at the front between the upwelled water and the Rhone River plume water. This phytoplankton production could be potentially associated with chemical contaminant (PCB). In addition, sediment erosion occurred in the South part of the Bay of Marseille, where the fetch for Mistral wind was the largest. The suspended particulate matter and the adsorbed chemical contaminant (PCB) were exported offshore by currents.

South-Easterly wind events induced strong intrusion of large-scale waters inside the domain and a downwelling at the coast, inducing a vertical mixing of the whole water column. This wind was associated with waves, which induced sediment erosion near the WWTP inputs. The suspended particulate matter and the adsorbed chemical contaminant (PCB) were transported nearshore by currents, in the South part of the Bay of Marseille.

The end of summer rainfall had a weak impact on hydrodynamics, but induced significant nutrients, suspended matter and PCB inputs in the Bay of Marseille by urban rivers and in the South area by the WWTP. The nutrients did not promote a significant phytoplankton production, which was limited by light and temperature in fall.

The intrusion events of Rhone River diluted water in the Bay of Marseille induced a decrease in salinity and an increase in nutrients, suspended matter and PCB. This nutrient enrichment induced a phytoplankton production and an increase in chlorophyll-a concentrations, potentially associated with PCB adsorption. These events could be associated with an anticyclonic eddy located off the Rhone River mouth [3].

References

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