MASSILIA PROJECT
Modelling of the Bay of Marseille:
Impact of the Anthropogenic Supply on the marine coastal ecosystem

Contact:
christel.pinazo@univ-amu.fr

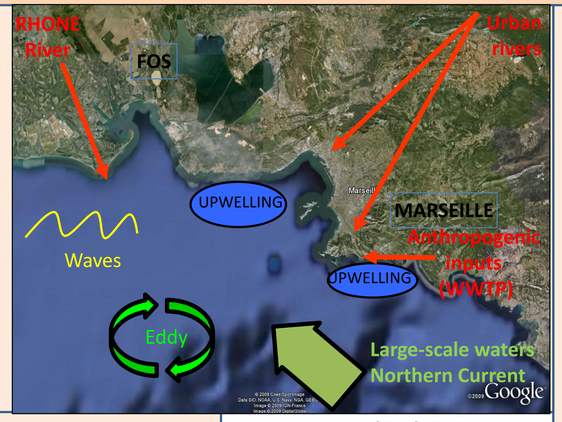
Christel PINAZO[1], Andrea DOGLIOLI[1], Vincent FAURE[1], Marion FRAYSSE[1,2], Oliver ROSS[1], Ivane PAIRAUD[2], Anne PETRENKO[1], Bénédicte THOUVENIN[3], Jacek TRONCZYNSKI[4], Romaric VERNEY[3], Christophe YOHIA[1]

[1]Aix-Marseille Université UM110, CNRS/INSU UMR7294, IRD 235, Mediterranean Institute of Oceanography, OSU Institut Pythéas, Oceanomed Bât. Méditerranée,13288 Marseille Cedex 09
[2] Laboratoire Environnement Ressources Provence Azur Corse, IFREMER Méditerranée, Zone portuaire de Brégaillon - BP 330, 83507 La Seyne/Mer Cedex
[3] Laboratoire Physique Hydrodynamique et Sédimentaire, Département Dynamiques de l'Environnement Côtier, Centre de Brest BP 70 29280 Plouzané
[4] Laboratoire Biogéochimie des Contaminants Organiques, IFREMER Département Biogéochimie et Ecotoxicologie, Rue de l'Ile d'Yeu BP 21105 44311 Nantes Cedex 03

INTRODUCTION

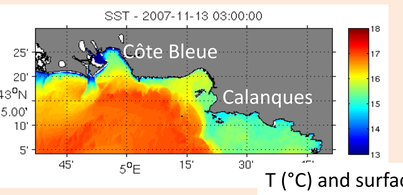
Numerical tools and in-situ observations were used in the area off Marseille to answer the following questions:

- What are the respective contributions of the physical forcing in the modulation of the oligotrophic level of this coastal ecosystem submitted to strong anthropogenic inputs?
- 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?
- 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?

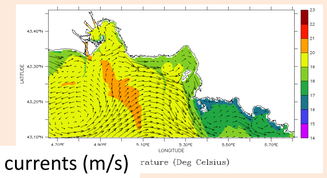


Mistral

Extrem event

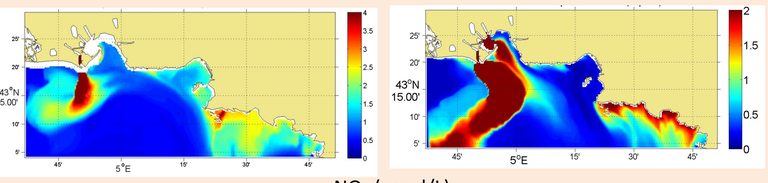


Typical event



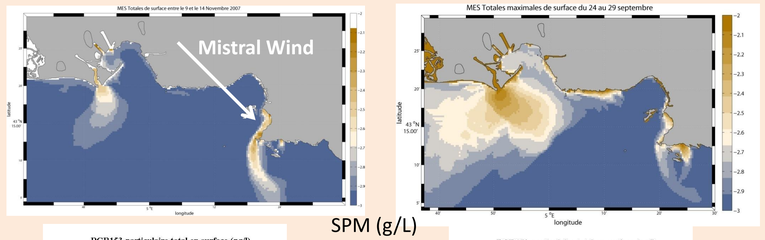
T (°C) and surface currents (m/s)

Decrease of T° of 2 - 4 °C in Calanques and Côte Bleue areas

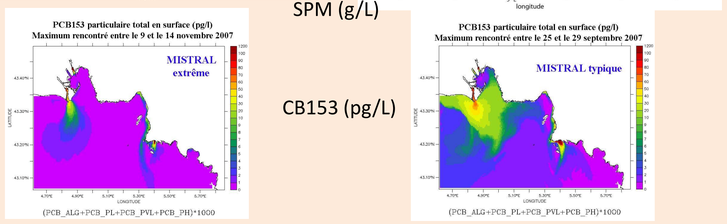


NO_3 (µmol/L)

NO_3 reach the sea surface and are exported offshore



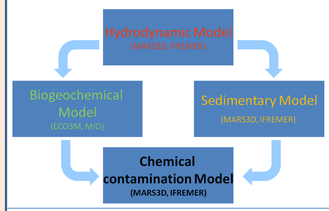
SPM (g/L)

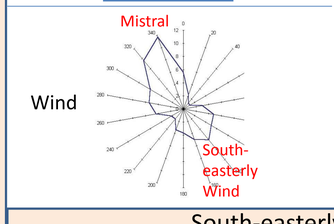


CB153 (pg/L)

Sediment erosion (SPM, particulate CB153) in the Southern Bay and offshore export at the sea surface

Numerical Tools System

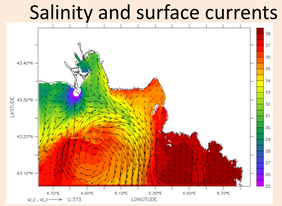




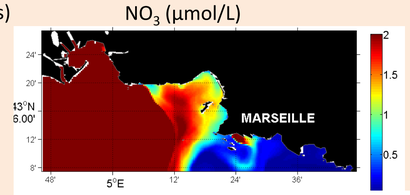
Rhone River diluted water intrusion

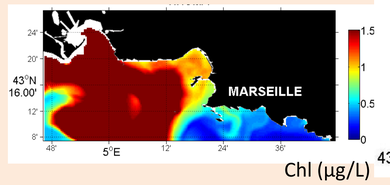
Decrease of salinity and anticyclonic eddy (Schaeffer et al, 2011) pushing Rhone River diluted water in the Bay of Marseille

Salinity and surface currents (m/s)

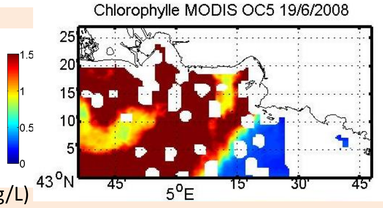


NO_3 (µmol/L)





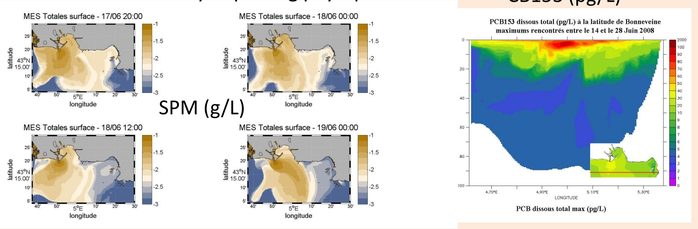
Chlorophylle MODIS OC5 19/6/2008



Chl (µg/L)

High Nutrients and Organic Matter inputs inducing a high increase of these surface concentrations directly impacting phytoplankton

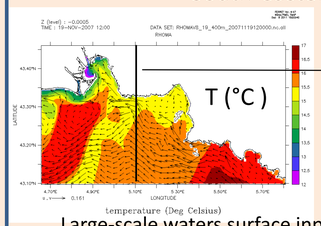
CB153 (pg/L)

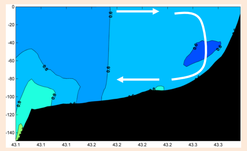


SPM (g/L)

High SPM and CB153 inputs increasing these surface concentrations in the first 20 meters depth in the Bay of Marseille

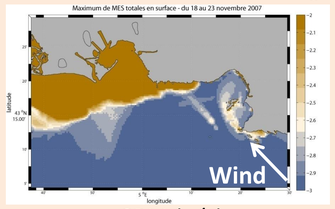
South-easterly wind event



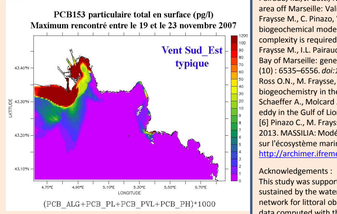


NO_3 (µmol/L)

Large-scale waters surface inputs and a homogenization by a downwelling process



SPM (g/L)

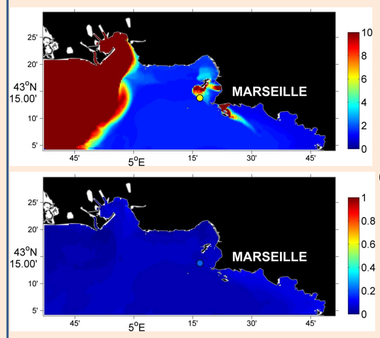


CB153 (pg/L)

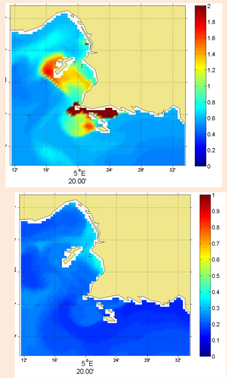
Erosion event in Cortiou (WWTP) and transport nearshore inside the Bay of Marseille

Autumn Rainfall

Extrem event

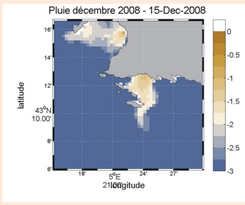


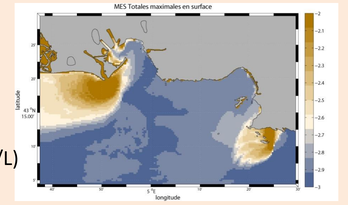
Typical event



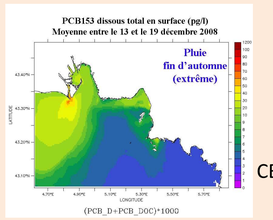
Chl (µg/L)

Strong OM and nutrients localized inputs inducing strong variations these concentrations locally but having weak impact on phytoplankton at this season

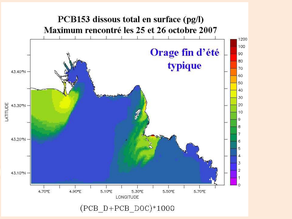




SPM (g/L)



CB153 (pg/L)



Strong SPM and CB153 localized inputs inducing strong variations these concentrations locally and in Calanques area and the Southern Bay

CONCLUSION

- Building of a Numerical tools system of the area off Marseille available for further studies
- Reliable simulation of meteorology, hydrodynamics, biogeochemistry, sedimentology and CB153 transfers in the Bay of Marseille
- Characterization for each event of the inputs of Nutrients, OM, SPM and CB153, their spatial impact and their export (see Table)
- The complete results could be found in the scientific report of the Massilia Project and in scientific publications:

Event	Inputs		Spatial Impact	Exports
Rhone River Intrusions	Strong Nutrients and OM inputs	Strong SPM and CB153	On the sea surface over a large area	--
Rainfall	Nutrients and OM	SPM and CB153	On the sea surface Over a limited area	--
Mistral Wind	Strong Nutrients inputs by upwelling	Erosion Southern Bay	The whole water column (upwelling)	Offshore Export of surface water
South-easterly Wind	Weak inputs (most of events)	Erosion WWTP	The whole water column (downwelling)	Offshore Export of deep water + Nearshore Export Of surface water

Pairaud, I.L., J. Gatti, N. Bensoussan, R. Verney and P. Garreau, 2011. Hydrology and circulation in a coastal area off Marseille: Validation of a nested 3D model with observations, *Journal of Marine Systems*, 88, 20-33.
Fraysse M., C. Pinazo, V. Faure, R. Fuchs, P. Lazzari, P. Raimbault, I.L. Pairaud. 3D, 2013. Coupled physical-biogeochemical model development around Marseille's coastal area (NW Mediterranean Sea) : What complexity is required in coastal zone?,*Plos One*, 8(12): e80012. doi:10.1371/journal.pone.0080012.
Fraysse M., I.L. Pairaud, O.N. Ross, V. Faure, C. Pinazo, 2014. Intrusion of Rhone River diluted water into the Bay of Marseille: generation processes and impacts on ecosystem functioning. *J. Geophys. Res. Oceans, 119*, (10) : 6535–6556. *doi:10.1002/2014JC010022*
Ross O.N., M. Fraysse, C. Pinazo, I. Pairaud. How intrusions of the Northern Current affect the biogeochemistry in the eastern Gulf of Lion, NW Mediterranean. *In prep.*
Schaeffer A., Molcard A., Forget P., Fraunie P. and P. Garreau, 2011. Generation mechanisms of mesoscale eddy in the Gulf of Lions: radar observations and modelling. *Ocean Dynamics*, 61 (10) 1587-1609.
[6] Pinazo C., M. Fraysse, A. Doglioli, V. Faure, I. Pairaud, A. Petrenko, B. Thouvenin, R. Verney, C. Yohia, 2013. MASSILIA: Modélisation de la baie de Marseille: Influence des apports anthropiques de la métropole sur l'écosystème marin: 1-136. *Rapport-MASSILIA RST.ODE/LER/PAC/13-14,* http://archimer.ifremer.fr/doc/00145/25592/

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