Impact of a mesoscale eddy on the structure of the trophic food web in the Gulf of Lion (NW Mediterranean)

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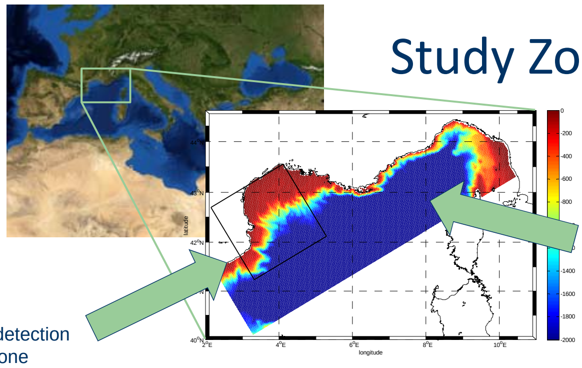
Introduction

The coastal ocean represents a key link between large ocean basins and the continent. In order to best understand this zone, we must study the hydrodynamic processes which transfer matter and energy between the coast and the open sea. By using a coupled biogeochemical-physical three-dimensional model, we study an eddy and describe the changes in the planktonic trophic web throughout the eddy's lifespan.

Study Zone



Modeled zone and bathymetry

Eddy detection zone

Model descriptions and validation

Biogeochemical model : Eco3M-NWMED

The biogeochemical model used is Eco3M-NWMED, which is a derivative of Eco3M, details of which are outlined in (Baklouti *et al.* [2006a,b]). The present model contains more variables and is adapted to the northwestern Mediterranean Sea (Hermann, 2007). The Eco3M-MED model can be considered as a multi-nutrient and multi-plankton functional types [*sensu* Le Quéré *et al.,* 2005] model since its code simulates the dynamics of several biogeochemical decoupled cycles of biogenic elements and pelagic plankton groups. Taken into account by this model are the following:

- Zooplankton (meso, nano and micro)
- Phytoplankton (Synechococcus, heterogeneous nanophytoplankton, diatoms) non-redfieldian ratios.
- Bacteria
- Particulate and dissolved organic matter
- Nutrients (NO_3^-, PO_4^{3-}, NH_4^+, Silicates)

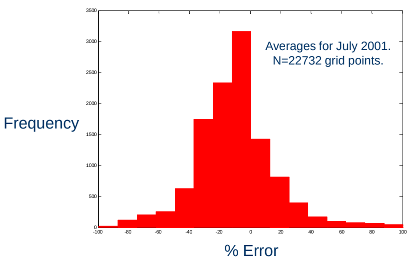
Hydrodynamic model: Symphonie

The hydrodynamic model used was developed at the Pôle d'Océanographie Côtière (Estournel *et al*., 2005; Marsaleix *et al*., 2008). This model is used for regional-scale oceanographic modeling (eg Ulses *et al*, 2008, Petrenko *et al* 2005). It is based on the following hypotheses: incompressibility, Boussinesq, hydrostatic.

Before using the model as a diagnostic tool, we must first verify its validity. Here we use both satellite and *in situ* data to validate our results.

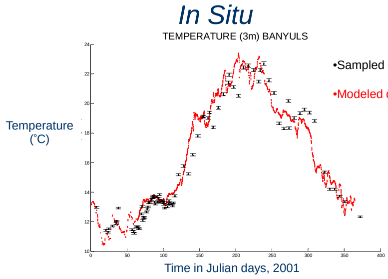
SeaWiFS

Point by point % error frequency: Average model vs SeaWiFS

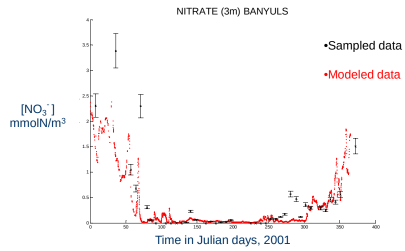


We calculate the monthly average surface chlorophyll concentrations derived from the model as well as from satellite images treated with a chlorophyll-extraction algorithm (Gohin *et al*, 2002). We show here the percent error of the model when compared to the satellite data, grid point by grid point. This error is comparable to the error of the satellite data when compared to in situ data at the regional level (GlobCOLOUR Validation Report, 2007).

In Situ



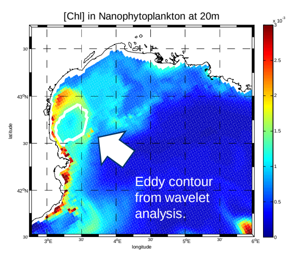
Several sets of data are available in the study zone which allow us to validate the model for quantities other than chlorophyll, and at various depths. Here we show good agreement between measured and modeled data of temperature and nitrate, over the study year 2001. Samples were collected inthe western part of the gulf, near Banyuls, France.



Results and Conclusions

Eddy detection

Previous work (Hu, 2007) has been carried out in order to identify eddy structures in the Gulf of Lions and quantify their location, duration, and physical properties. Wavelet analysis was conducted on a horizontal slice of relative vorticity, which was calculated based on the model velocity outputs.



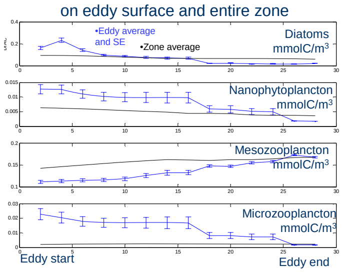
Results

We examine the biogeochemical properties of the eddy throughout its lifetime. A timeseries of biogeochemical quantities averaged over the surface of the eddy provides information as to how the trophic web changes during the eddy episode.

As the eddy develops, we observe:

- Rising up of various biogeochemical tracers on the edge of the eddy
- A decrease in bacteria, possibly due to lack of nutrients and predation (HNAN)
- An increase in all phytoplankton groups in the first 5 days of the episode, followed by a decrease from days 5 to the end
- An increase in Mesozooplankton, possibly due to increased predation on Nanophytoplankton, which decrease
- Decrease in particulate and dissolved organic carbon, indicating possible transport from the eddy to the rest of the gulf of these quantities

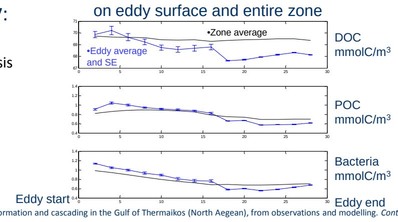
Time series: Quantities averaged on eddy surface and entire zone



Anticyclonic eddy:

- Located using wavelet analysis
- July 17 – August 18, 2001
- Diameter 40±8 km
- Salinity: 37.75
- Temperature: 21˚C

Time series: Quantities averaged on eddy surface and entire zone



Conclusions

Within the span of a few days the eddy transforms the zone by trapping organisms and causing a reduction in all classes of phytoplankton and bacteria due to predation and lack of nutrients. We observe trophic cascading and an increase in mesozooplankton at the end of the episode. Future studies will aim to quantify matter transported by the eddy.

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