Coastal (sub)Mesoscale Eddies in the Gulf of Lion

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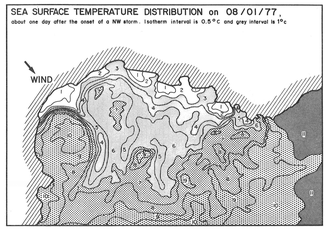
Introduction

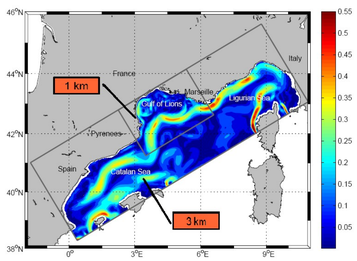
Millot [1982] was pioneer in observing an anticyclonic circulation in the western part of the Gulf of Lion (GoL), following upwelling phenomena and an offshore drift of surface water.



Sea surface temperature (AVHRR) August 1, 1977 at about 09 00 TU. [Millot 1982]

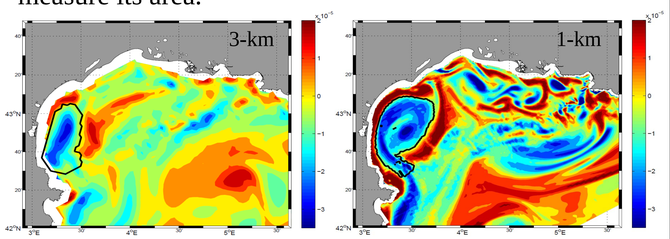
Numerical Modeling

We used the SYMPHONIE numerical model [Marsaleix et al, 2008]. Starting from a regional model (Northwestern Mediterranean, 3-km resolution), we implemented a nested high resolution shelf-scale model (Gulf of Lion, 1-km resolution) and we tested the spatial grid resolution and a new horizontal diffusion scheme.



Horizontal slice of the modeled speed intensity on July 25, 2001 at 20-m depth for 3-km and 1-km (in the GoL). [Hu et al., 2009]

We use the technique developed by Doglioli et al.[2007], based on wavelet analysis of horizontal slices of relative vorticity to identify and follow the eddy structure and to measure its area.

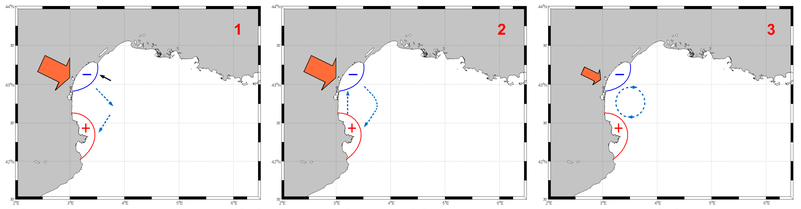


Sensitivity study on the model resolution: Simulated horizontal field of relative vorticity [s^{-1}] of 3-km resolution (left) and of 1-km resolution (right), on July 25, 2001 at 20-m depth. The black contour is the identification of the eddy structure issued from the wavelet analysis [Hu et al., 2009]. For the sensitivity study on the horizontal diffusion, please see [Hu et al., 2009].

Abstract

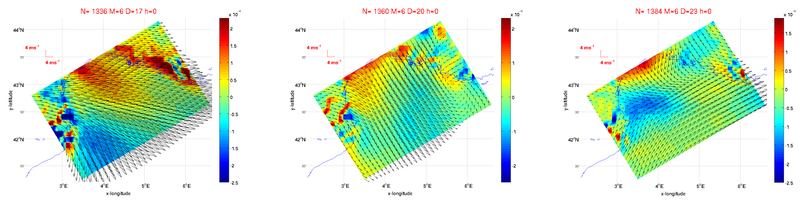
The Lagrangian Transport Experiment (LATEX) project (2008-2011) has been initiated in order to study the impact of (sub-) mesoscale eddies interacting with the Northern Current on the evolution of conservative or biogeochemical tracers' distributions with a combined use of satellite data, numerical modeling, and Eulerian and Lagrangian in situ measurements.

Eddy generation process

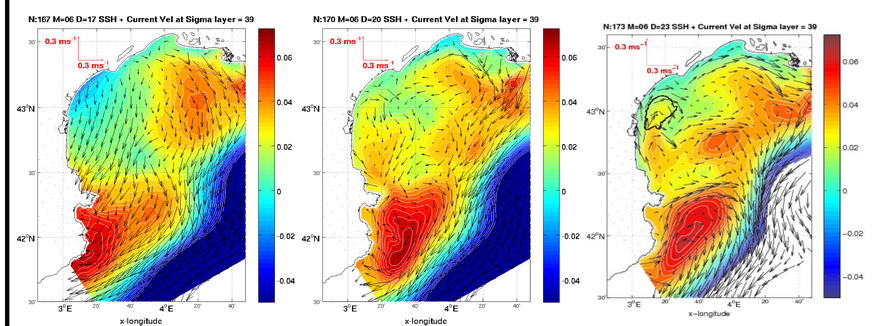


Schematic representation of the anticyclonic eddy generation process: wind forcing (orange arrow); sea surface level (red or blue zone); surface current (blue dash arrow) and bottom current (black solid arrow).

Numerical illustration



Meteological forcing used in Symphonie model: wind vectors and relative voricity fields on July 17 (left), 20 (center) and 23 (right), 2001.

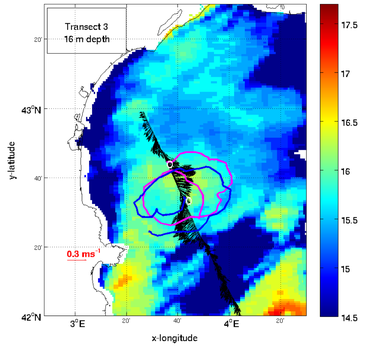


Simulated sea surface height and surface current vectors on July 17 (left), 20 (center) and 23 (right), 2001; the black contour on July 23, issued from the wavelet analysis, identifies the 'birthday' of the eddy.

Acknowledgments

The authors warmly thank Emmanuel Bosc for the satellite data. The MODIS Aqua data were supplied by the Distributed Active Archive Center at NASA Goddard Space Flight Center and made by the MODIS Project. The LATEX project is supported by the programs LEFE/IDAO and LEFE/CYBER of INSU-Institut National de Sciences de l'Univers and by the Region PACA-Provence Alps Côte d'Azur.

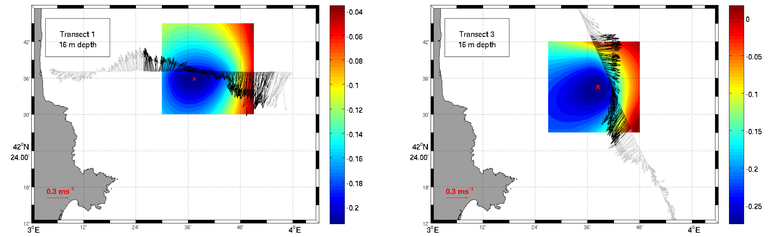
in situ observations (Cruise Latex08)



The Cruise Latex08 (September 1-6, 2008) was launched in order to confirm and to identify eddies in the western side of the GoL.

⬅ Sea surface temperature (AVHRR: Météo-France) on Sept. 2, 2008; horizontal current measured by ADCP along the transect 3 at 16 m depth on Sept. 5, 2008; trajectories of floating buoys from Sept. 5 to 8, 2008 with their inital positions (white o).

The buoys accomplished the complete circle in around 5 days with a displacement velocity of around 30 cm/s. The eddy radius is in the range: 20-30 km.
Nencioli et al. [2008] showed that we can determine the eddy center position by using transect ADCP data.



Estimated positions of the center of anticyclonic eddy at 16-m depth (red *) for Transect 1 (left) and Transect 3 (right). The colored areas are divided into a 30x30 grid. Tangential components of the black vectors are computed for each point within the grid. The center of the eddy is defined as the point for which the mean absolute value of tangential velocity is maximal. Isopleths indicate values of equal mean tangential velocity.

Conclusions:

The sensitivity study on model resolution and horizontal diffusion allows us to find the best model setup to reproduce (sub) mesoscale eddies in the GoL.
With this model setup, from the numerical results, we propose a hypothesis for the generation process of this simulated anticyclonic eddy.
The cruise Latex08 confirmed the presence of an anticyclonic eddy.

Perspectives:

Simulations will be run for a long period (2001-2008) to obtain annual variability and statistics on coastal eddies.
Combined with the data from the next cruises (Latex09 and Latex2010), we will quantify the role of these (sub) mesoscale eddies on the shelf-offshore exchanges in the GoL.

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