Influence of (sub)mesoscale anticyclones on coastal biogeochemical processes in the western part of the Gulf of Lion (NW Mediterranean)

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EGU 2011
OS 3.2
Poster n° XY 599

Introduction : The Gulf of Lion

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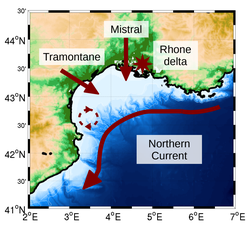

- The circulation is forced by three main factors: Northern Current – Mistral & Tramontane – Rhone
- The Northern Current (NC) acts as dynamical barrier between the Gulf of Lion (GoL) and the Mediterranean basin.
- Cross-shelf exchanges are regulated by intrusions of the NC and (sub)mesoscale anticyclones in the western part of the basin.

In the framework of the **LATEX** (Lagrangian Transport EXperiment) project, the influence of these structures on coastal biogeochemistry and horizontal transport was investigated using a multidisciplinary approach.

Anticyclones in the western part of the GoL

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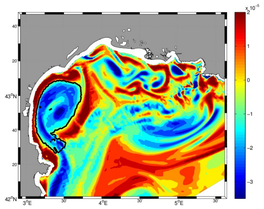
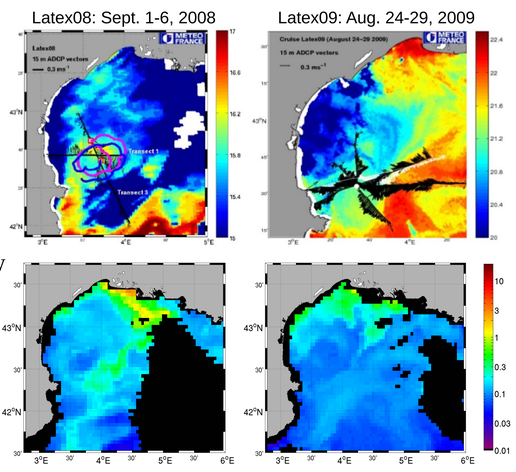


- **Numerical simulations,** using Symphonie, evidenced that (sub)mesoscale anticyclones occurs frequently in the western part of the GoL.
- In the late stages of their lifetime portions of these eddies can be entrained within the NC and leave the continental shelf.

Above: *Map of relative vorticity from numerical simulation; contour of the eddy calculated by a wavelet analysis technique (Doglioli et al., 2007; Hu et al., 2009).*

Below: *In-situ observations superimposed to AVHRR Sea Surface Temperature (SST) maps; corresponding maps of MODIS chlorophyll concentrations.*



- **Direct observations** (ADCP, drifters) collected during Latex08 and Latex09 campaigns evidence two anticyclones.
- **Satellite SST** confirm the presence of the eddies..
- Daily composite images of **satellite chlorophyll** show low concentrations within the eddies.
- The plume of the Rhone river is influenced by the presence of the two anticyclones.

- To better understand the role of these structures in regulating cross-shelf exchanges and biogeochemical characteristics of the GoL, horizontal transport was analyzed using a **Lagrangian Choerent Structures (LCSs)**.

Lagrangian Coherent Structures

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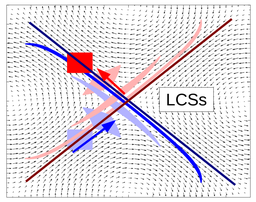
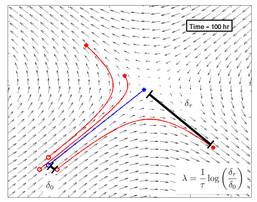
- LCSs are an important diagnostic to characterize horizontal advection of oceans flows as they identify preferential directions and transport barriers.

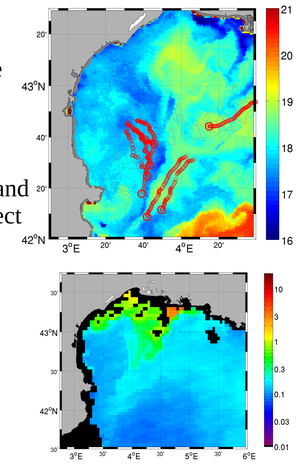




- LCSs can be identified by local maxima of the Finite-Size Lyapunov Exponent (FSLE; computed using the method developed by d'Ovidio et al., 2004).
- FSLEs were obtained from geostrophic velocities derived from AVISO Sea Surface Height (SSH) data at 4km resolution.
- Accuracy of satellite derived LCSs was tested during the **Latex10 field experiment** (Sept. 1-24, 2010).

CONCLUSIONS

- (Sub)mesoscale anticyclones and coastal circulation in the western part of the GoL are important factors in regulating cross-shelf exchanges.
- Such exchanges have a strong impact on the biogeochemical characteristics of the region and their understanding is fundamental for a correct management of the coastal environmental resources.
- Horizontal transport properties can be investigated using Lagrangian methods; however, satellite velocities still need some refinements in the coastal regions.
- The adaptive sampling strategy developed during Latex10 allowed to accurately reconstruct LCSs for two weeks.
- Comparison with AVHRR SST and MODIS chlorophyll concentrations confirm that the reconstructed *in-situ* LCSs were associated with physical structures of the flow.



More on LATEX at EGU2011:
Lagrangian Tools, Doglioli, OS2.1, Poster XY 597
Lyapunov exponents, Nencioli NP6.1, Thursday 9:30
Biogeochemical modeling, Campbell, OS3.2, Wed. 11:00
Anticyclones generation, Petrenko OS2.1, Poster XY 624

In-situ detection of LCSs

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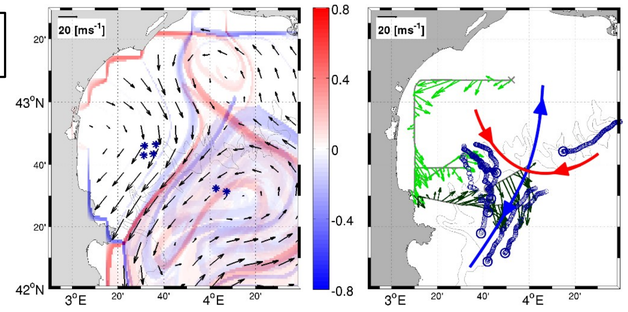
- During Latex10 and adaptive sampling strategy allowed to obtain *in-situ* estimates of LCSs.
- The sampling strategy combined:
  1) Satellite data;
  2) Iterative Lagrangian drifter releases;
  3) Ship-based ADCP measurements;
- Information from the different datasets was integrated to obtain synaptic maps of transport structures in the western part of the GoL.
- The strategy allowed to successfully localize and track LCSs for two weeks from September 12 to 24.
- The *in-situ* LCSs were then compared to the structures derived from satellite velocities to test their accuracy.

Below: *Left – Satellite derived attracting and repelling LCSs (shaded blue and red respectively), AVISO geostrophic velocites (vectors) and initial position of the drifter arrays; Right – Drifter trajectories (large circle indicate the final position of each drifter), ADCP velocities (lighter green are more recent) and reconstructed in-situ LCSs (Nencioli et al., submitted).*

Lyap01 Sept. 14-17 2010



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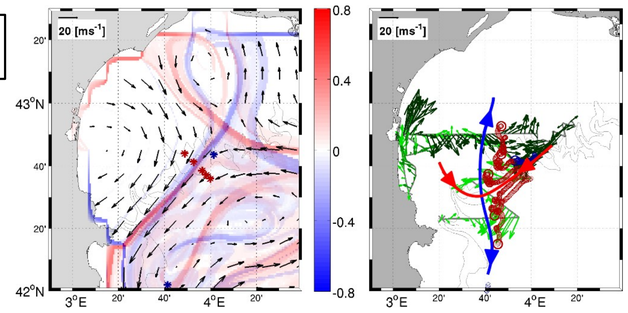

Acknowledgments
The authors warmly thank Ziyuan Hu for providing the figures from the numerical simulation. They thank the crew of the RV Téthys II for their help at sea during the Latex10 experiment. They acknowledge Météo-France for AVHRR satellite imagery.
The LATEX project is supported by the programs LEFE/IDAO and LEFE/CYBER of INSU-Institut National de Sciences de l'Univers and by the Region PACA-Provence Alpes Côte d'Azur.

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