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

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Introduction: The Gulf of Lion

- 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.

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.
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Anticyclones in the western part of the GoL

- Numerical simulations, using Symphonie, evidenced that (sub)mesoscale anticyclones occur 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.

Below: 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).

Lagrangian Coherent Structures

- LCs are an important diagnostic to characterize horizontal advection of ocean flows as they identify preferential directions and transport barriers.
- LCs can be identified by local maxima of the Finite-Size Lyapunov Exponent (FSE; computed using the method developed by d’Ovidio et al., 2004).
- FSEs were obtained from geostrophic velocities derived from AVISO Surface Height (SSH) data at 4km resolution.
- Accuracy of satellite derived LCs was tested during the Latex10 field experiment (Sept. 1-24, 2010).

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).

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 Coherent Structures (LCSs).

Below: In-situ observations superimposed to MODIS chlorophyll concentrations.

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.

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- 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.