Section 12
N° : 1517

Dynamics of meso- and submesoscale processes from in situ data and numerical modeling in a coastal environment

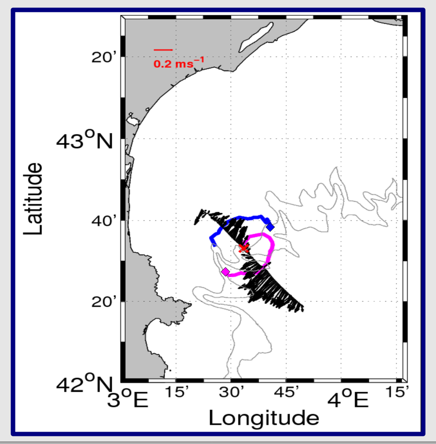
Marion Kersalé[(1)], Anne A. Petrenko[(2)], Andrea M. Doglioli[(2)], Francesco Nencioli[(2)], Jérôme Bouffard[(2)] and Ivan Dekeyser[(2)]

[(1)] Laboratoire de Physique des Océans, UMR 6523 CNRS-Ifremer-IRD-UBO, Brest, France

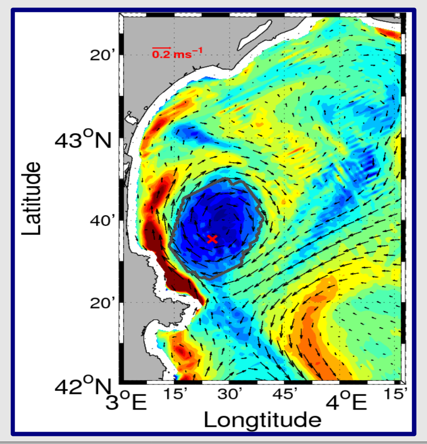
[(2)] Aix Marseille Université, CNRS/INSU, IRD, Mediterranean Institute of Oceanography (MIO), UM 110, 13288 Marseille.

Latex09 - In situ observations – Numerical model

- The **Latex09 campaign** (August 24-28, 2009) investigated the characteristics and dynamics of a coastal **anticyclonic eddy** using ships measurements, surface drifters, and satellite sensors.
- The collected information allowed the near real- time determination of eddy center and the horizontal and vertical characterization of the feature.
- The **numerical simulation** reproduces a persistent anticyclonic eddy with dimensions and position in very good agreement with *in situ* measurements.



Horizontal current measured by ADCP along Transect 3 at 15 m depth on August 27; trajectories of floating buoys from August 26 to 29. End of trajectories : Colored squares.



Eddy detected by wavelet analysis [Doglioli, 2007] Relative vorticity [s^{-1}] 15m depth August 27

[Kersalé et al., 2013]

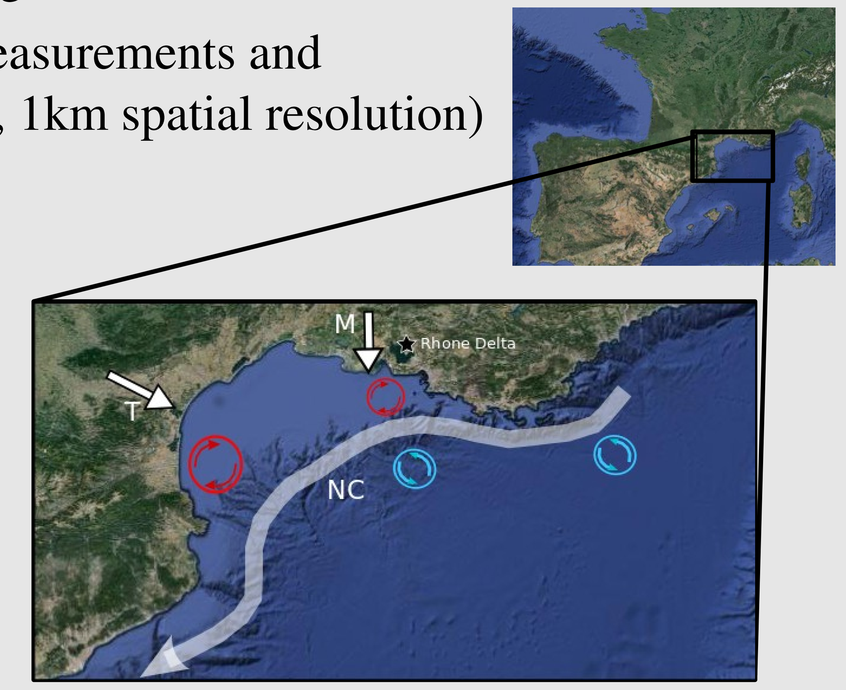
	Data	Model
Center	3°34'E – 42°33'N	3°26'E – 42°36'N
Depth impact (m)	35	37
Diameter (km)	22.7±1.2	28.6±1.4

Motivations – Area of study

- Hydrodynamics in coastal areas is characterized by the presence of numerous **meso-** and **submesocale** features.
- In the framework of the **LATEX (Lagrangian Transport Experiment)** project, the generation of these features, their dynamics and their potential impacts on the dispersion of coastal waters have been investigated.
- Multi-disciplinary project based on *in situ* measurements and numerical model simulations (SYMPHONIE, 1km spatial resolution)

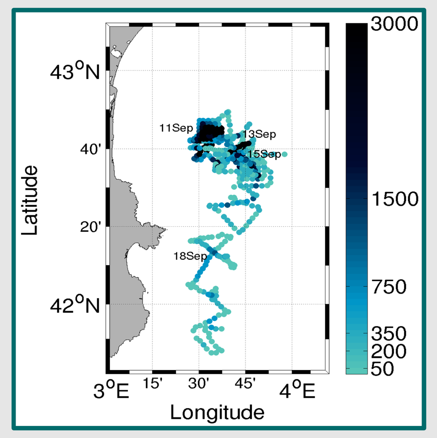
Gulf of Lion (GoL):

- Hydrodynamics: complex and highly variable, influenced by three main forcings:
  1. Mistral & Tramontane – wind
  2. Northern Current (NC)
  3. Rhone delta – river plume
- Intense (sub)mesoscale activity due to NC instabilities and strong wind forcings
- Recurrent generation of mesoscale eddies

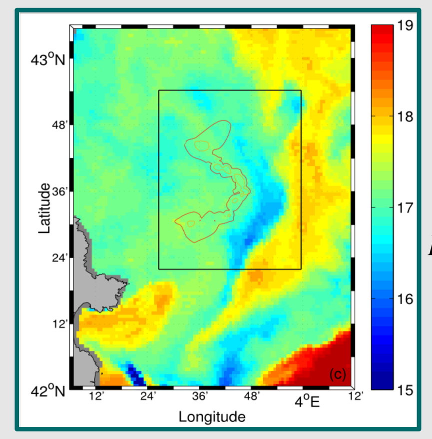


Latex10 - In situ observations

- The **Latex10 campaign** (September 1-24, 2009) investigated the turbulent mixing in the western part of GoL & the influence of submesoscale structures on horizontal transport and cross-shelf exchanges.
- The dispersion of a patch of **an inert tracer (SF6)** have been monitored for seven days obtaining four horizontal mappings (12 hours of sampling each 36 hours).
- In order to release the tracer as homogeneously as possible in the horizontal, the vessel route was continuously adjusted using the **Lagrangian navigation software** [LATEXtools, Doglioli et al., 2013].
- The presence of a front affected the dynamics within the region of release [Nencioli et al., 2013] and thus, the temporal evolution of the patch.



Map of the patch color-coded by SF6 concentration (fmol l^{-1}) over 7 days



SST (°C) September 14 and Lagrangian contour lines representing the patch center and the total patch area for mapping #3

Conclusion

Synergy of model results and in situ data
New generation process of eddies in the western part of the Gulf of lion
Observations of transient submesoscale structures
Investigation of cross-shelf exchanges in a coastal environment
Quantification & validation of the gas exchange
Estimation of turbulent mixing coefficient

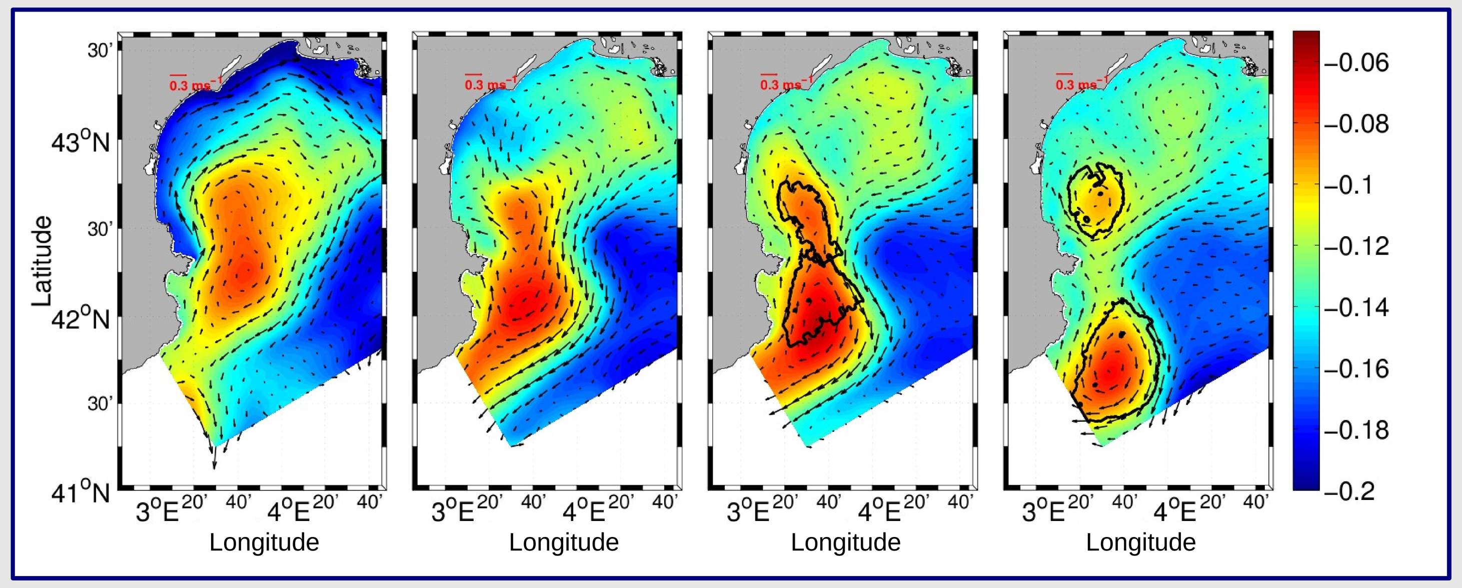
Latex09
Presence of an eddy

Latex10
Presence of a front

Eddy generation process

- The numerical results suggest a generation process for the Latex09 eddy mainly due to the pushing and squeezing of an anticyclonic circulation between a meander of the NC and the coast, leading to the separation of the circulation in two structures.

July 20 **August 8** **August 16** **August 27**

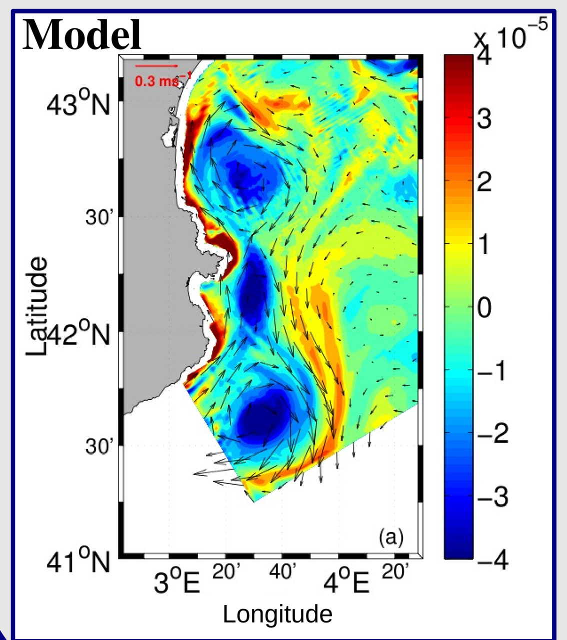


Time sequences of the generation process of the eddy A2-Latex09 in 2009. Sea surface height and current velocity field at 5 m depth. Black contours show the eddies identification issued from the wavelet analysis.

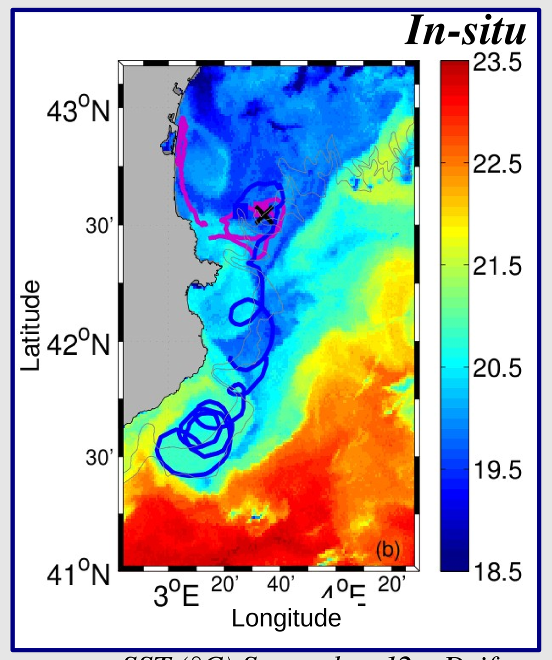
- This mechanism represents a **new eddy generation process** not identified in previous studies [Millot, 1982; Hu et al., 2011]

Shelf-to-shelf exchanges

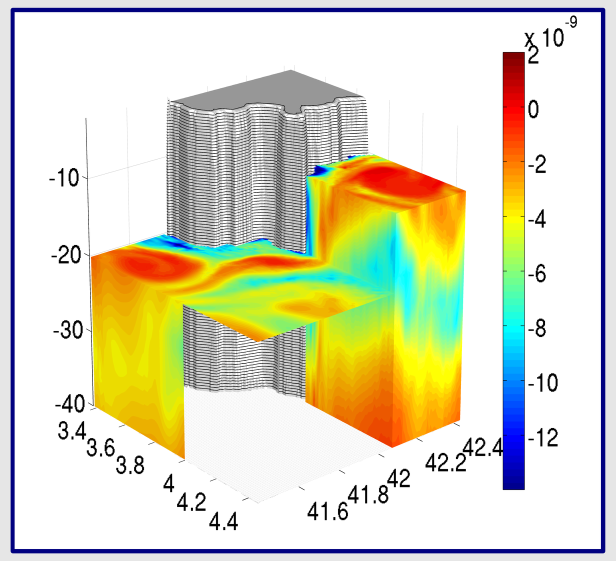
- The interaction between the Latex09 eddy and the coastline induced the generation of a transient meso-scale structure.
- This model result is confirmed by the trajectories of a series of Lagrangian drifters launched during Latex09



Relative vorticity [s^{-1}] 20m depth September 3



SST (°C) September 12 +Drifter trajectories from August 26- September 12

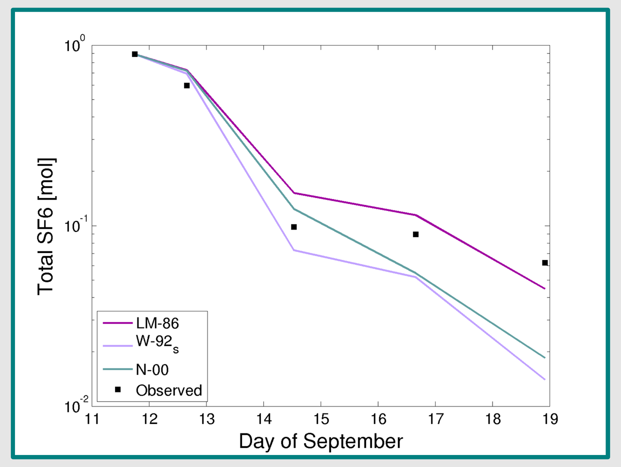


Potential vorticity [$kg.m^{-4}.s^{-1}$] in 3D on September 3

- The southward migration of the transient structure lead to a **transfer** of mass and vorticity from the GoL to the Catalan shelf

Atmospheric Loss & K_h determination

- The evolution of SF6 concentration with time due to **atmospheric loss** has been modeled as a negative exponential function.

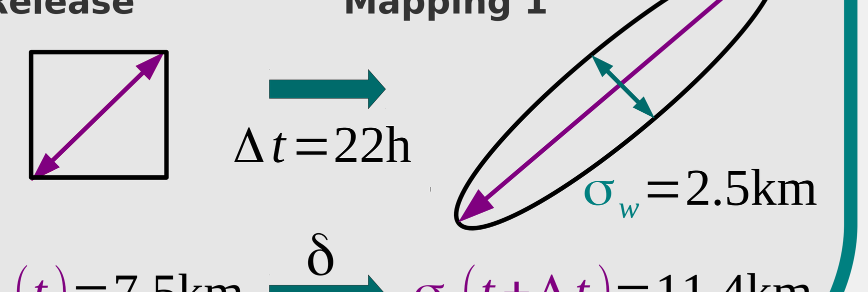


- Three parameterizations of the transfer velocity are used.
- Good match between the theoretical curve (LM-86) and total SF6 mapped ➡ Good coverage of the patch
- The gas exchange shows the impact of the strong wind.

Distribution of SF6 (mol) with respect to time. SF6 measured : black squares + theoritical curves based on Liss & Merlivat [1986], Wanninkhof [1992] and Nightingale et al. [2000].

- The initial increase of the patch surface area was used to estimate the the strain rate (δ=0.38 d^{-1}) and the **horizontal diffusivity coefficient** (K_h =7.6 $m^2 s^{-1}$)

Release **Mapping 1**



$\Delta t = 22h$ $\sigma_w = 2.5km$

$$\sigma_l(t) = 7.5km \xrightarrow{\delta} \sigma_l(t+\Delta t) = 11.4km$$

$$K_h = \sigma_w^2 \delta$$

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