

Physical characteristics and dynamics of a coastal anticyclonic eddy Gulf of Lion (NW Mediterranean Sea)



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LATEX

Lagrangian Transport Experiment

Objective

Understand influence of coastal mesoscale eddies :

- physical – biogeochemical interactions
- cross-shelf (coast-offshore) exchanges

Methodology

Multi-disciplinary project

In-situ measurements & Numerical modeling

3 Oceanographic Cruises

LATEX08 }
LATEX09 } Eddy mapping

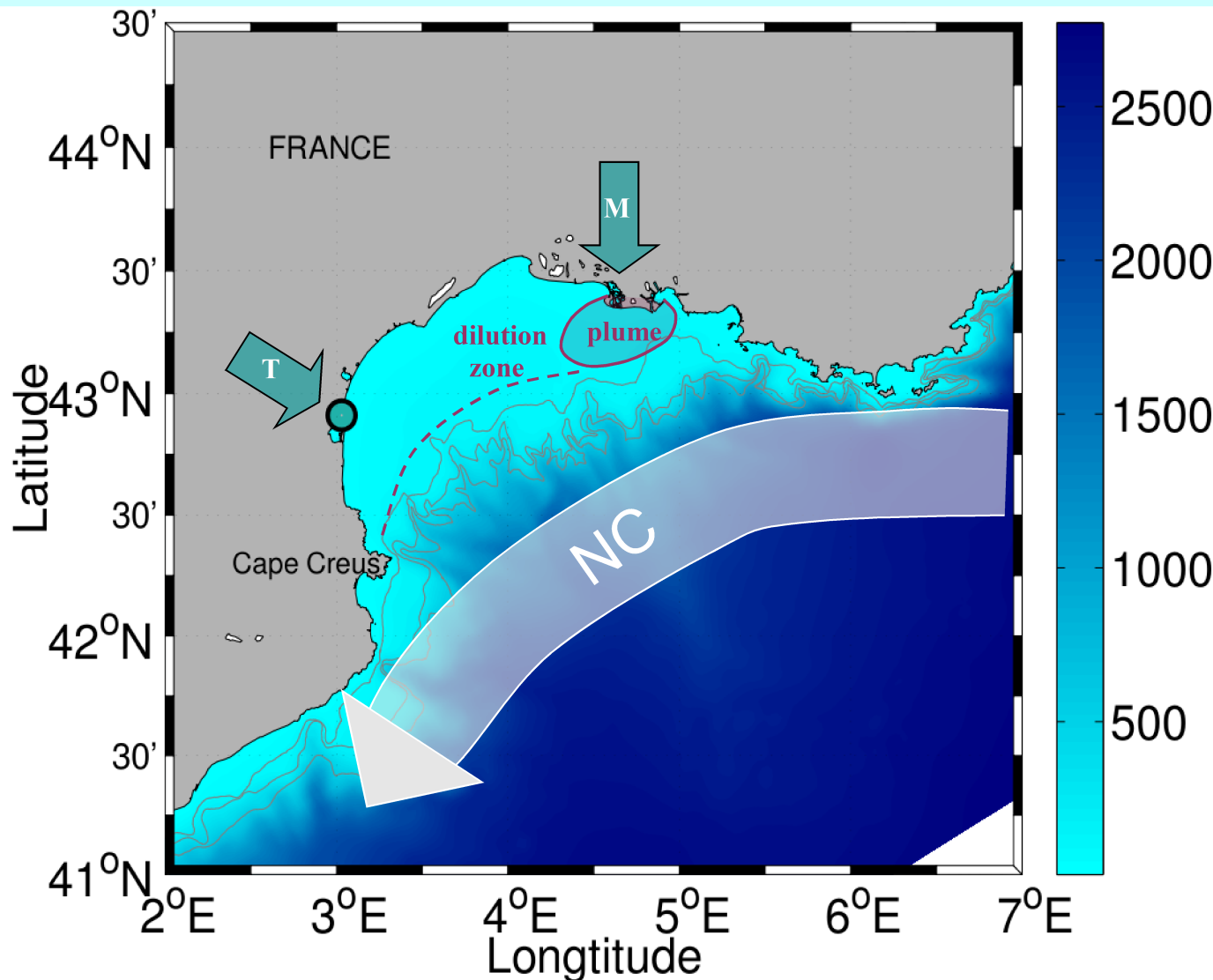
LATEX10

Numerical Time Series

2001 → 2008 [Hu et al., 2011]

2009

Study Zone: Gulf of Lion NW Mediterranean Sea

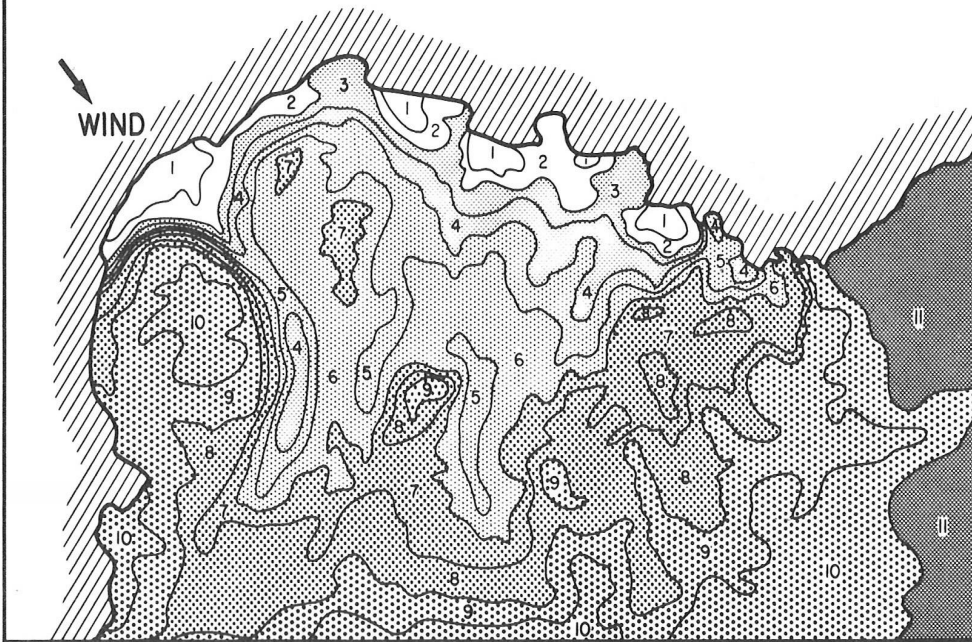


Forcings:

- 1- Rhone plume
- 2- Winds :
Tramontane
Mistral.
- 3- Northern Current
(NC)

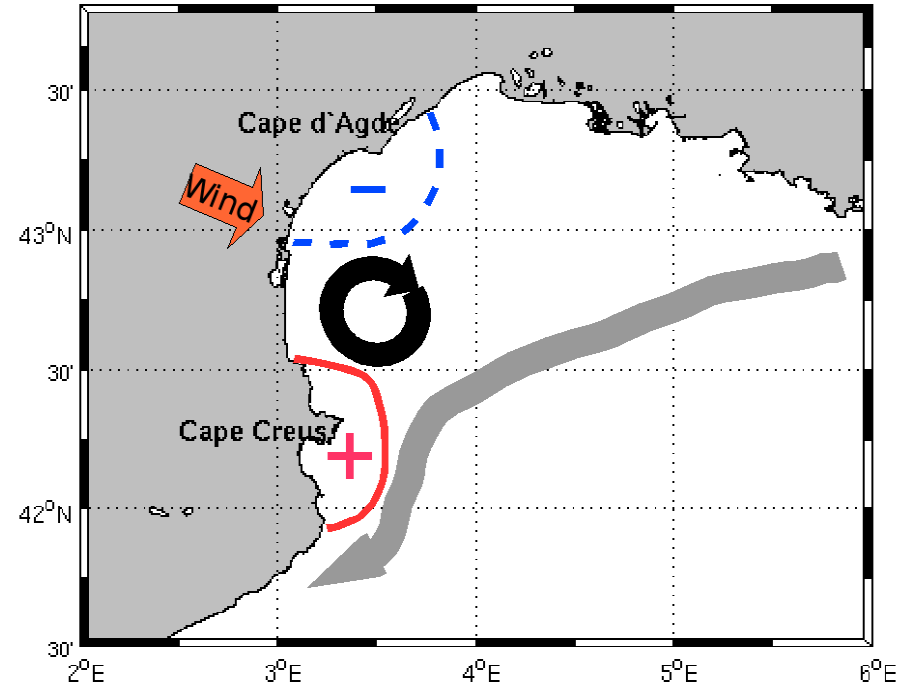
Western Anticyclonic Eddy

SEA SURFACE TEMPERATURE DISTRIBUTION on 08/01/77,
about one day after the onset of a NW storm. Isotherm interval is 0.5°C and grey interval is 1°C



First observation
[Milot, 1982]

Mesoscale anticyclonic
circulation in the western part
of the GoL



Hypothesis of generation
2001-2008
[Hu et al., 2011]

→ Persistent & strong northwest
wind
→ Strong stratification

Field campaign Latex09

- Western part of the GoL
- August 24 to 28 2009
- Investigation of an anticyclonic eddy

Satellite observations



ADCP
Thermosalinometer



CTD



Lagrangian floats



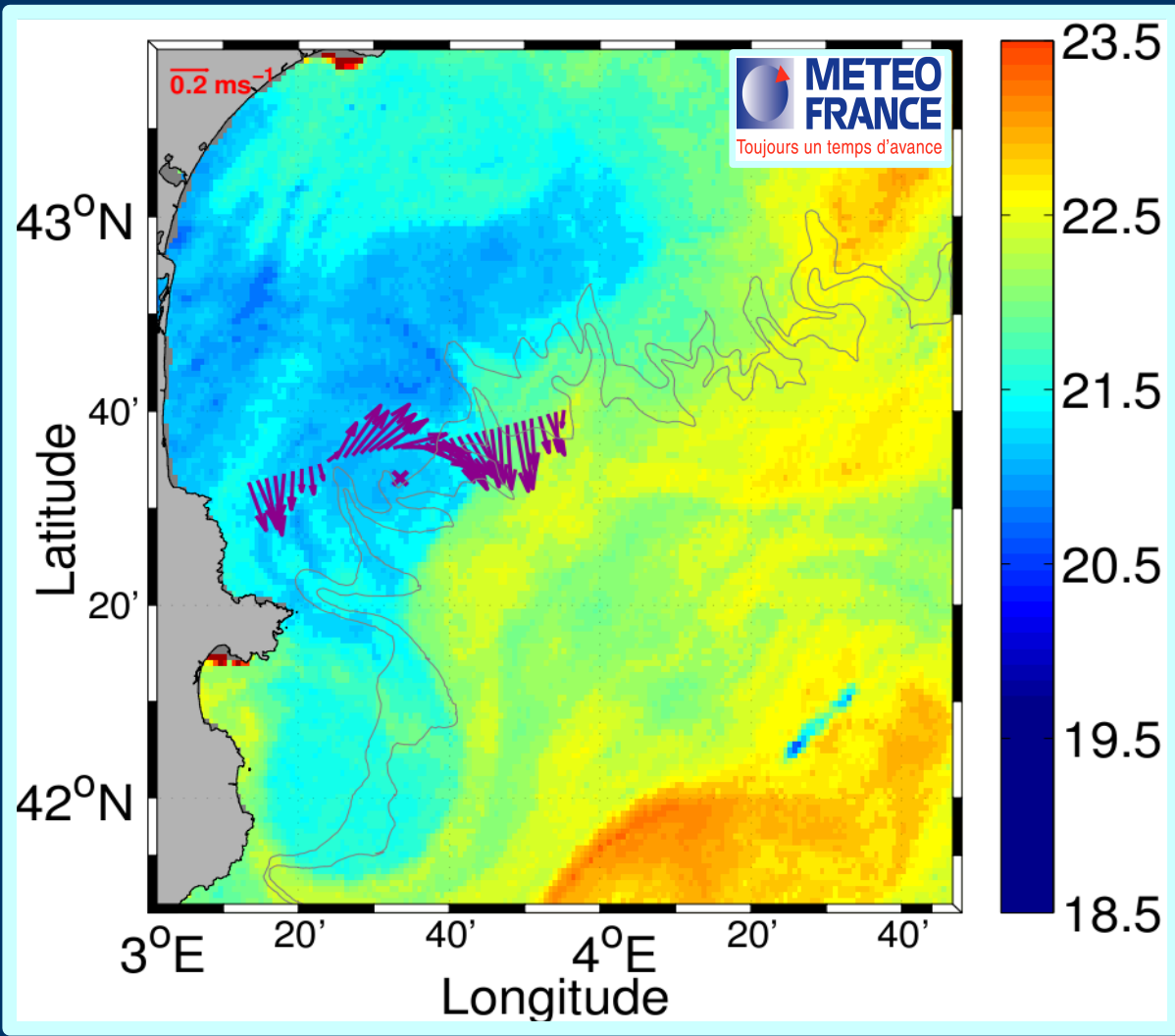
Objective

Further characterization of mesoscale activity in the western part of the GoL

Horizontal Characteristics

Transect 1

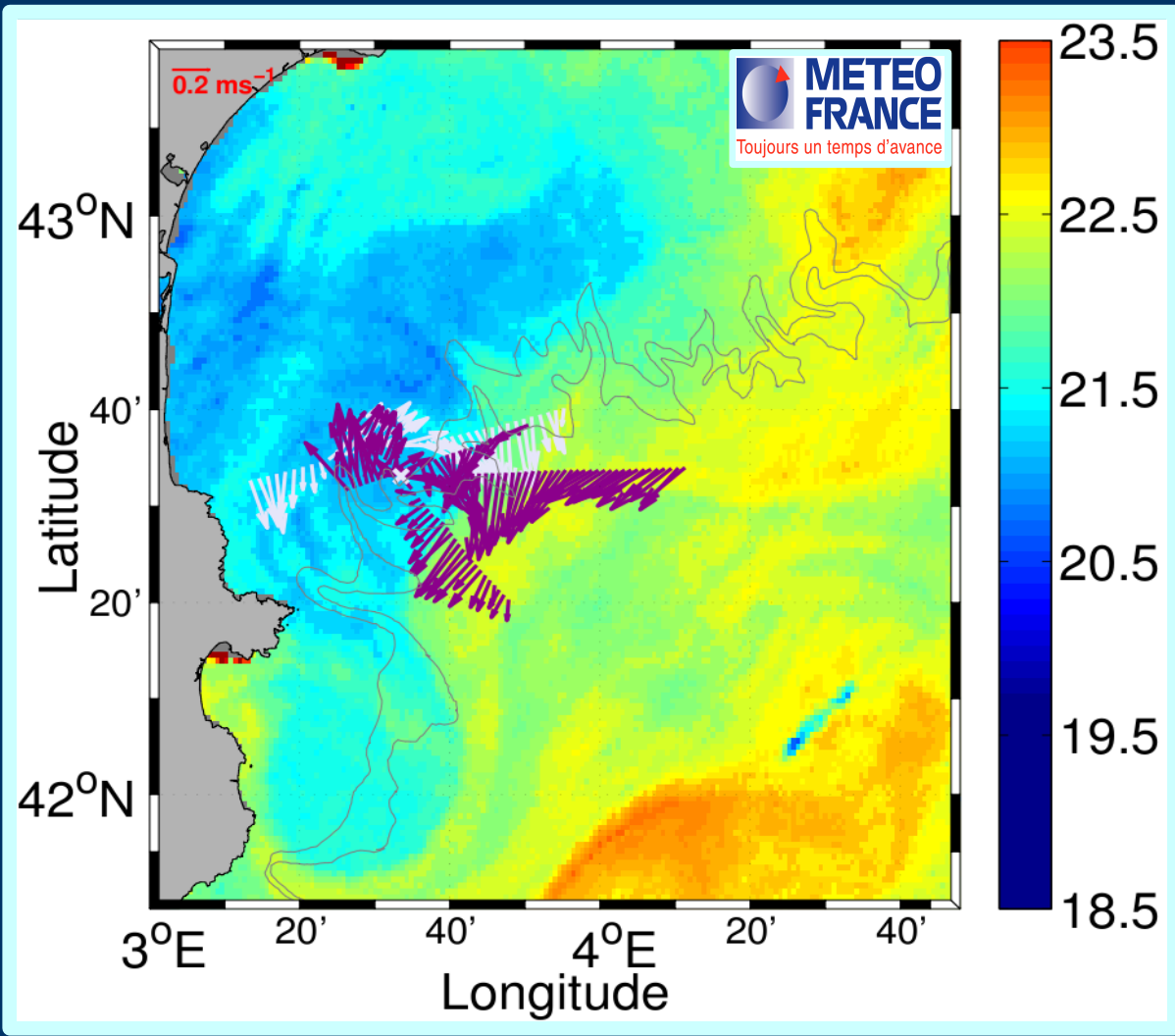
ADCP 15m depth - SST (°C) August 28



Horizontal Characteristics

Transects 1-2-3-4

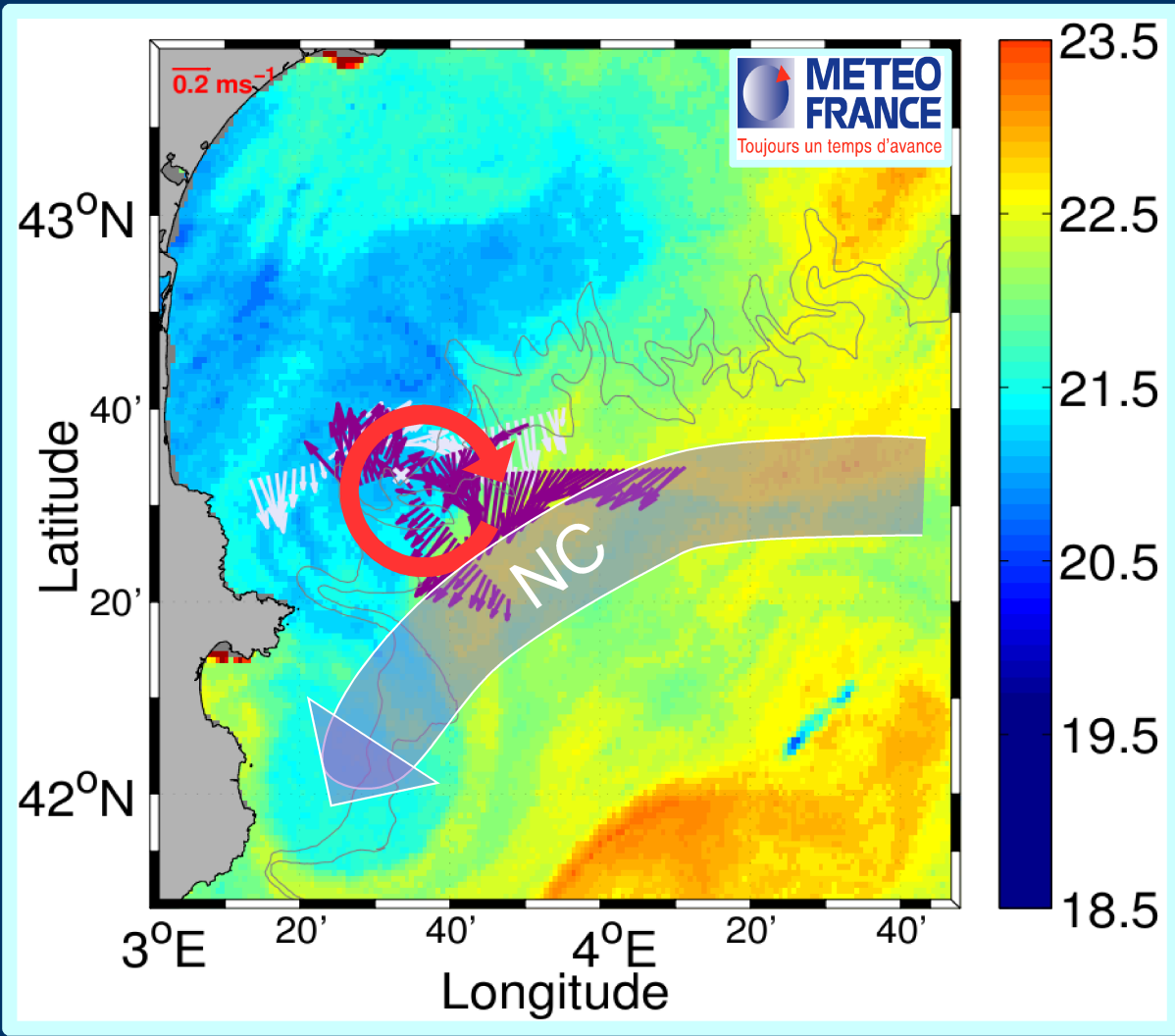
ADCP 15m depth - SST (°C) August 28



Horizontal Characteristics

Transects 1-2-3-4

ADCP 15m depth - SST (°C) August 28



Anticyclonic circulation

$V_{max} \sim 0.4 \text{ m.s}^{-1}$
 $T \sim 3 \text{ days}$

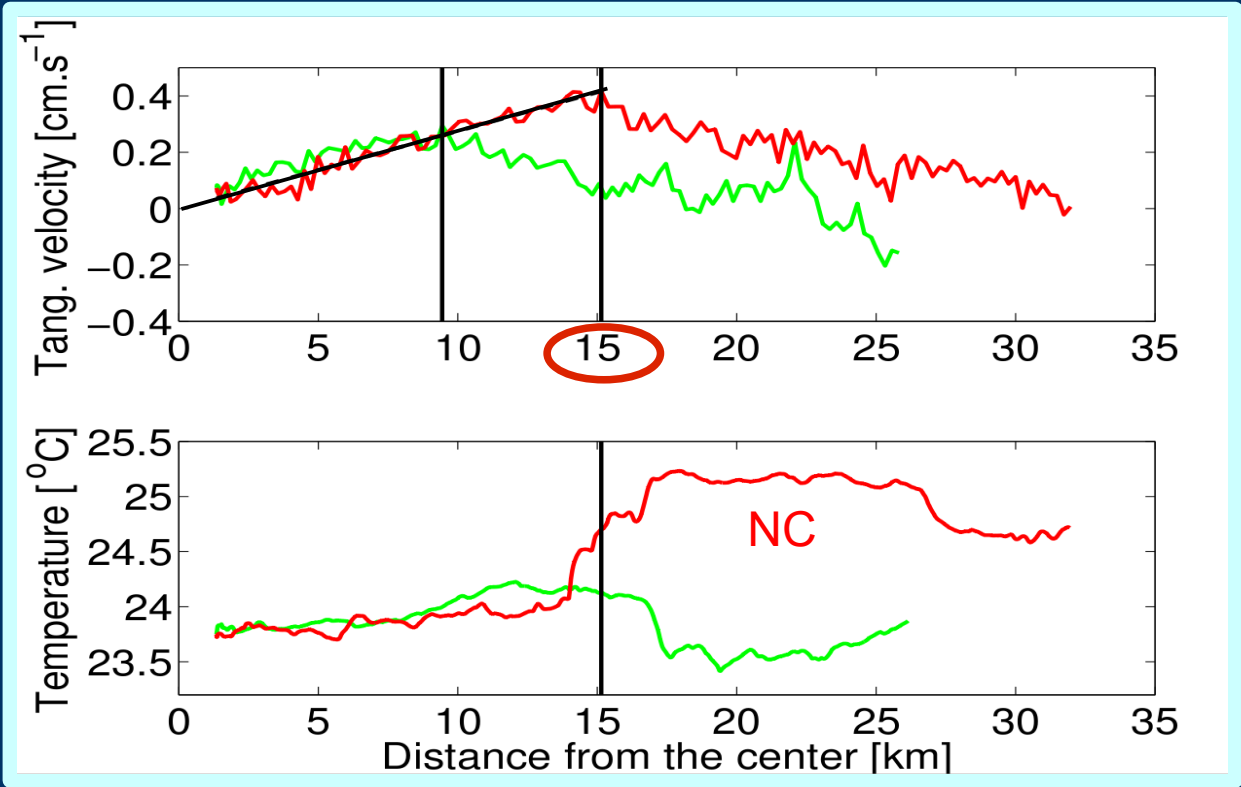
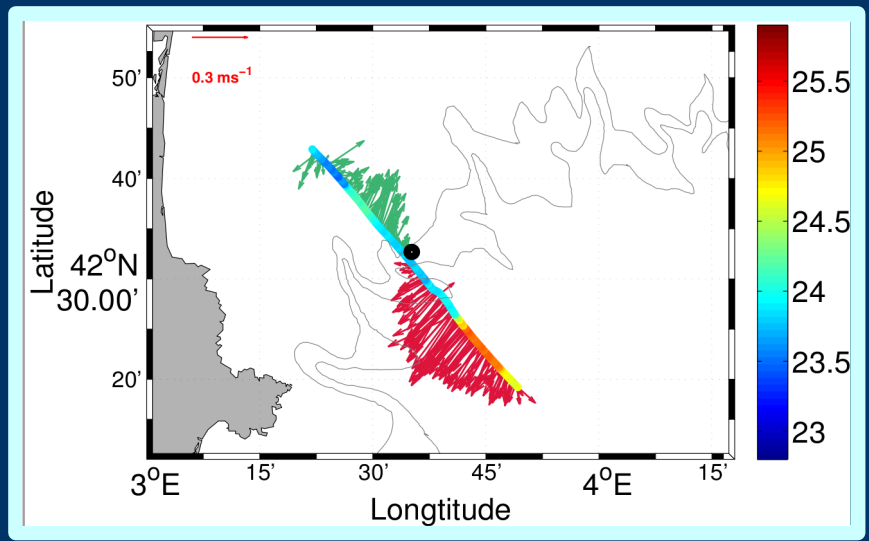
Center:
3°34'E - 42°33'N

Presence of the NC

Horizontal Characteristics

Transect 3

Tangential component decomposition with respect to the position of the center [Nencioli et al., 2008]

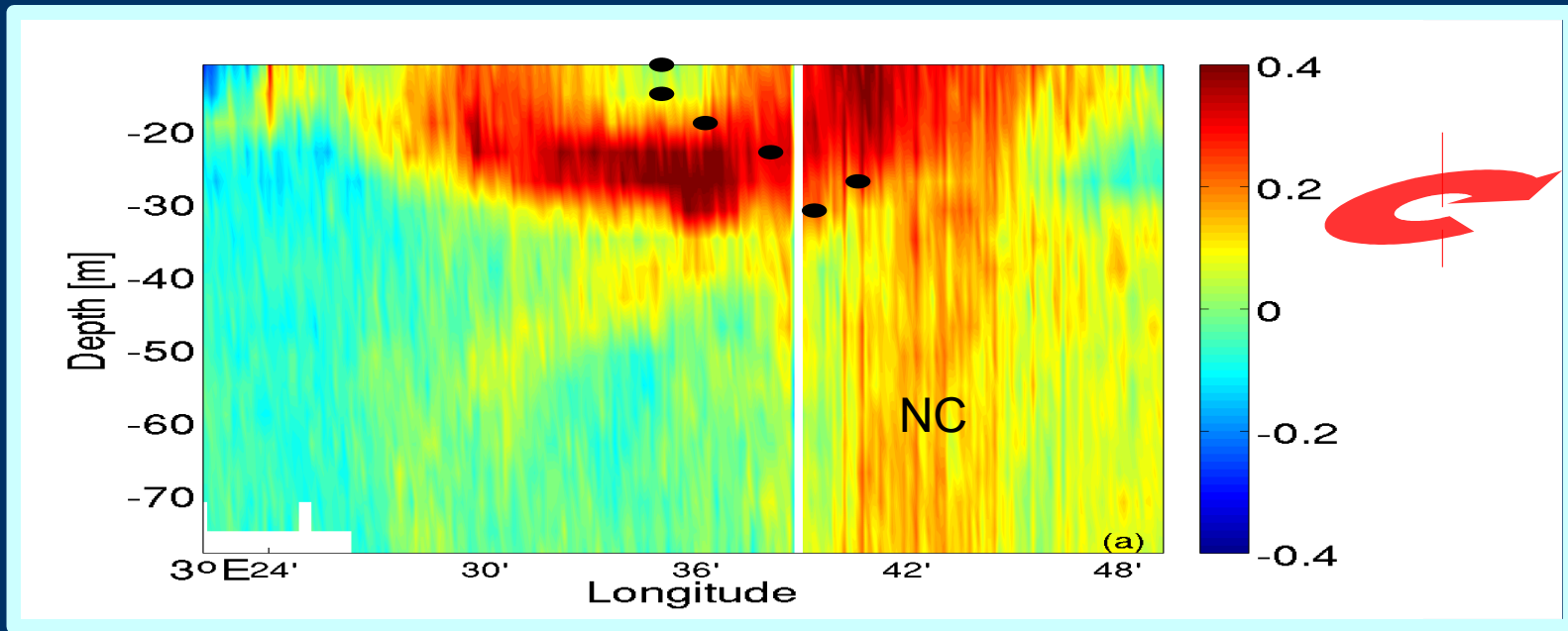


ADCP 15m depth - SST (°C)

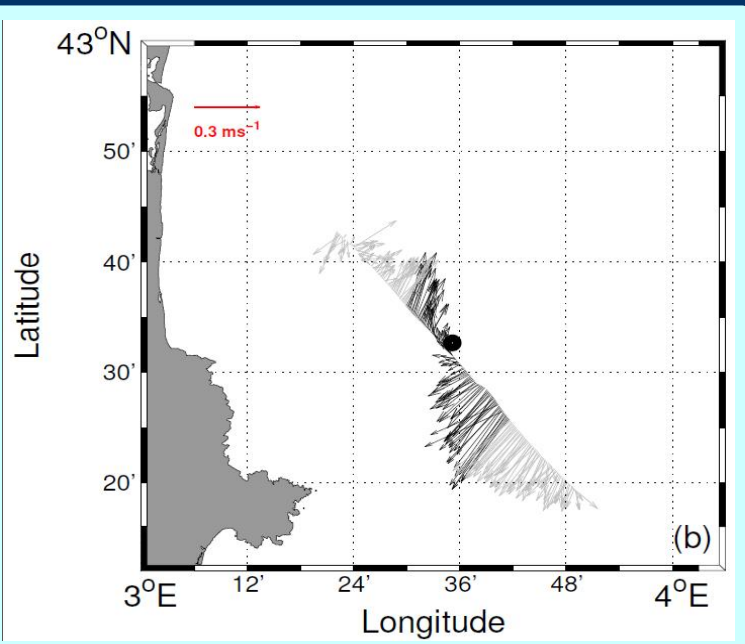
$$D_{\text{eddy}} = \bar{D} \pm \sqrt{D_{\text{var}}}$$

$$D_{\text{eddy}} = 22,7 \pm 1,2 \text{ km}$$

Vertical section

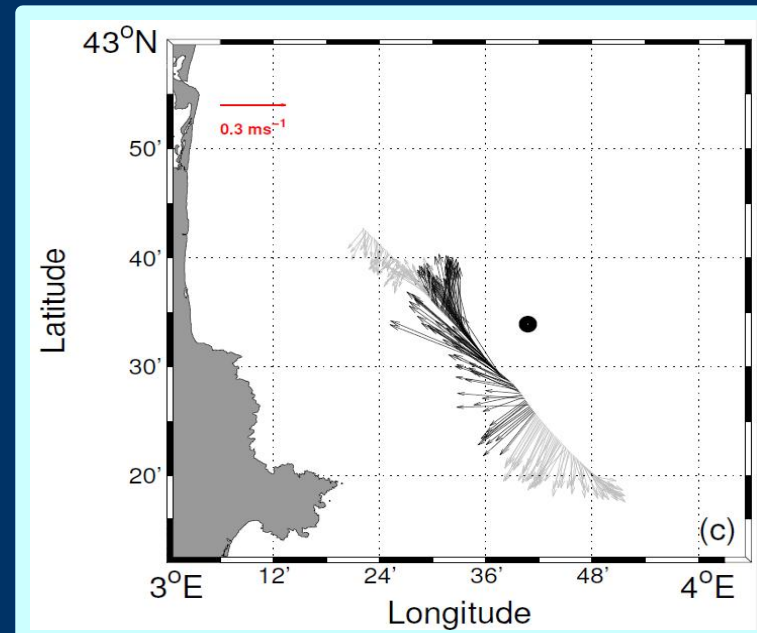


Vertical section of the tangential component of the horizontal current (m.s^{-1}) for Transect 3



ADCP current at
← 15 m depth
27 m depth →

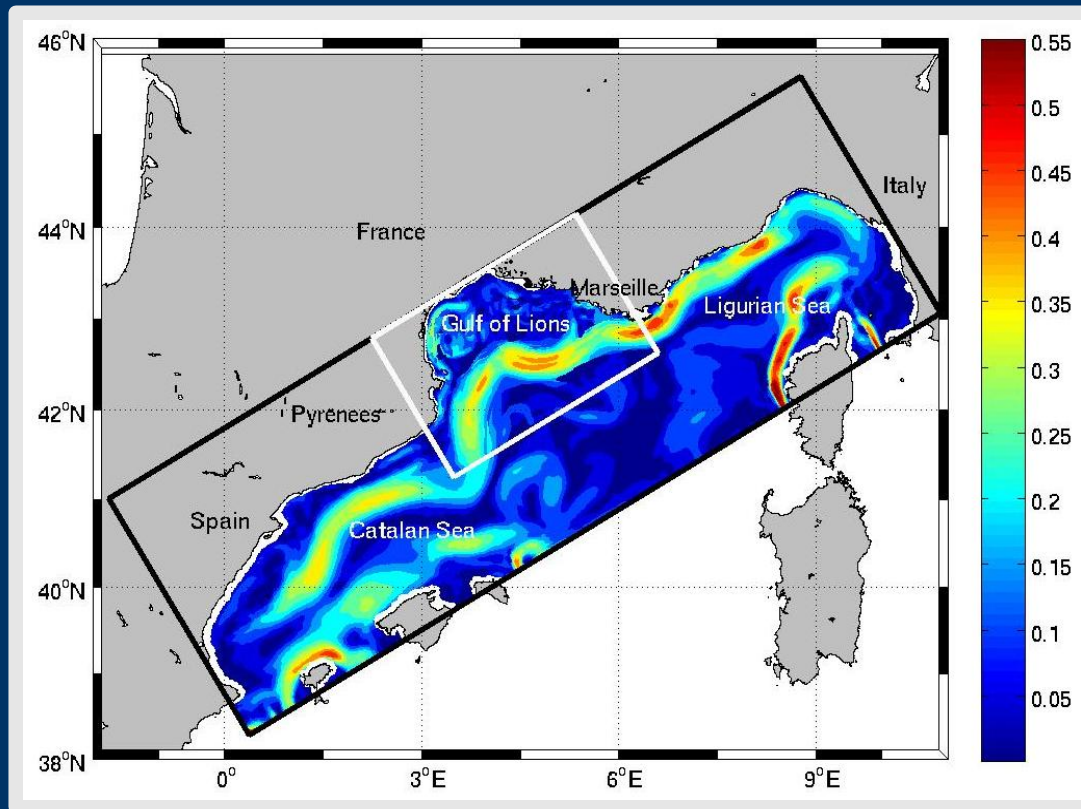
Depth_{max}
30-35 m



Numerical Modeling

Numerical model: **SYMPHONIE**

Laboratoire d'Aérodologie de Toulouse
France [P. Marsaleix and C. Estournel]



3D; Primitive Equations

Horizontal grid : Arakawa C

Vertical: 40 sigma-z hybrid

Closure Scheme: [Gaspar et al., 1990]

Atmos. Forcing: Météo-France Aladin

Boundaries: OPA outputs (MFSTEP)

Initialization: [Estournel et al., 2003]

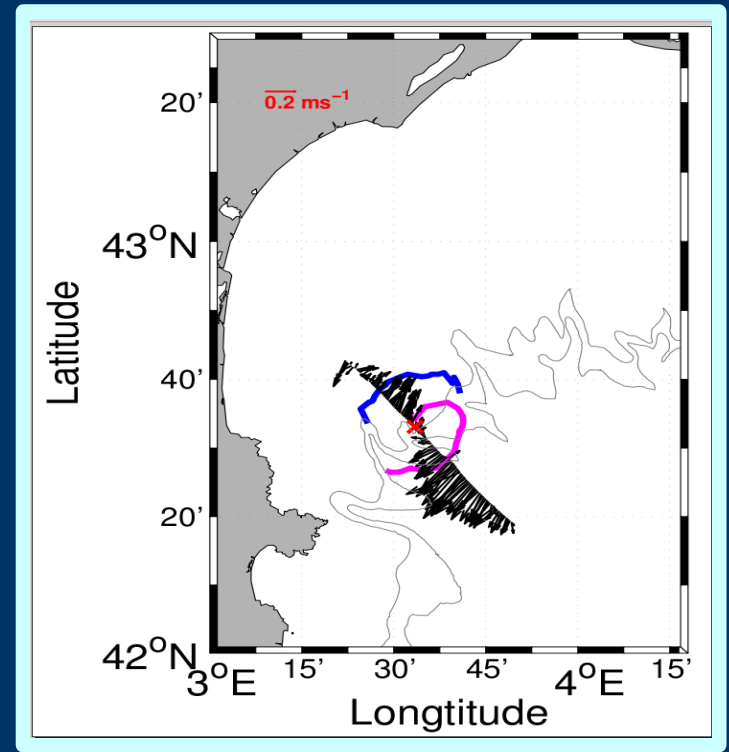
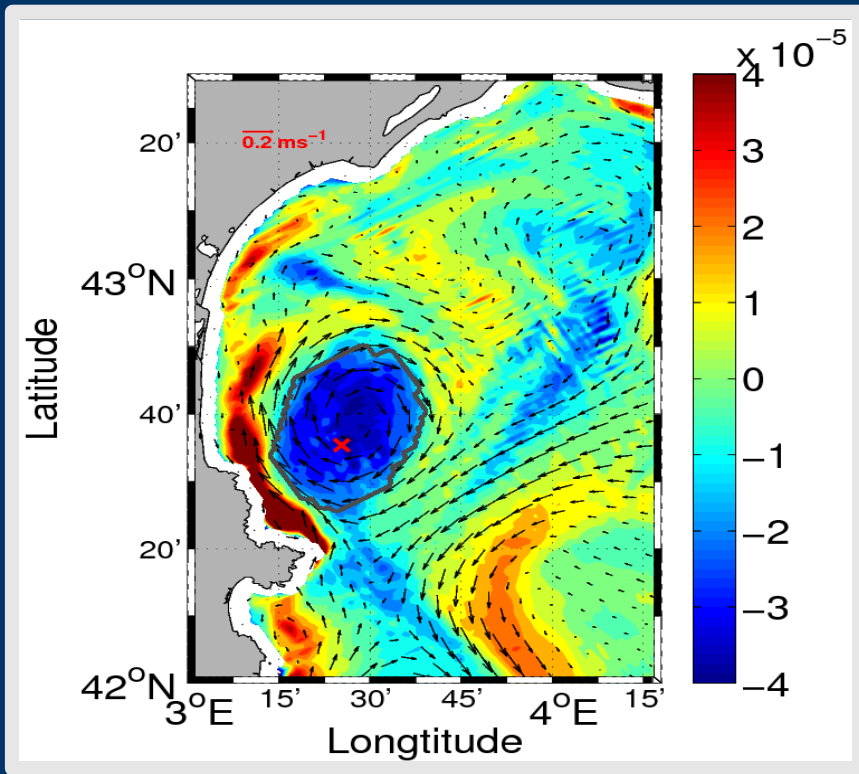
Zoom on the Gulf of Lions

One - Way nesting [Spall et Holland, 1991]

Resolution: 3km \rightarrow 1km

[Hu et al., 2009]

Numerical eddy



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

Latex09 ADCP data **August 27**
 +Buoys from August 26-29

Center: 3°26'E - 42°36'N
 $D_{\text{eddy}} = 28,6 \pm 1,4 \text{ km}$
 $\text{Depth}_{\text{max}} = 37 \text{ m}$

Center: 3°34'E - 42°33'N
 $D_{\text{eddy}} = 22,7 \pm 1,2 \text{ km}$
 $\text{Depth}_{\text{max}} = 35 \text{ m}$

→ Similar eddy found in the numerical results

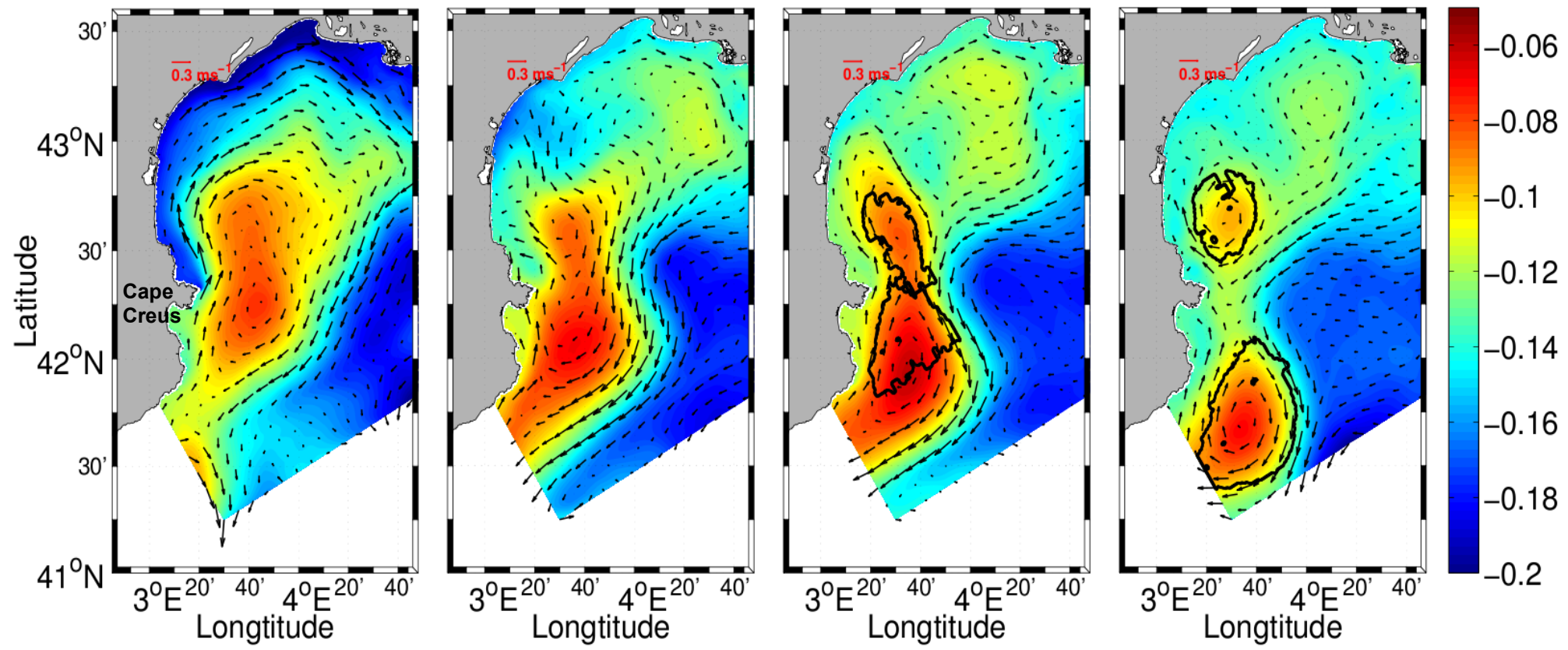
Eddy Generation Process

July 20

August 8

August 16

August 27



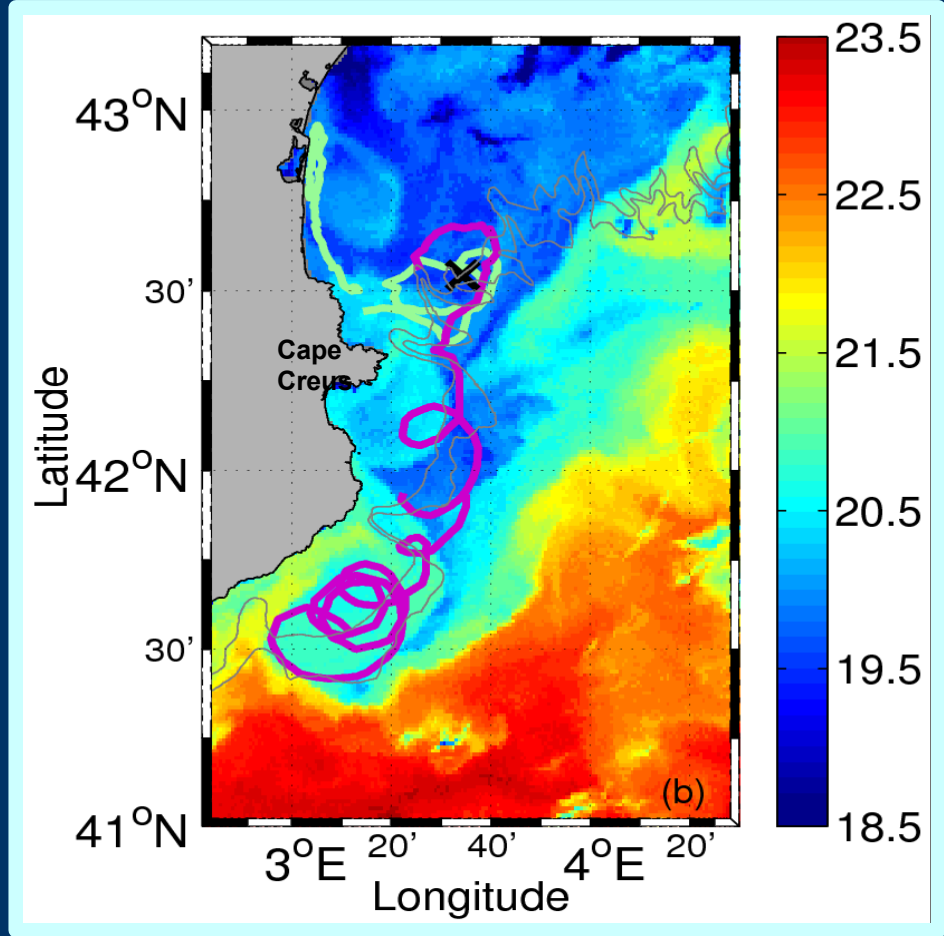
Eddies detected by wavelet analysis
Sea Surface Height [m]

New Generation Process

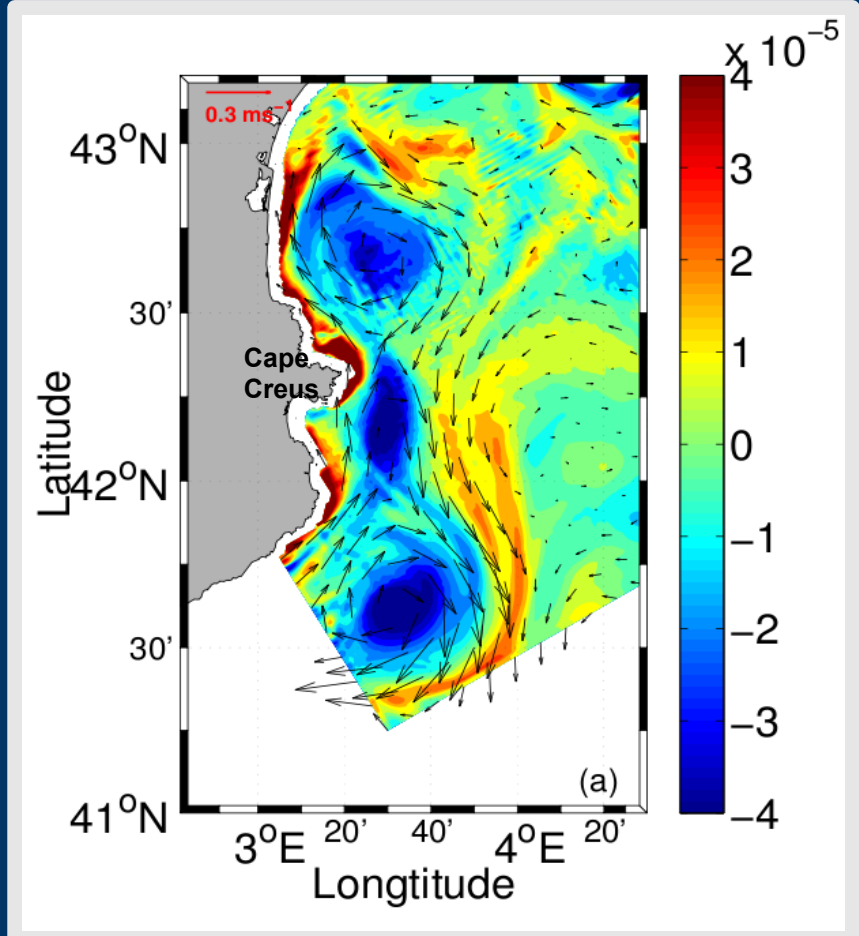
- Pushing and squeezing of an anticyclonic circulation between a meander of the NC and the coast
- Separation in two structures

Post Generation dynamics

- Latex09 feeds the Catalan eddy



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



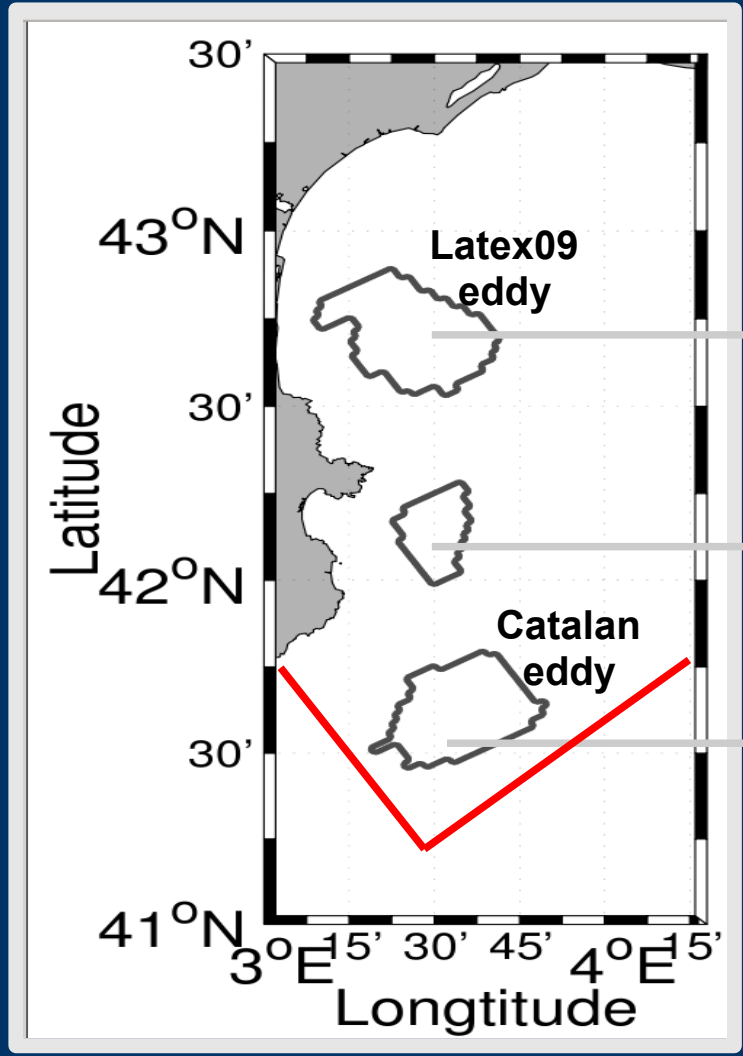
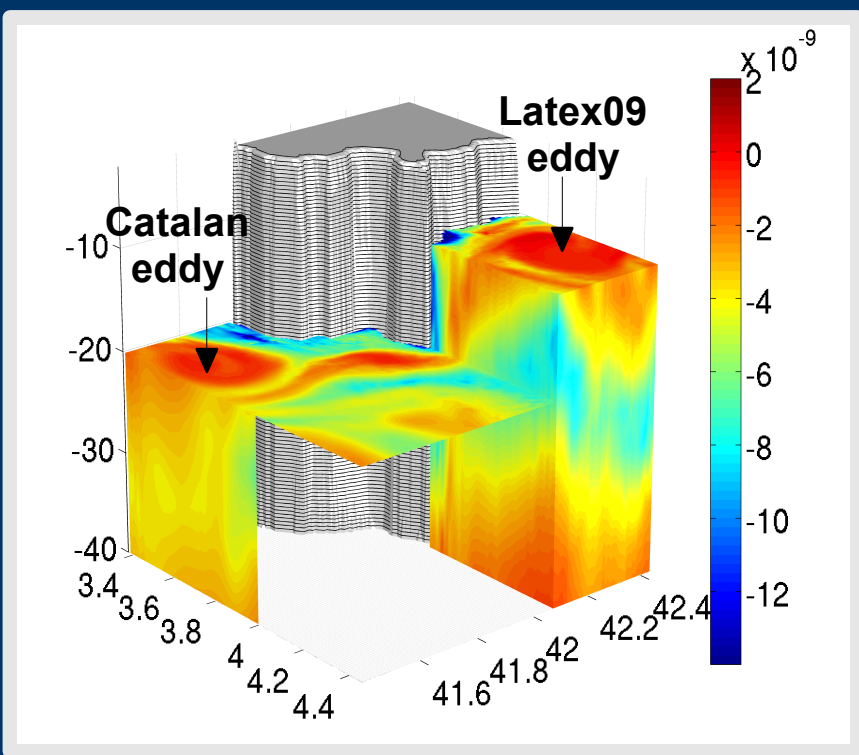
Relative vorticity [s^{-1}]
20m depth September 3

➔ Drifter trajectories explained by the generation of a transient structure

Latex09 - Loss of mass

Eddies detected by wavelet analysis

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



Loss of mass 41%

33% of the Latex09 eddy's mass

Gain of mass?

➔ Interactions between the two eddies lead to a transfer of mass and vorticity from the GoL to the Catalan shelf

Conclusion

- **Characterization of a coastal anticyclonic eddy by integrating *in-situ* measurements and numerical modeling**
- **New eddy generation mechanism**
- **Transfer of mass and vorticity from the GoL to the Catalan shelf**

Perspectives

- Role of mesoscale structures on cross-shelf exchanges
- Full 3D analysis from numerical simulation
- Impact on biogeochemistry

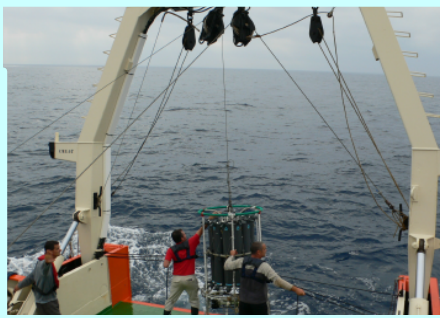
Thank you for your attention

LATEX web site

<http://www.com.univ-mrs.fr/LOPB/LATEX>





14/08/2007



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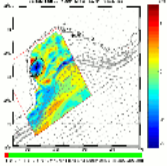
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Lagrangian Transport Experiment

PIs : Frédéric Diaz and Anne Petrenko (LOPB - COM)
Project fouded by CNRS LEFE/IDAO/CYBER and Région PACA



Objective : influence of submesoscale coupled physics – biogeochemistry on cross-shelf (coast-offshore) exchanges

Methodology : lagrangian strategy to follow a submesoscale eddy using lagrangian floats and an inert chemical tracer (SF6)
Multi-disciplinary project & multi-« tools » : Lagrangian floats, SF6, hull-mounted ADCP, moorings, satellite images, numerical modelling, gliders and, radars.

Site of study : Gulf of Lion, north-western Mediterranean sea

Anticyclonic eddy A1, here on August 1st, 2001, detected with wavelet analysis of numerical relative vorticity (click image to enlarge)

General description of the project in [English](#) and in [French](#)

!!! What's New !!! [Participants](#) [Tools, Software & Miscellaneous](#) [Publications](#)

Rechercher : Occurrence suivante Occurrence précédente Surligner tout Resp.