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

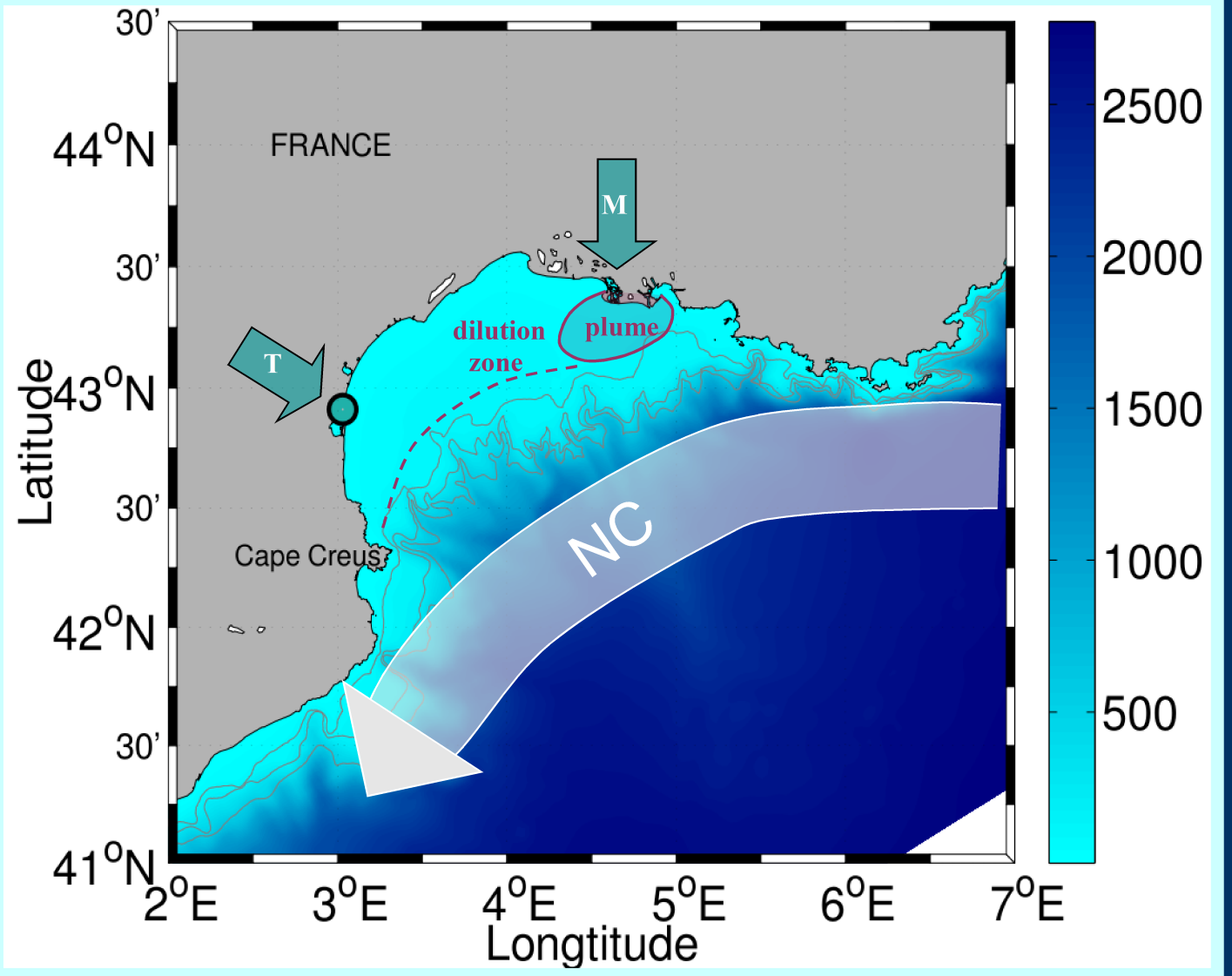
LATEX10

Numerical Time Series

2001 ➡ 2008 [Hu et al., 2011]

2009

Study Zone: Gulf of Lion NW Mediterranean Sea



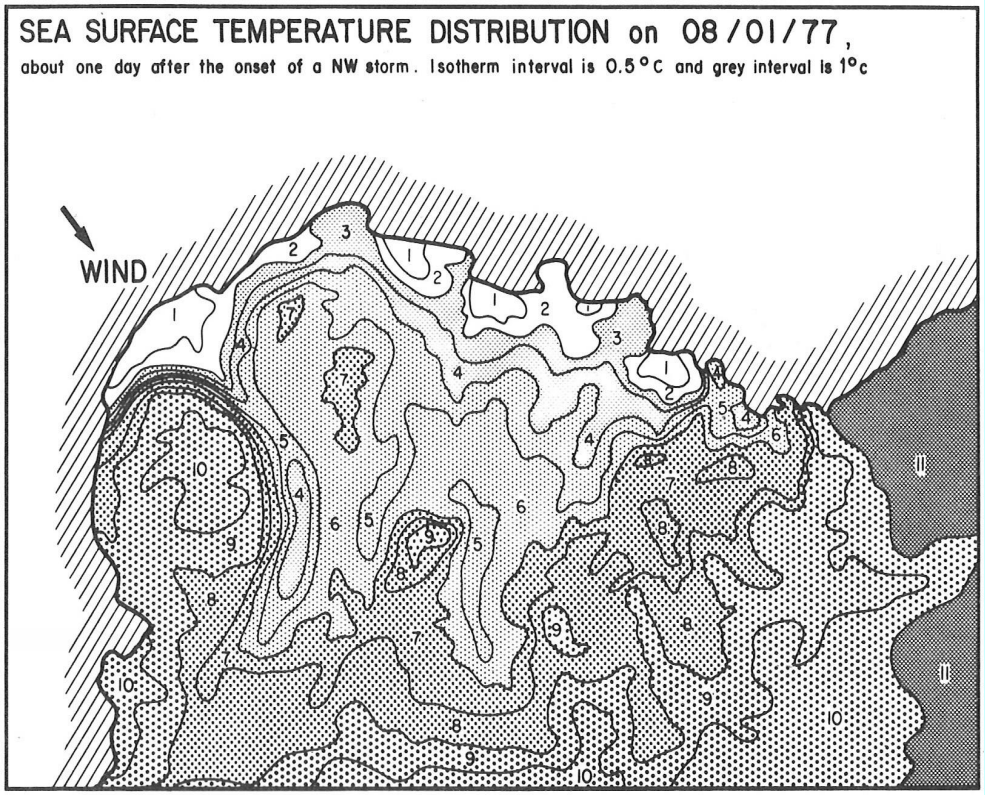
Forcings:

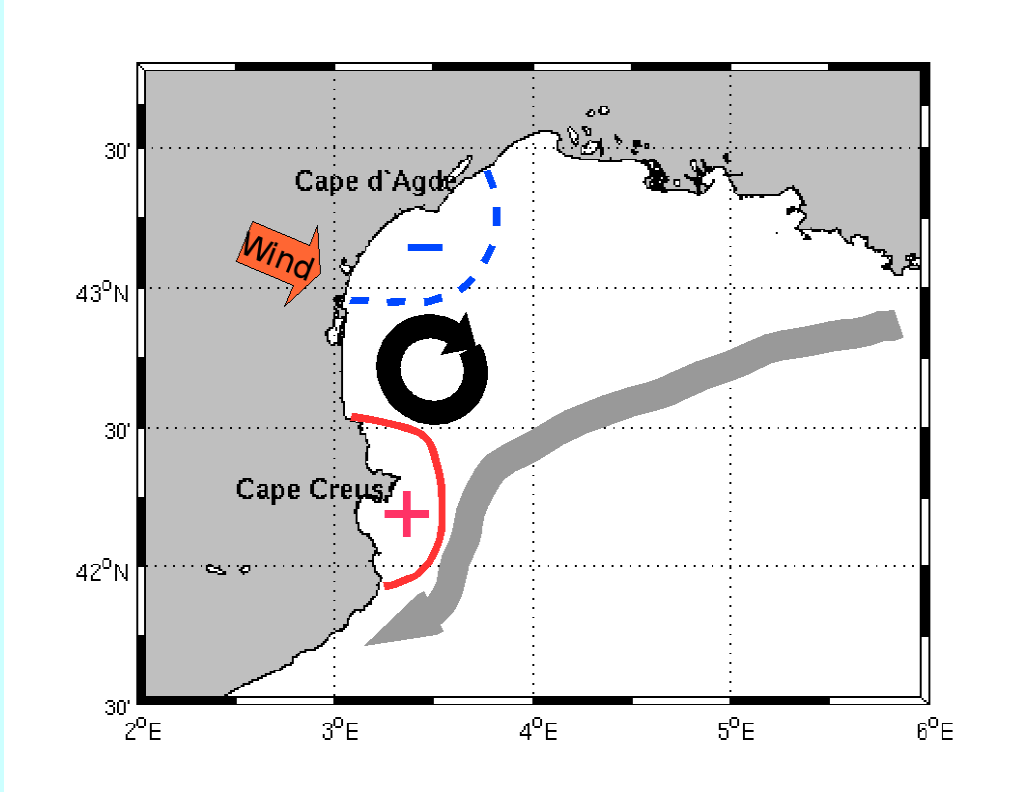
1- Rhone plume

2- Winds :
Tramontane
Mistral.

3- Northern Current (NC)

Western Anticylonic Eddy





First observation
[Millot, 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

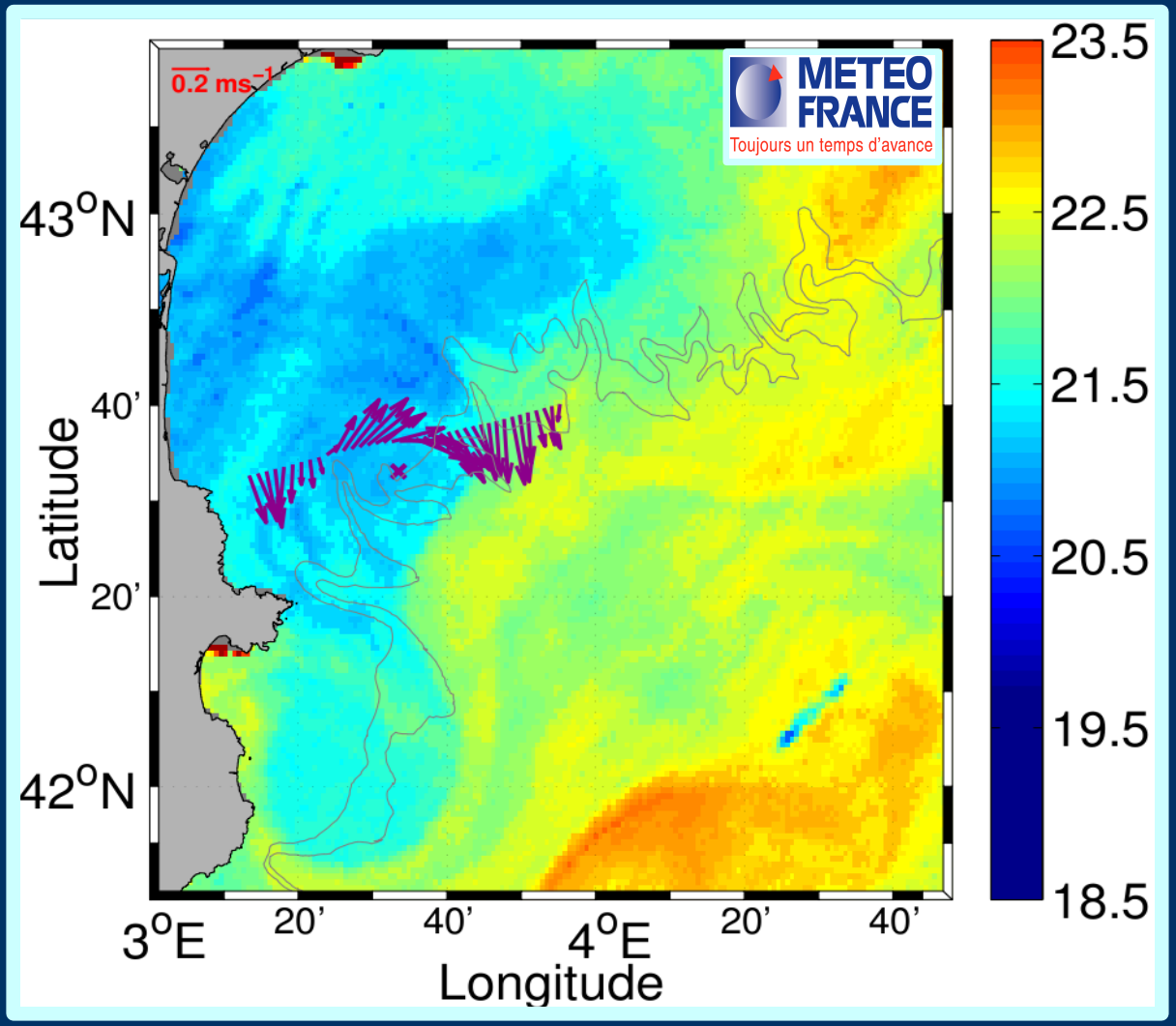
Futher characterization of mesoscale activity in the western part of the GoL

in-situ

Horizontal Characteristics

Transect 1

ADCP 15m depth - SST (°C) August 28



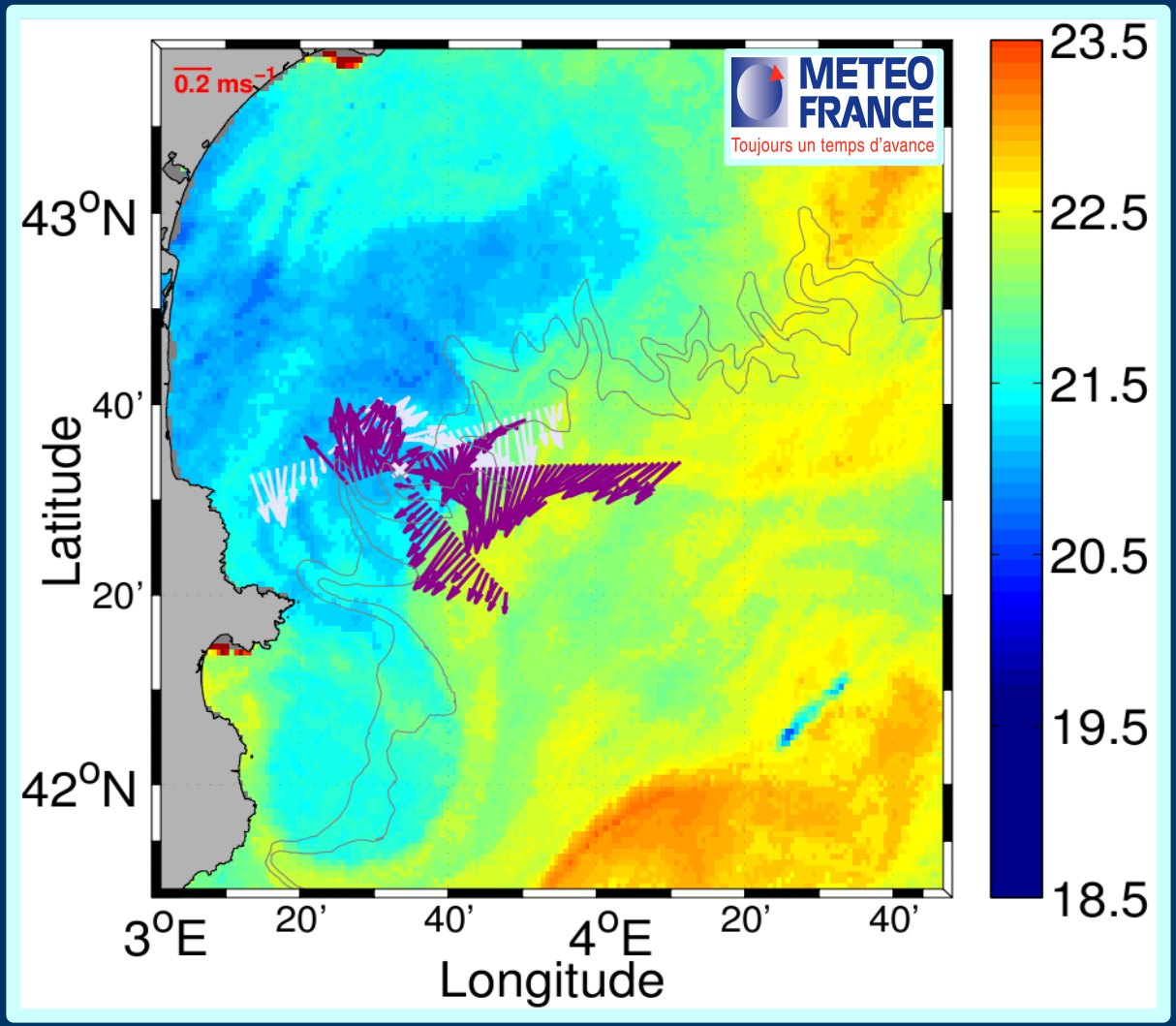
Eddy center detection [Nencioli et al., 2008]

in-situ

Horizontal Characteristics

Transects 1-2-3-4

ADCP 15m depth - SST (°C) August 28

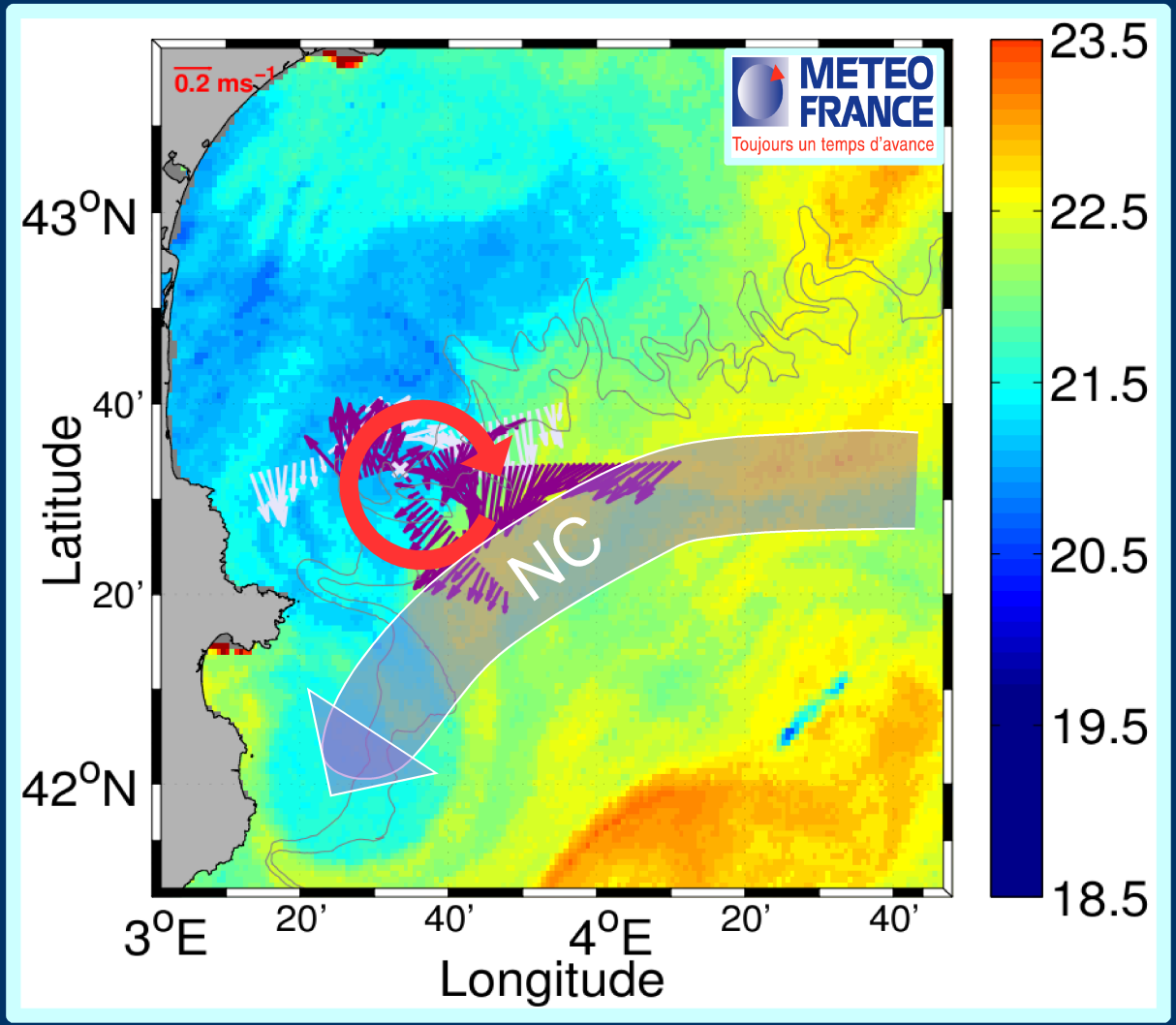


in-situ

Horizontal Characteristics

Transects 1-2-3-4

ADCP 15m depth - SST (°C) August 28



Anticyclonic circulation

V_{max} ~ 0.4 m.s^{-1}

T ~ 3 days

Center:
3°34'E – 42°33'N

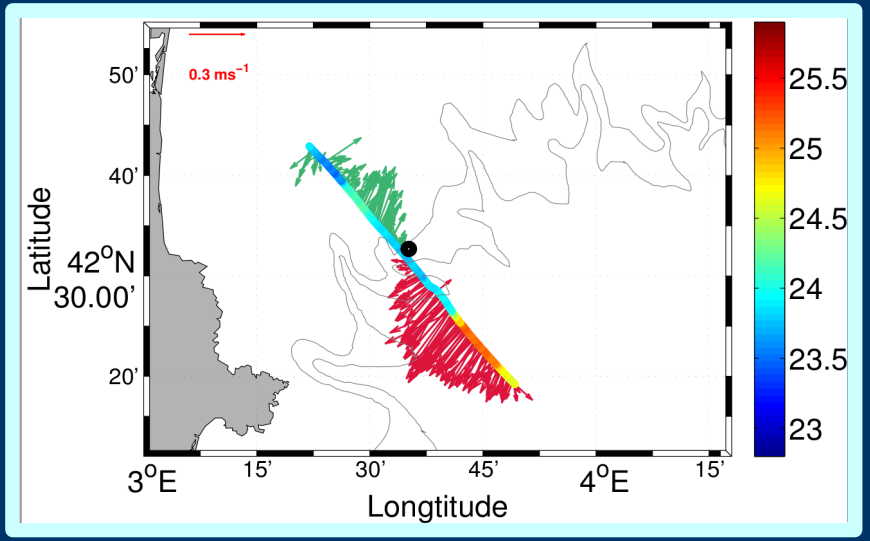
Presence of the NC

in-situ

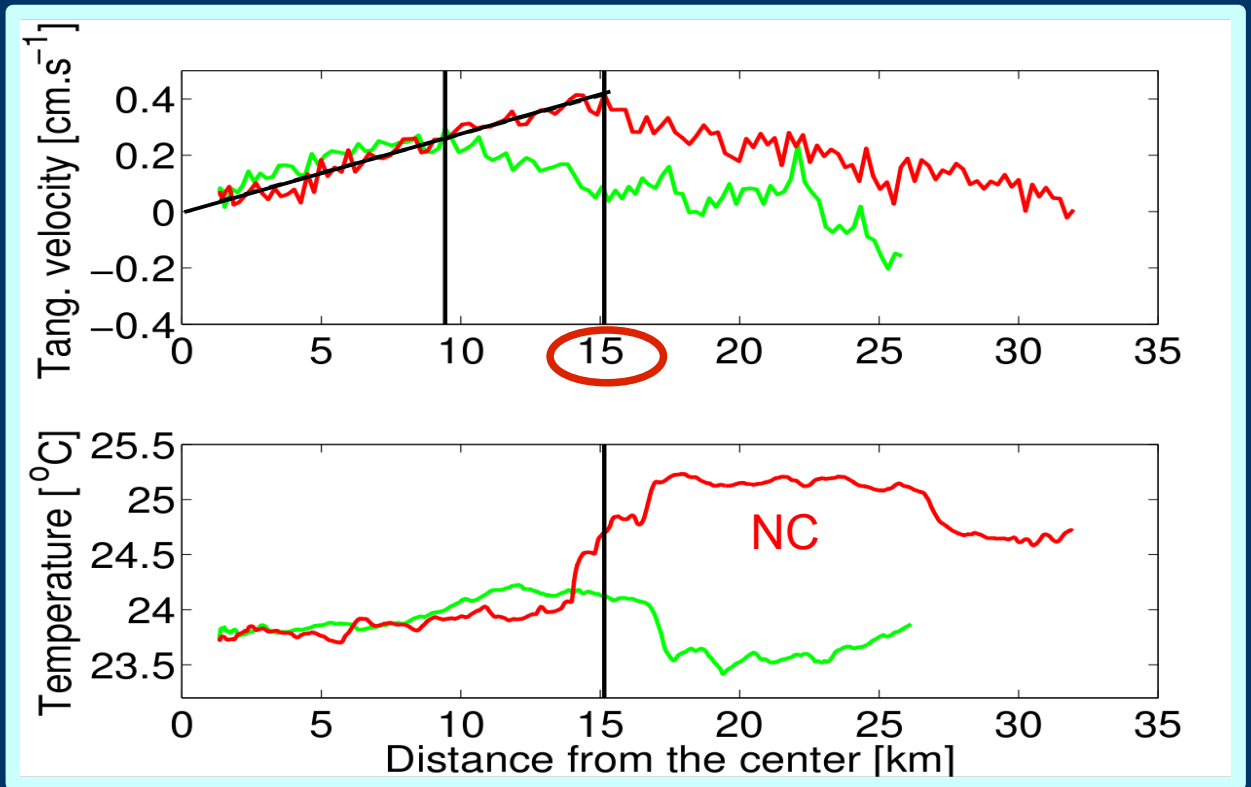
Horizontal Characteristics

Transect 3

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



ADCP 15m depth - SST (°C)

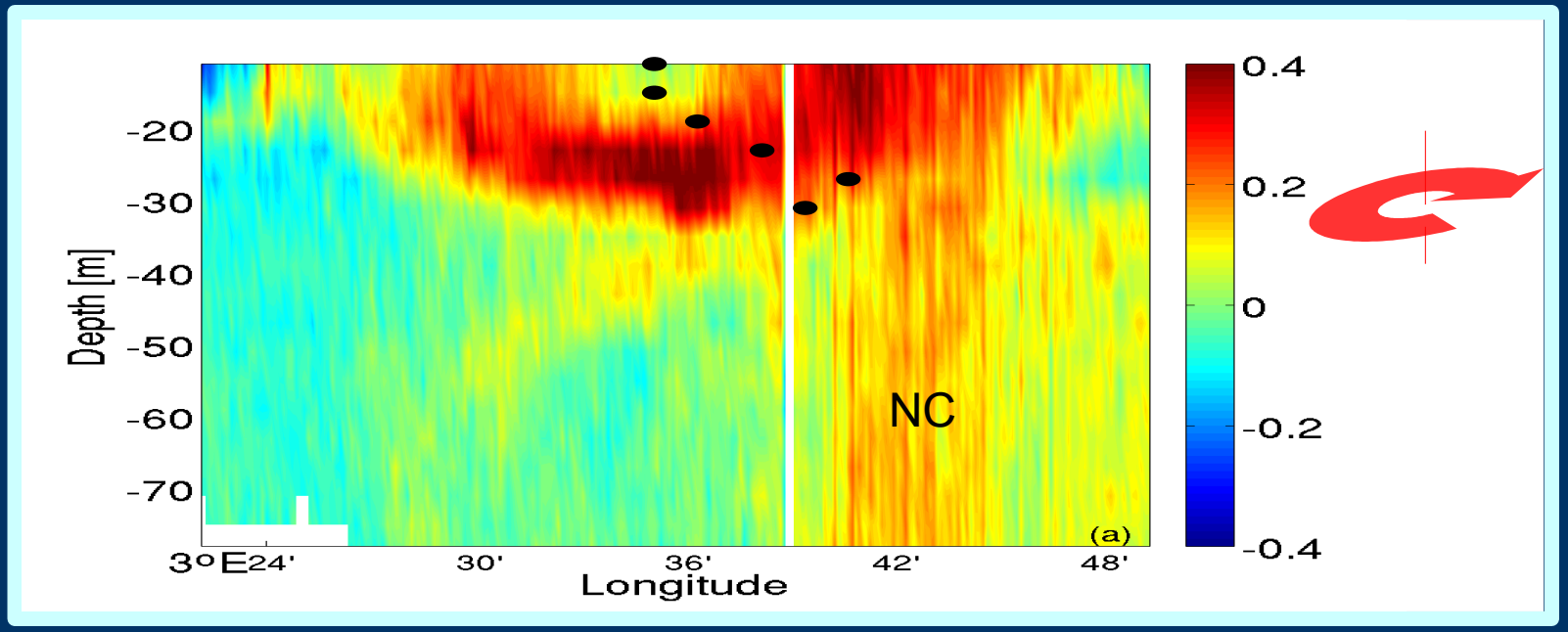


$$D_{eddy} = \bar{D} \pm \sqrt{D_{var}}$$

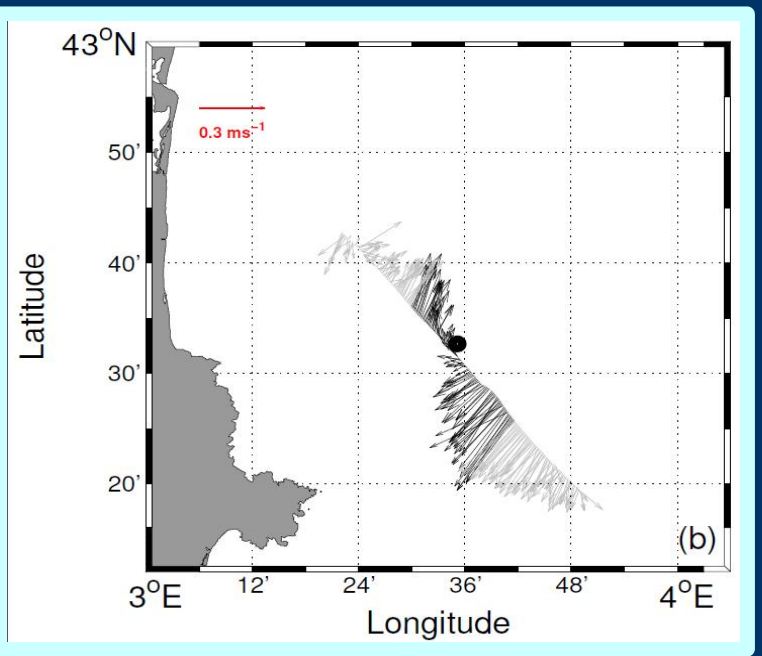
$$D_{eddy} = 22{,}7 \pm 1{,}2 \text{ km}$$

in-situ

Vertical section

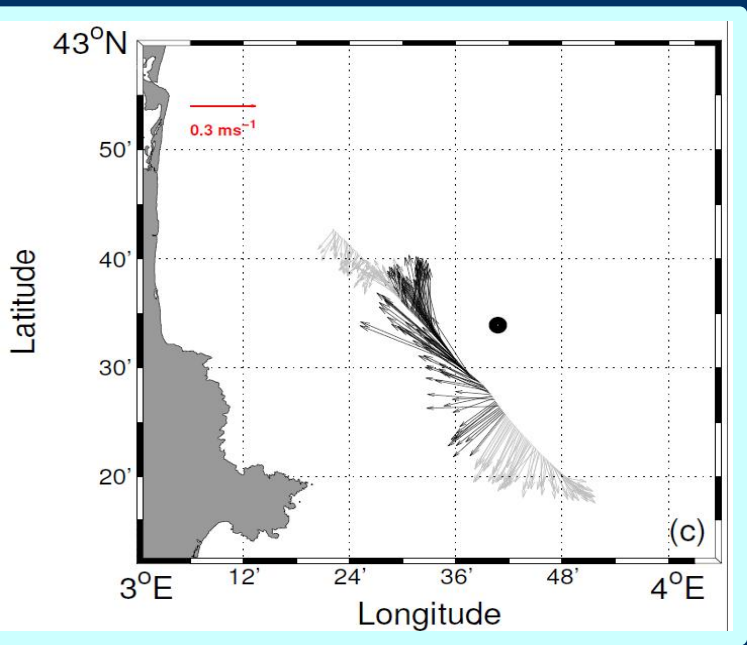


Vertical section of the tangential component of the horizontal current ($m.s^{-1}$) for Transect 3



ADCP current at
15 m depth
27 m depth

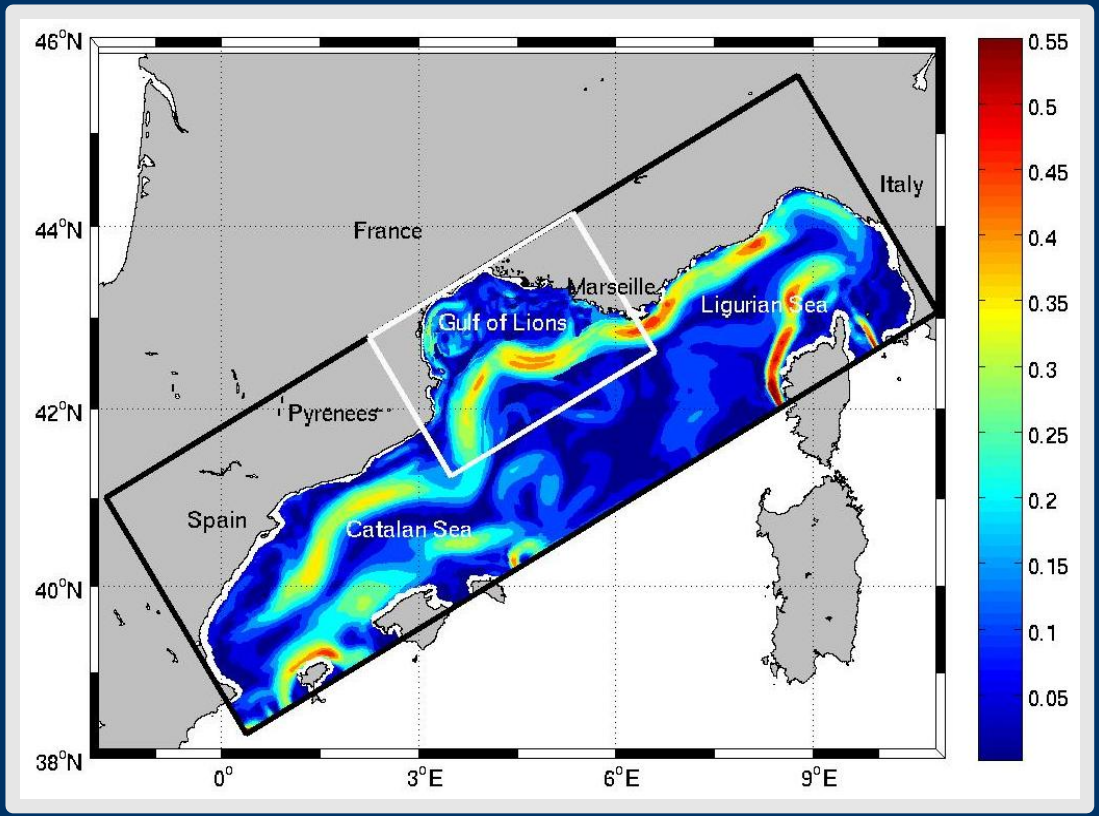
Depth $_{max}$
30-35 m



Numerical Modeling

Numerical model: **SYMPHONIE**

Laboratoire d'Aérologie 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]

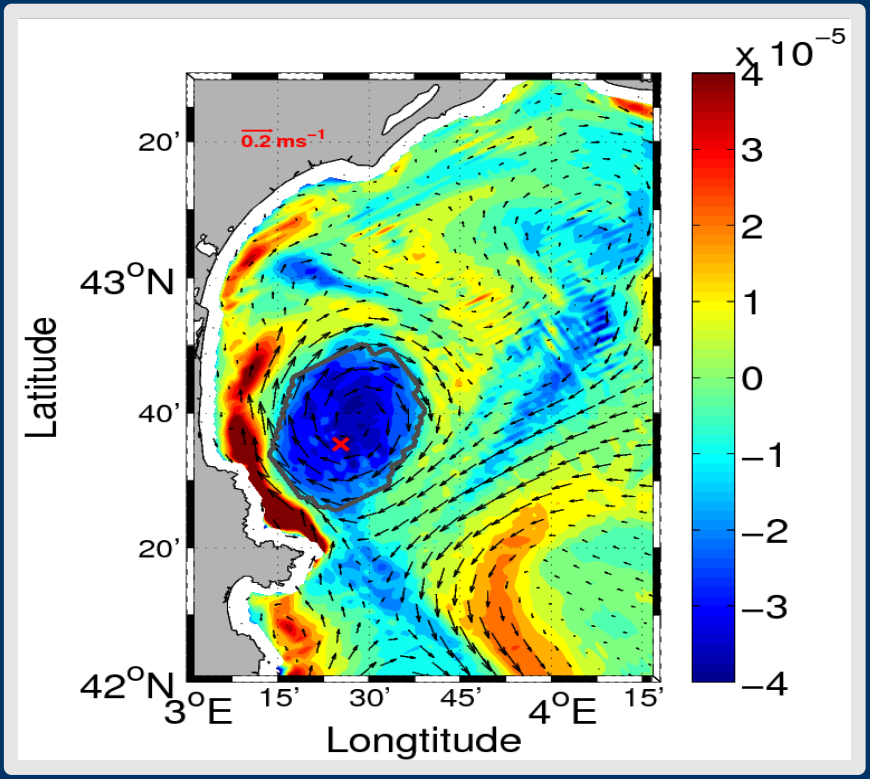
Atmos. Forcing: Météo-France Aladin
Boundaries: OPA outputs (MFSTEP)
Initialization: [Estournel et al., 2003]

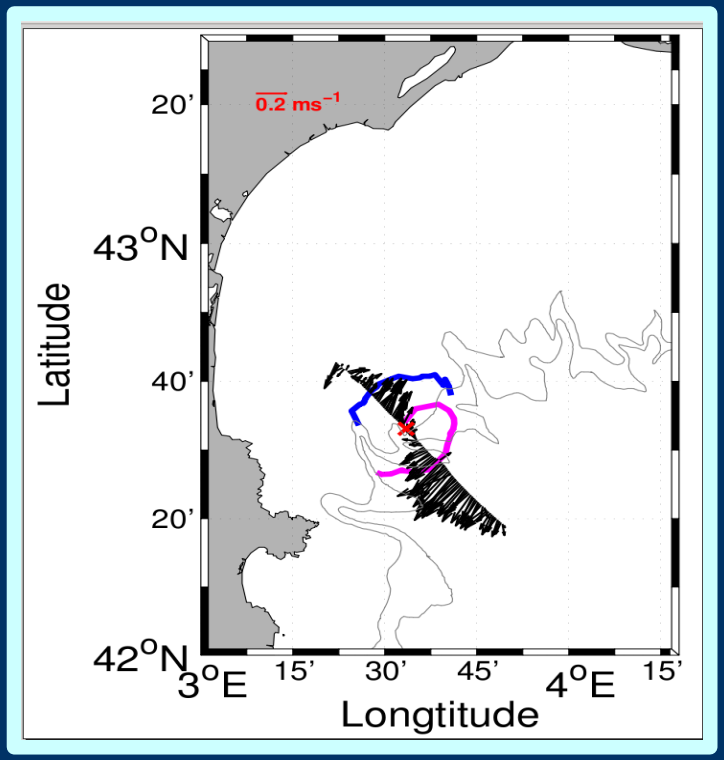
Zoom on the Gulf of Lions
One – Way nesting [Spall et Holland, 1991]
Resolution: 3km → 1km

[Hu et al., 2009]

model

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_{eddy} = 28,6 ± 1,4 km

$Depth_{max}$ = 37 m

Center: 3°34'E – 42°33'N

D_{eddy} = 22,7 ± 1,2 km

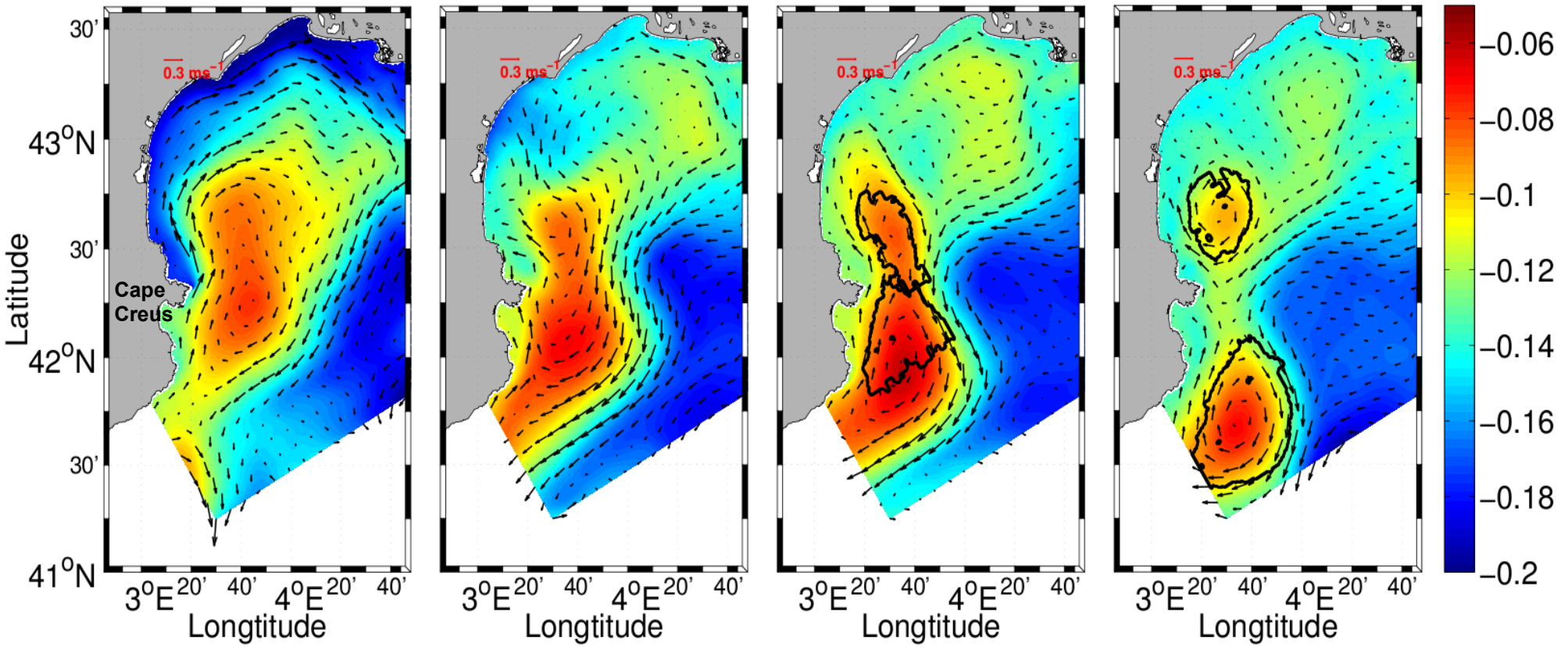
$Depth_{max}$ = 35 m

➔ Similar eddy found in the numerical results

model

Eddy Generation Process

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



Eddies detected by wavelet analysis
Sea Surface Height [m]

New Generation Process

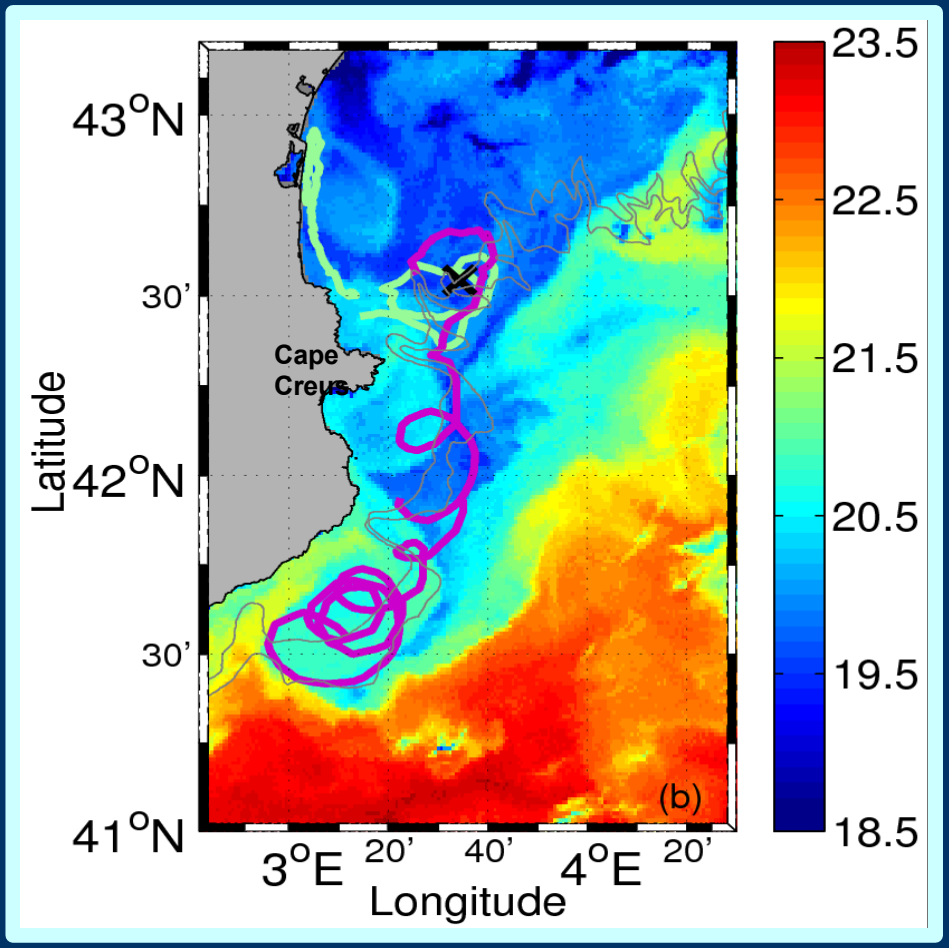
➔Pushing and squeezing of an anticyclonic circulation between a meander of the NC and the coast

➔ Separation in two structures

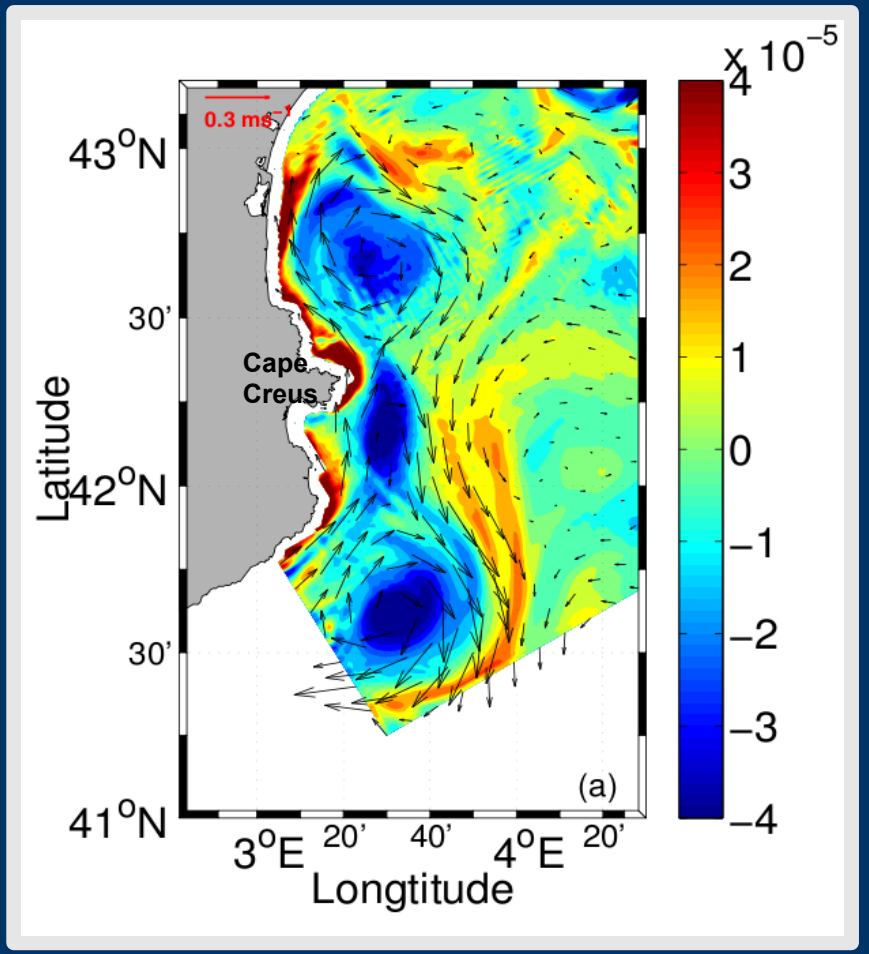
model

Post Generation dynamics

- Latex09 feeds the Catalan eddy



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



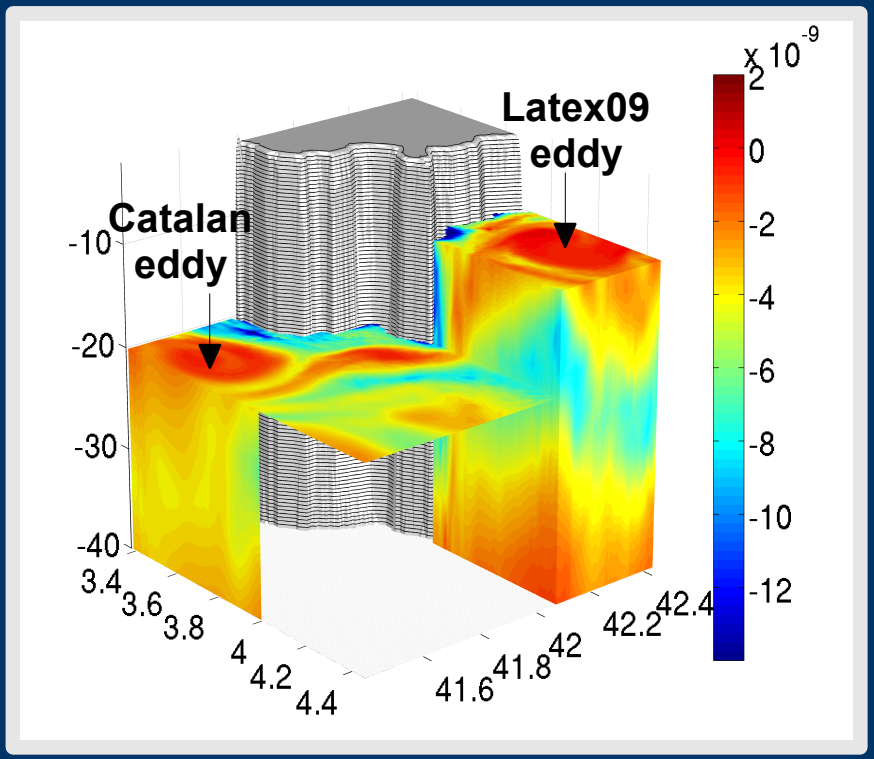
Relative vorticity [s^{-1}]
20m depth September 3

➔ **Drifter trajectories explained by the generation of a transient structure**

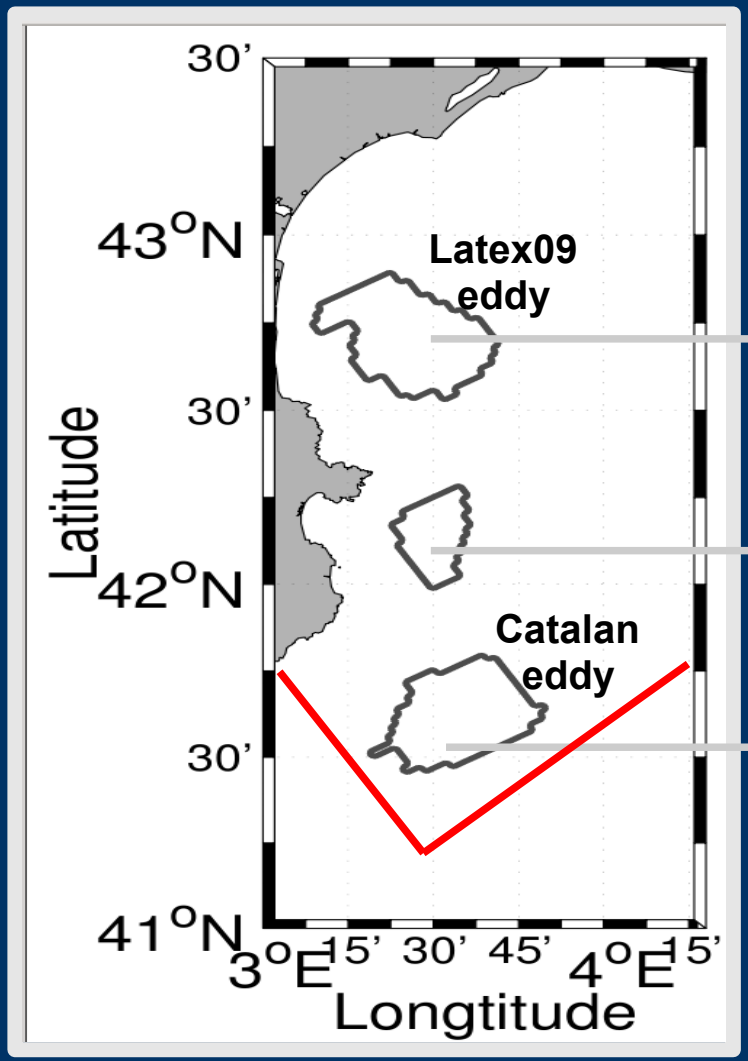
model

Latex09 - Loss of mass

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



Eddies detected by wavelet analysis



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 biogeochimistry

[Kersalé et al., submitted]

Thank you for your attention

LATEX web site

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