JONSMOD 2010

DYNECO/PHYSED

Ifremer

Eddy resolving modelling of the Gulf of Lion and Catalan Sea

Pierre GARREAU
Ifremer centre de Brest
pierre.garreau@ifremer.fr

Observing and modelling a Catalan Eddy

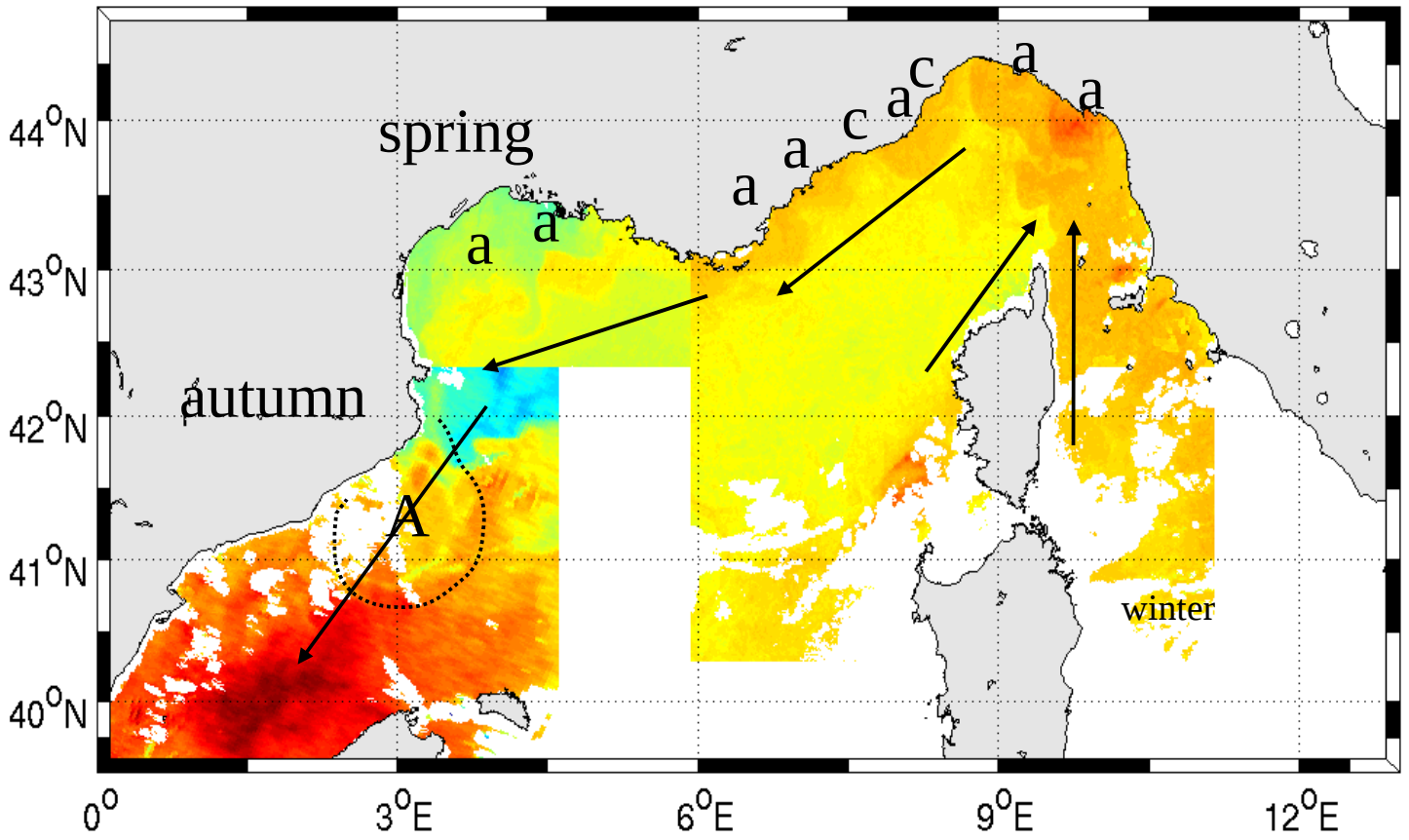
1 - Description of the process
Observations (satelite images , drifting buoys, in situ measurements)

2 - Modelling the Eddy

3 - Validation of the Model

4 - Interpretation

Eddy resolving modelling is needded



Sea Surface Temperature

→ **E**ast **C**orsica **C**urrent + **W**est **C**orsica **C**urrent = **N**orth **C**urrent

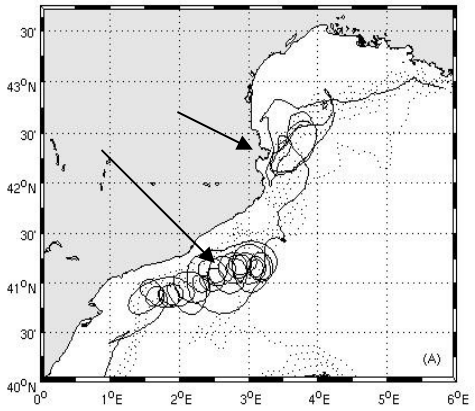
a = anticyclonic eddies

c = cyclonic eddies

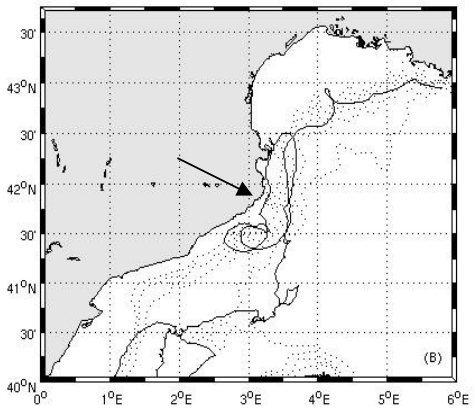
A = Catalan Eddies

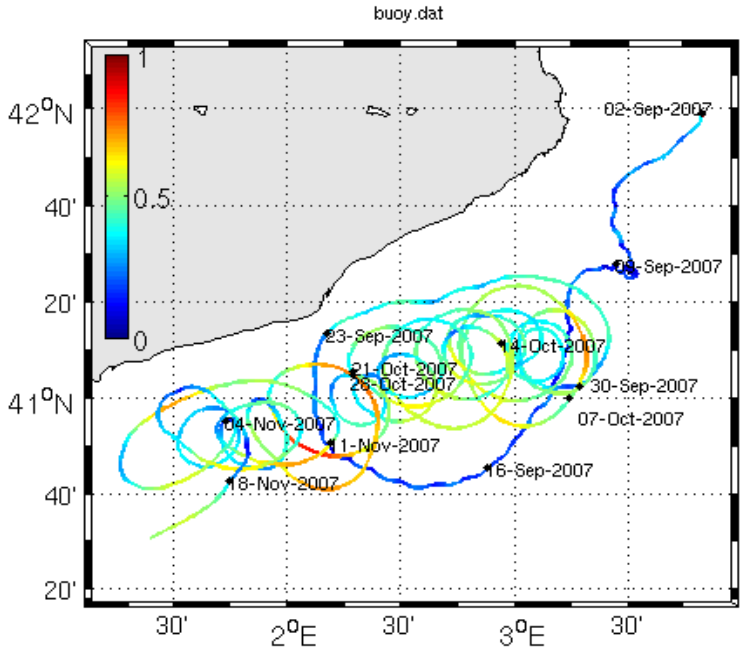
Observing and modelling a Catalan Eddy

(A)



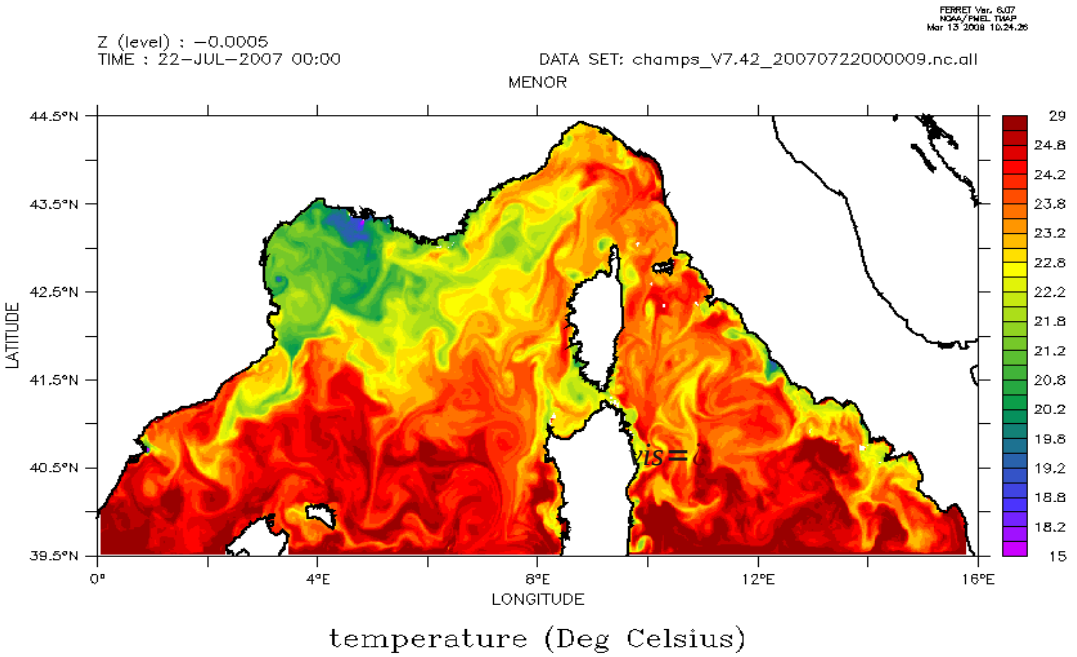
(B)





2 drifting buoys were dropped mid-june 2007 front of Toulon.
Buoy (A) remains 1.5 month in the South-West corner of the Gulf of Lion before to be trapped by a long lived eddy on the Catalan Shelf.
Buoy (B) flows directly on the Catalan Shelf, is trapped by an eddy (2loops) and flows northwards back to the <Gulf of Lion.

MENOR CONFIGURATION of Mars3D



Boundary condition :

- MFS global modelling

- High relolution wind forcing.

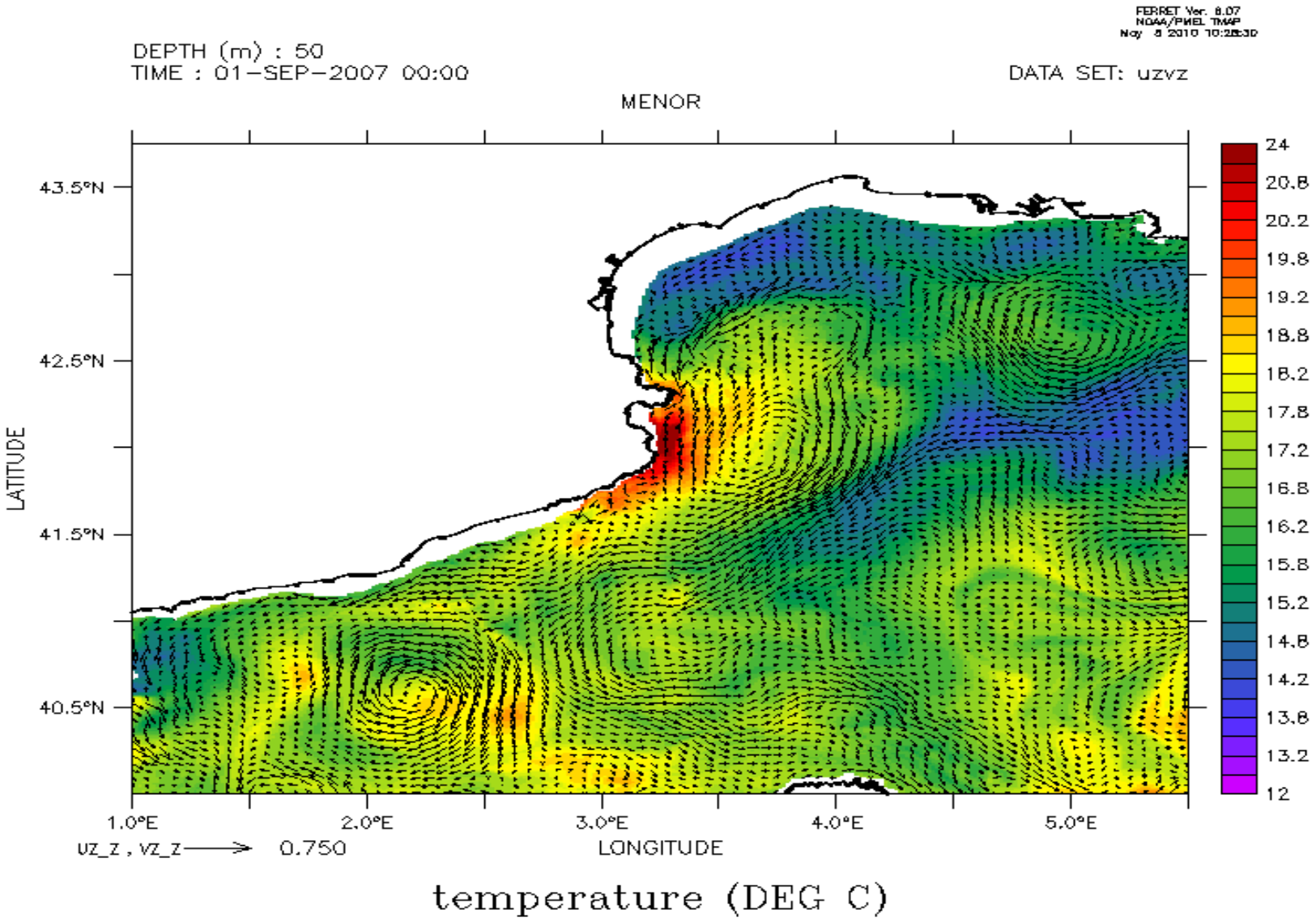
Resolution :1.2 km / 30 sigma levels
Size :1100x460 mpi-paralellized on 256 cpus
Spatial en temporal improve of Mars3d numerics
Tuning : Smagorinsky coefficient for horizontal diffusion

$$A_M = \alpha \Delta x \Delta y \left[\left(\frac{\partial u}{\partial x} \right)^2 + \left(\frac{\partial v}{\partial y} \right)^2 + \frac{1}{2} \left(\frac{\partial u}{\partial y} + \frac{\partial v}{\partial x} \right)^2 \right]^{1/2}$$

Alpha =.20 >> smoothed eddy
Alpha =.100 >> too much small scale processus inhibits the eddy generation
Alpha= .15 >> correct generation and advection of the eddy.

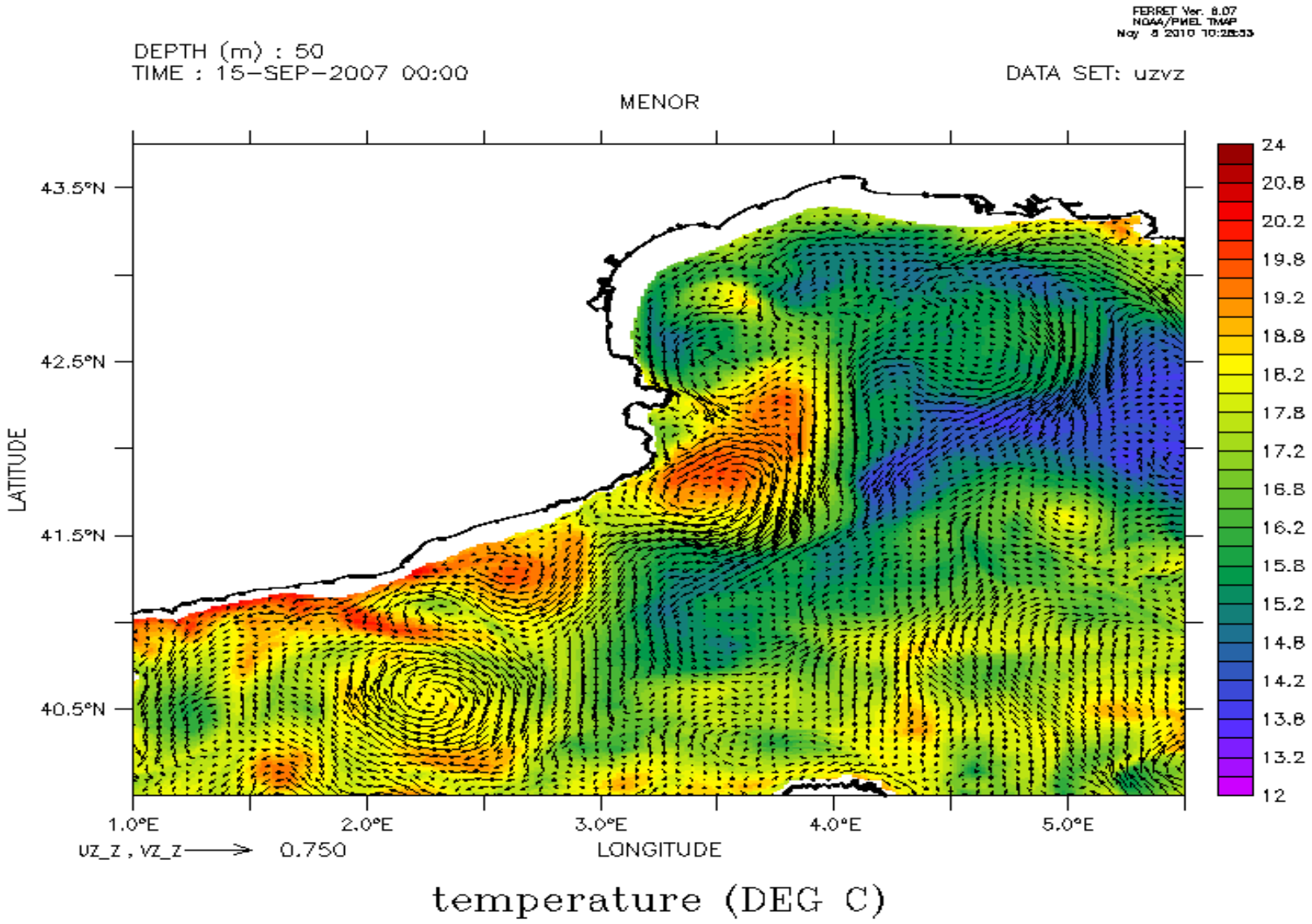
Results

current and temperature at 50 m depth



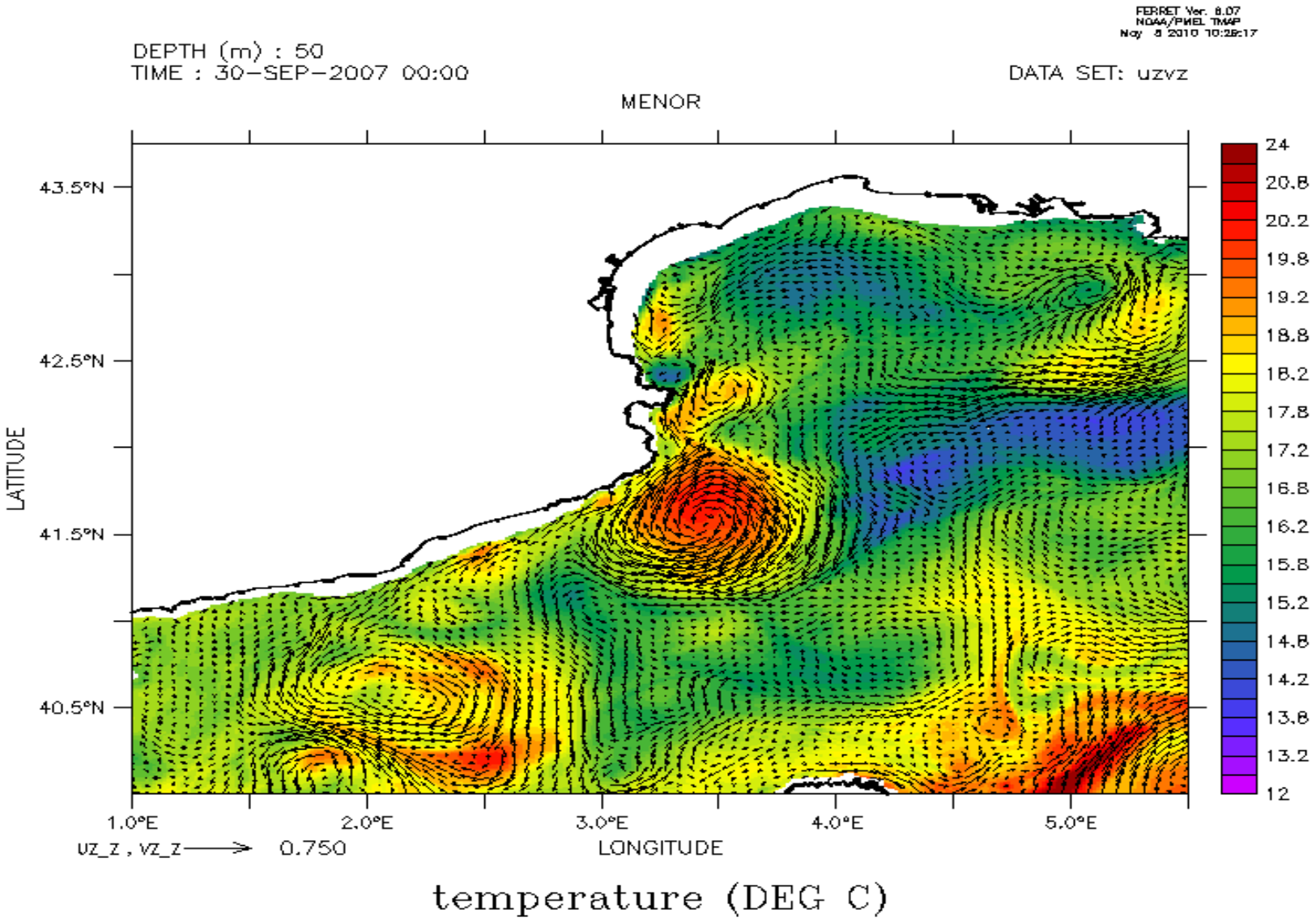
Results

current and temperature at 50 m depth



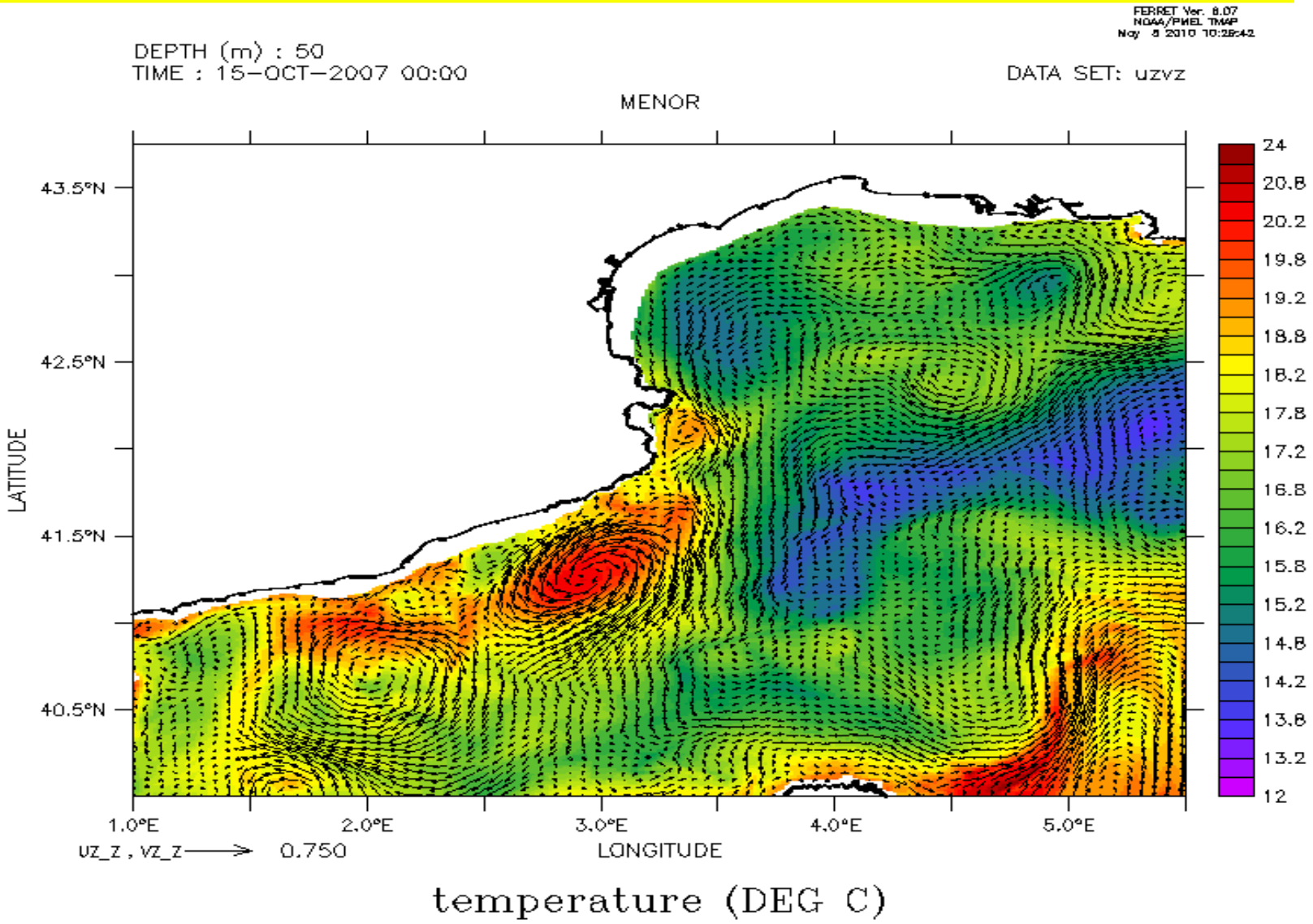
Results

current and temperature at 50 m depth



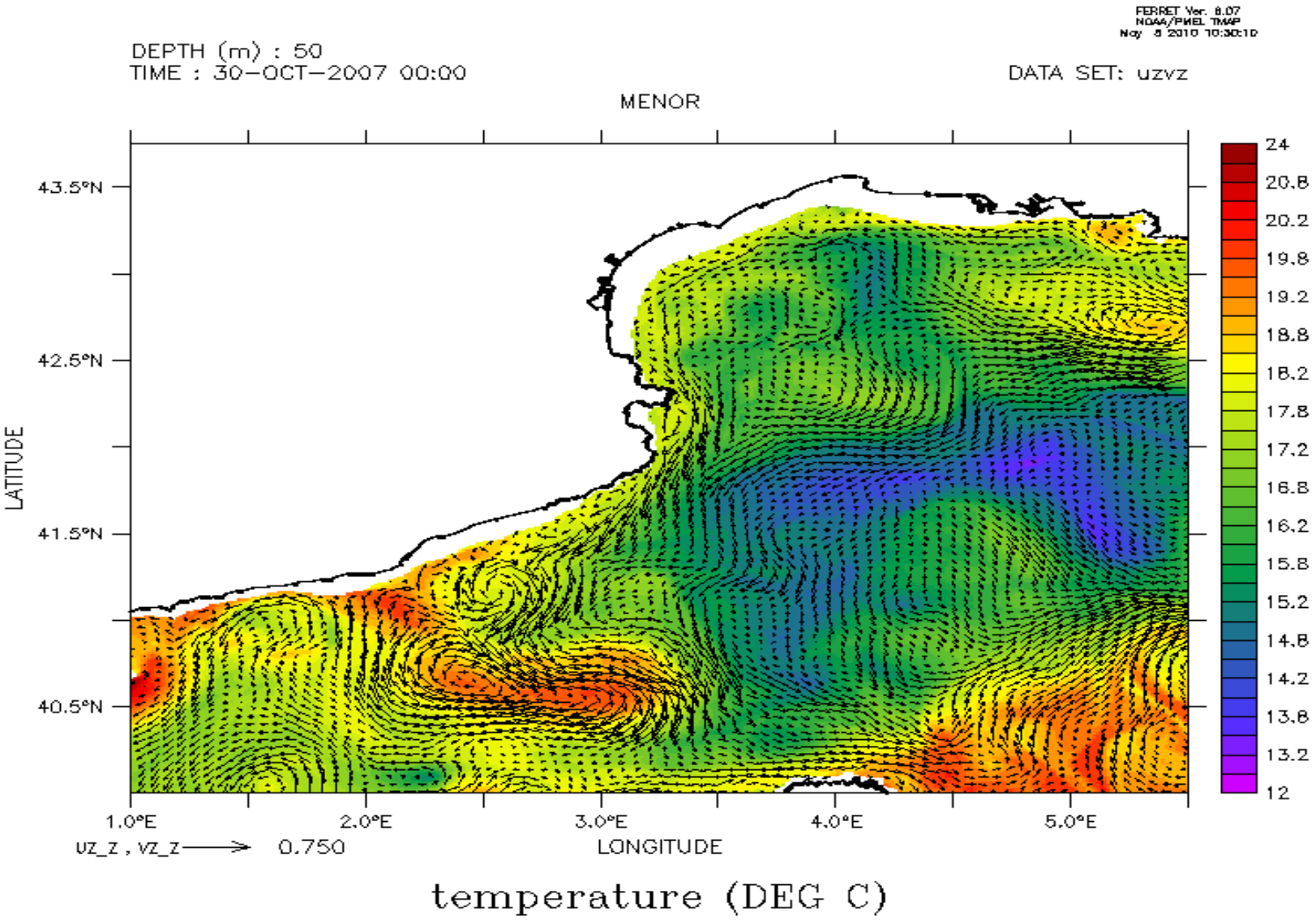
Results

current and temperature at 50 m depth



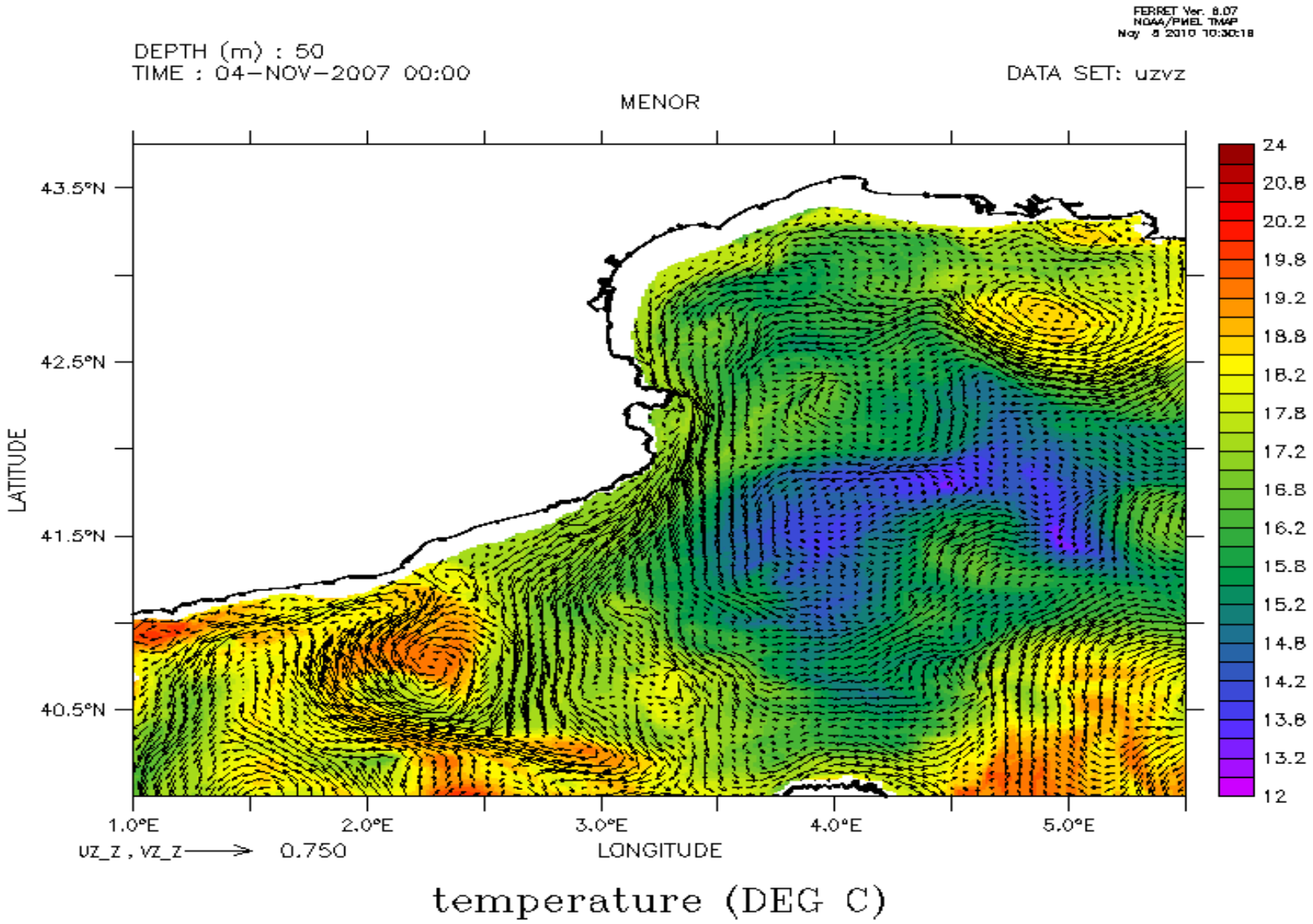
Results

current and temperature at 50 m depth

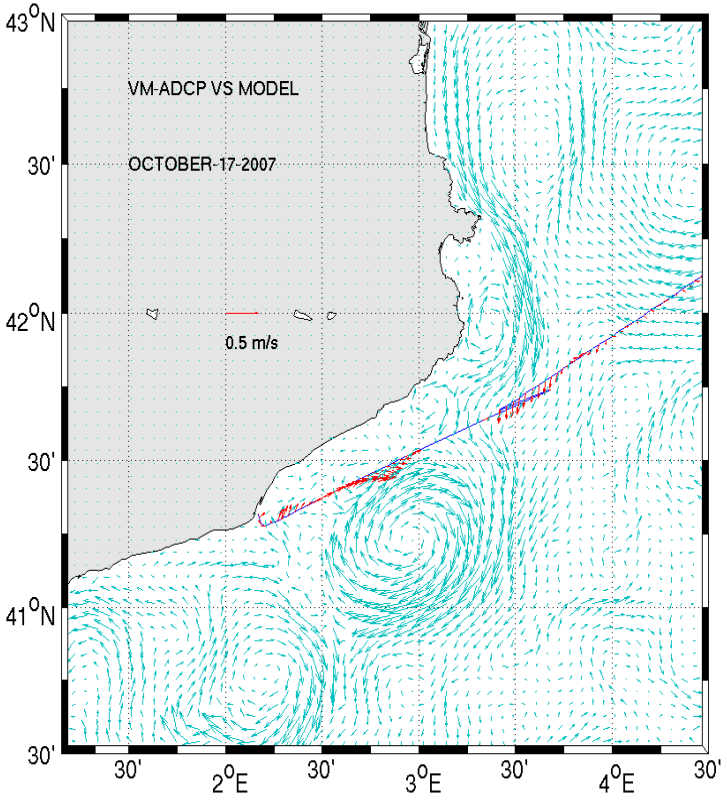


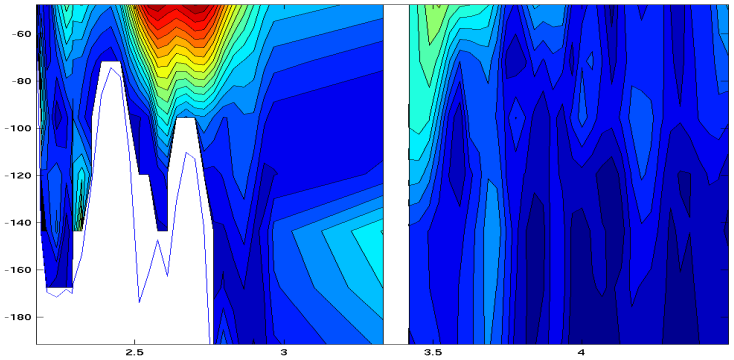
Results

current and temperature at 50 m depth



Validation comparison VM-ADCP



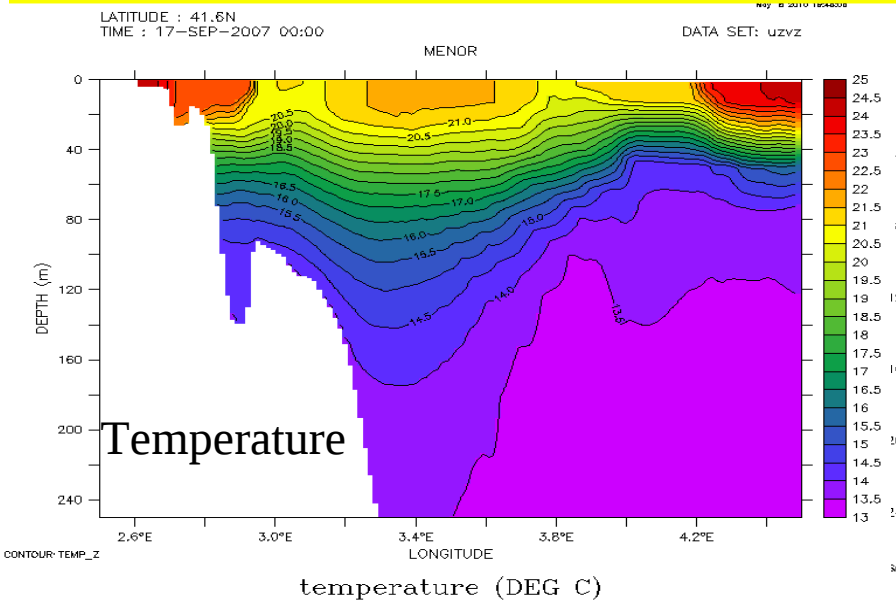


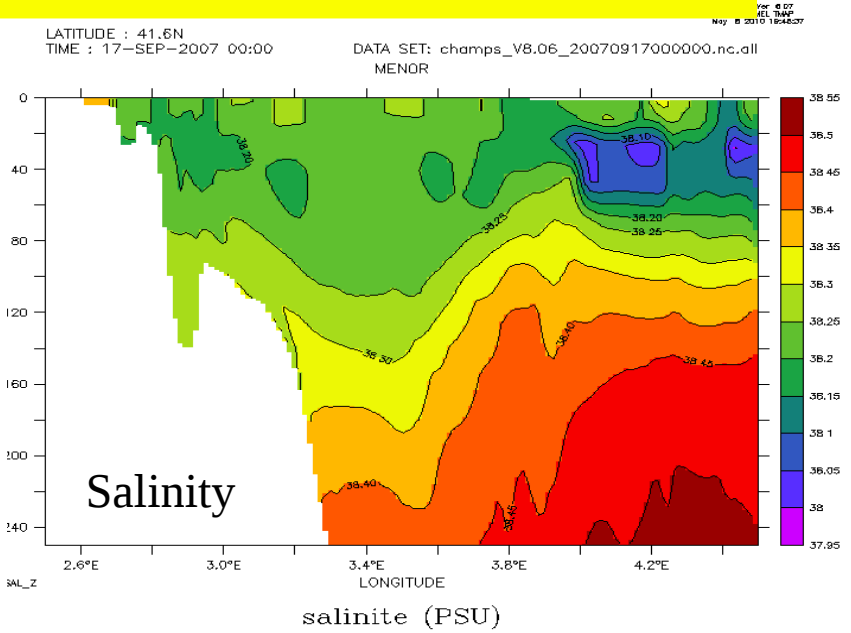
« diving » in the Coriolis data base...

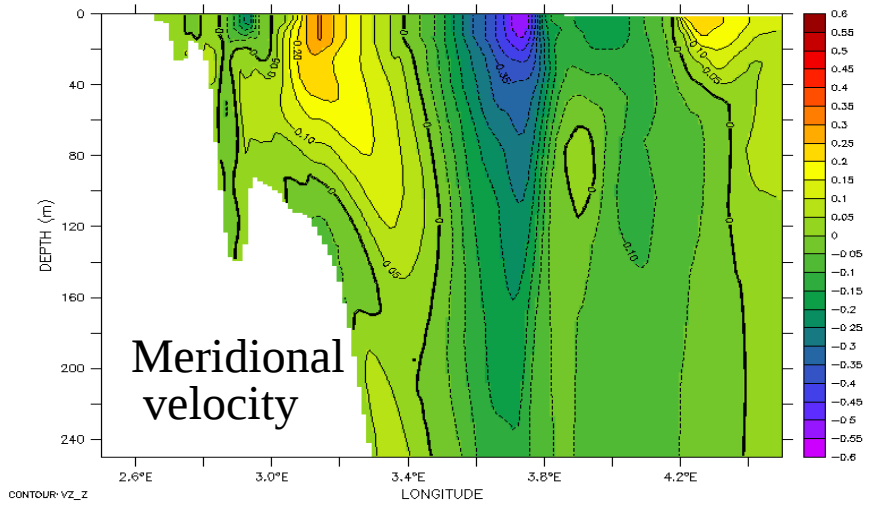
A transit of the **Beautemps-Baupré** Research Vessel was found crossing the eddy. A profile of velocity is available

Modelled velocity at 50 meter depth is in the range of the observed one.

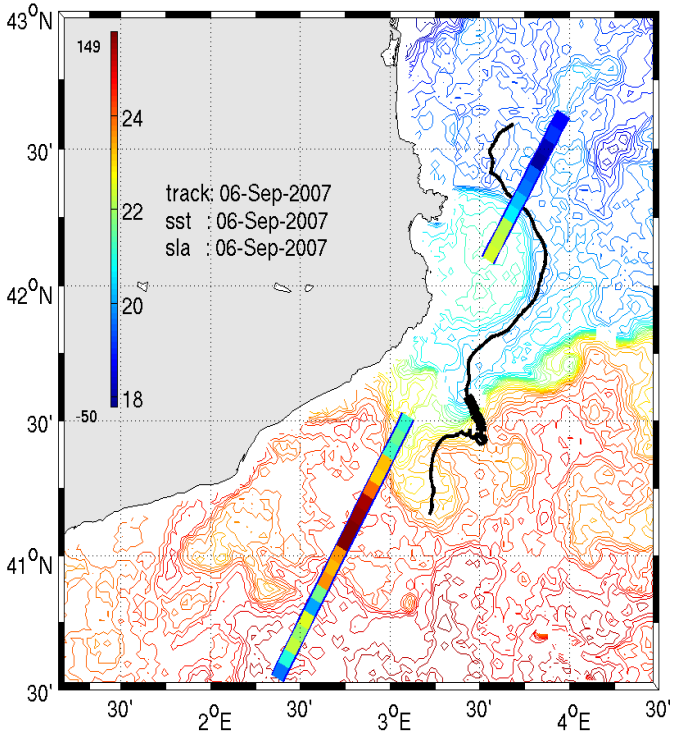
Transect across the eddy

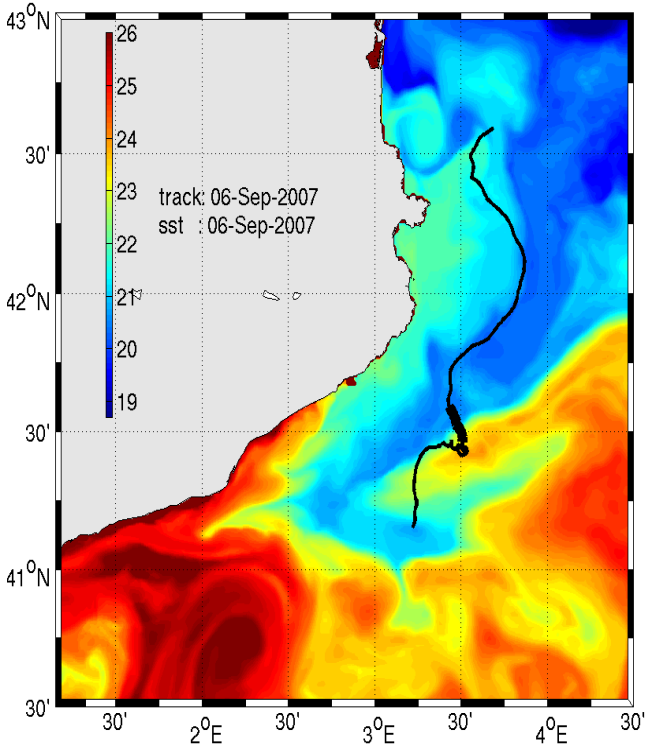




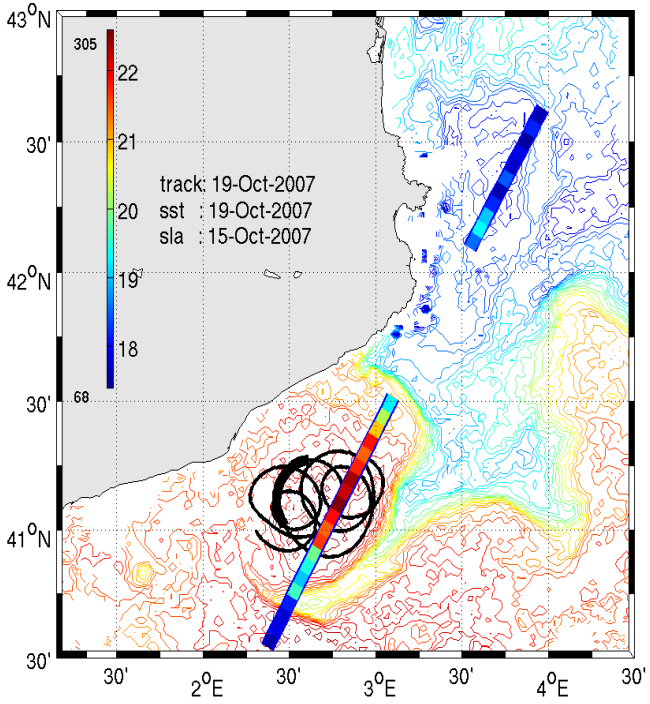


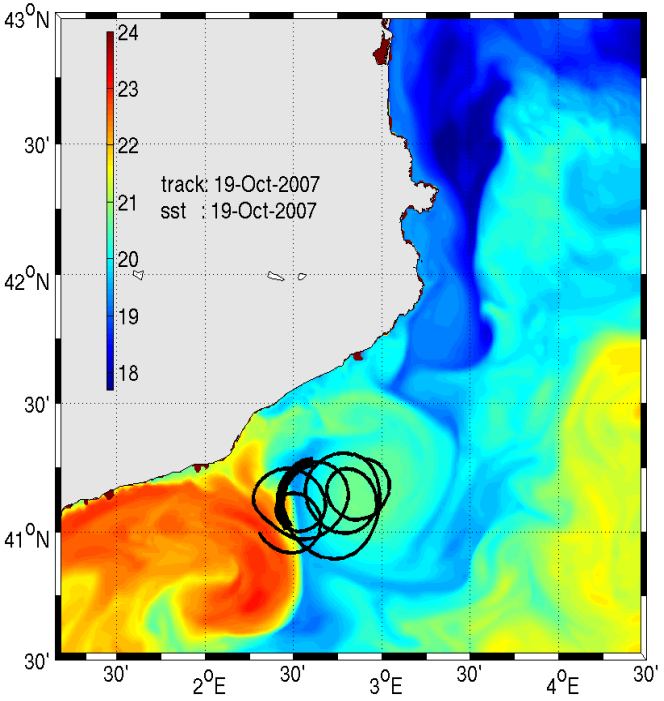
Validation
Comparison SST and tracks



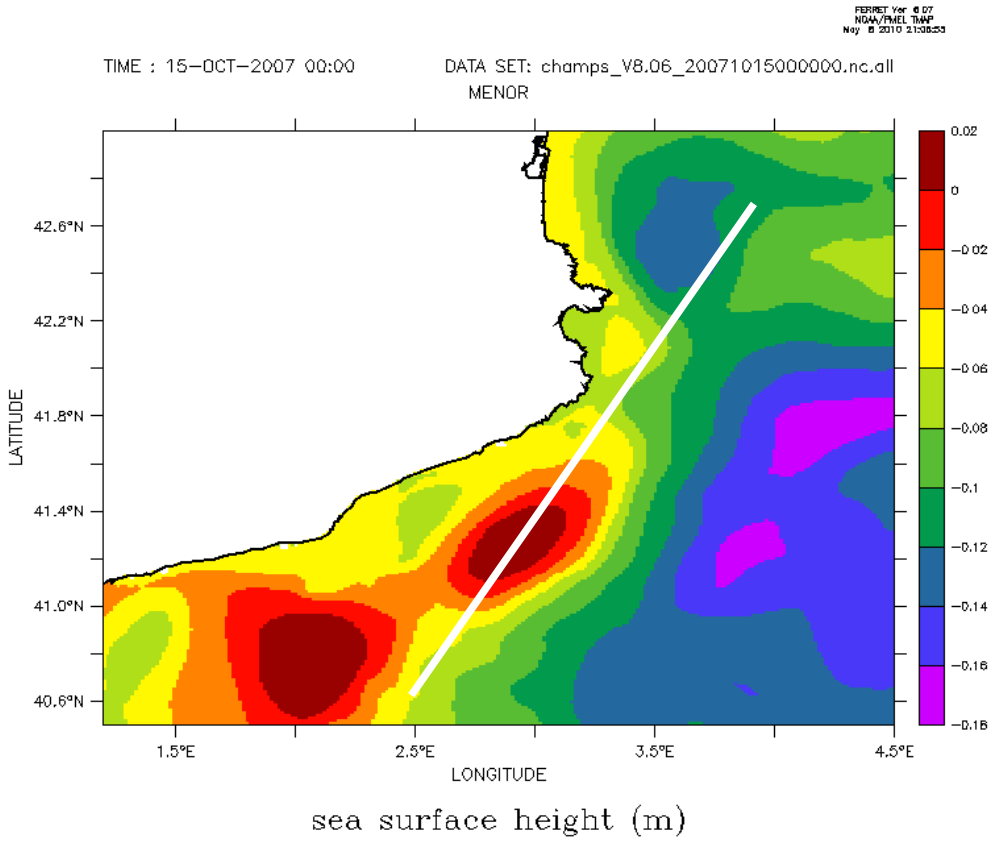


Validation
Comparison SST and tracks



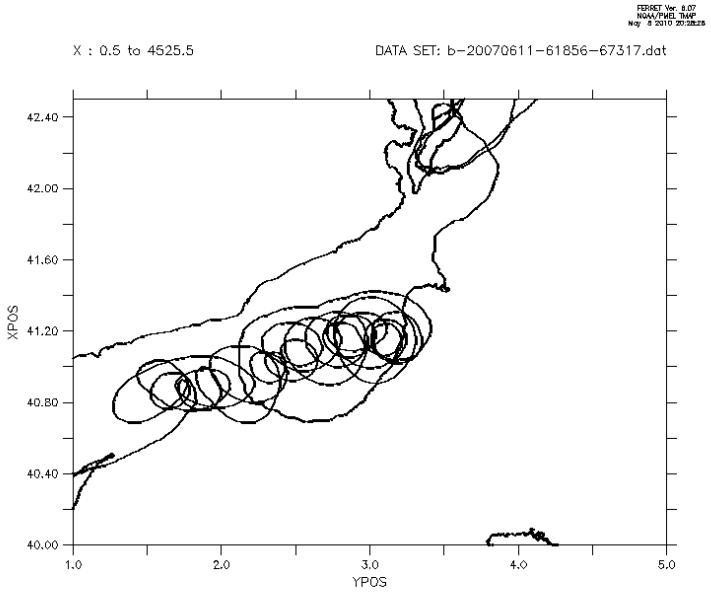


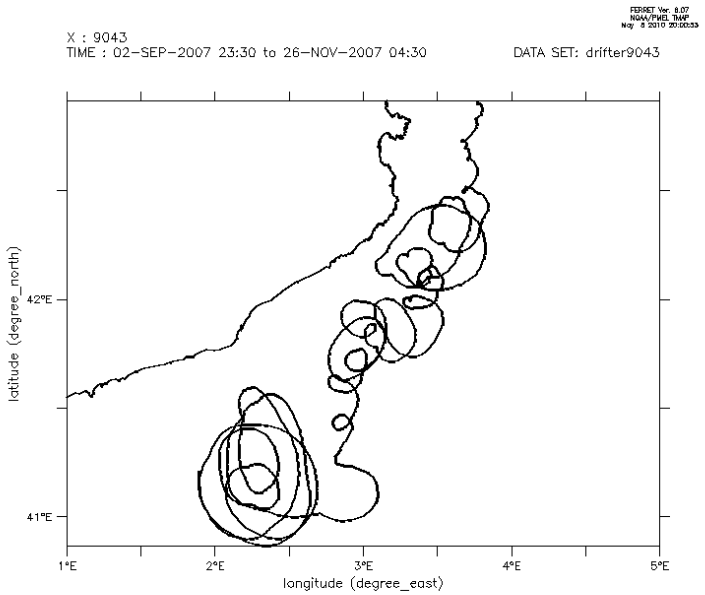
Sea level Anomaly



The Difference of Sea Leval Anomaly between the eddy centre is :
Model : 16 cm
Jason SLA : 24 cm

wavelet analysis of the trajectory





A direct comparison of trajectories is not possible, wavelet tool allows to acces to loop charcteristics :

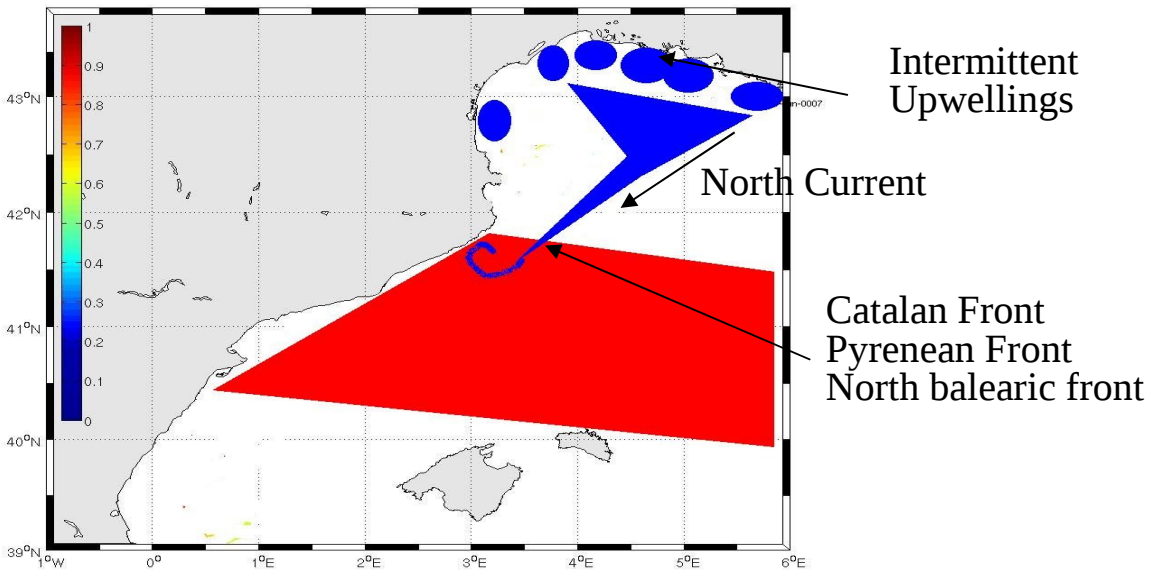
Modelled period : 3.0 day (between 2.5 and 4.0 days)
Observed period : 2.5 day (between 2.0 and 3.0 days)

Modelled radius : between 8 and 20 km
Obverved radius : between 10 and 24 km

The modelled eddy is simmilar to observed one but less energetic.

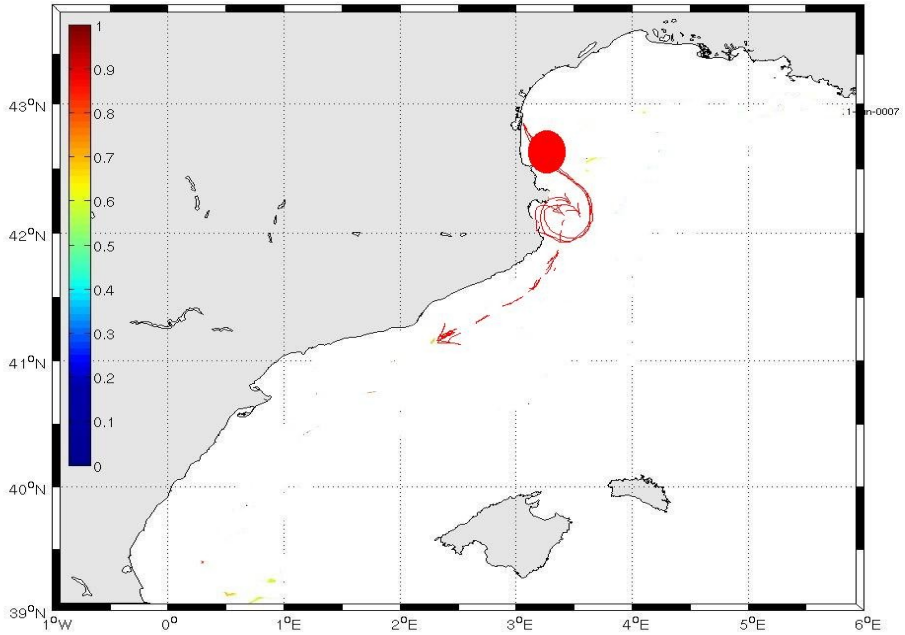
What are the processes involved in the generation of this vortex ?

At the end of summer cold water from Gulf of Lion is advected by the wind and the Nord Current and penetrates the Catalan front generating instabilities (possible interactions with deep and sharp canyons).

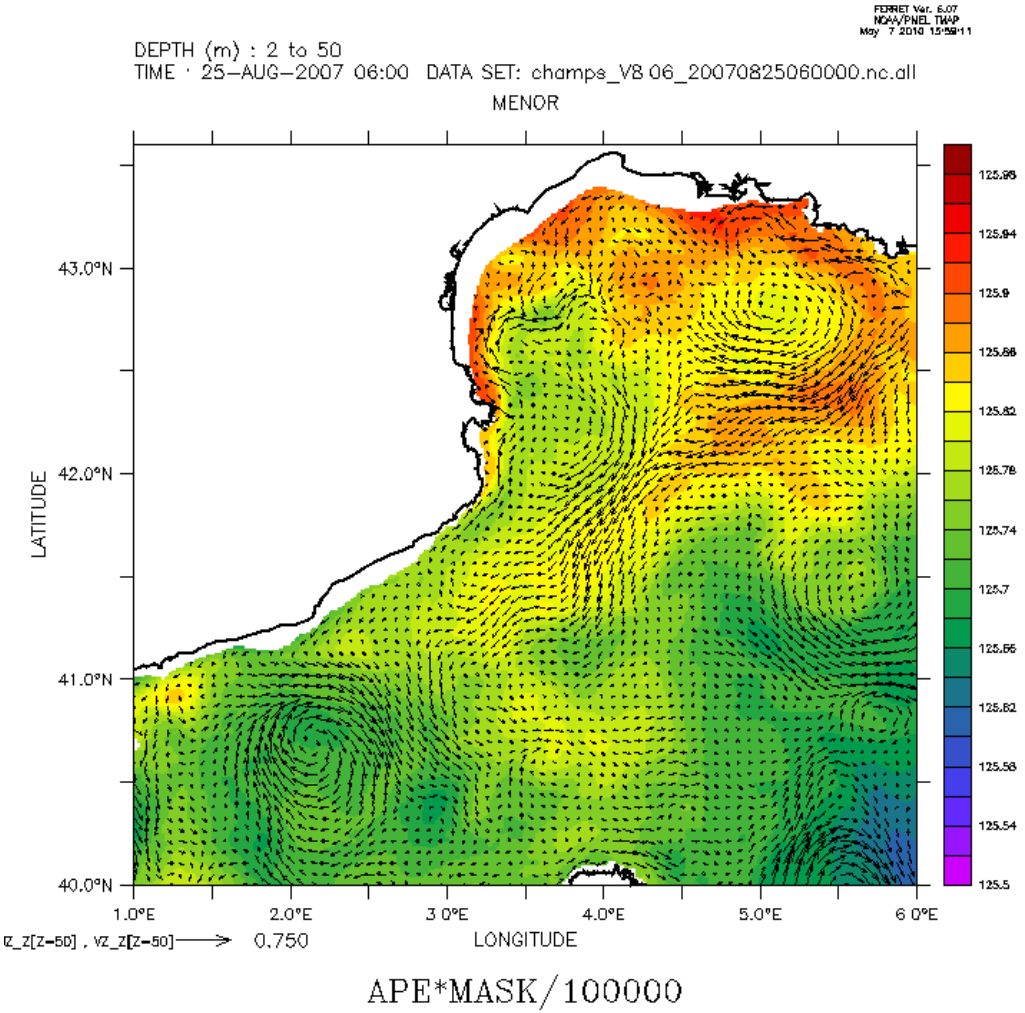


What are the processes involved in the generation of this vortex ?

Voticity generation behind the Cap Creus, by a Southwards flux. Warm water mass (flowing from the Gulf of Lions) gains vorticity around this lee vortex and increase the potential energy of this mesoscale structure. (Rubio et all 2009)



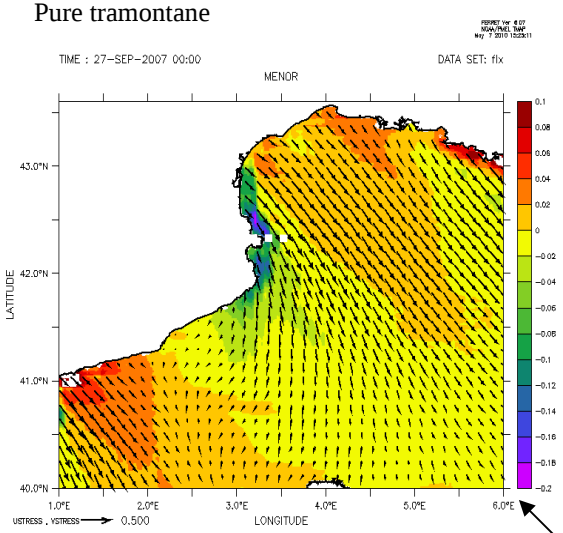
potential energy in the surface layer (50 m)



$$\int_{50} \rho g z dz$$

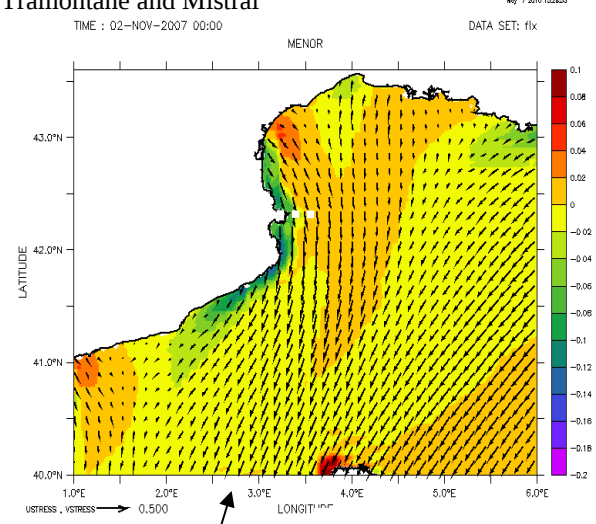
Effect of Wind in Summer on the flux at Cap Creus

Pure tramontane



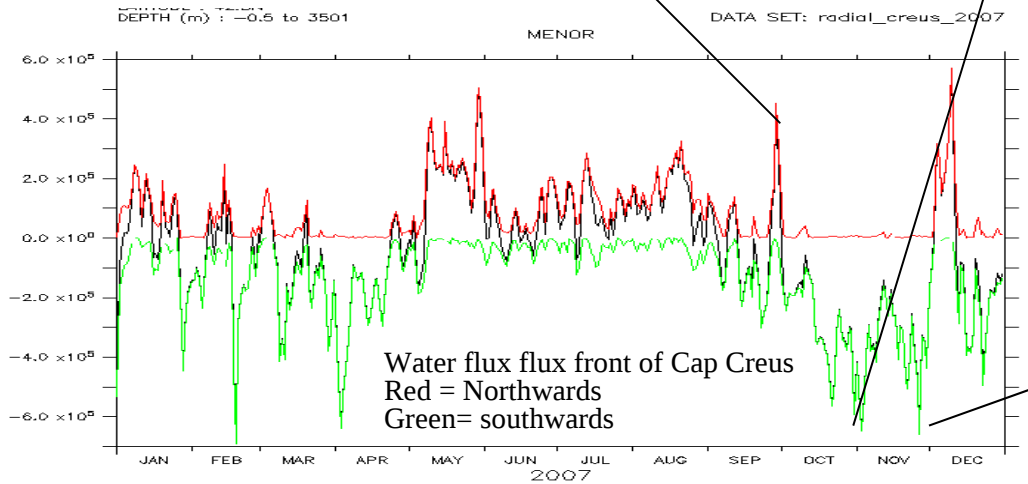
curl_tau/f

Tramontane and Mistral



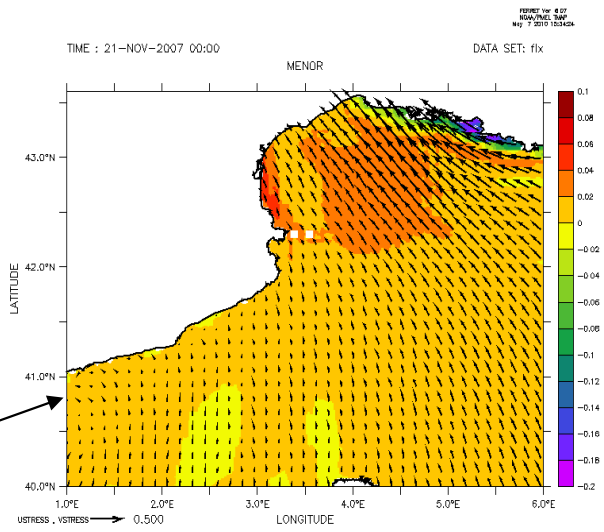
curl_t

North-Westward wind



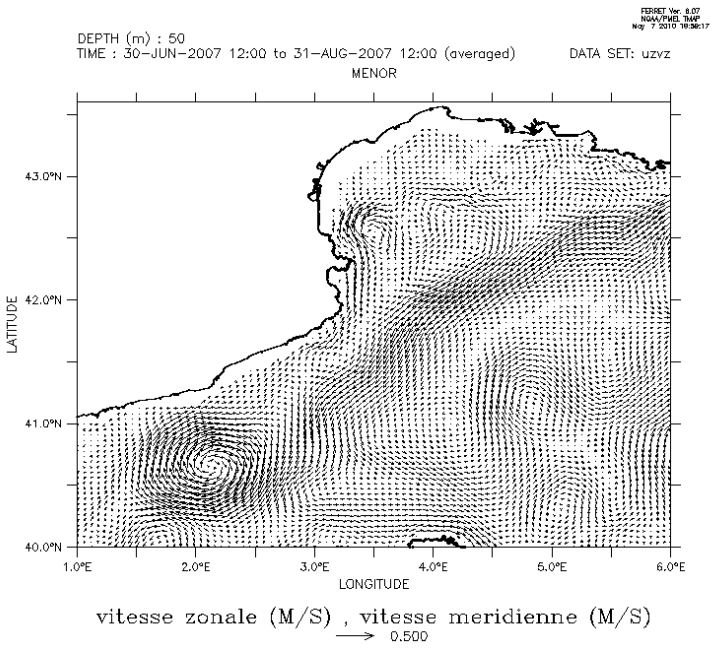
Water flux flux front of Cap Creus
Red = Northwards
Green= southwards

water flux : Cap Creus transect

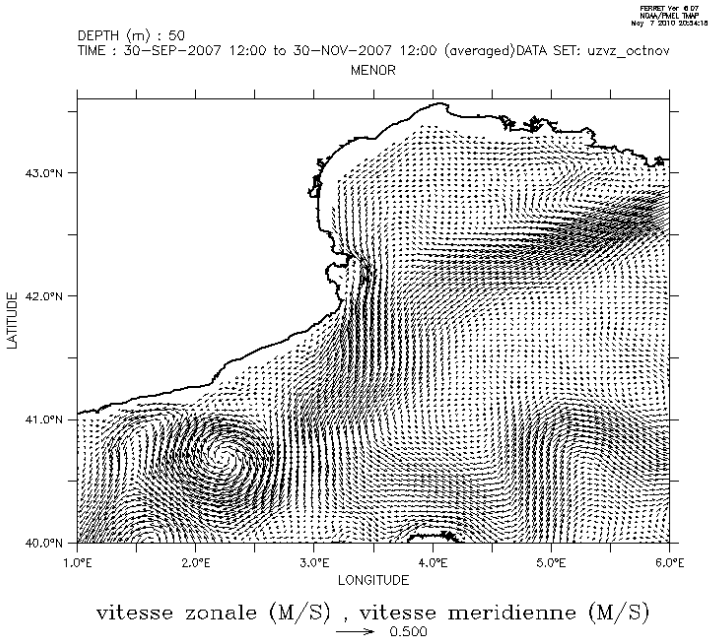


curl_tau/f

Averaged currents at 50 meters depth



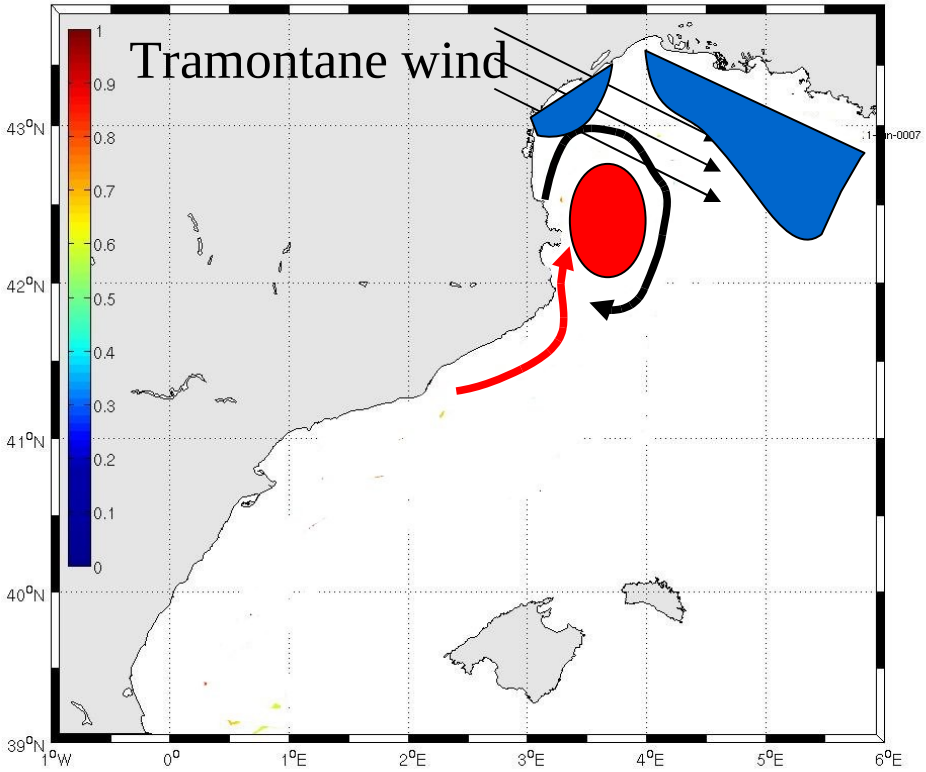
July- August



October-November

What are the processes involved in the generation of this vortex ?

The South-Western part of the Gulf of lion is is a tank of potential energy at the end of Summer. Water is trapped in this corner before to be released on the Catalan slope.



conclusion

- A realistic long lived (2 months) and intense eddy has been modelled on the Catalan Shelf.

- Numerical modelling allows a new interpretation of the eddy generation :
A warm pool of water is maintained by the Tramontane wind in the South Western part of the Gulf of Lion increasing his potential energy during summer before to be released one the Catalan Slope inducing a strong eddy.

PhD opportunity :
Modelling of mesoscale structures responsible for exchanges across ocean margins: identification, validation and physical interpretation
Contact : Pierre.garreau@ifremer.fr
http://www.ifremer.fr/ds/animation_scientifique/bourses/doctorales/appel/sujets.htm