DYNECO/PHYSED

Ifremer

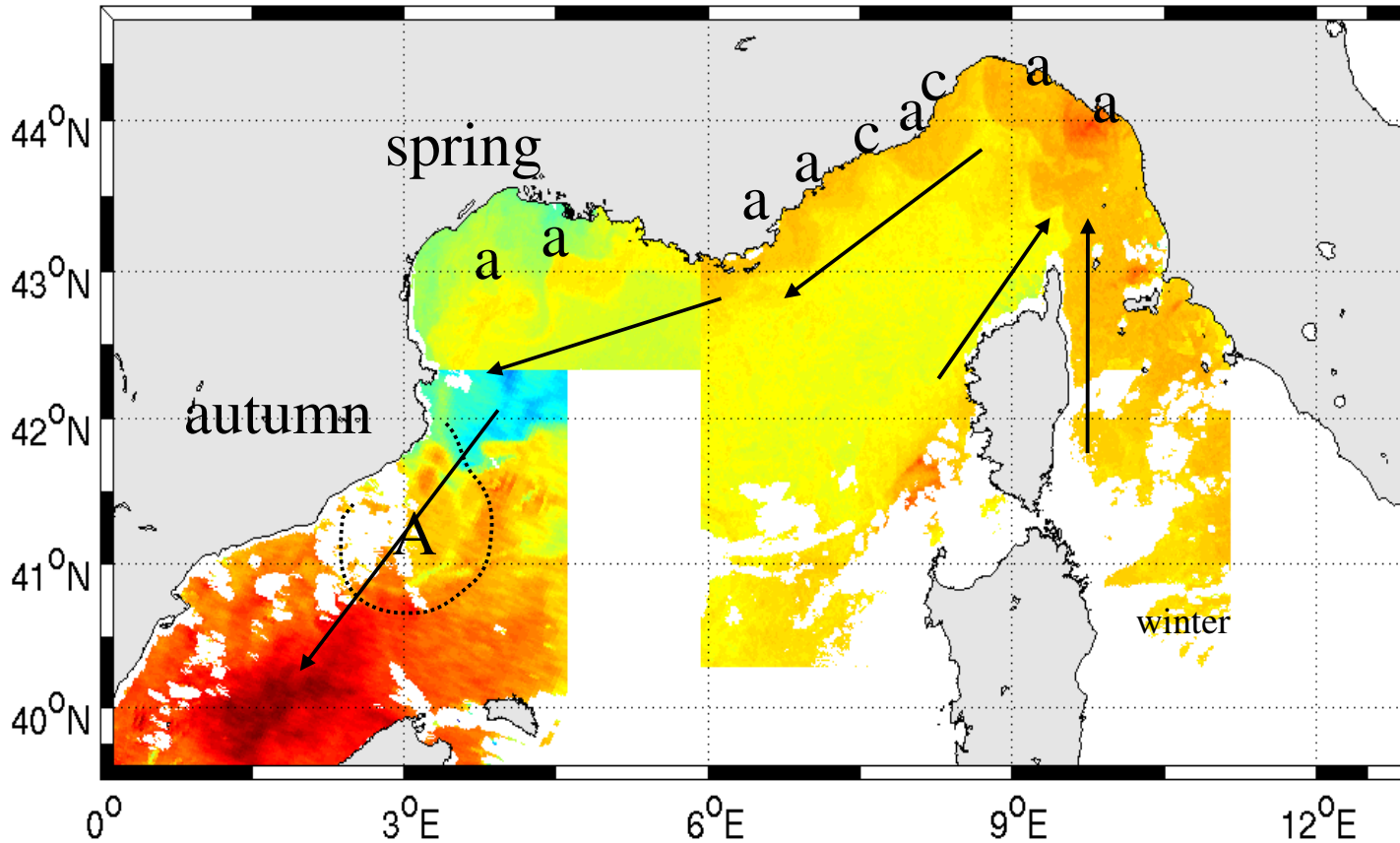# MESOSCALES MODELLING ISSUES
THE MENOR CONFIGURATION

Pierre GARREAU

Ifremer centre de Brest

pierre.garreau@ifremer.fr

Mesoscales structures are important
- Retention of contaminant
- Onshore/Offshore exchanges
- Biological activity (primary production / recruitment
  of fishes ...
- and very interesting to investigate …

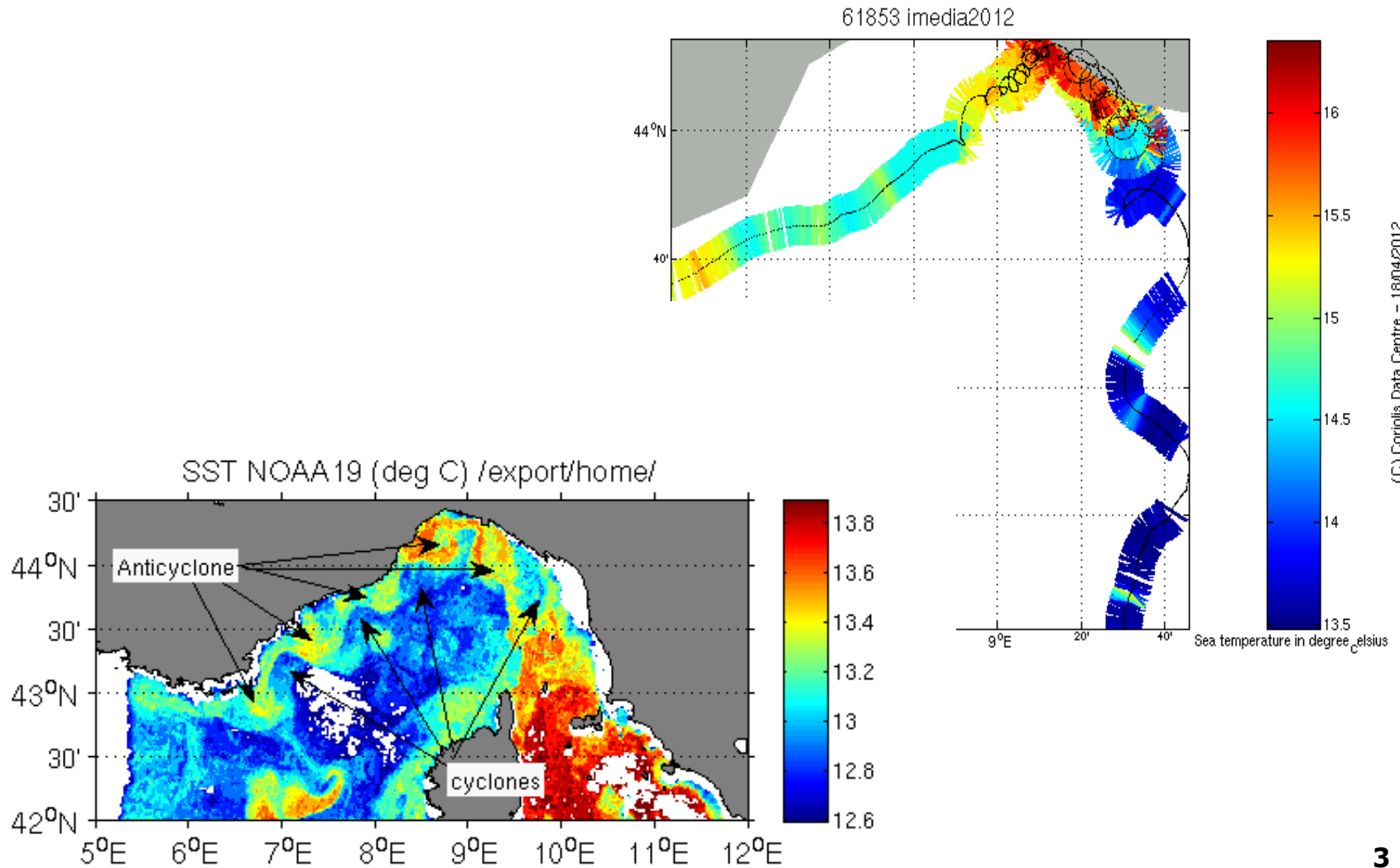# Eddy resolving modelling is needded

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

Recent eddy in Ligurian Sea. drifter trapped by a cyclone (!)

61853 imedia2012

(C) Coriolis Data Centre – 18/04/2012

Sea temperature in degree celsius

SST NOAA19 (deg C) /export/home/

Anticyclone

cyclones

3

MENOR is a configuration of the PREVIMER forecasting System

temperature (Deg Celsius)

MARS3D is IFREMER's code : http://wwz.ifremer.fr/mars3d
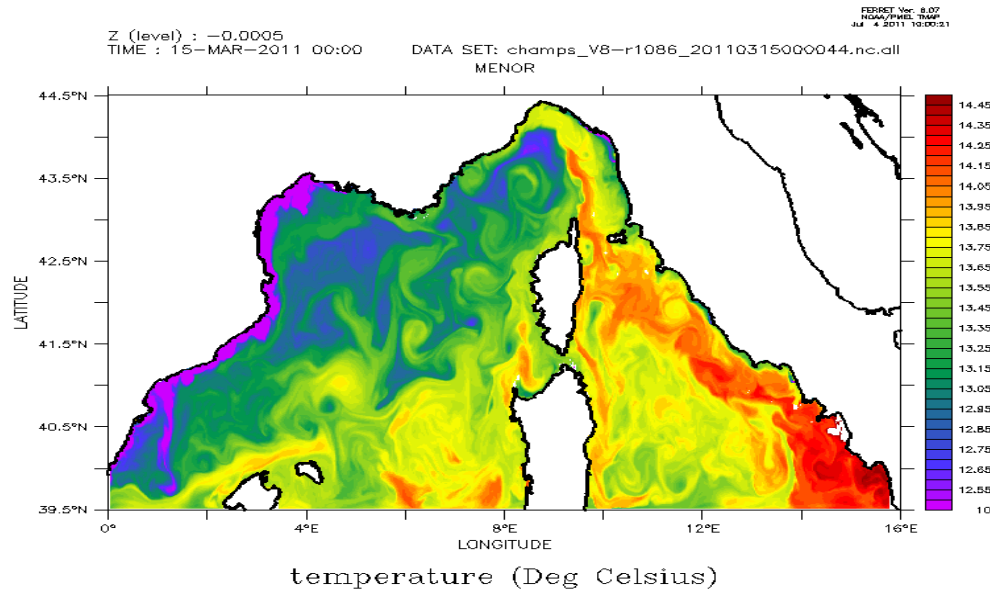
- North from 39.5°N
- Forced by OGCM : INGV-MFS SYS3a2 and now INGV-MFS SYS4
- Atmospheric forcing is a zoom of MM5 model embbeded in NCEP
- Free run = no assimilation
- Daily release of 5 days forecast of SSH,U3D,V3D,TEMP,SAL.Kz
- 3-hourly outputs in a mass conservative conservative form to allow offline runs.
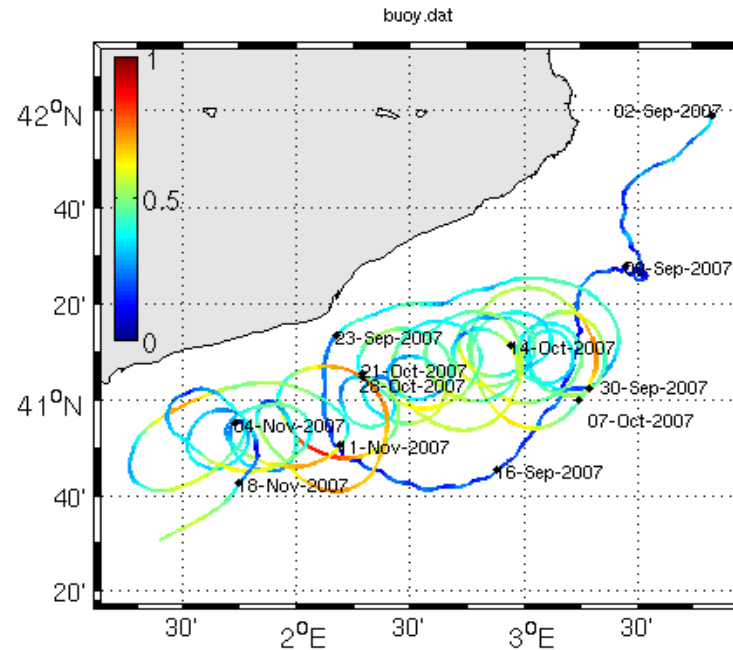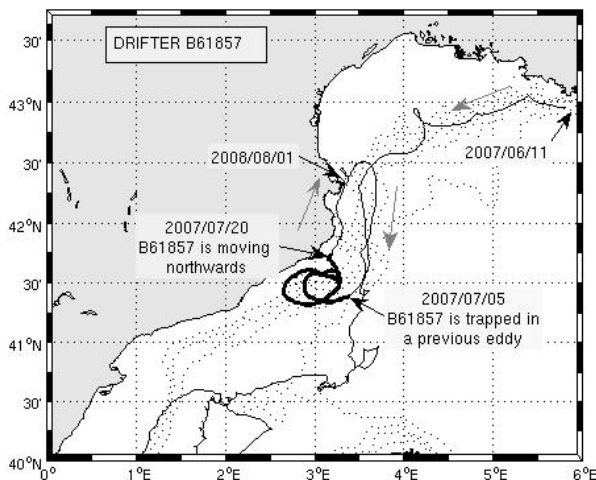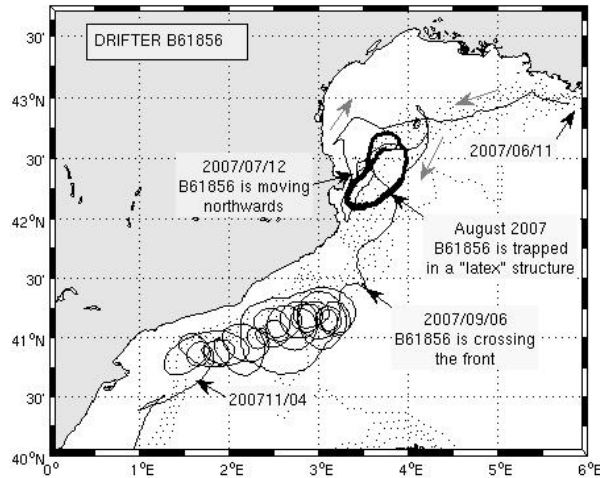- Resolution about 1.2 km /30 sigma level

High resolution model (400 m resolution) embedded in MENOR

« Bastia eddy »
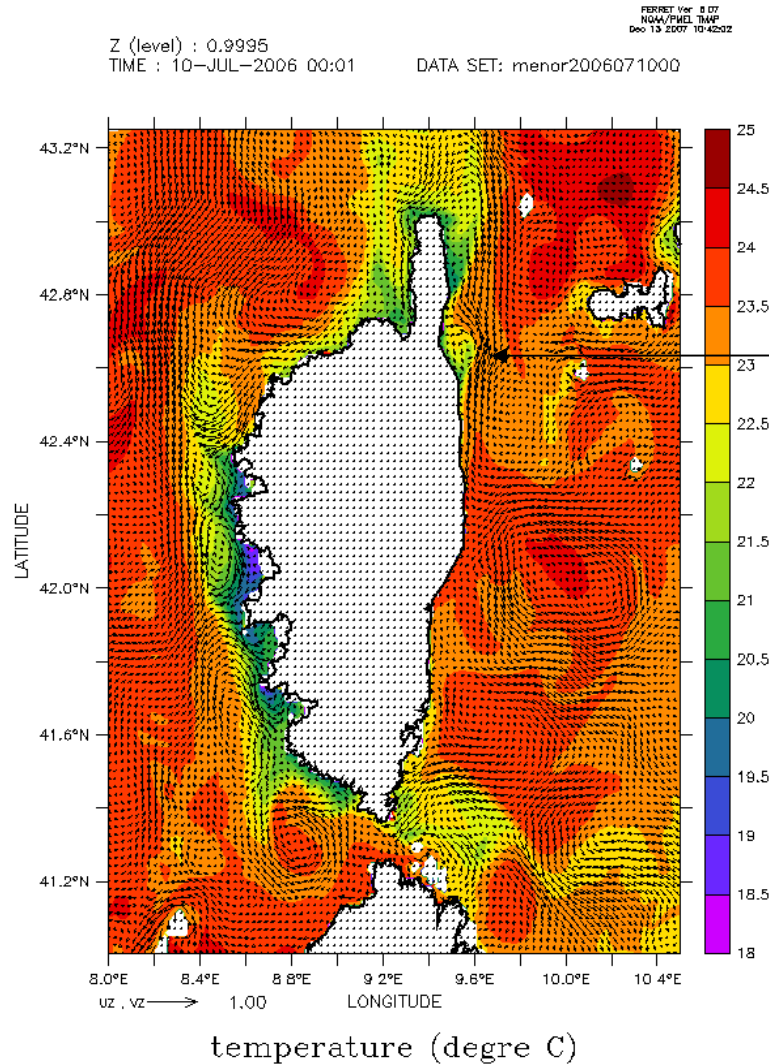
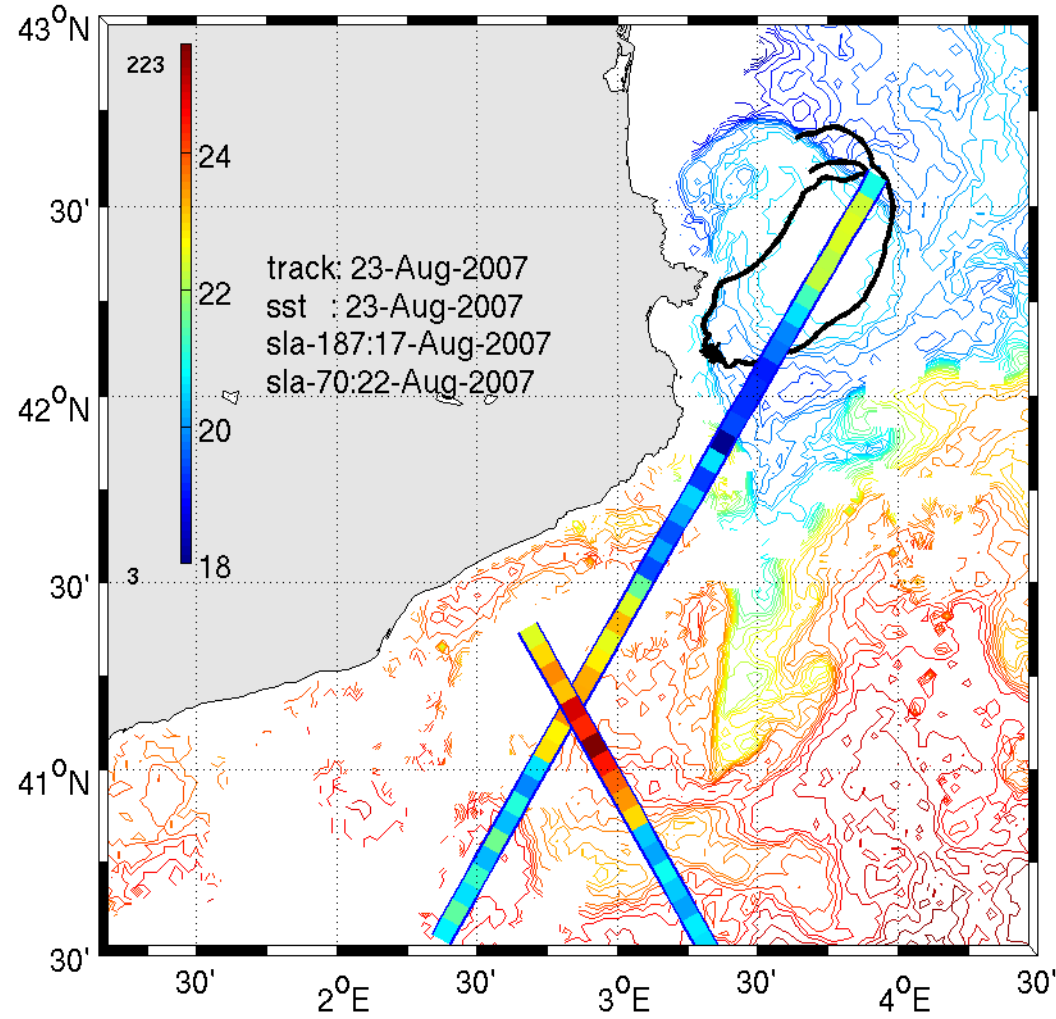Sylvain Coudray

Observing and modelling a Catalan Eddy

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 (2 loops) and flows northwards back to the <Gulf of Lion.
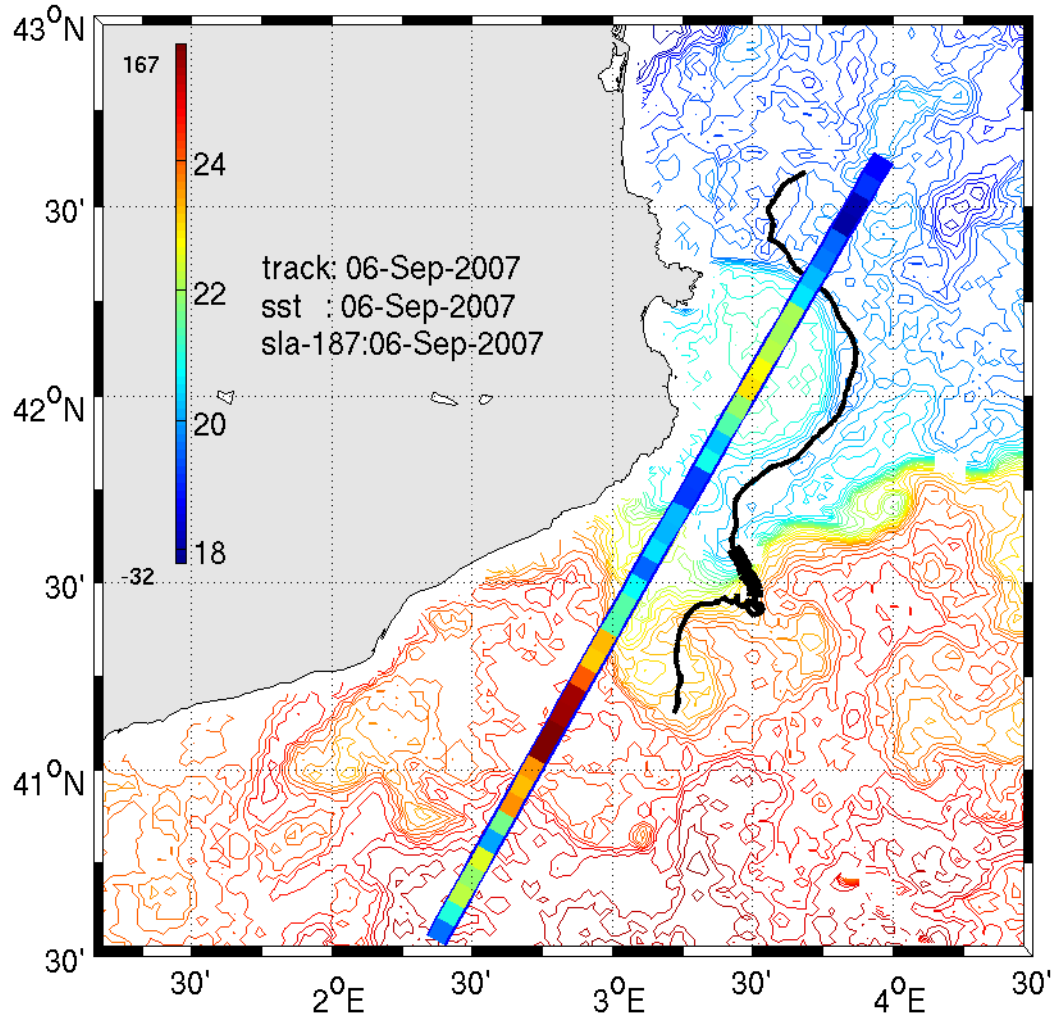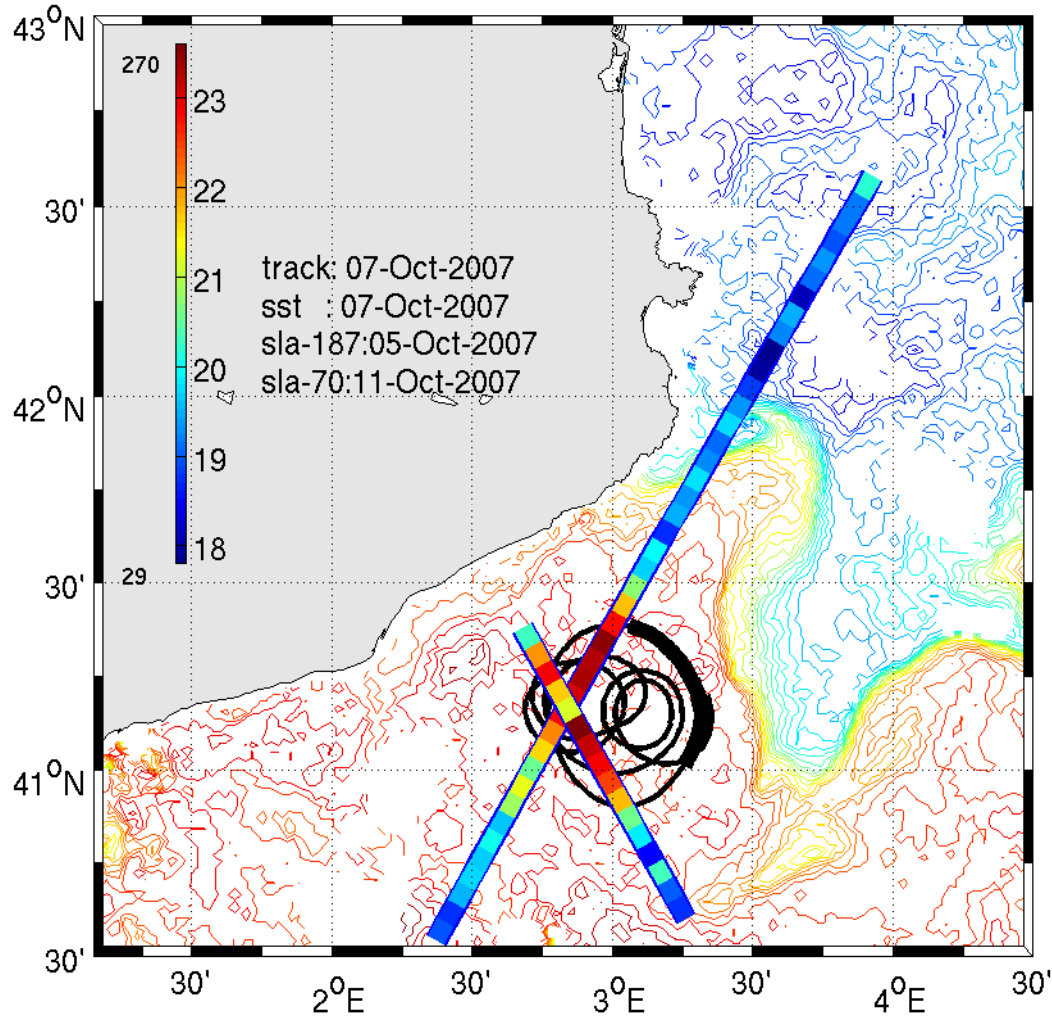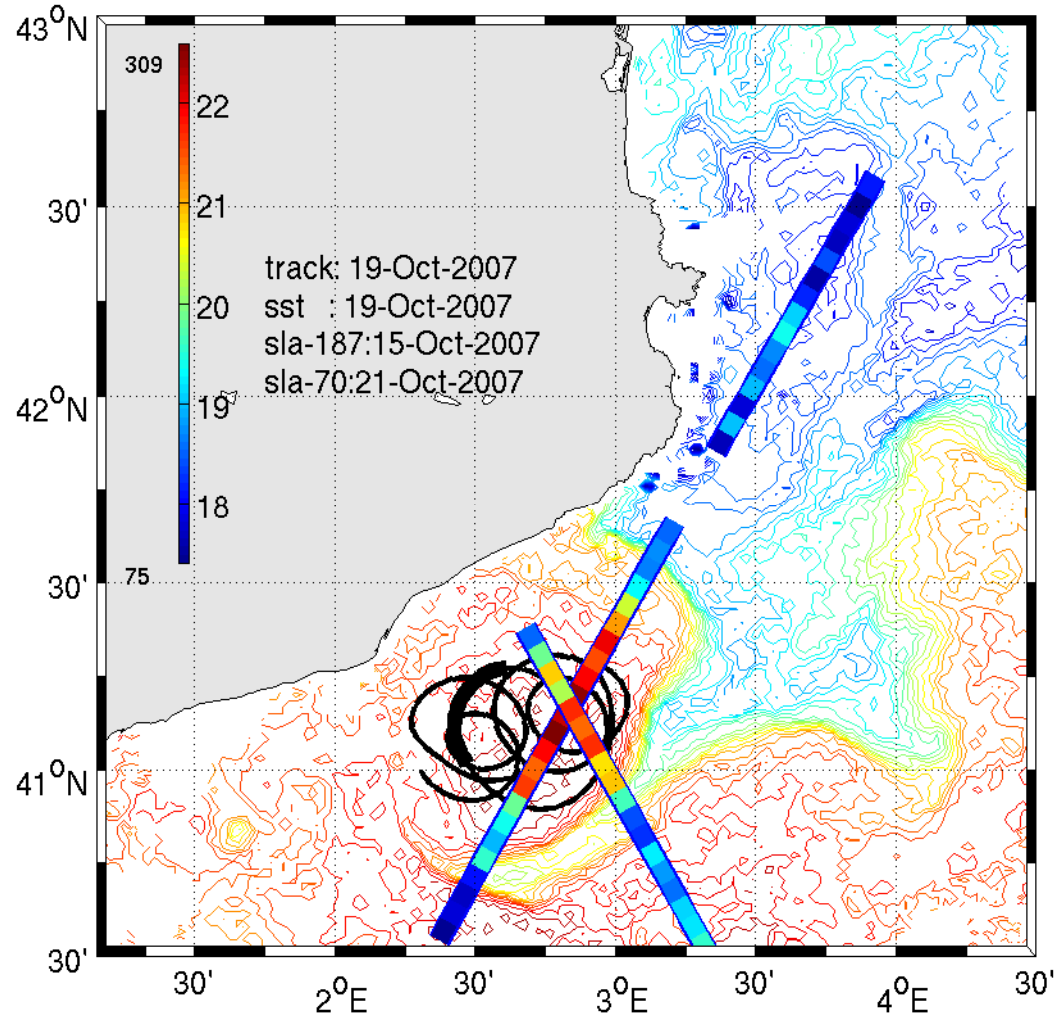
6

End of August 2007

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Early september 2007

Early October 2007

DYNECO/PHYSED

Ifremer

track: 07-Oct-2007
sst : 07-Oct-2007
sla-187:05-Oct-2007
sla-70:11-Oct-2007

Mid October 2007

track: 19-Oct-2007
sst : 19-Oct-2007
sla-187:15-Oct-2007
sla-70:21-Oct-2007

Early November 2007

DYNECO/PHYSED

Ifremer
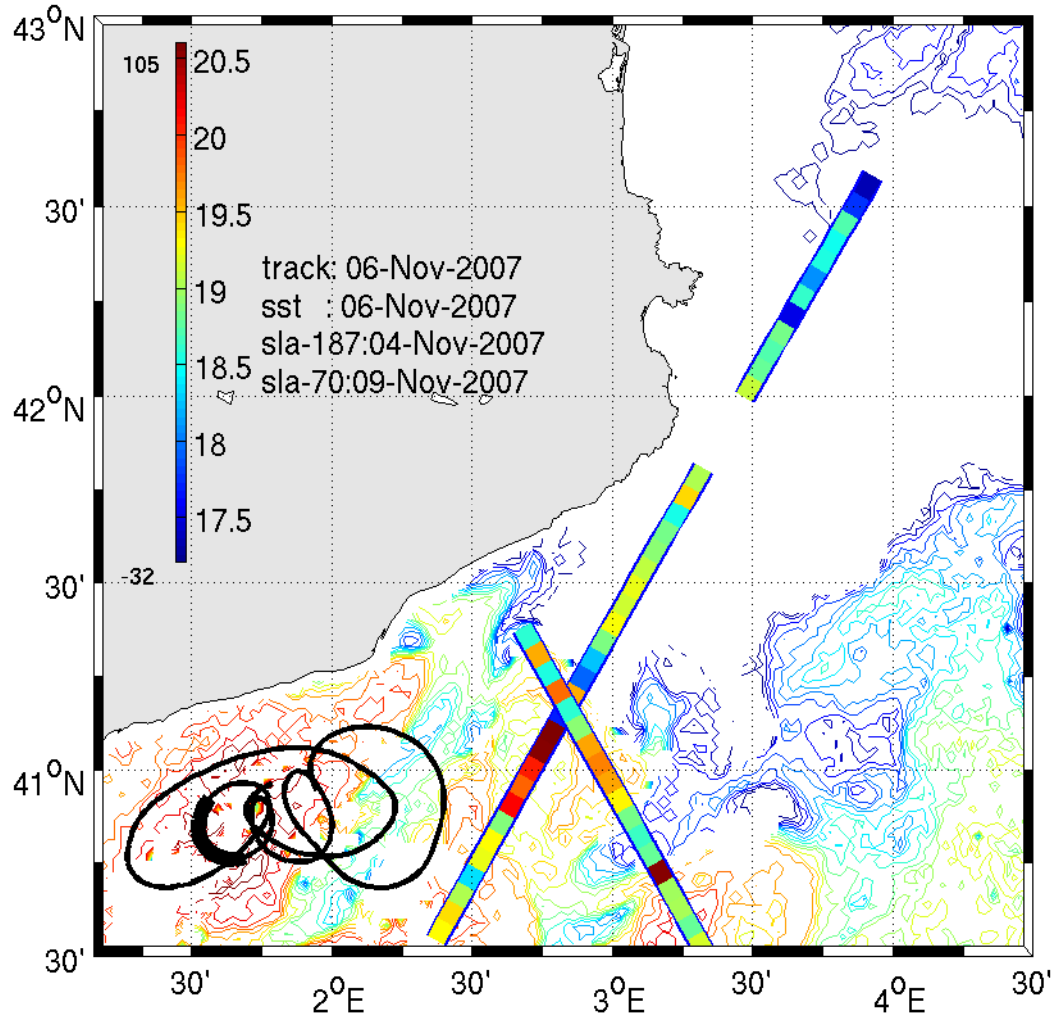
Gaussian fit on SSH
mid - october

gaussian fit of the Sea Surface heigth
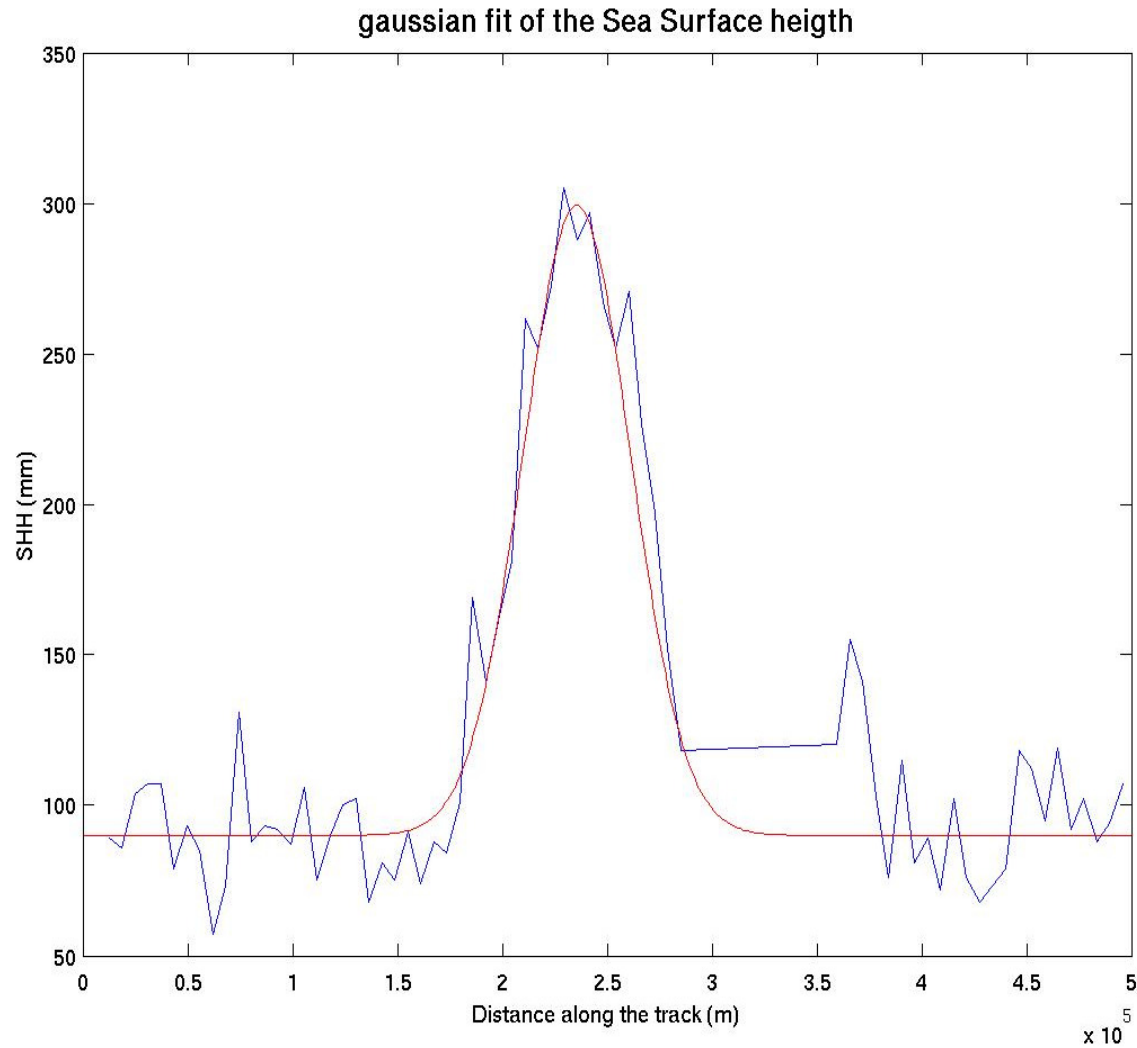
Geostrophic and cyclo-geostrophic velocity

Geostropic (black) and Cyclogeostrophic (red) velocity
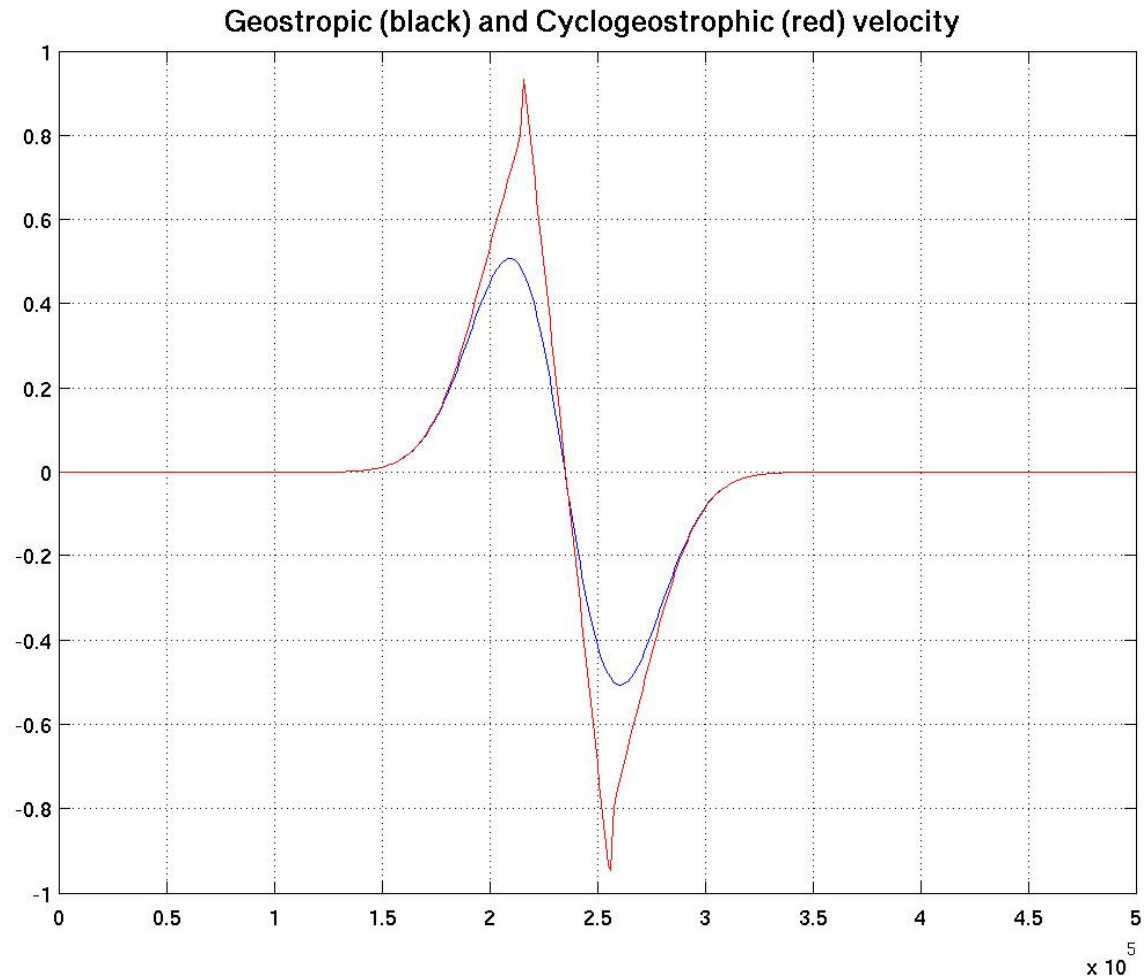
SST + geostrophic velocity + lagrangian velocity along the track
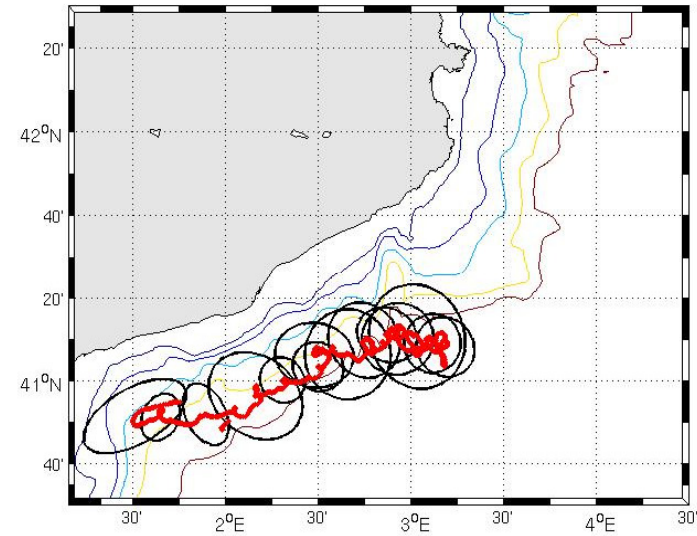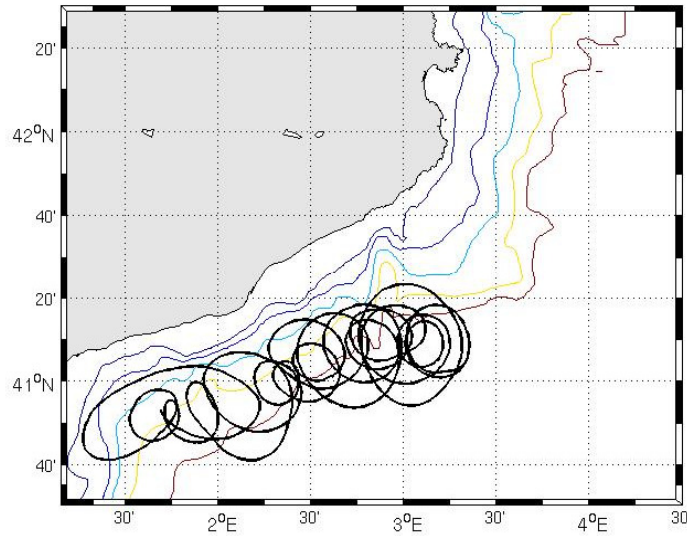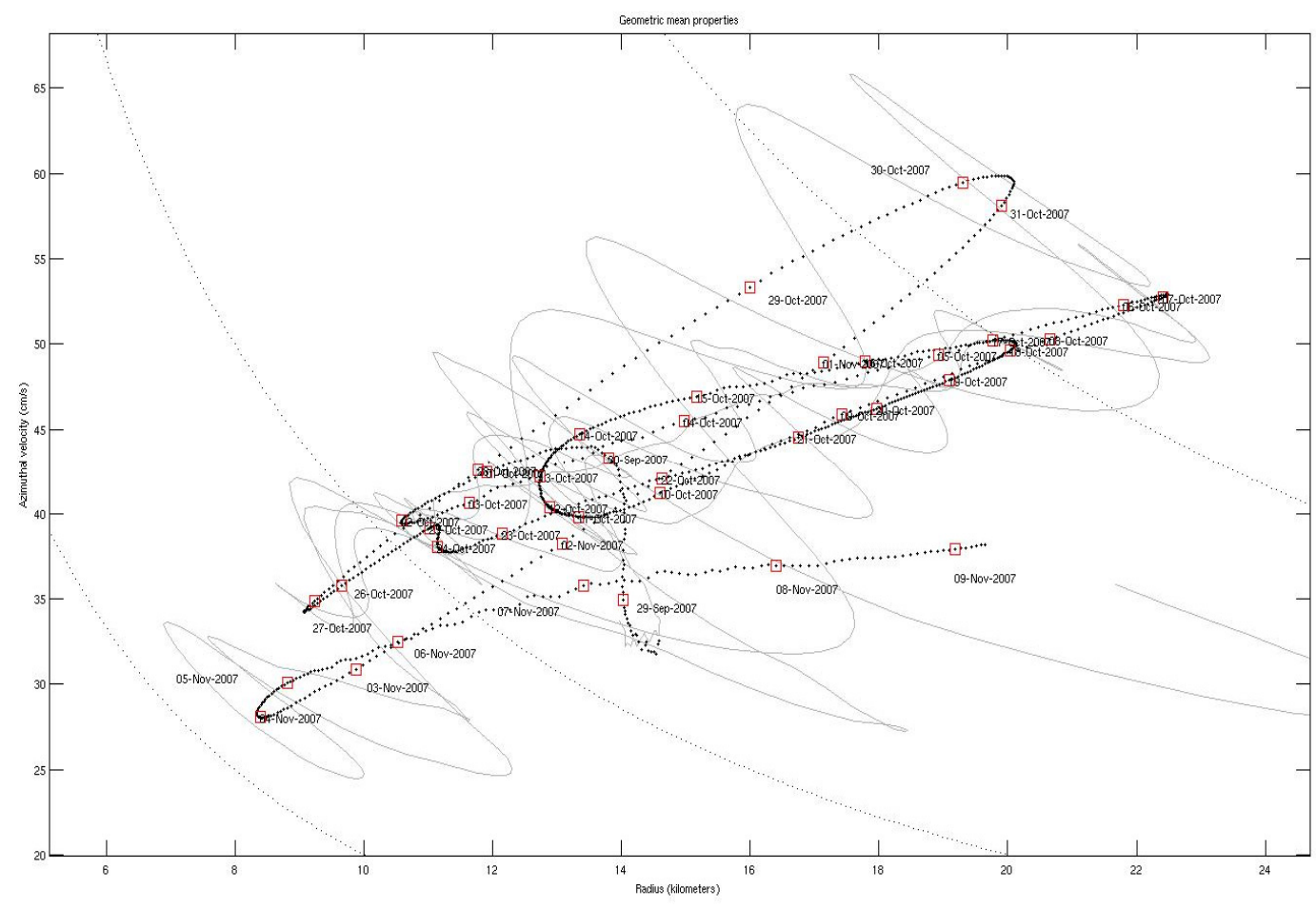
DYNECO/PHYSED

Ifremer
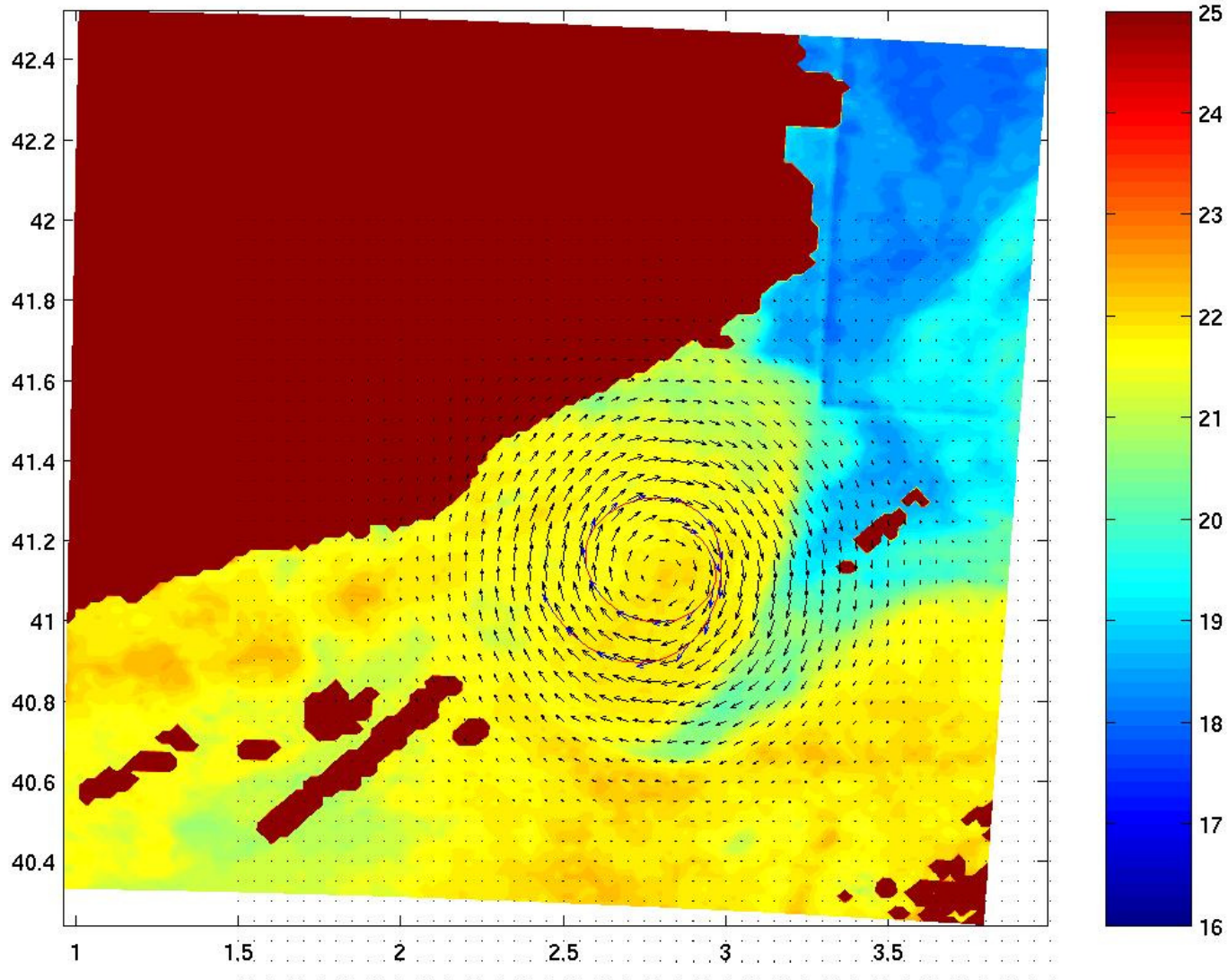
Wavelets (Lilly 2005) are use to analyse the eddy

- Radius is in the range of 15-25km
- Period is about 2.2 days
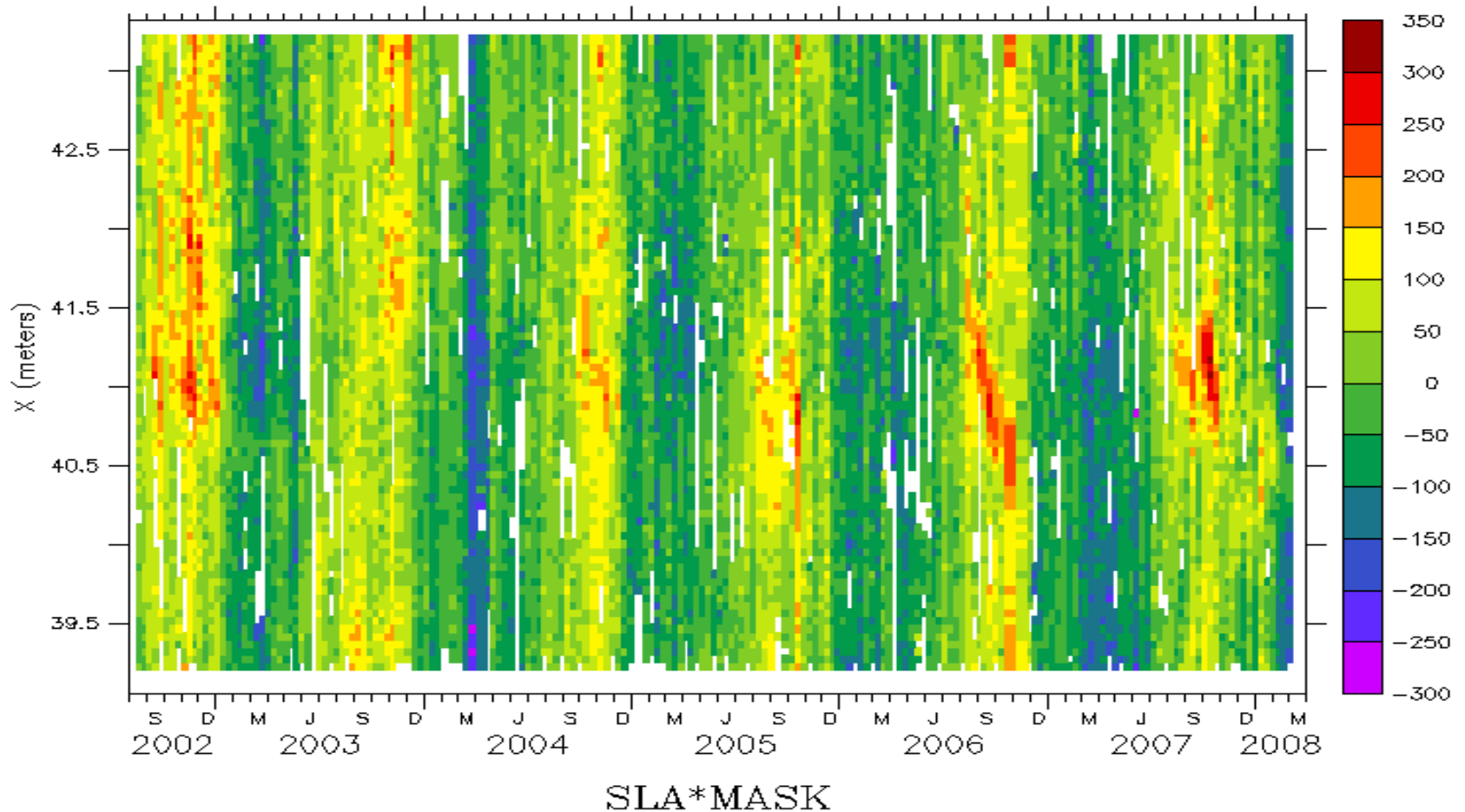- Estimation of the instantaneous ellipse
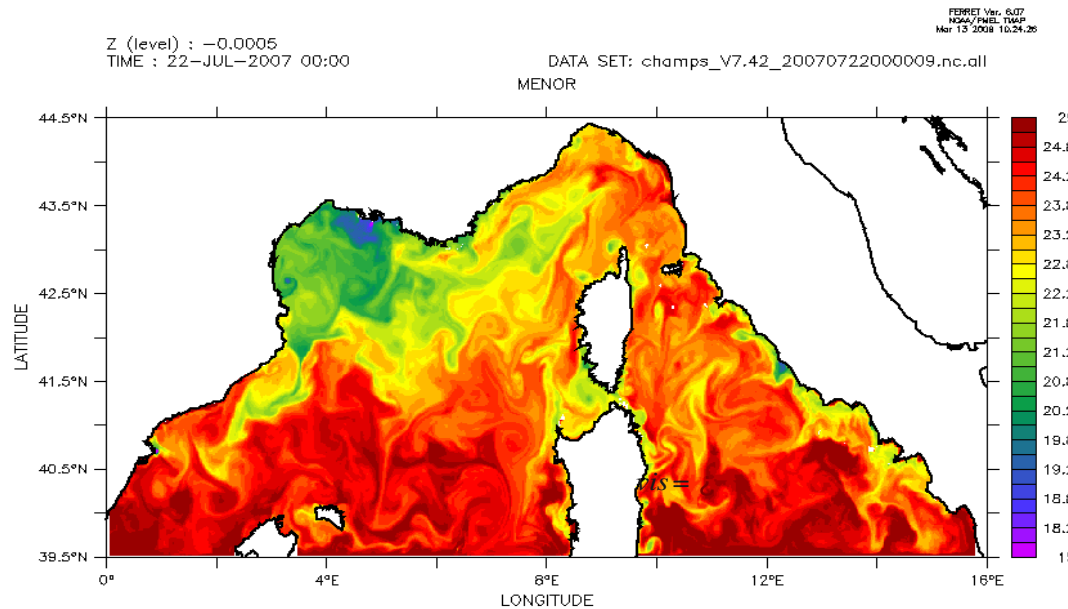
Velocity / Radius

Geometric mean properties

Is this eddy recurrent ?
Hovemoller diagram of the SLA

MENOR CONFIGURATION of Mars3D

Z (level) : −0.0005
TIME : 22−JUL−2007 00:00   DATA SET: champs_V7.42_200707220000009.nc.all
MENOR

FERRET Ver. 6.07
NOAA/PMEL TMAP
Mar 13 2008 10:24:26

temperature (Deg Celsius)

Boundary condition :

- MOON MFS global modelling

- High relolution wind forcing.

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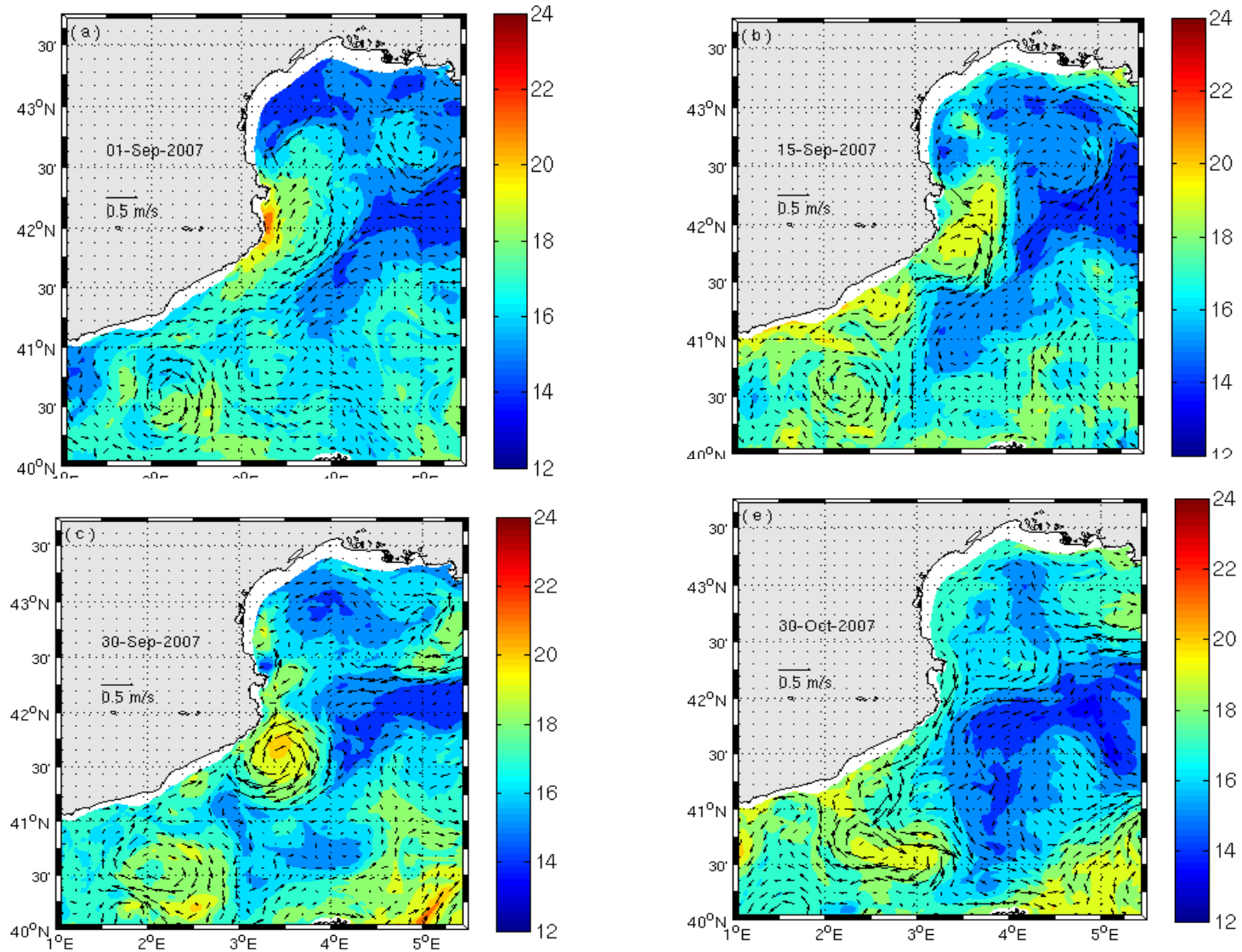Tuning : Smagorinsky coefficient for horizontal diffusion

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

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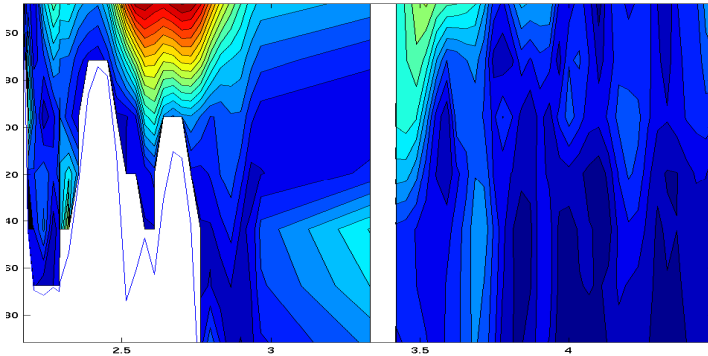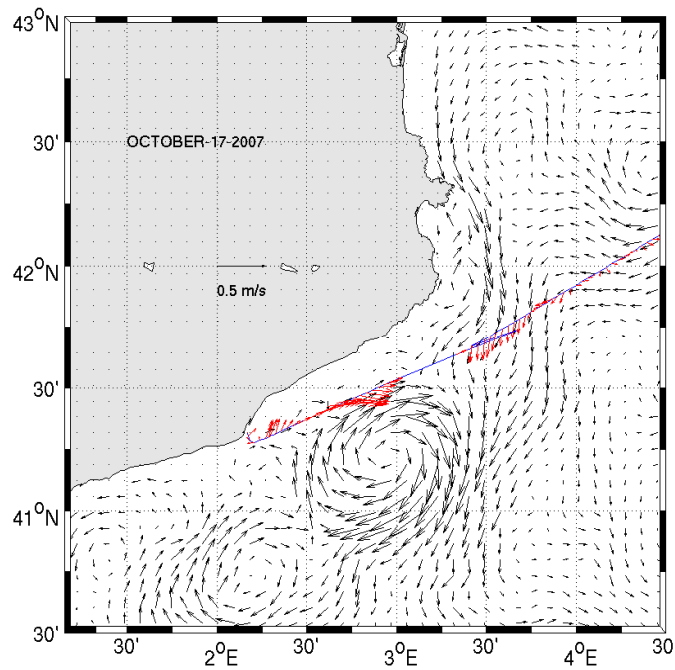Alpha= .15 >> correct generation and advection of the eddy.

Results
current and temperature at 50 m depth

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Validation
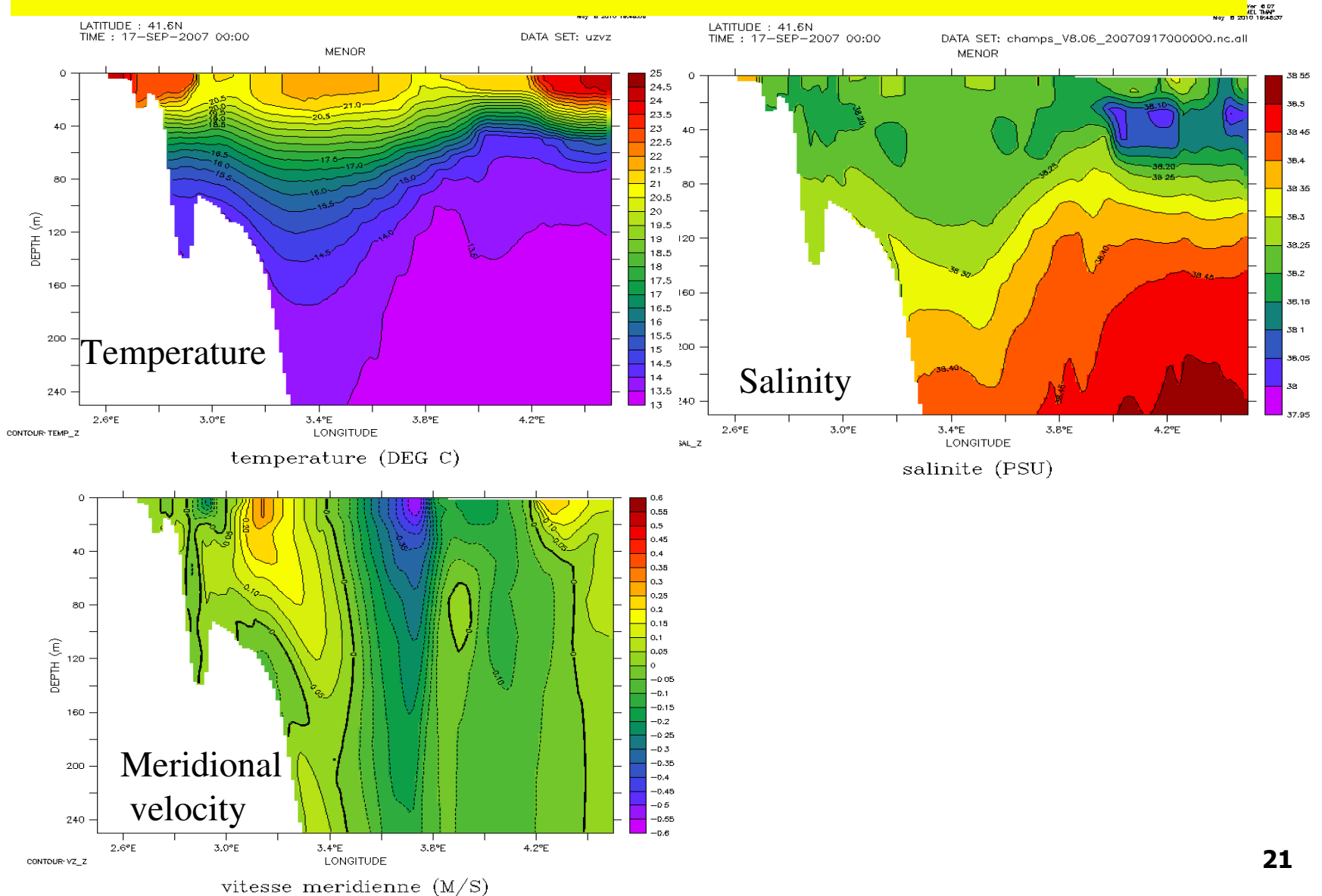# comparison VM-ADCP

OCTOBER-17-2007

0.5 m/s

« 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
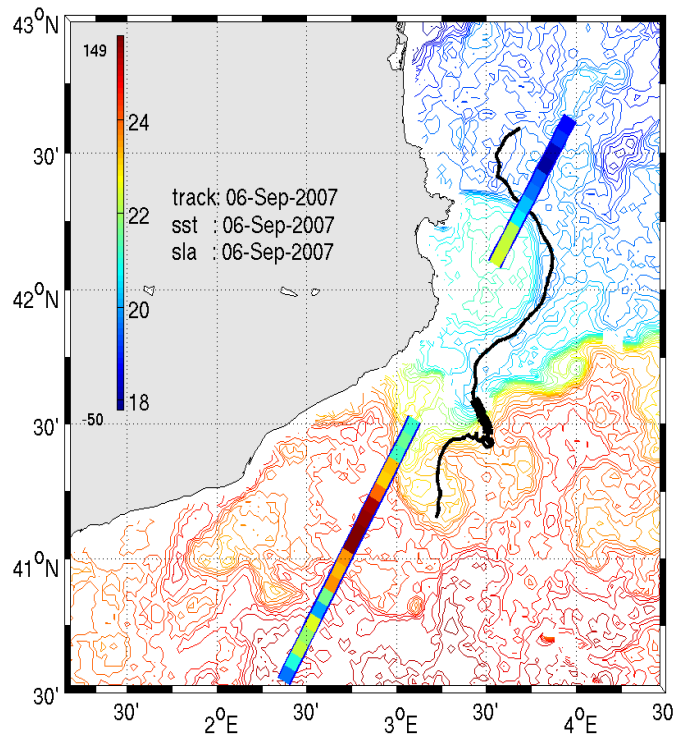
Modelled velocity at 50 meter depth is in the range of the observed one.
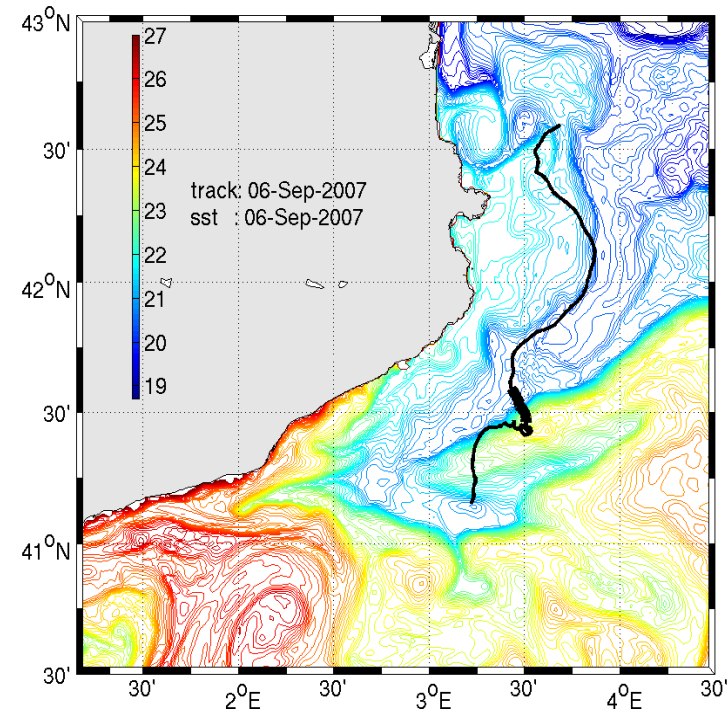
20

Transect across the eddy

Temperature

temperature (DEG C)

Salinity

salinite (PSU)

Meridional velocity

vitesse meridienne (M/S)

Validation
Comparison SST and tracks
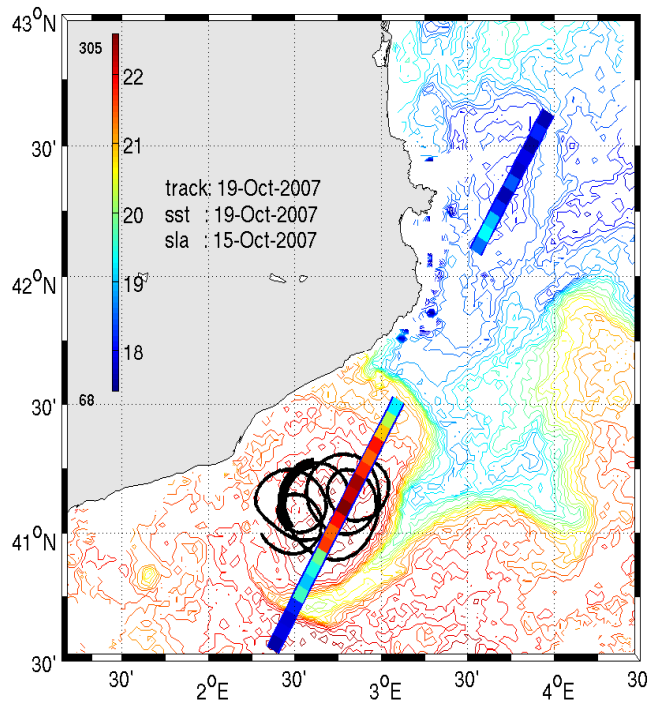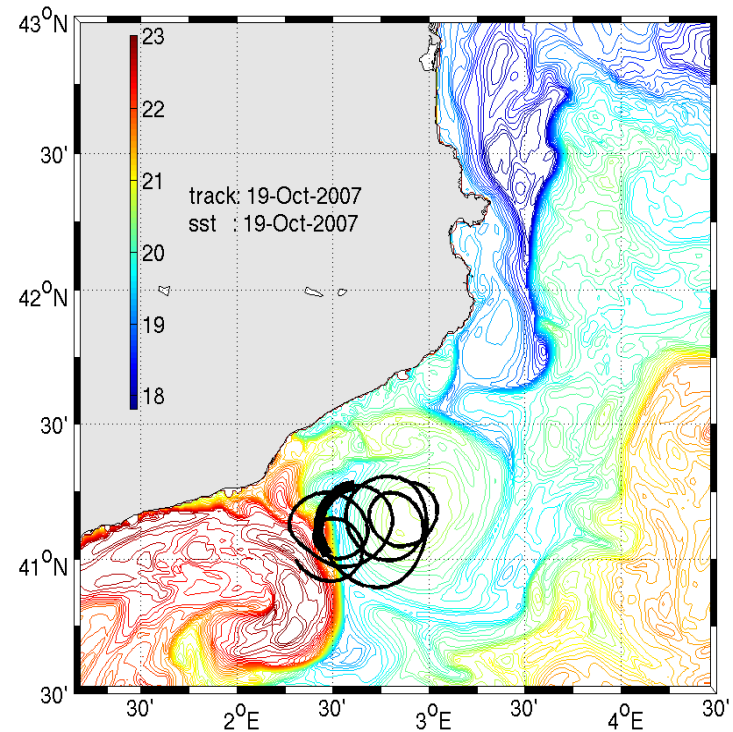

Remote sensed SST

Modelled SST

Validation
Comparison SST and tracks

Remote sensed SST

Modelled SST

Modelled Sea level Anomaly vs observed

TIME : 15-OCT-2007 00:00   DATA SET: champs_V8.06_20071015000000.nc.all
MENOR

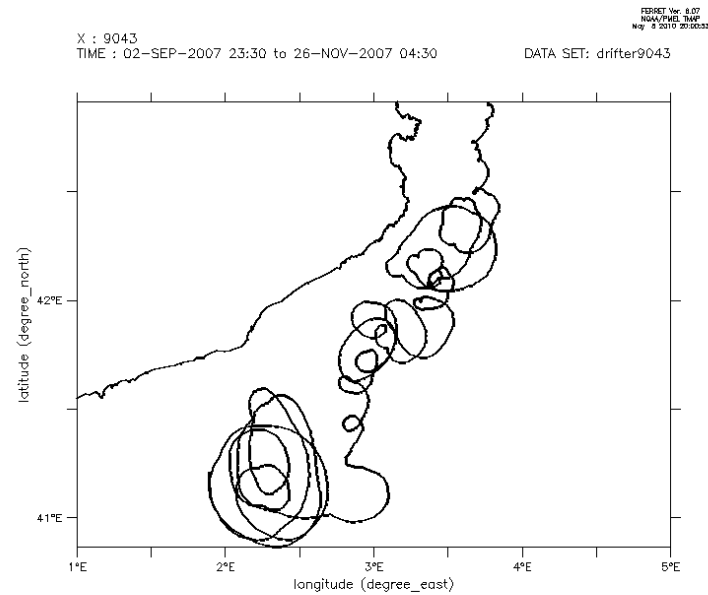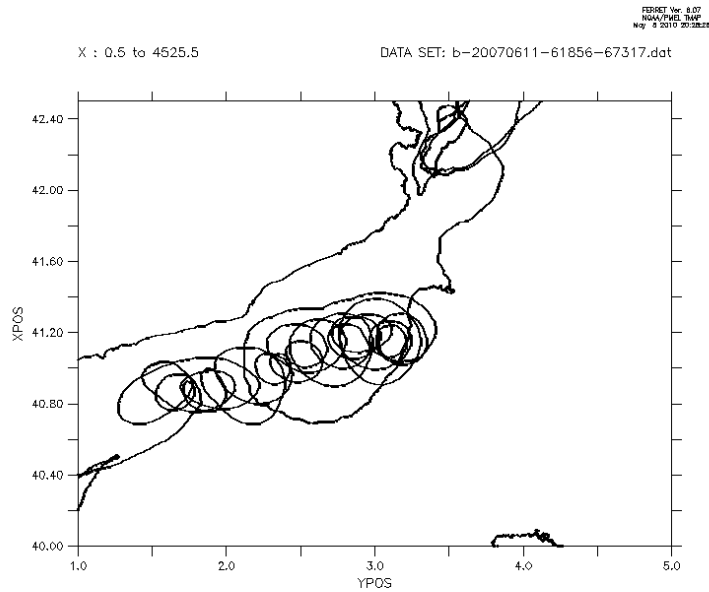sea surface height (m)
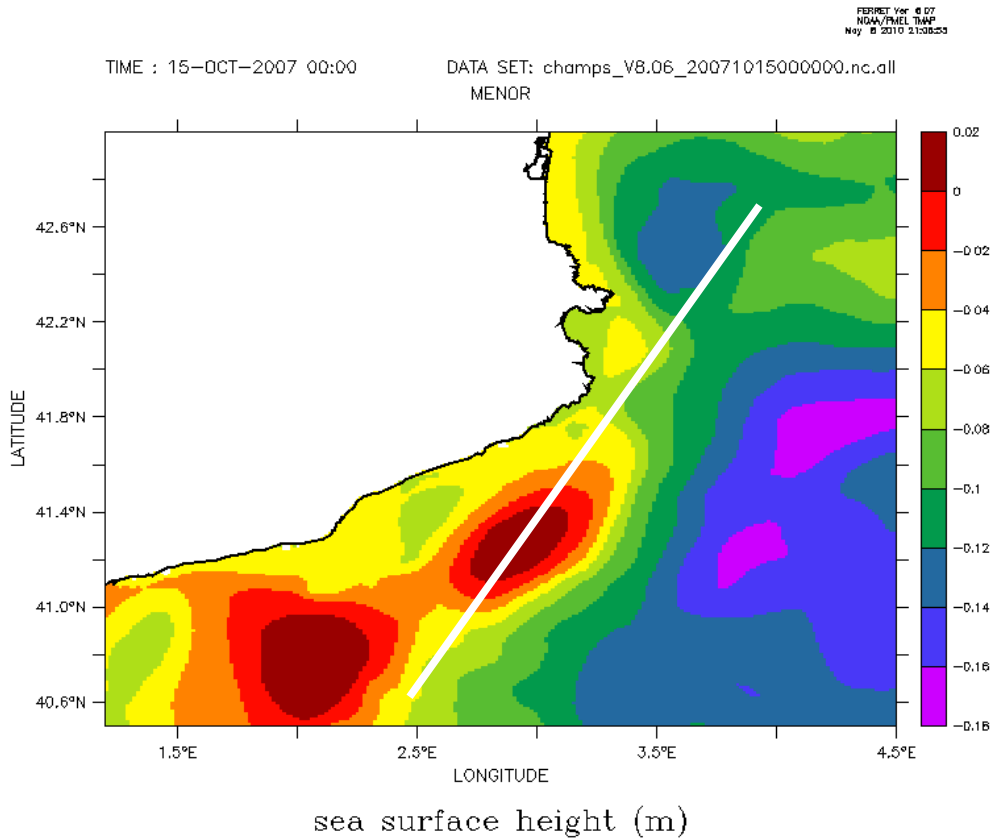
The Difference of Sea Leval Anomaly between the eddy centre is :
Model   : 16 cm
Jason SLA : 24 cm

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

Ifremer — **DYNECO/PHYSED**

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 (with possible interactions with deep and sharp canyons).


Intermittent Upwellings

North Current

Catalan Front
Pyrenean Front
North balearic front
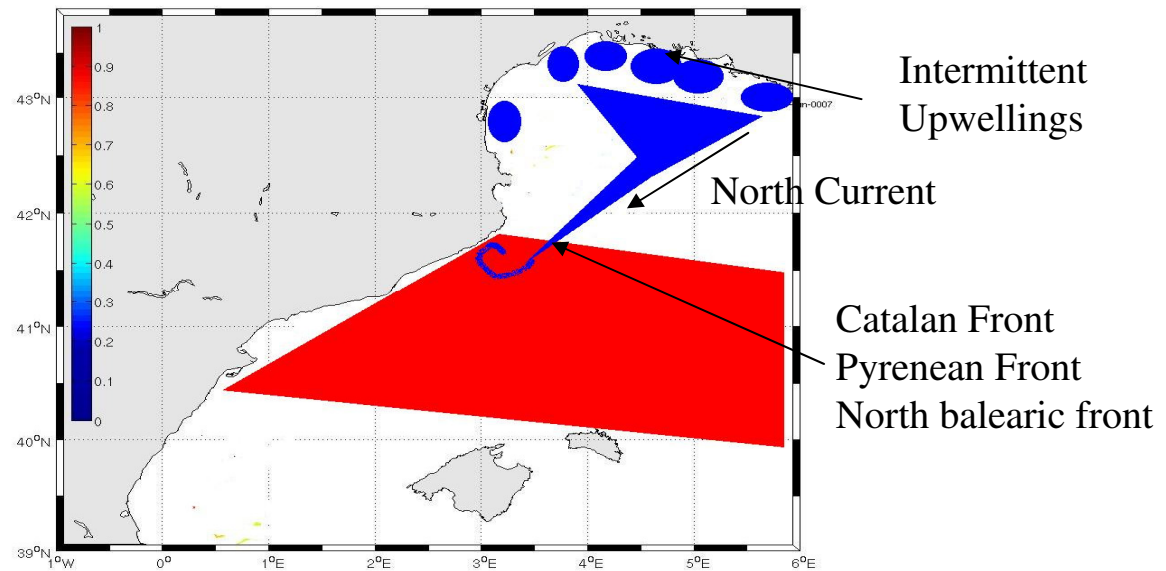
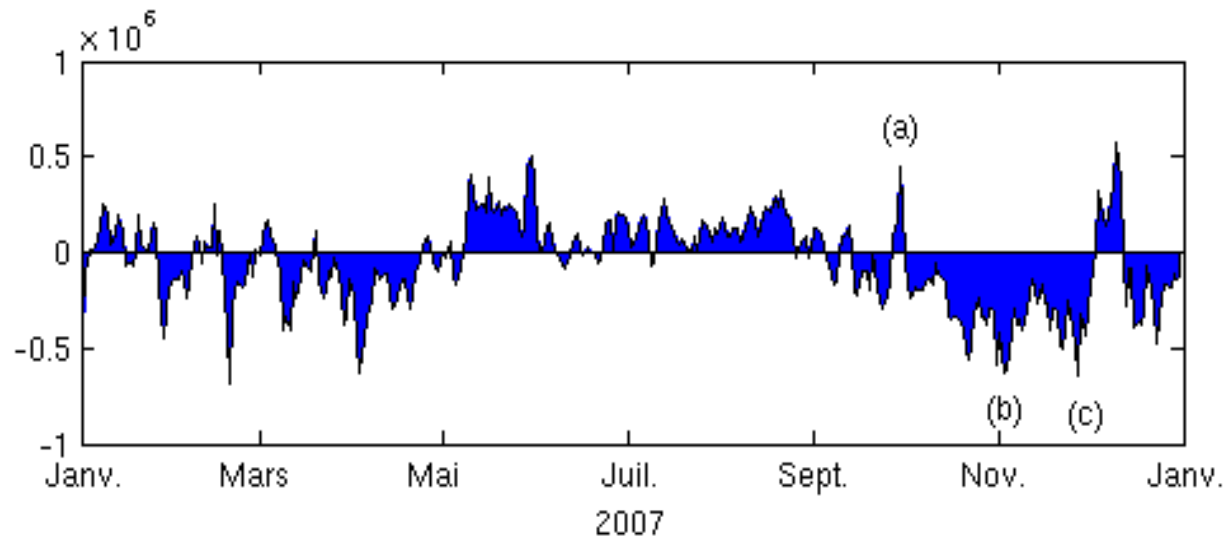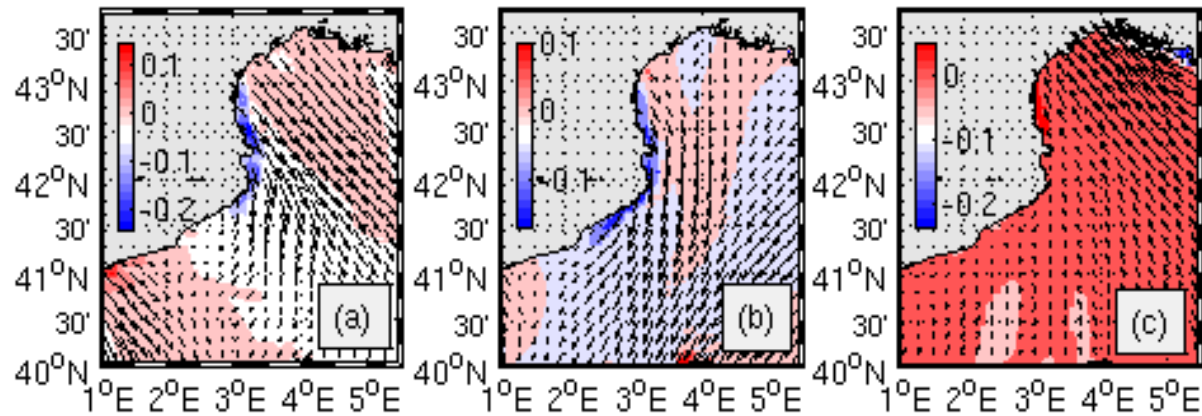## What are the processes involved in the generation of this vortex ?

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)
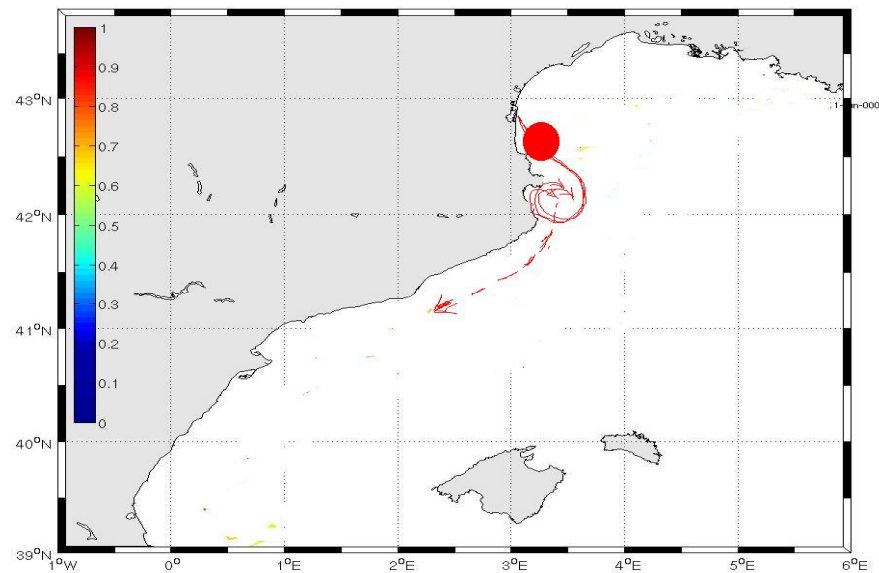
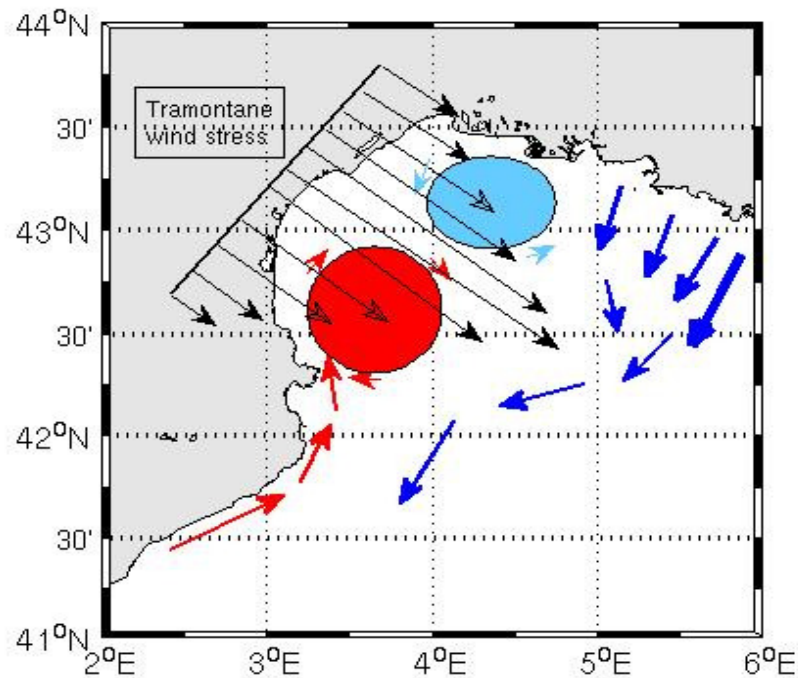# Available potential energy in the surface layer (50 m)
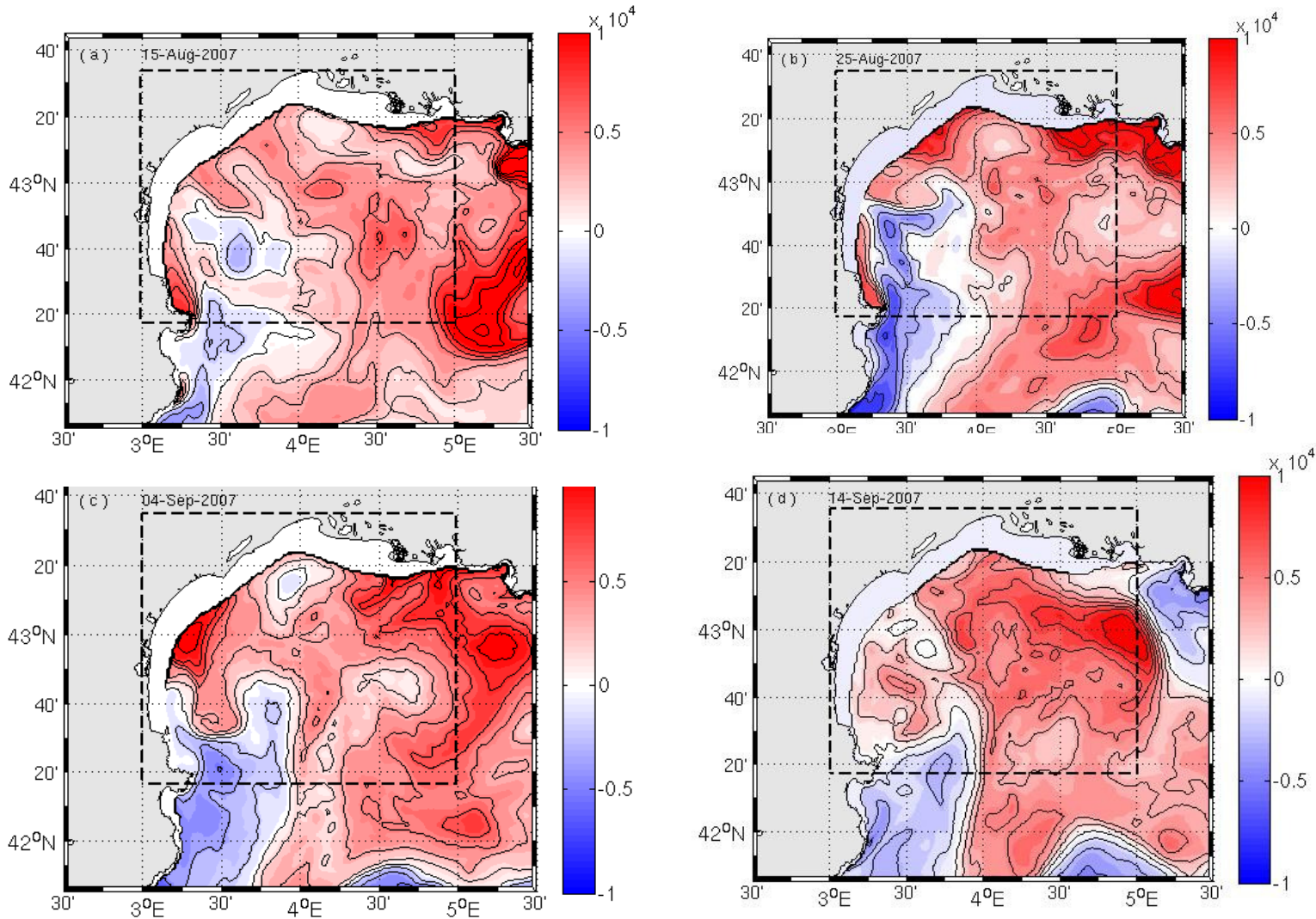
Effect of Wind in Summer on the shelf water flux at Cap Creus

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 and shelf

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.

DYNECO/PHYSED

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Future and on-going development

Investigate the processes in Ligurian Sea and Corsica Channel (and the Tuscana shelf ?)

   - Analysing the data of IMEDIA field experiment (March 2012)
   - Modelling the IMEDIA period

Experiment the **spectral nudging** to force the regional model to "follow" the global one (and take advantage of the assimilation)

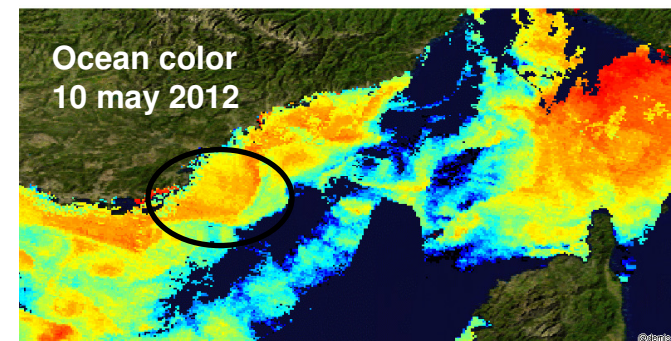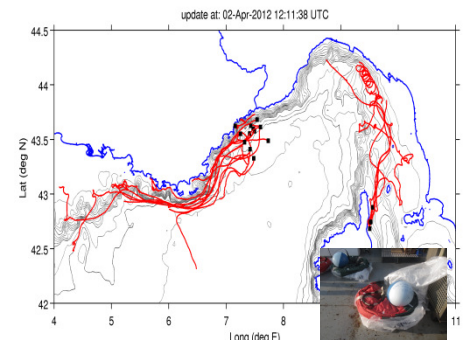Operating system at sea:

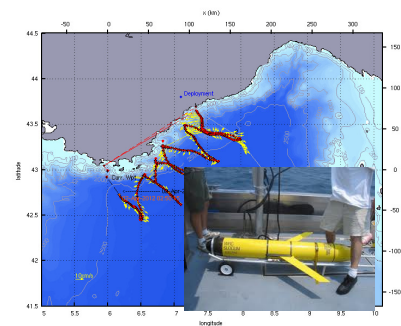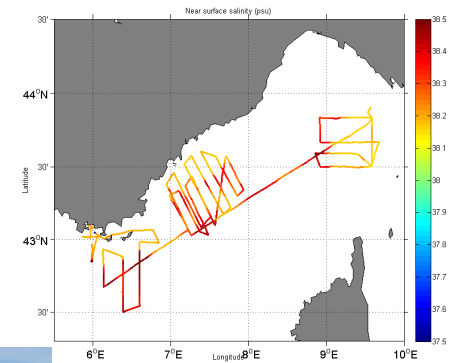Hull-mounted ADCP
TSG+fluorimeter
MVP
CTD

1 Slocum glider
20 Drifters (50m)

+ daily informations:

MENOR Previmer forecasts
Meteorological forecasts
Satellite SST/ocean color images

Ocean color
10 may 2012

Northern Current meandering north of Corsica

S

T

A(V)

Phi(V)

VELOCITY MAGNITUDE - NAV
Avg = 171 ±131

Scale (mm/s)
0   300   600

VELOCITY DIRECTION - NAV

Scale (degrees)
0   180   360

Transect NS number 10