Numerical model and observations of interactions between a continental shelf tidal front and a barotropic jet.

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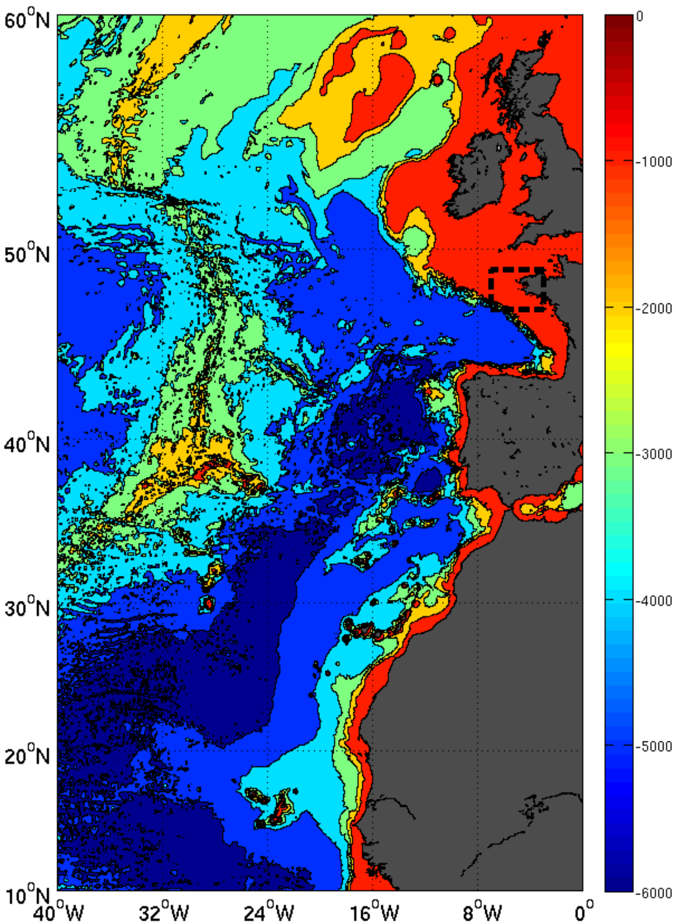
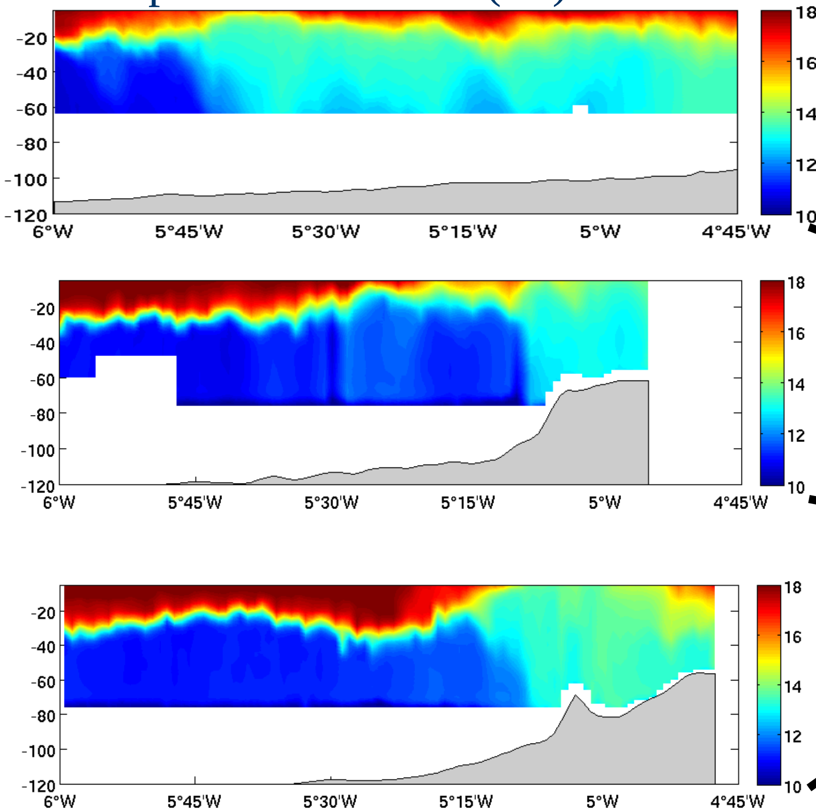


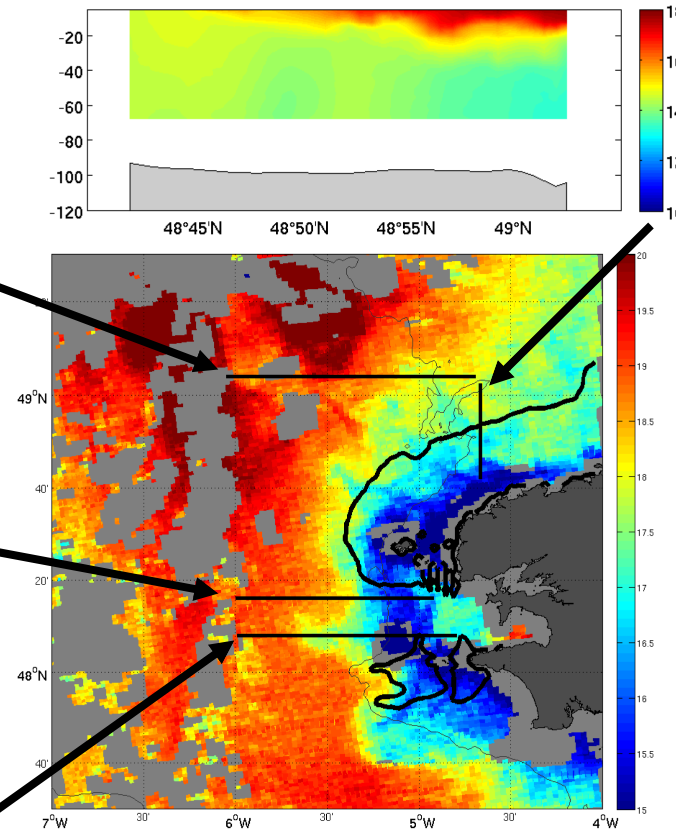
- Introduction, the Iroise sea
- Interactions between a **barotropic jet** and the **baroclinic current** induced by a **seasonal thermal front (observational).**
- **Movements** of a thermal front driven by the **divergence** of **Ekman layer velocities** at the bottom of a **jet (numerical)**.

Hydrography of the Iroise sea: the tidal front

« Scanfish » CTD measurements made during the FROMVAR 2010 cruise.

Temperature sections (°C)

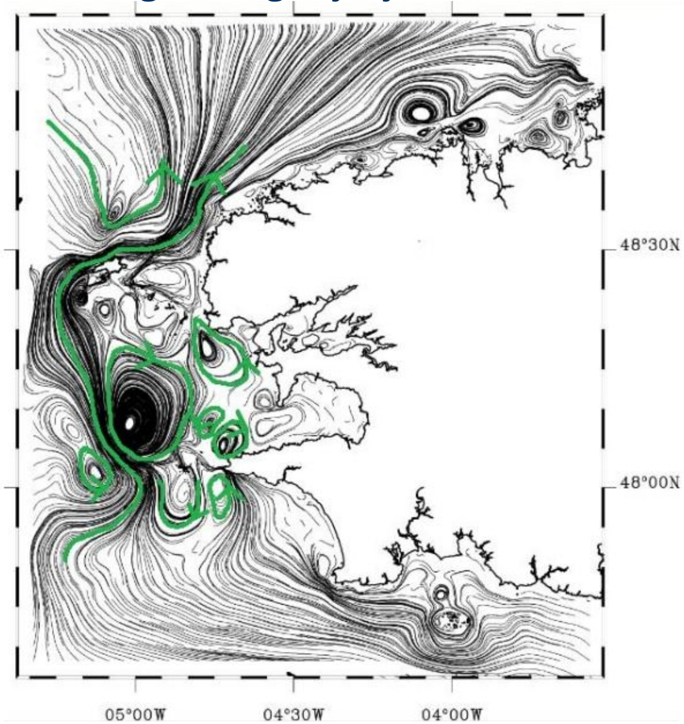




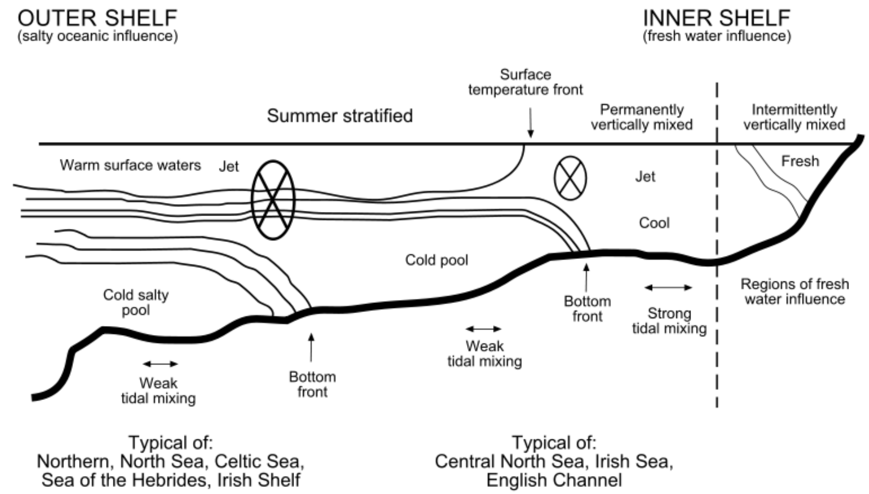
08/08/2010 MODIS SST,
Simpson-Hunter (1974) criterion superimposed

Low frequency circulation

-Semidiurnal **tidal currents** (0.7 m/s)
-Strong fortnightly cycle



Lagrangian tidal residual streamfunction (M2). Salomon, 1981, Muller 2010



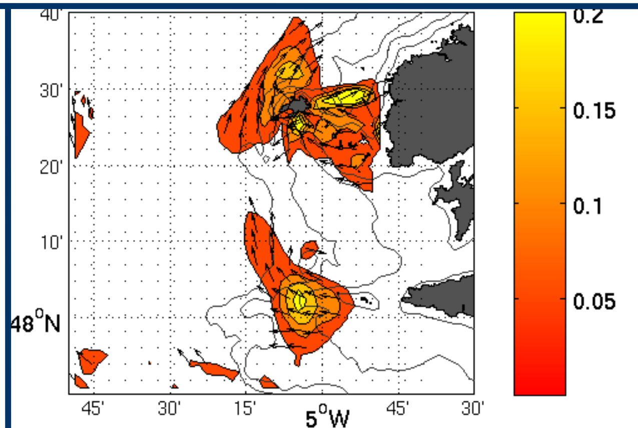
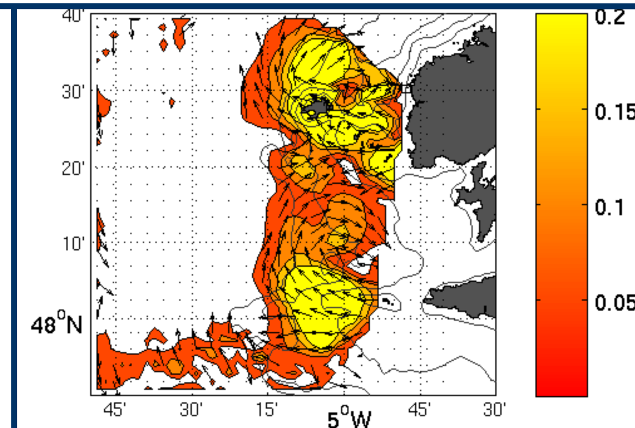
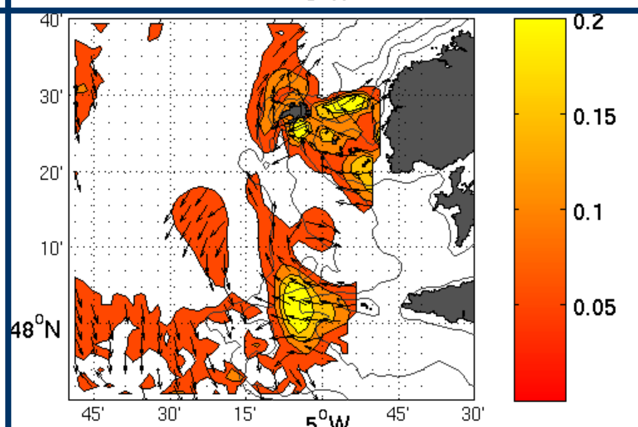
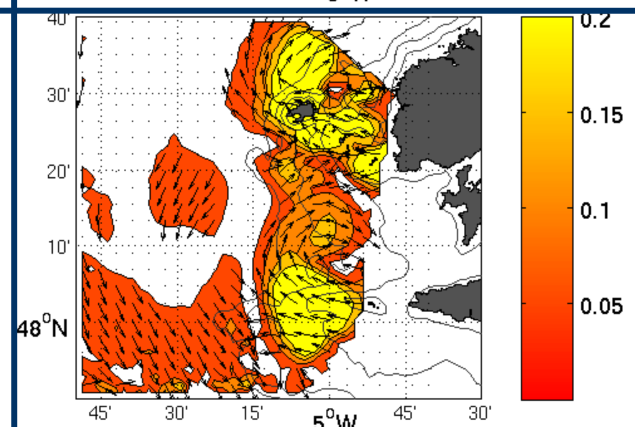
(Taken from Hill et al, 2008)

- The northward along-shore low frequency current is composed of both a **tidal residual** and a **thermal wind currents**.

Surface currents measurements

4 years of **surface currents** measurements by two HF radars.

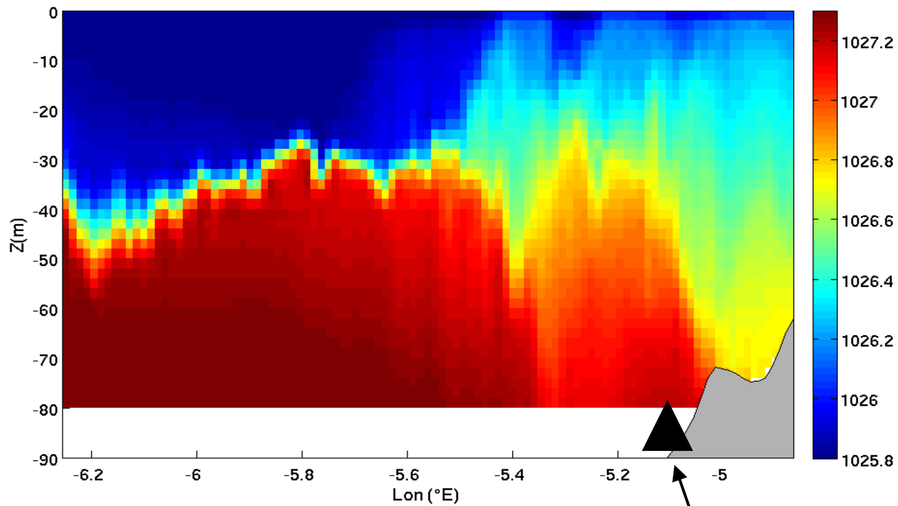
(The frequencies down to the semidiurnal and the wave induced Stokes drift have been removed)

Homogeneous conditions		
Stratified conditions		
Unit: m/s	Tidal range: 2-3 m	Tidal range: 5-6 m

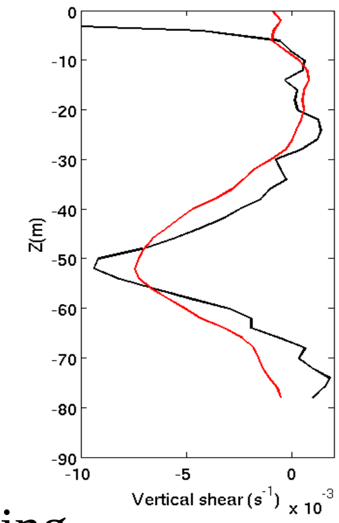
⇒Stratification makes no difference in the surface currents. Thermal wind????

Vertical shear measurements

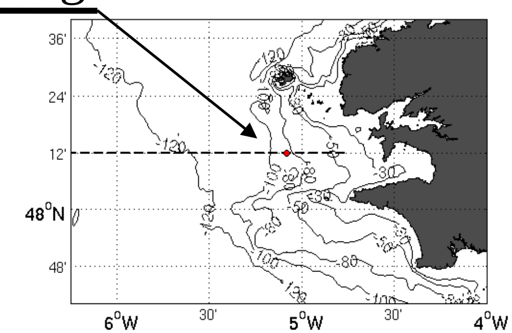
Density measured by a towed undulating CTD (kg/m3)



ΔV=0.2 m/s



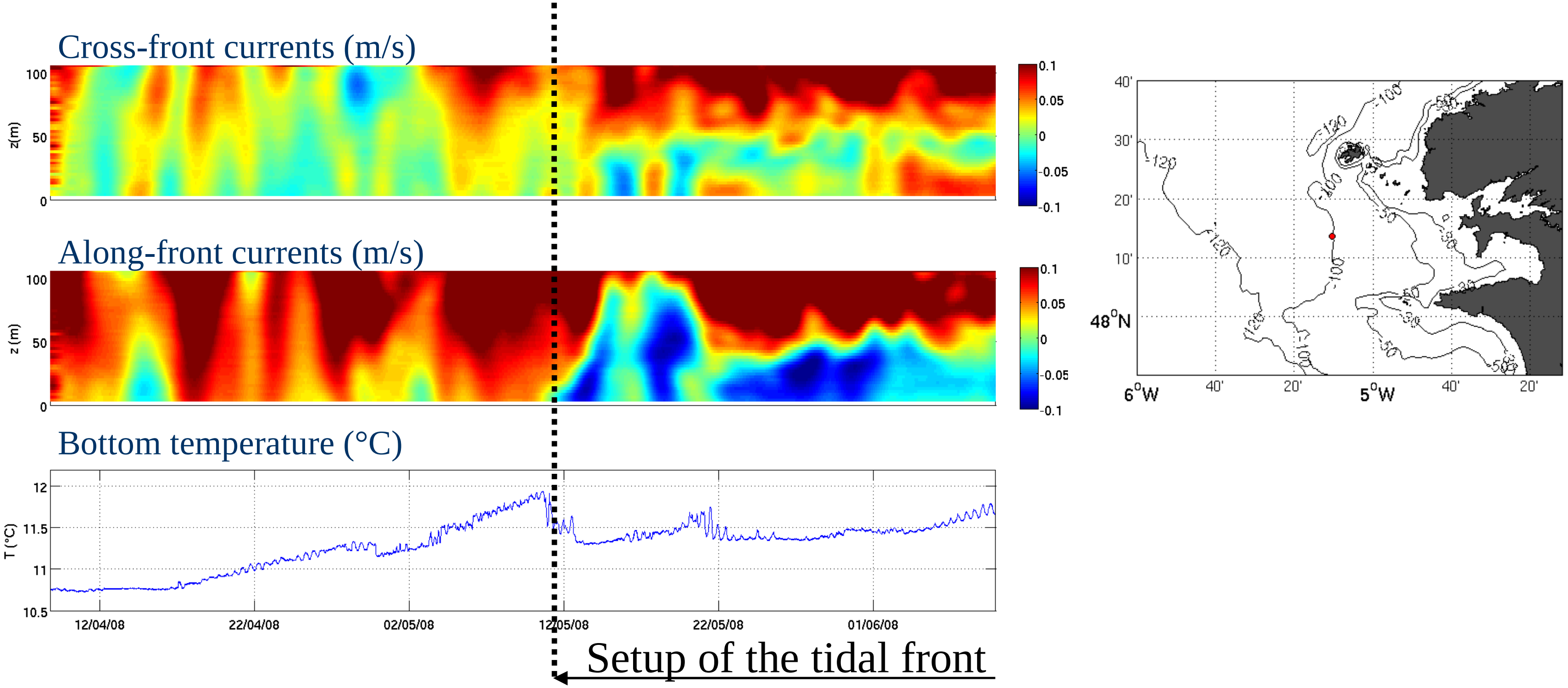
ADCP mooring



- The vertical shear **measured** above the ADCP fits well with the vertical shear induced by the **thermal wind balance**

Interactions tides/frontal-current

Tide-filtered velocity measured by an ADCP (April-July 2008)



- The low frequency current is **almost barotropic** during winter and **baroclinic** during summer, **but** :
- Thermal wind induced currents are to be sought at the **bottom** !

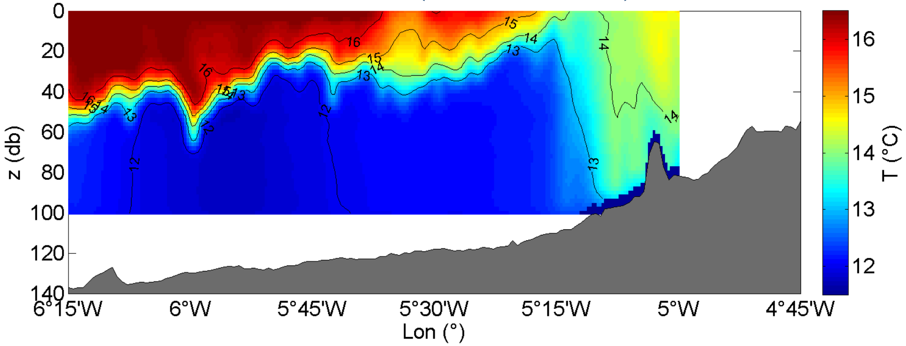
Part 1: conclusion (observations)

- During **winter** the circulation is dominated by the **barotropic** tidal residual (in periods of low winds).
- During **summer**, the surface circulation remains the same.
- The tidal front induces a **vertical shear** in the along front direction, and a **southward** along front circulation at the **bottom**.

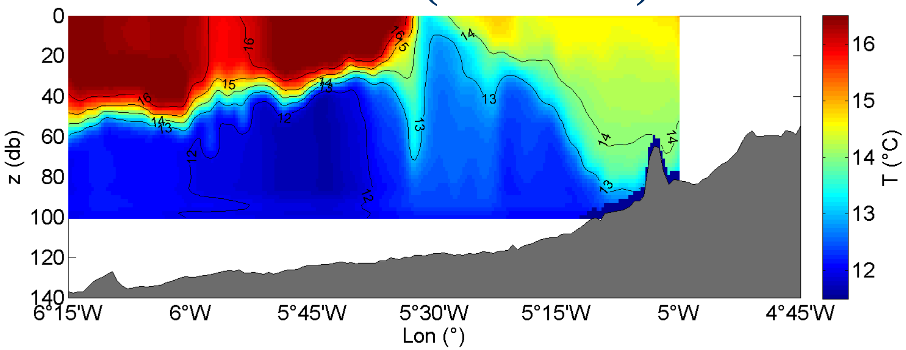
Movements of the bottom front

Temperature sections measured by a towed undulationg CTD

21/09/2009 (TR: 5.8 m)



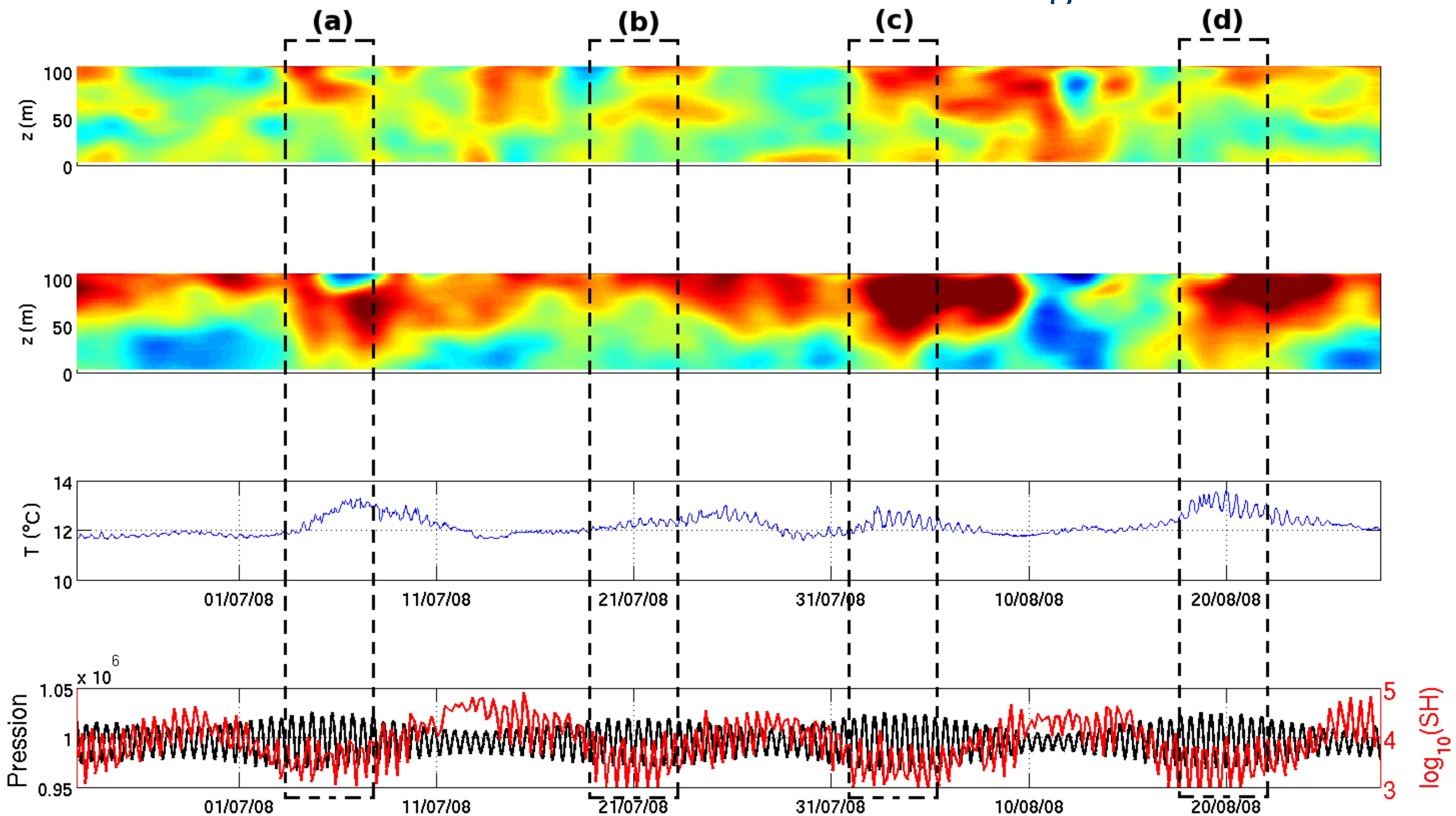
28/09/2009 (TR: 1.1 m)



The **bottom front** shifts periodically with the **S/N cycle**.
(Le Corre and Mariette, 1980, Cambon, 2007)

Movements of the bottom front

Western and Northern currents from and ADCP mooring.



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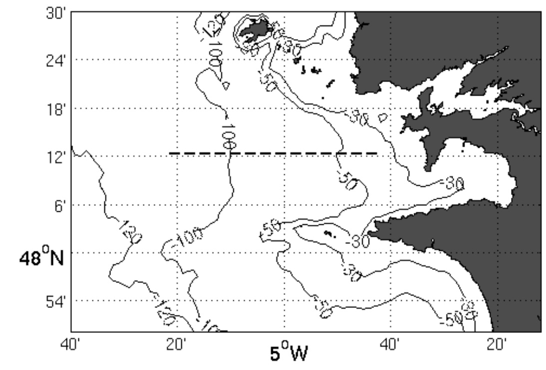
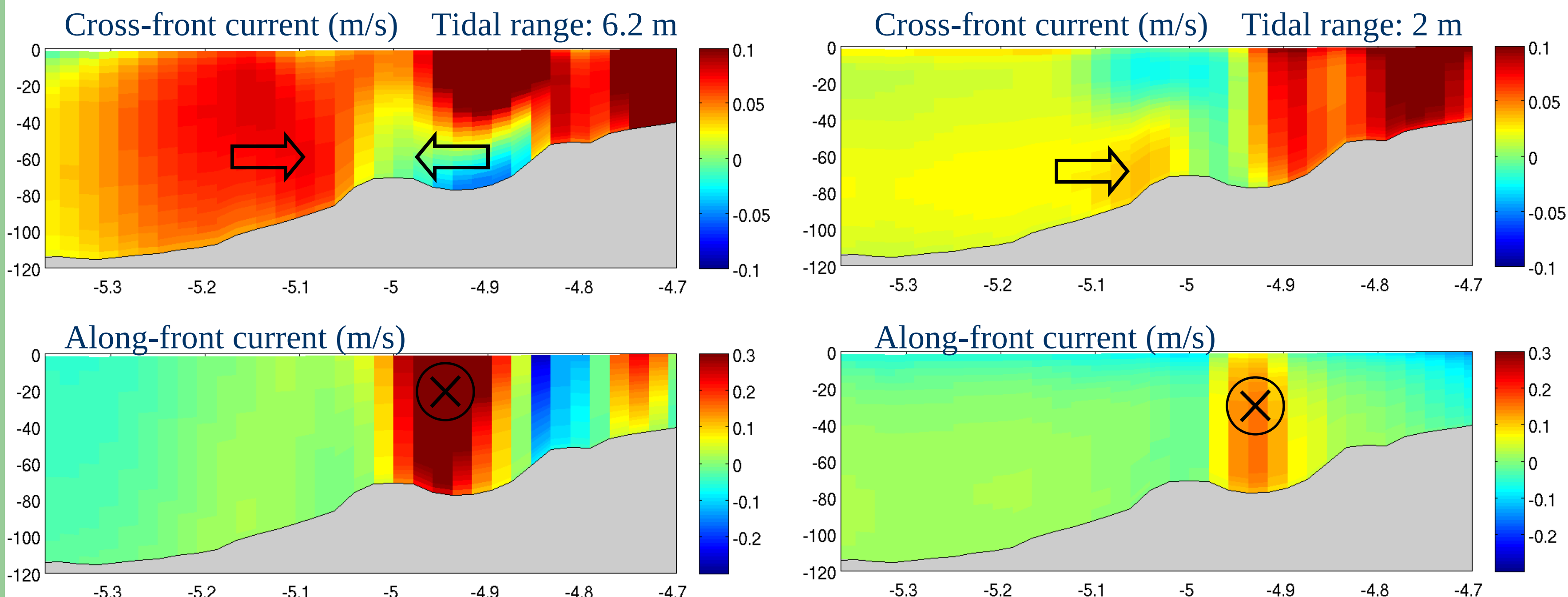
(Le Corre and Mariette, 1980, Cambon, 2007)

Modelised circulation during homogeneous conditions

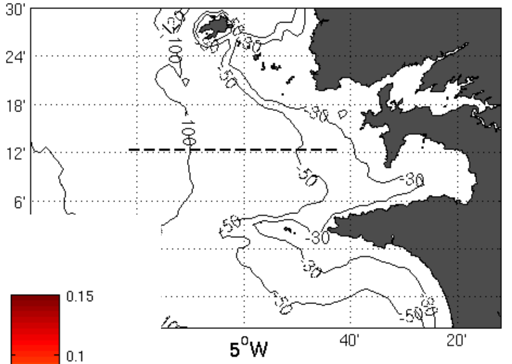
ROMS model (Cambon, 2007) : 1.5 km grid, 30 sigma levels
Realistic forcing : Meteo France atmospheric/radiative forcings
COMAPI tides (F.Lyard, LEGOS)

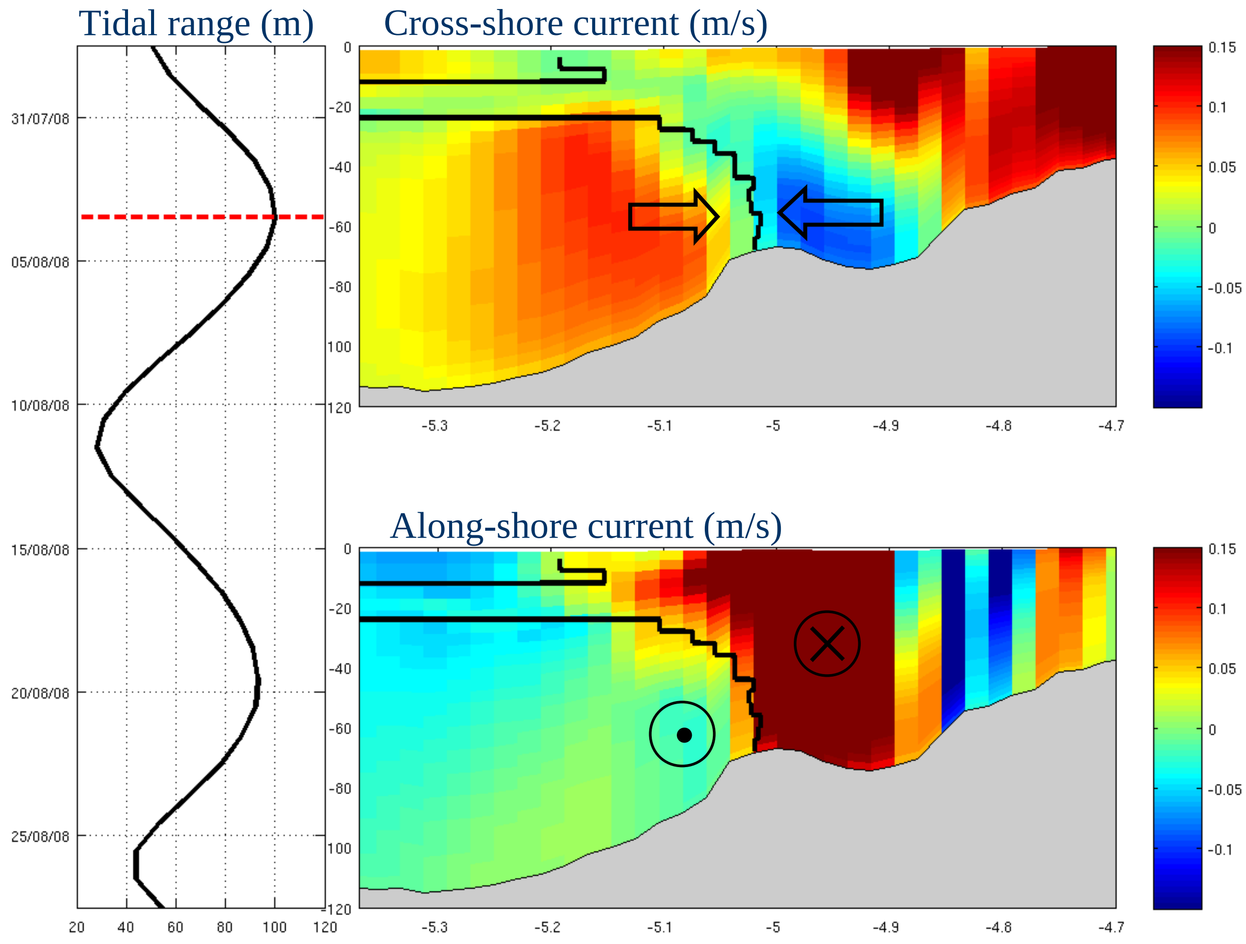




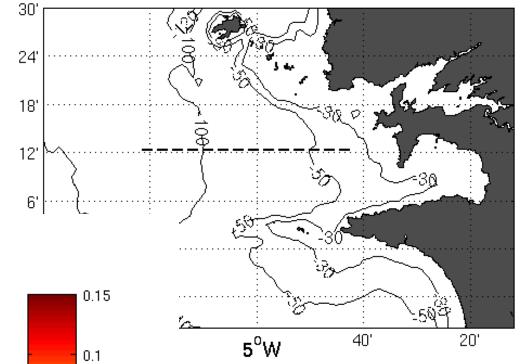
(plots generated without wind forcing, for a homogeneous water column)

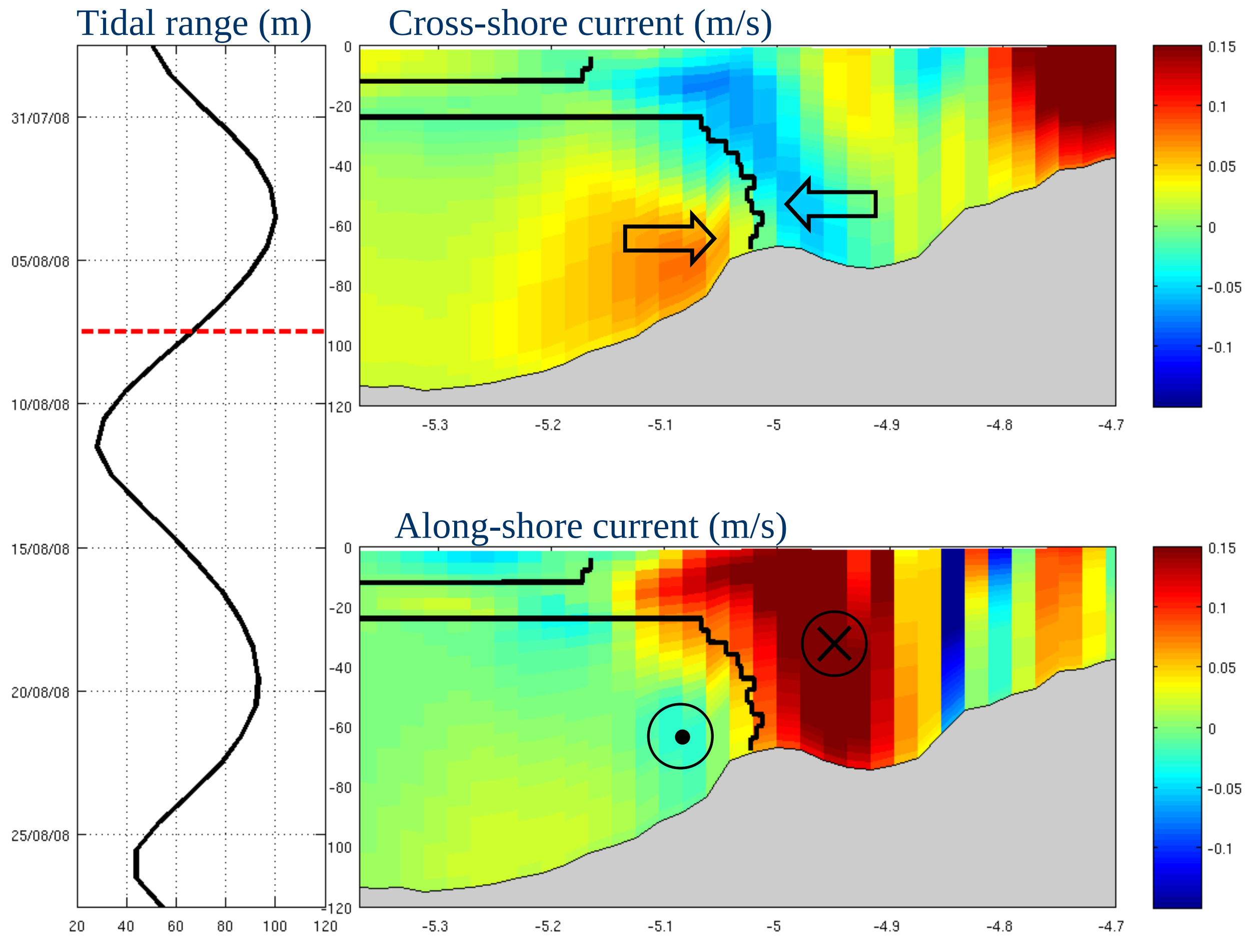
Oscillations of the tidal front



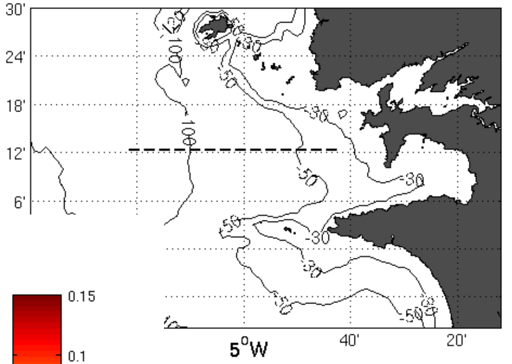


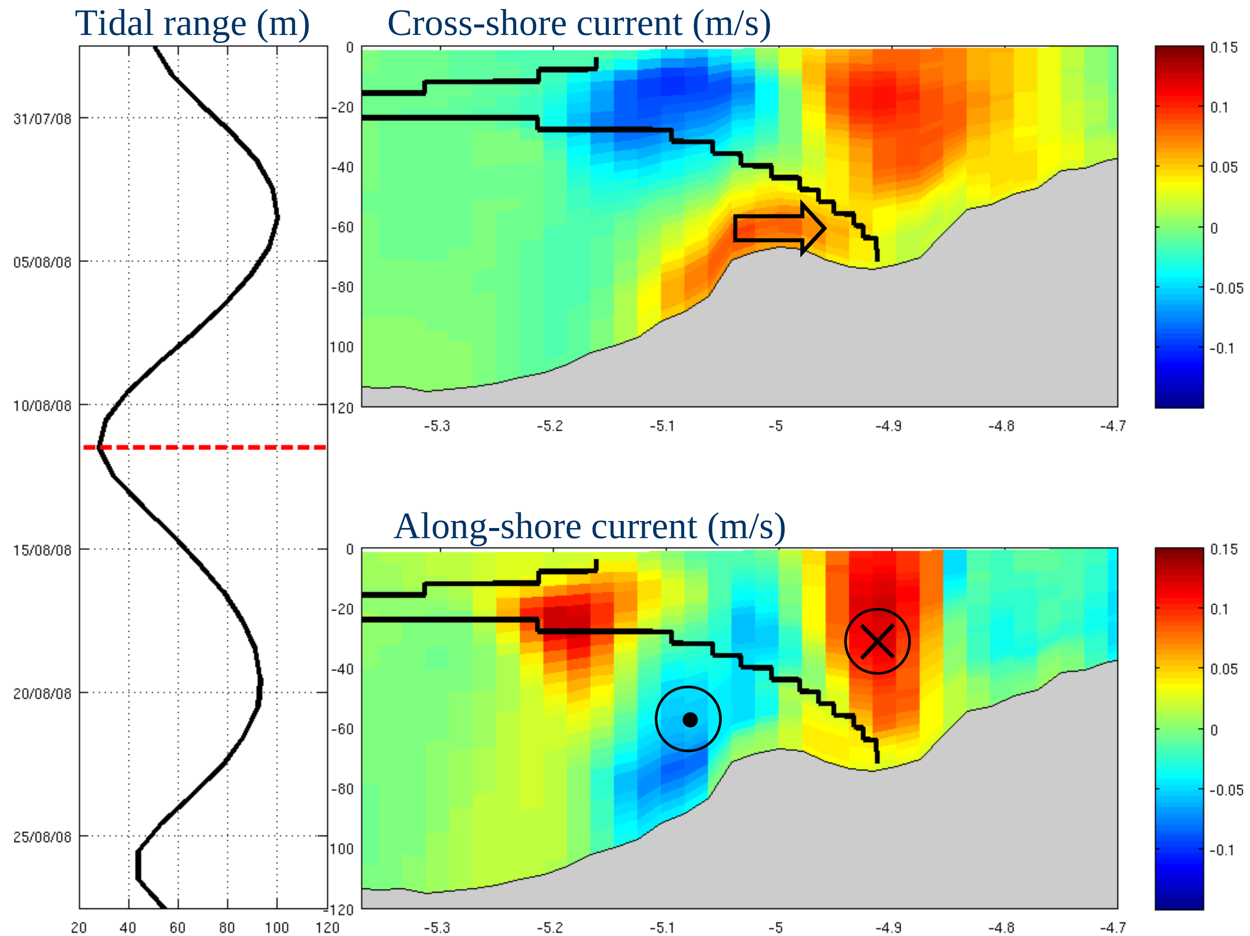
Oscillations of the tidal front



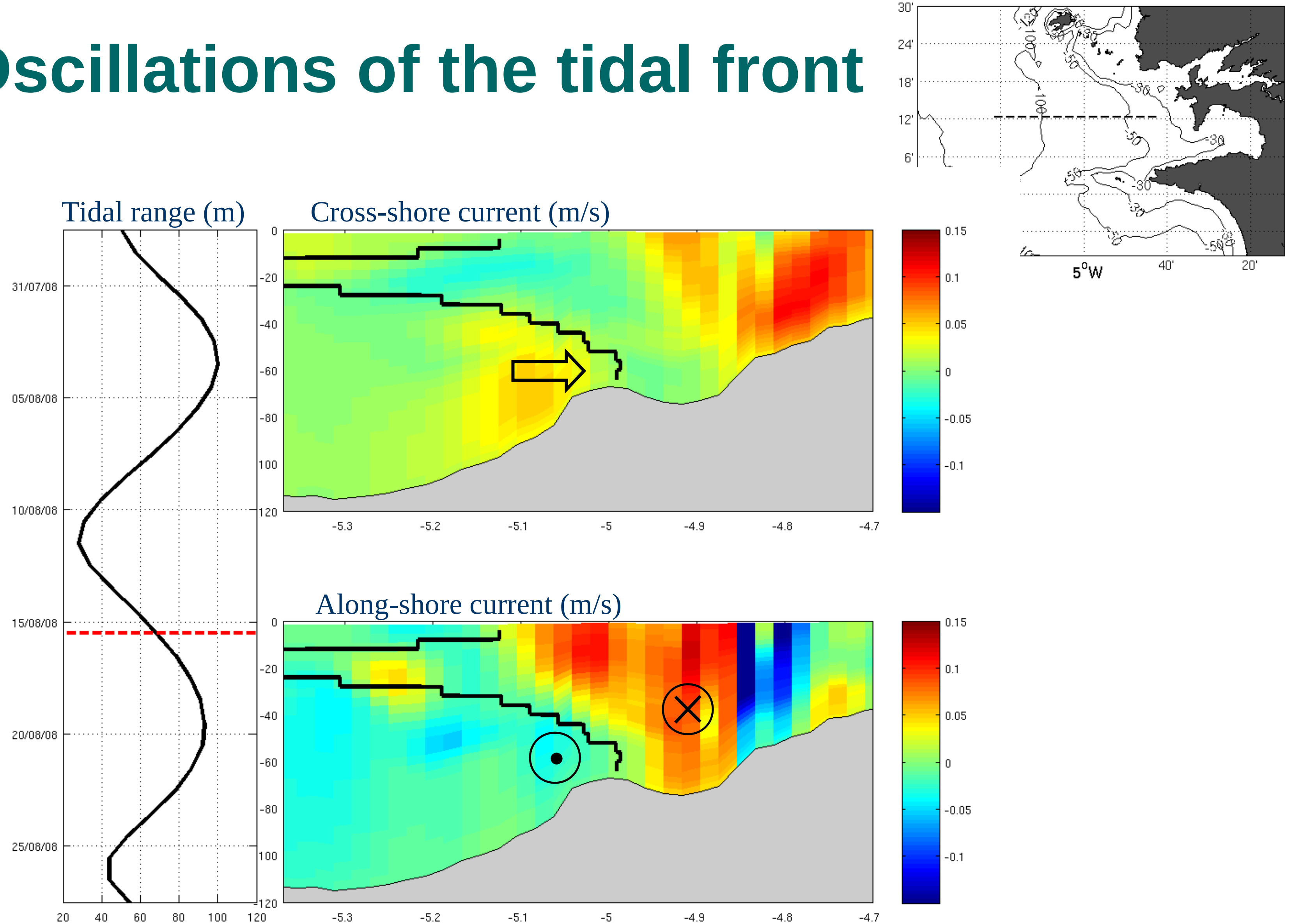


Oscillations of the tidal front

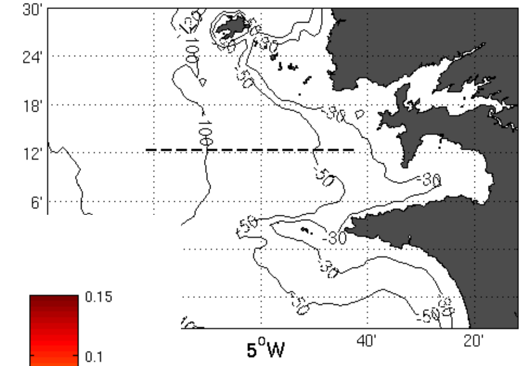


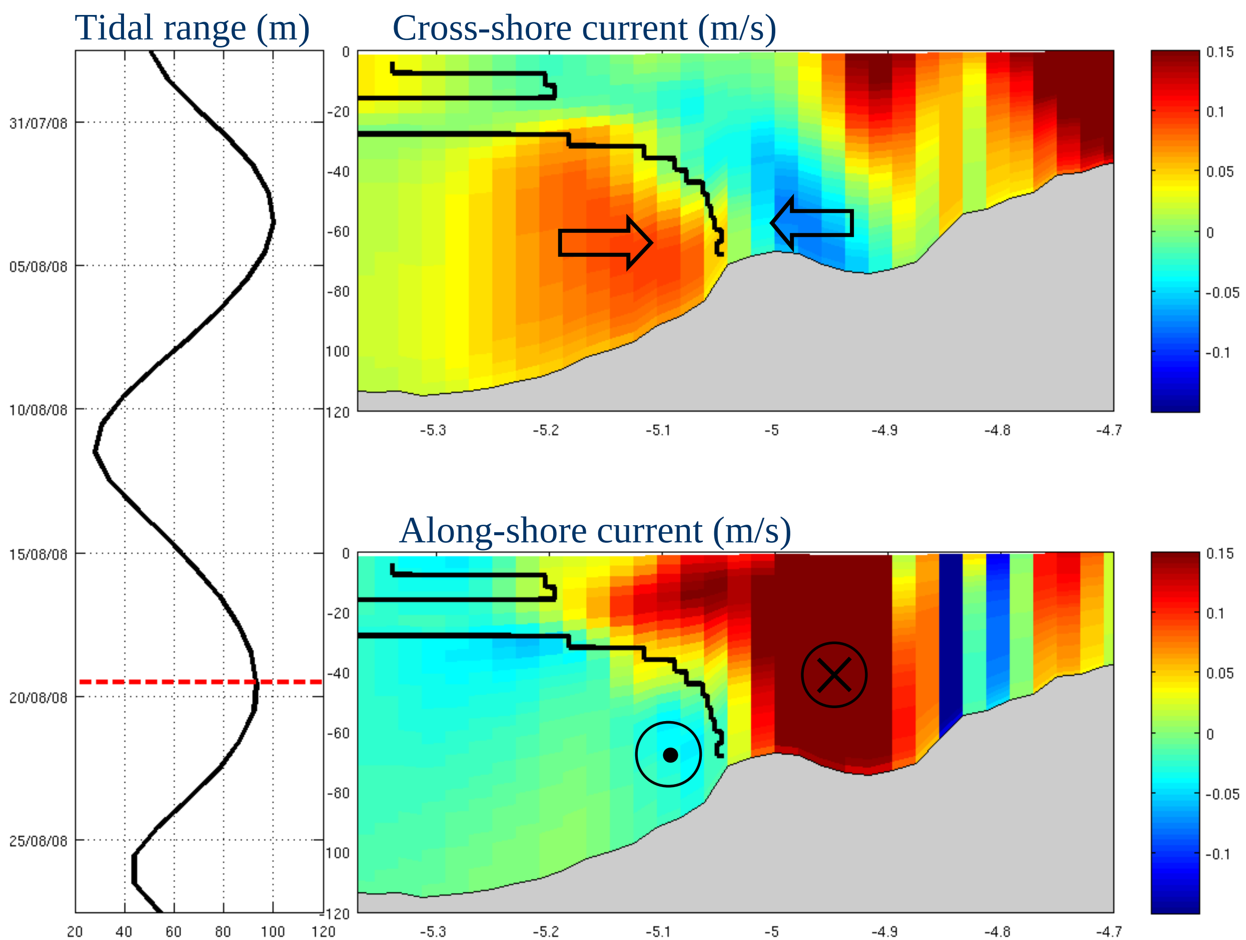


Oscillations of the tidal front



Oscillations of the tidal front





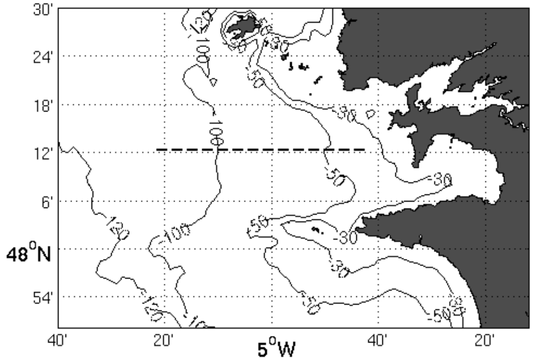
Part 2: conclusion (modelling)

- The variation of the **bottom front position** is related to the variation of the amplitude of the **tidal residual** jet.
- Velocities in the **Ekman layer** generated by the tidal residual jet prevent the collapse of the bottom front.

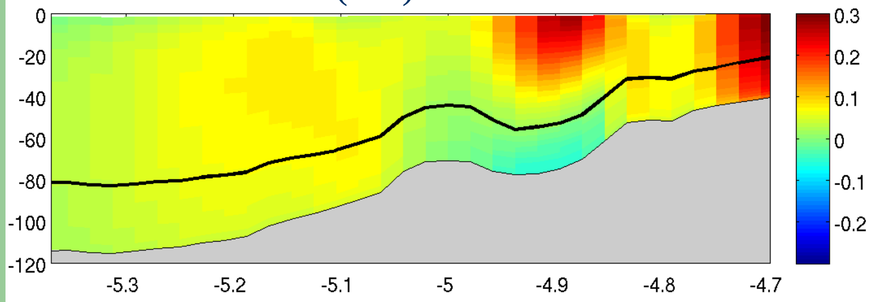
Conclusions

- The bottom front induce **bottom southward** velocities.
- The position of the front is related to the **convergence** of the velocities in the **Ekman layer**.

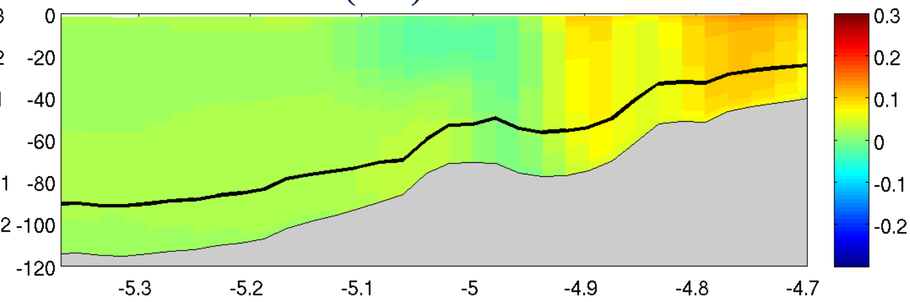
Scaling of the Ekman layer depth



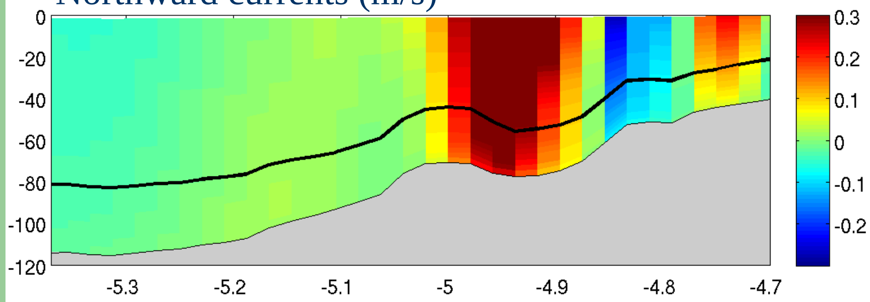
Eastward currents (m/s)



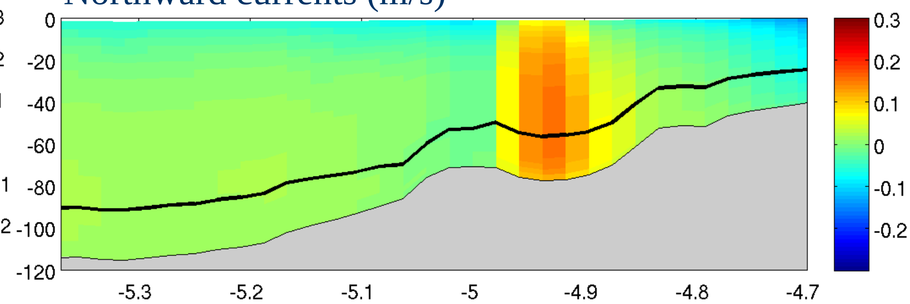
Eastward currents (m/s)



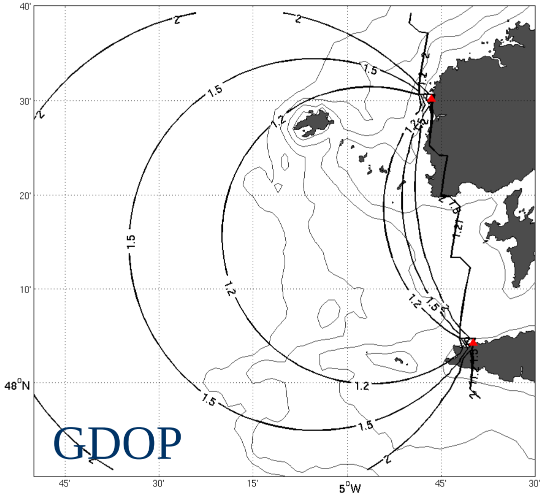
Northward currents (m/s)



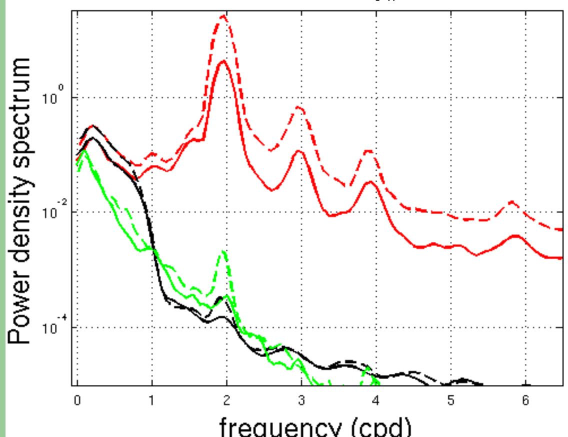
Northward currents (m/s)

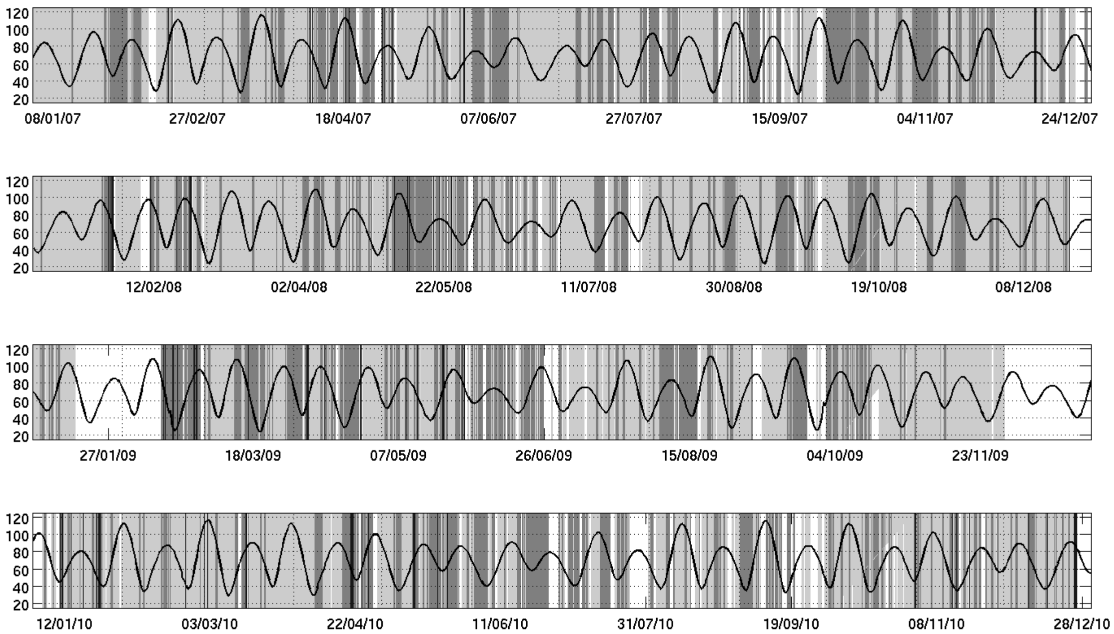


HF radar measurements

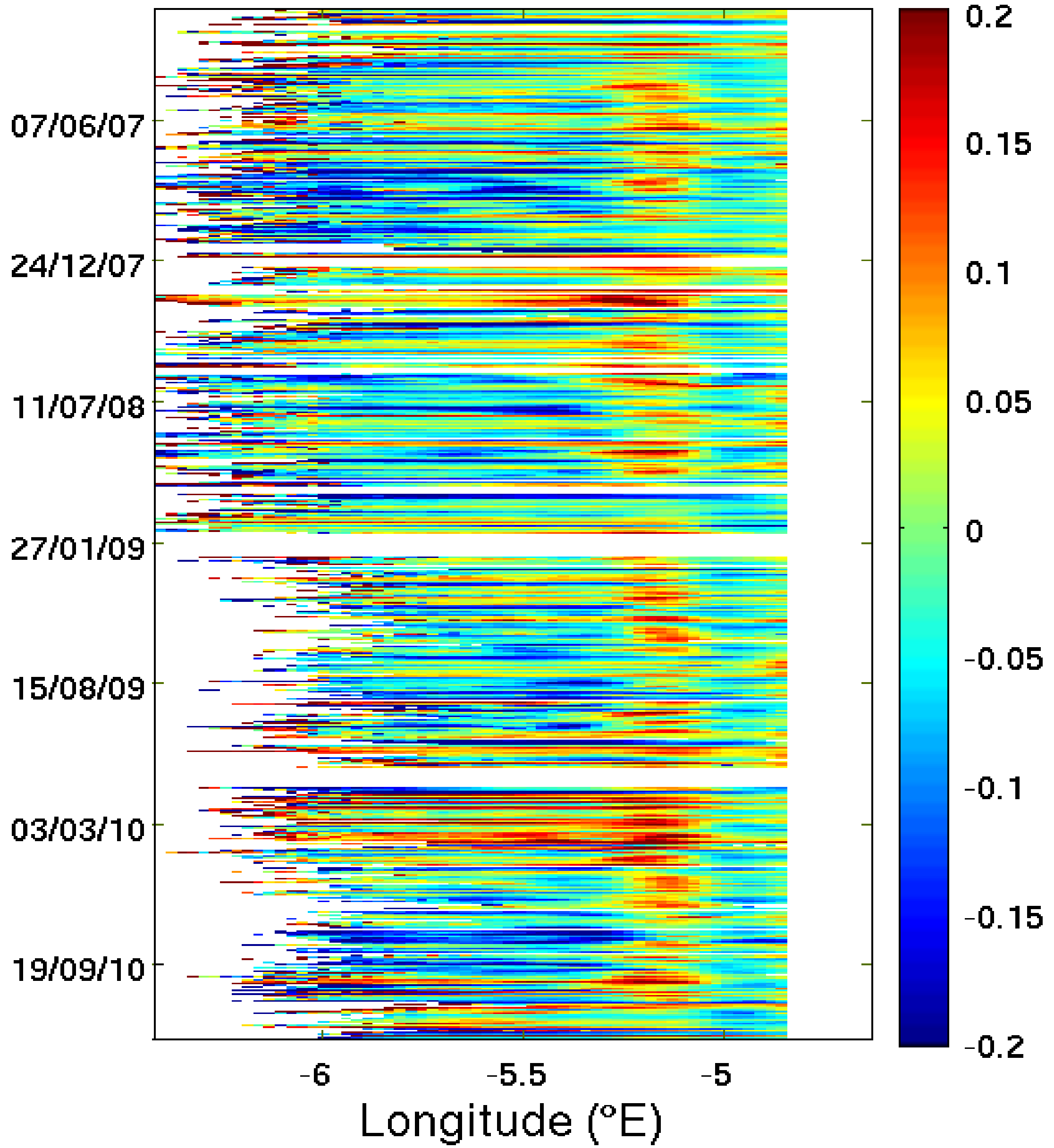


GDOP

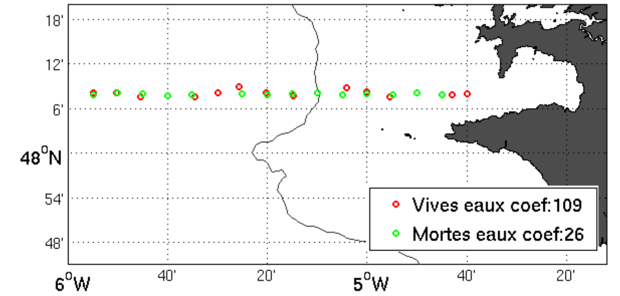




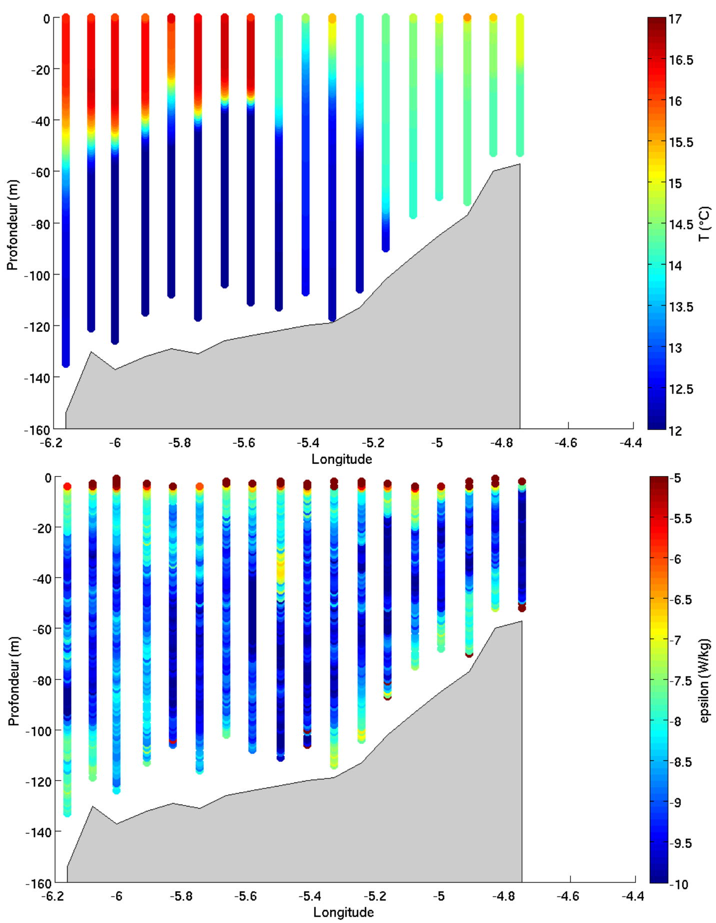
Temporal repartition of samples.


07/06/07
24/12/07
11/07/08
27/01/09
15/08/09
03/03/10
19/09/10
-6
-5.5
-5
Longitude (°E)
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2

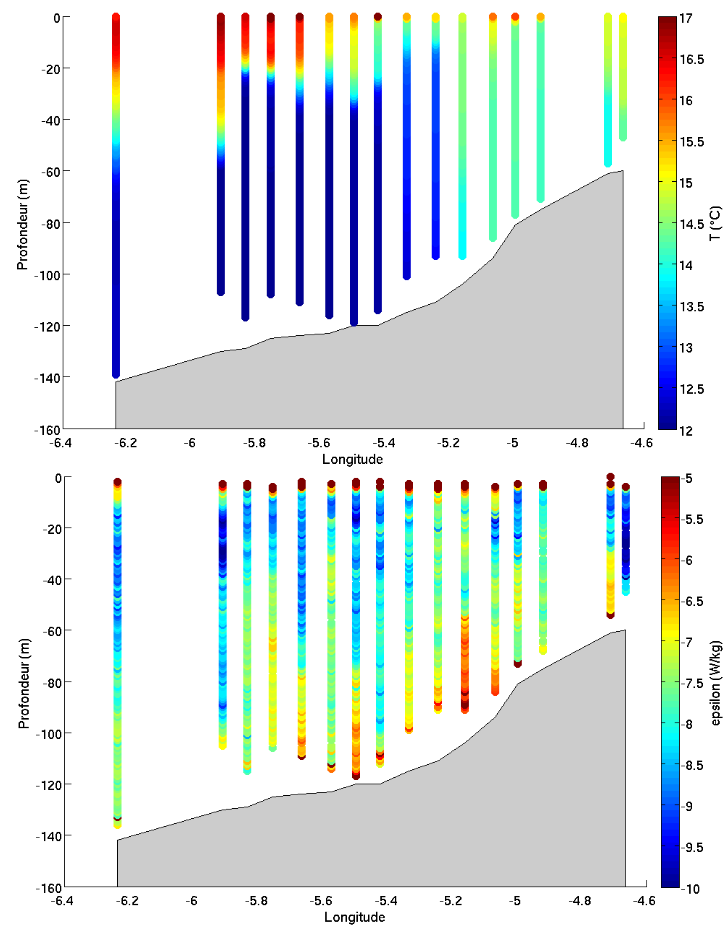
Mesures de microstructure

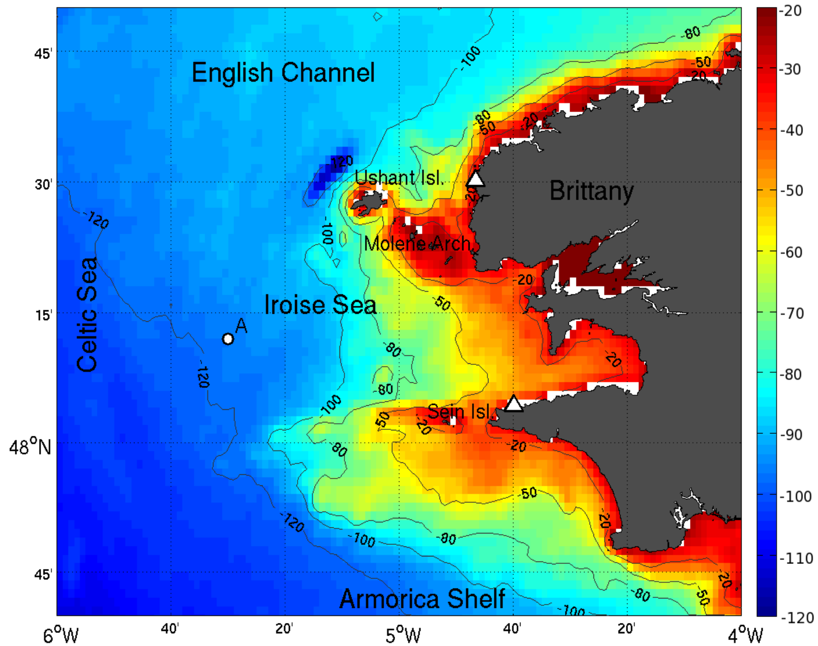


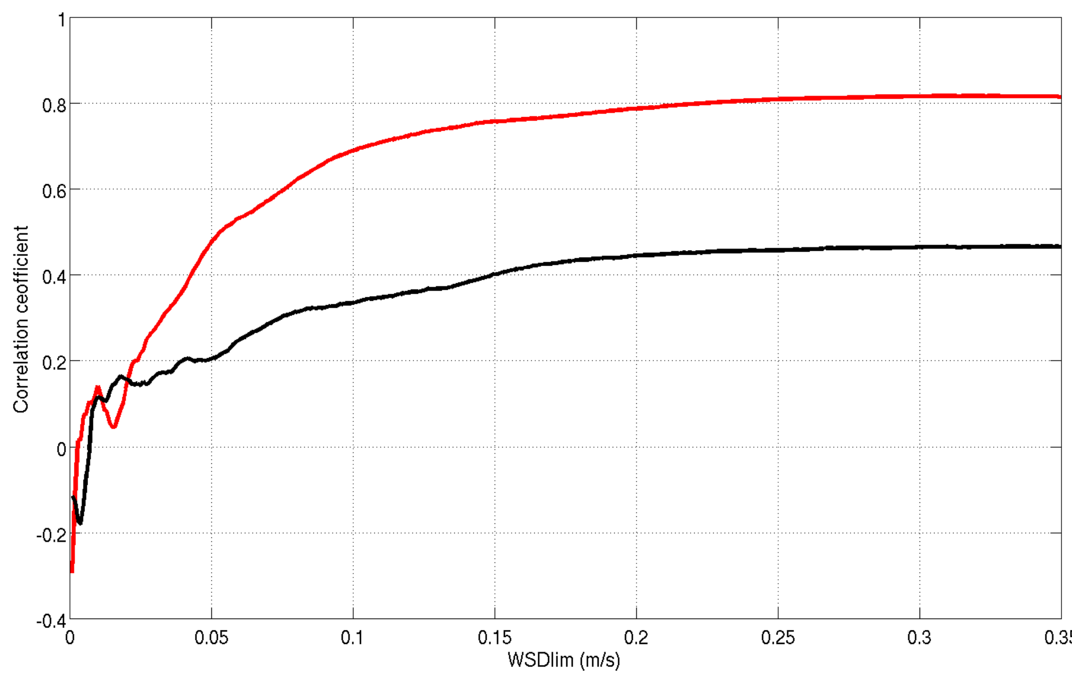
Mortes eaux

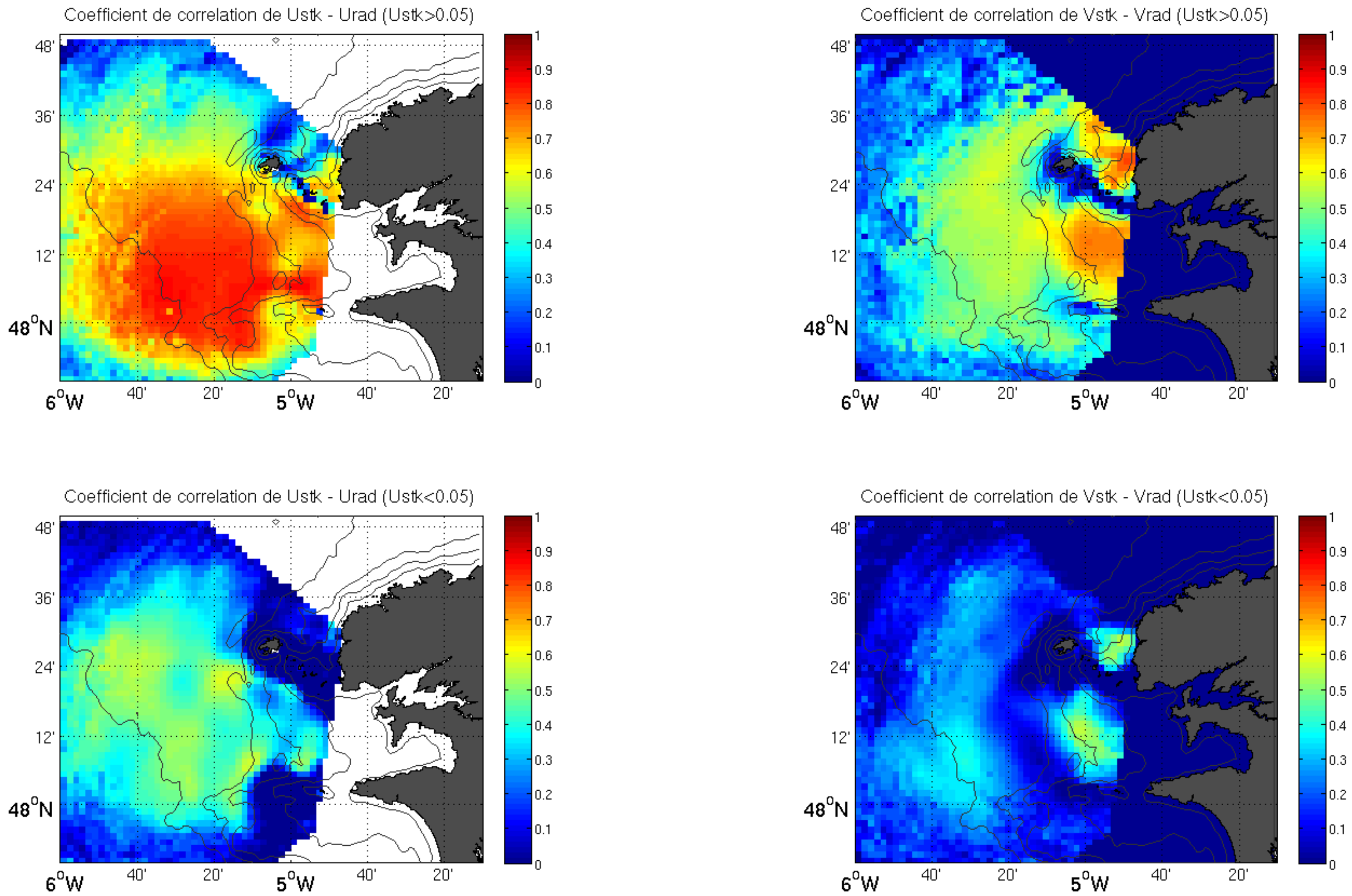


Vives eaux




English Channel
Ushant Isl.
Brittany
Molene Arch.
Celtic Sea
Iroise Sea
A
Sein Isl.
Armorica Shelf
48°N
6°W
5°W
4°W


Correlation ceofficient
WSDlim (m/s)


Coefficient de correlation de Ustk - Urad (Ustk>0.05)
Coefficient de correlation de Vstk - Vrad (Ustk>0.05)
Coefficient de correlation de Ustk - Urad (Ustk<0.05)
Coefficient de correlation de Vstk - Vrad (Ustk<0.05)
48'
36'
24'
12'
48°N
6°W
40'
20'
5°W
40'
20'
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1