# Dynamics of the Ushant front in the Iroise sea

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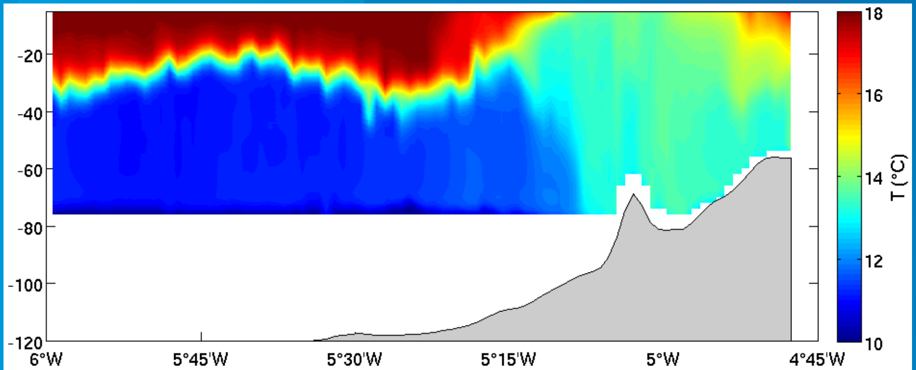
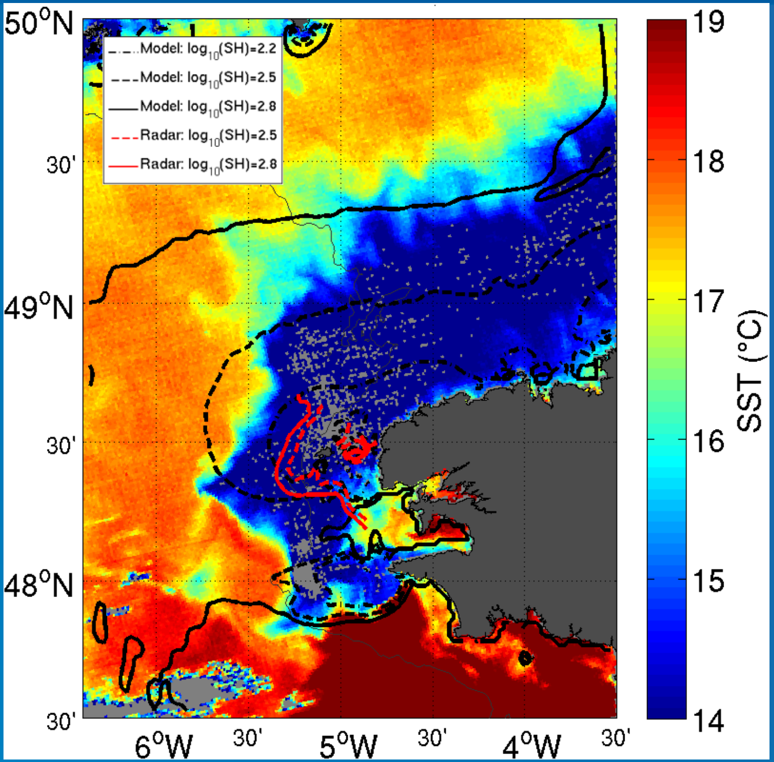
# Observations of the Ushant tidal front

- Tidal fronts are coastal density fronts
  - Homogeneous waters, mixed by tides
  - Stratified waters




Temperature section of the Ushant front, along the 48°16' N radial. (FROMVAR cruse, July 2010)

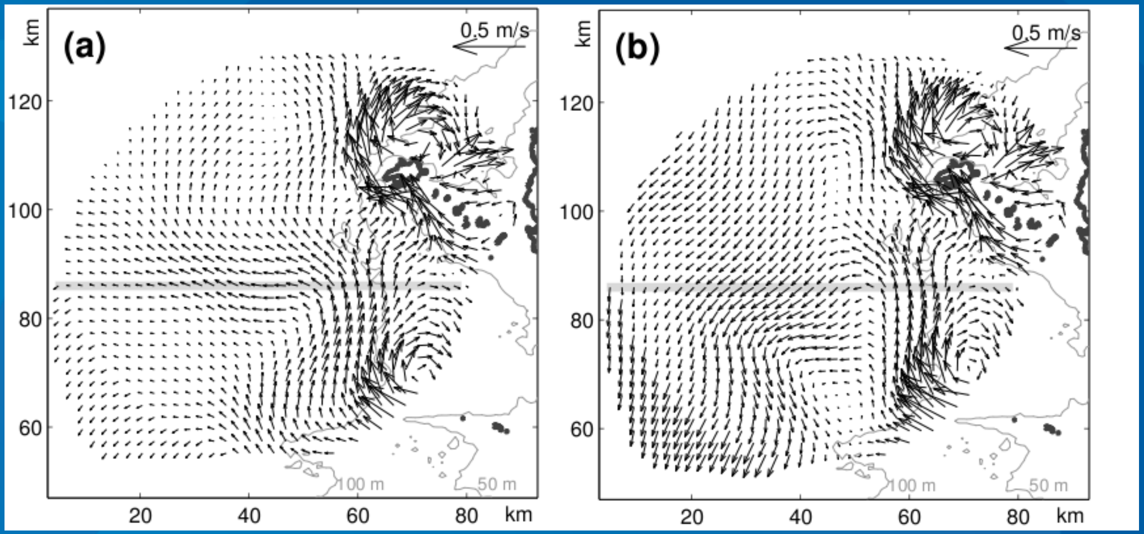



Simpson-Hunter criterion computed by tide model (black) and Radar observations (red)

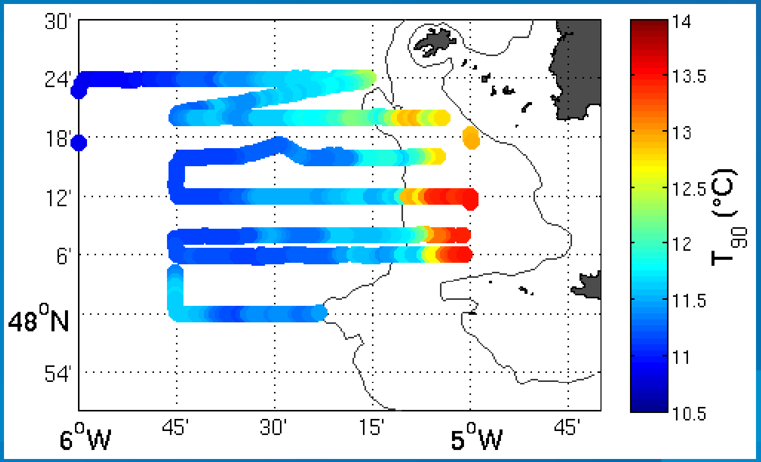
$$SH = \frac{h}{U^3}$$

# Observations of the Ushant tidal front

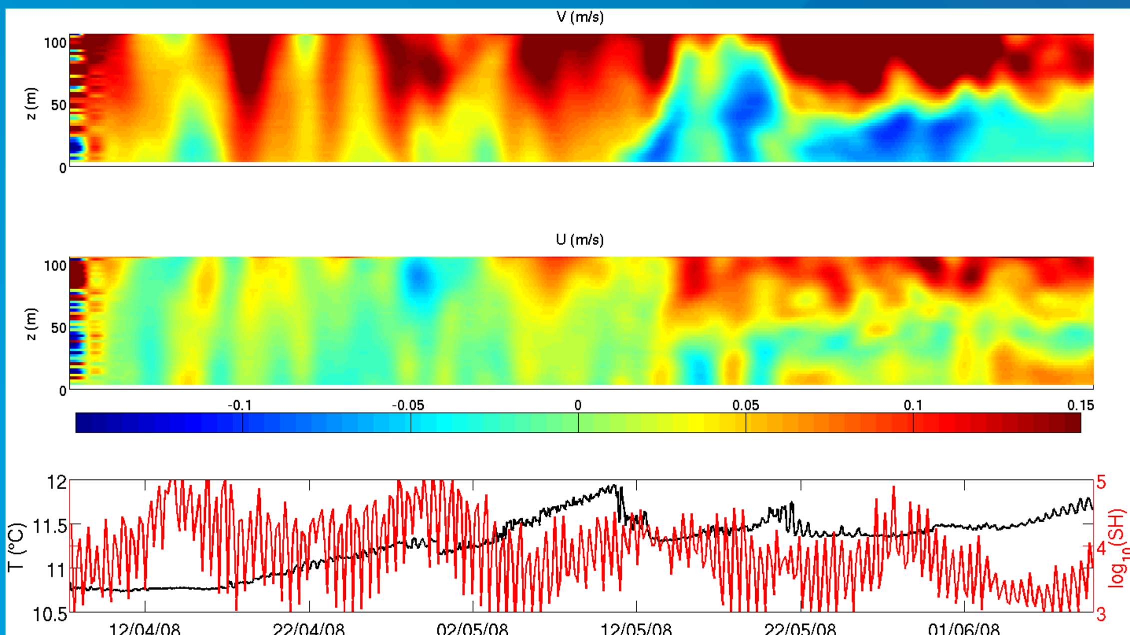
Residual currents measured by HF radars in April (a) and September 2007 (b)
(Sentchev et al. 2010)

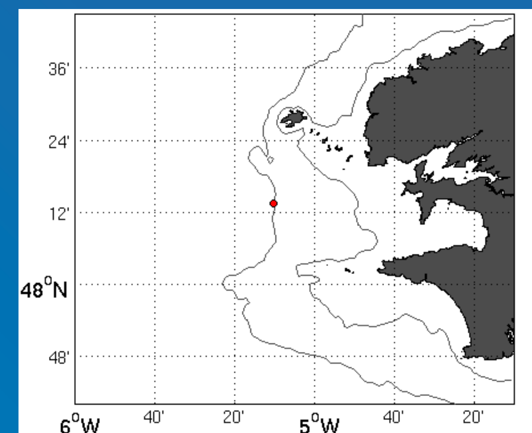



Mean temperature between -70 and -80 meters measured during the FROMVAR cruse, in August 2010.



# Observations of the Ushant tidal front



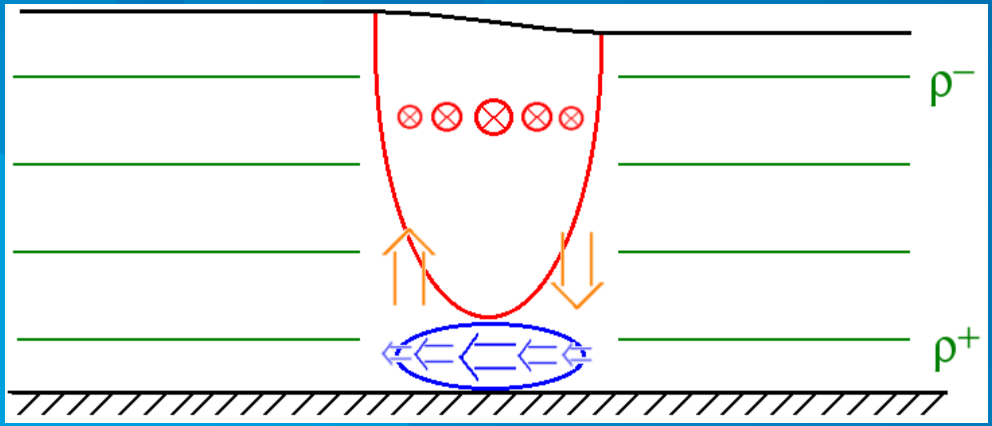




Circulation measured by an ADCP mooring, filtered from tidal motion (1 and 2).
Temperature at 102m depth and Simpson-Hunter criterion.

The residual jet is almost barotropic.

# Frontogenetic mechanism

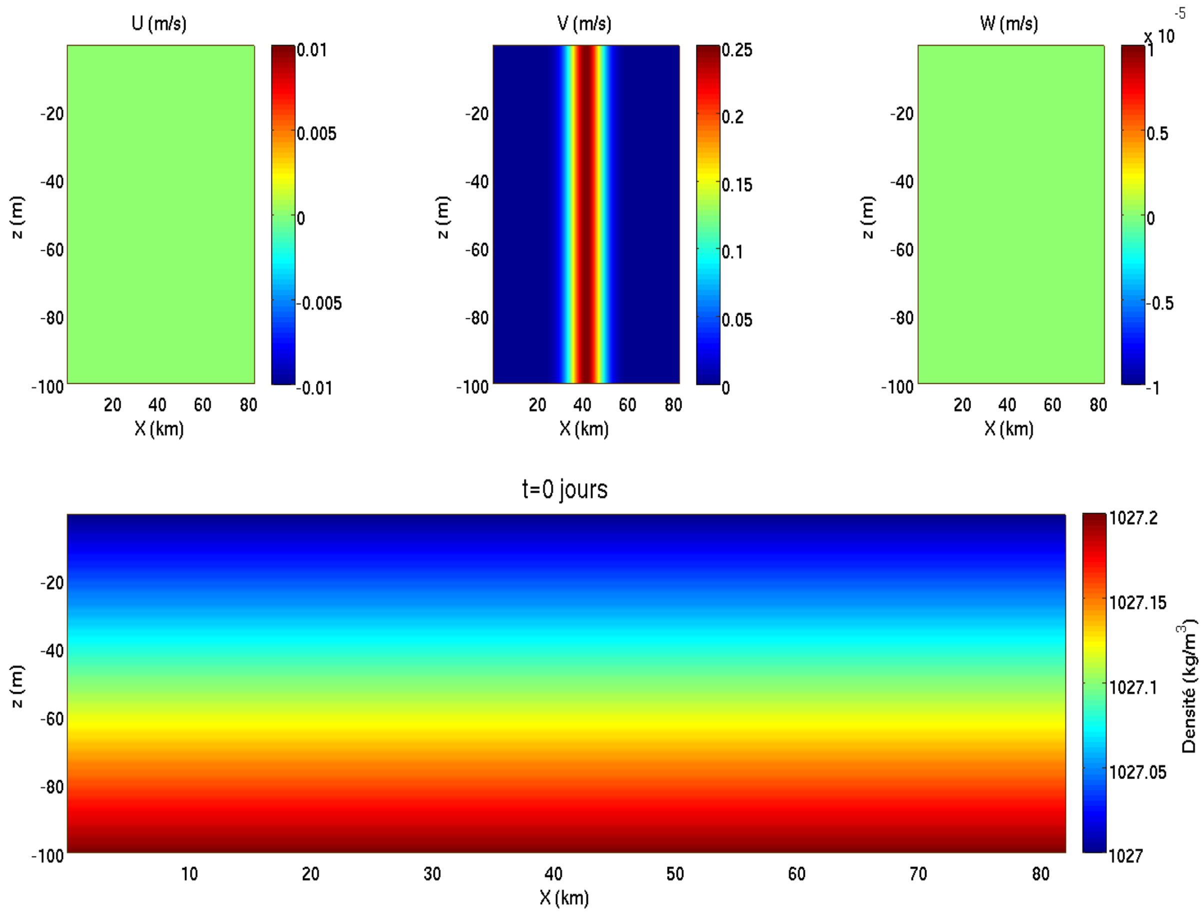
- Let's consider a barotropic jet on a coastal ocean with constant depth.
- There is an Ekman layer on the bottom.
- The vertical gradient of density is weak.



# Non-hydrostatic idealized model

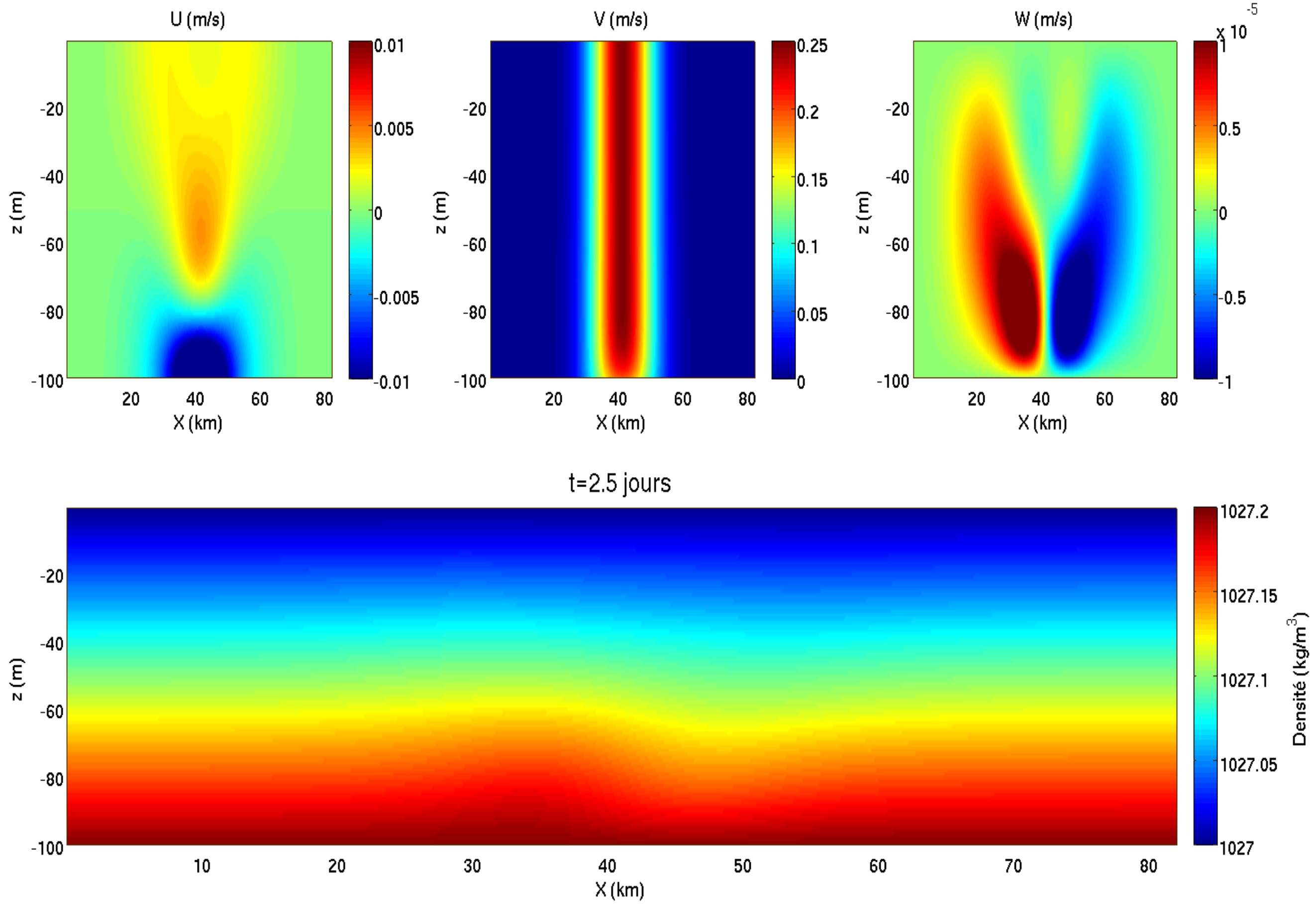
- Model parameters:
  - Meshing
    - 1024*80 m in the x direction
    - 100*1 m in the z direction
  - Non-hydrostatic simulation
- Physical parameters
  - H=100 m
  - $V_0$=0,25 m/s
  - $\nu_v=5.10^{-2}$ m/s$^{-2}$

# Model results



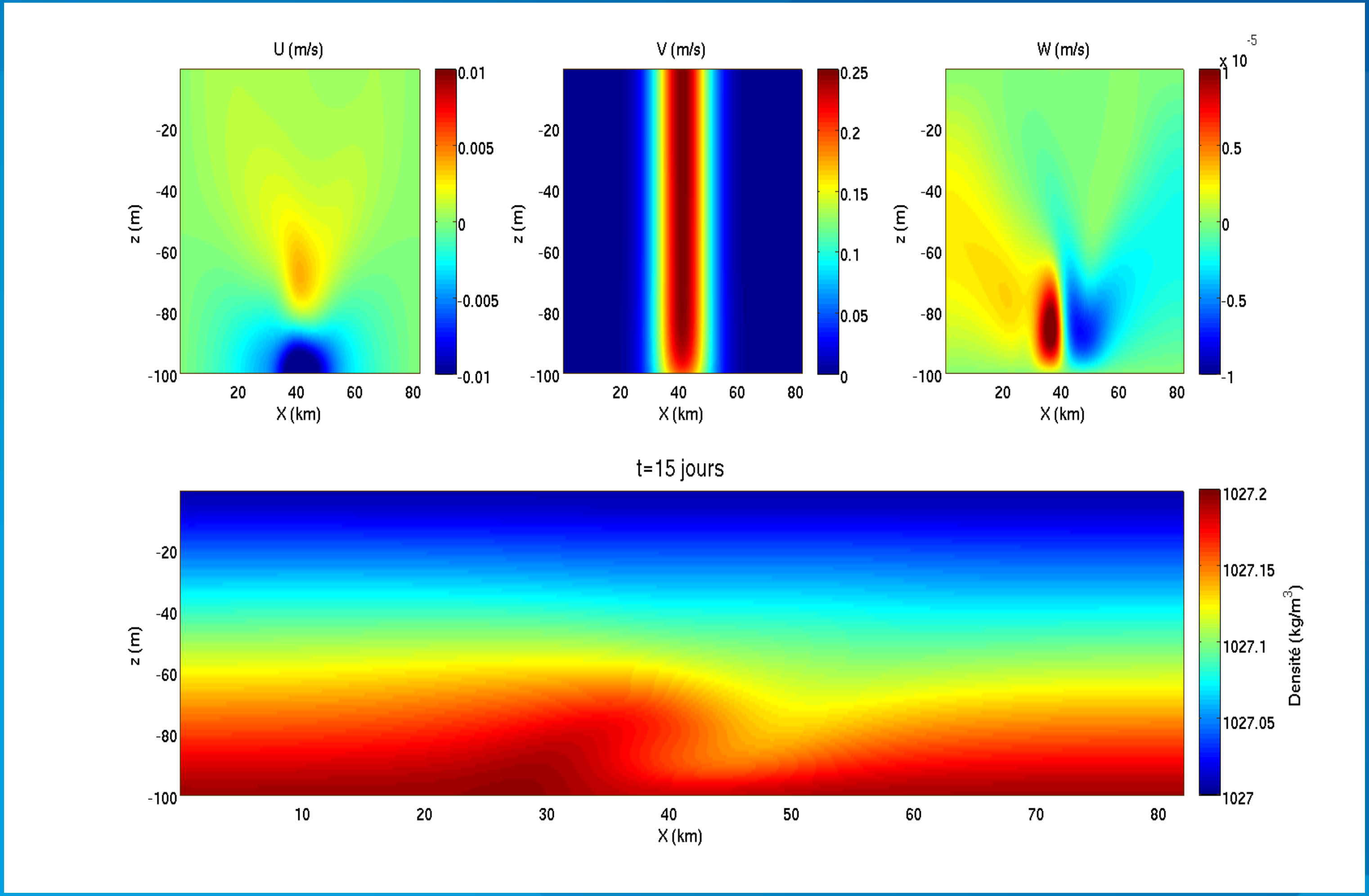

Initial conditions

# Model results



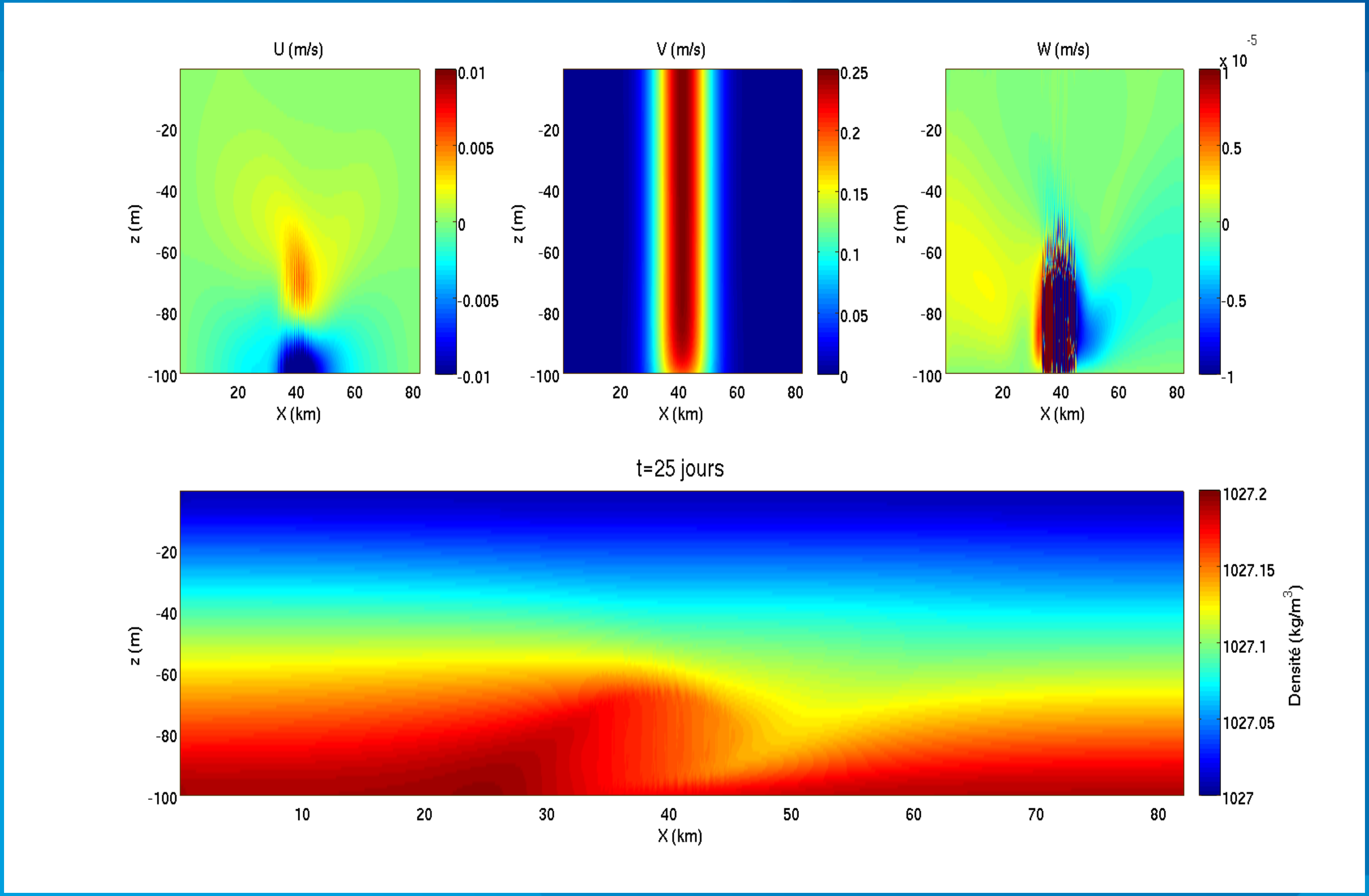

1st step: set up of the Ekman layer

# Model results



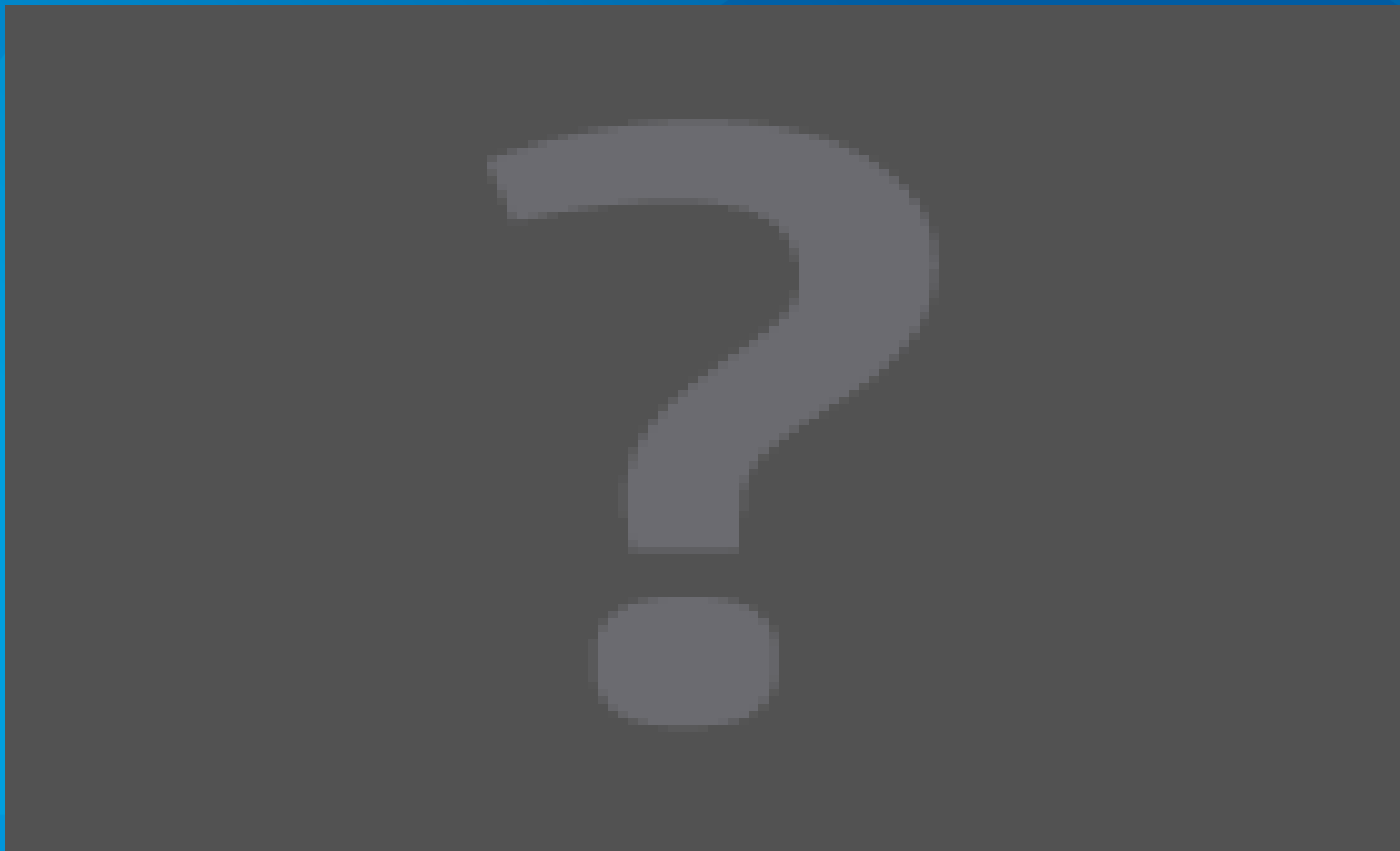

$2^{nd}$ step: advection of the density field

# Model results

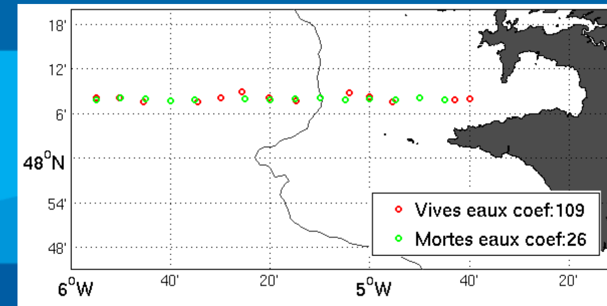



3rd step: convection

# Animation

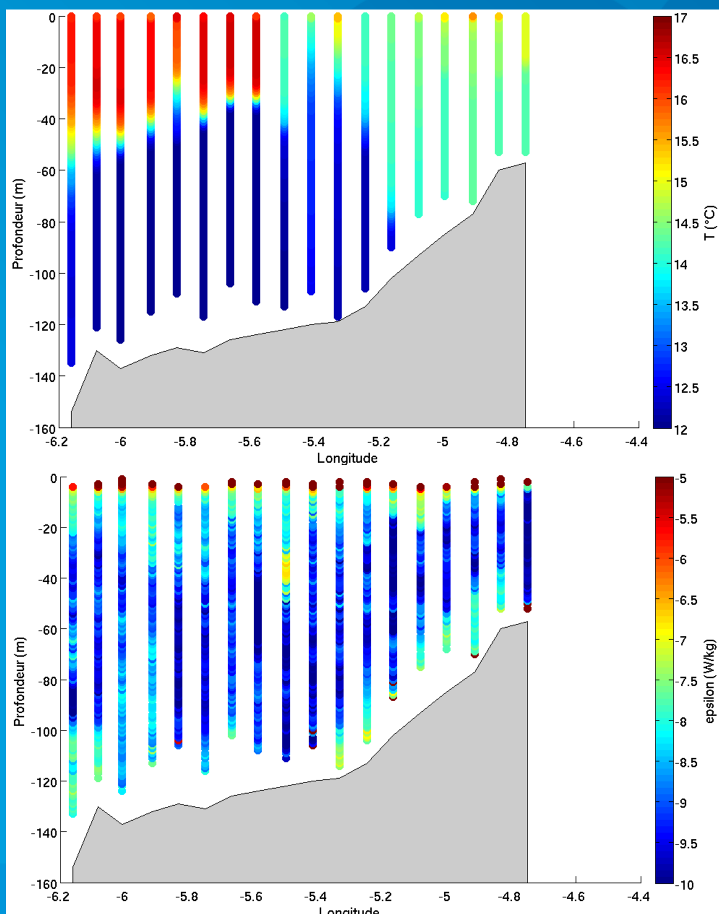


# VMP measurement

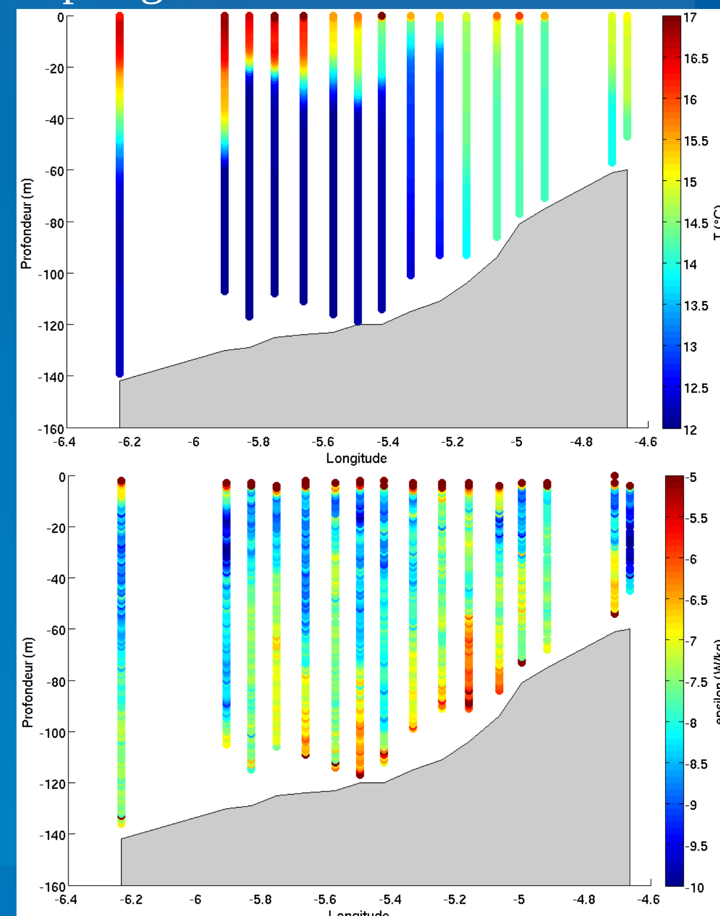



Observations made during the FROMVAR 2009 cruise, (coll. Bruno FERRON)

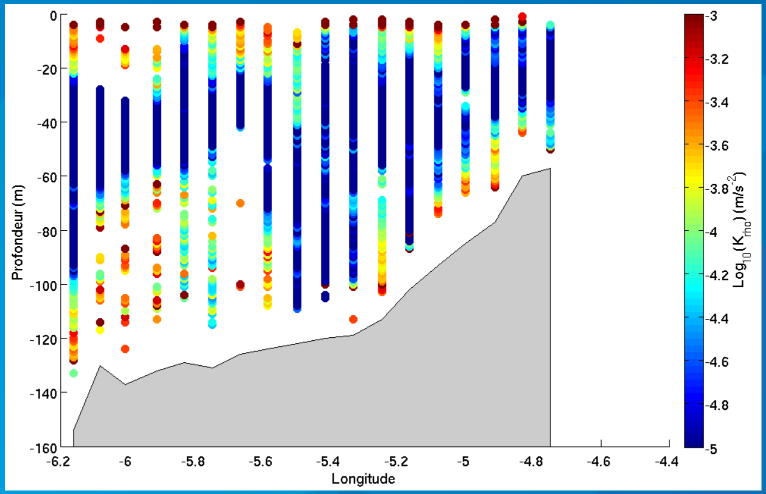
Neap



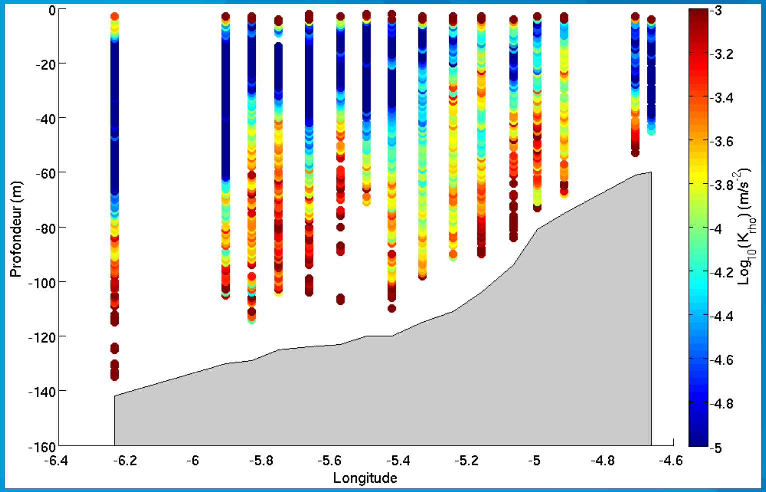

Spring



# VMP measurement




Neap




Spring

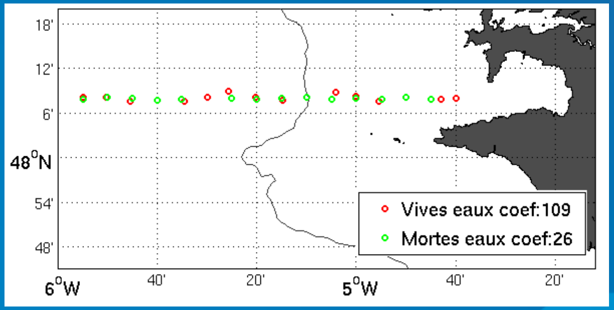
Parametrisation of scalar eddy diffusivity by Shih et al. 2005

For $\varepsilon/\nu N^2 < 100$

$$\kappa_\rho \sim 0{,}2\varepsilon/N^2$$

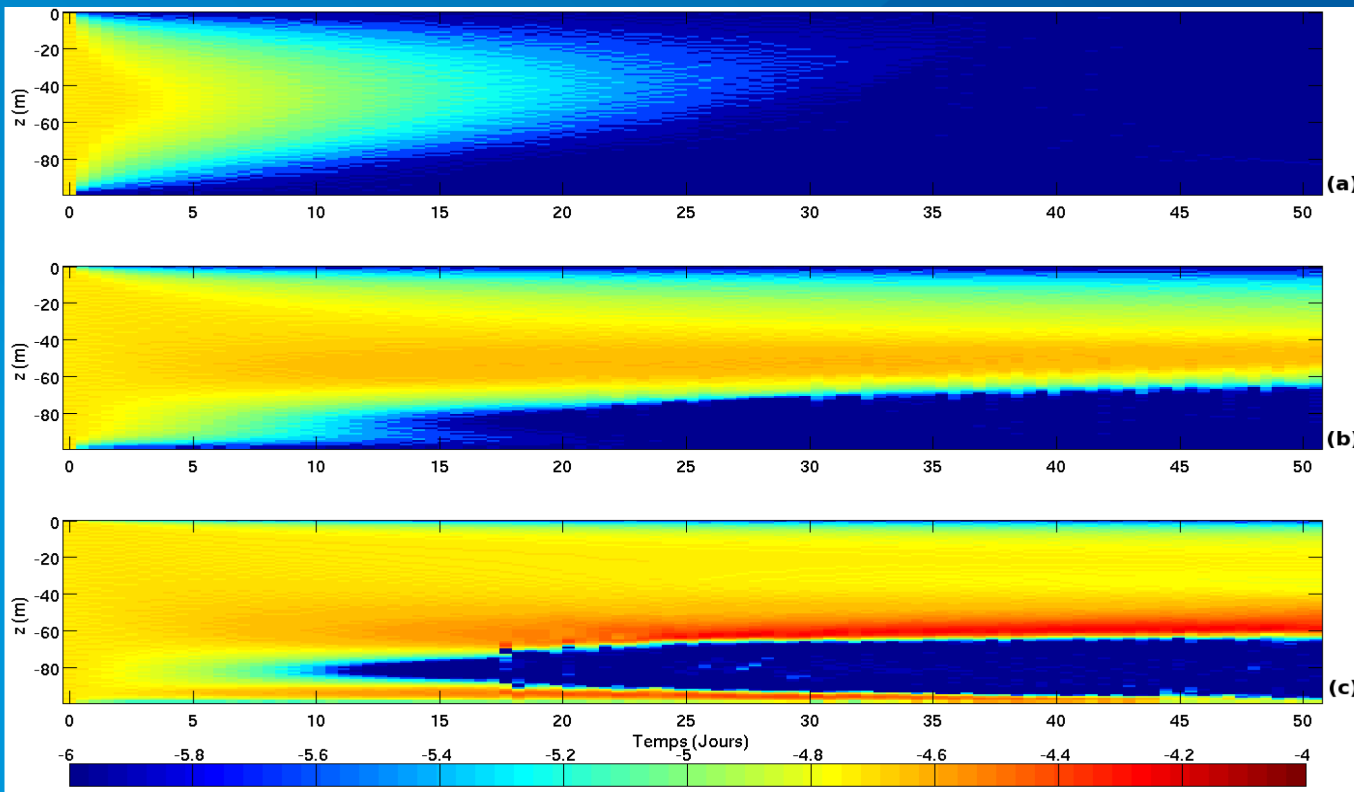
For $\varepsilon/\nu N^2 > 100$

$$\kappa_\rho \sim 2\nu(\varepsilon/\nu N^2)^{1/2}$$



# Sensibility to the diffusion parameter

Vertical section of $\log_{10}(N^2)$ vs time at x=40km

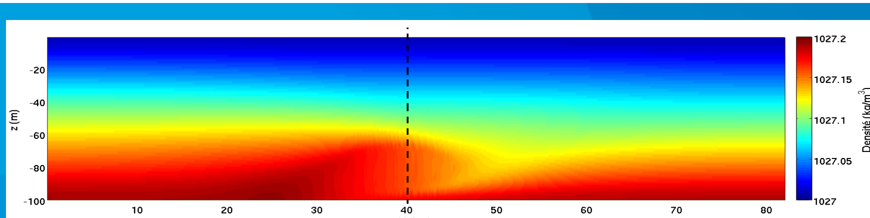



Evolution of the Brunt-Väisälä frequency for

**(a)** $\kappa_\rho = 10^{-3}$ m/s$^2$

**(b)** $\kappa_\rho = 10^{-4}$ m/s$^2$

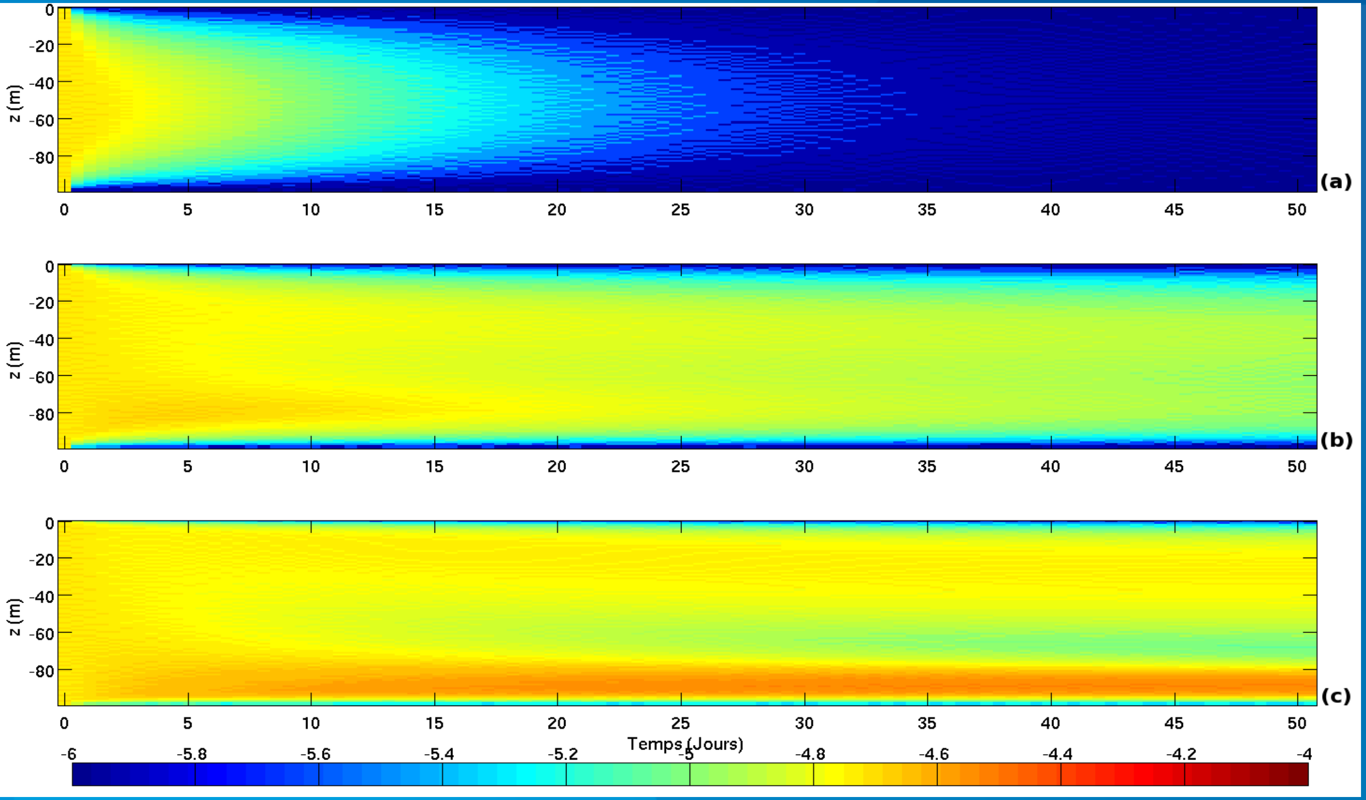
**(c)** $\kappa_\rho = 10^{-5}$ m/s$^2$




Position of the vertical section

# Sensibility to the diffusion parameter

Vertical section of $\log_{10}(N^2)$ vs time at x=55km

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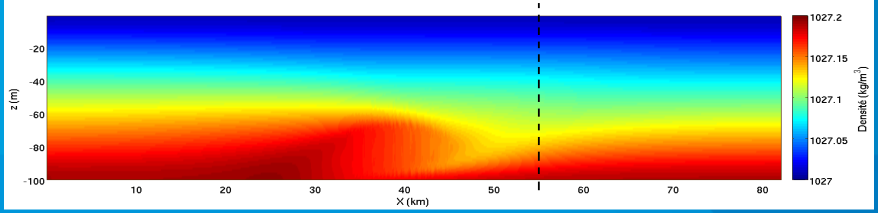


Position of the vertical section

# Conclusion

- The residual circulation observed in the Iroise sea may be involved in the dynamics of the Ushant front.
- The divergence of the Ekman transport can homogenize the water column on the right side of the jet and stratify on the left.
- This mechanism may play a role in the formation of the Ushant front.

# Perspectives

- A better model is needed to represent the space-time variation of the diffusion.
- Is this mechanism involved in the spring-neap variation of the front?