# Dispersion of homogenized water in coastal areas
# Application to the Ushant Front

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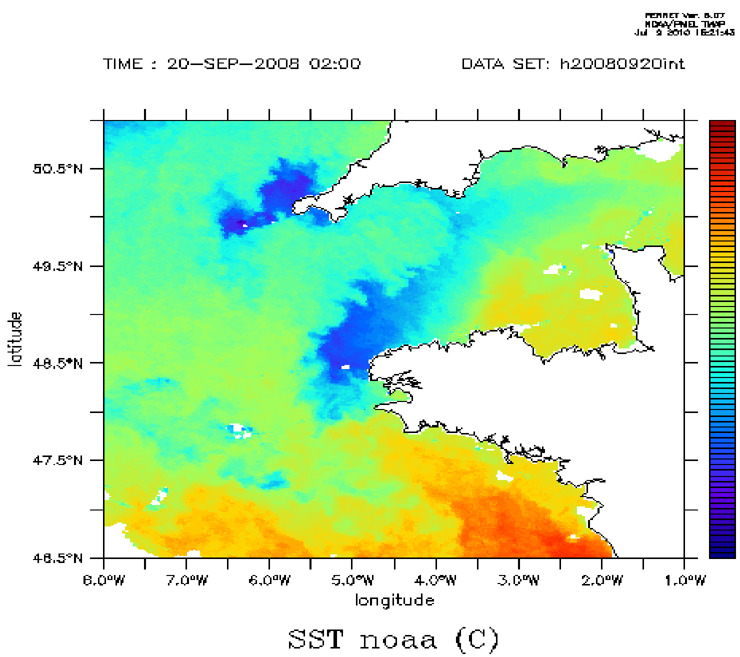
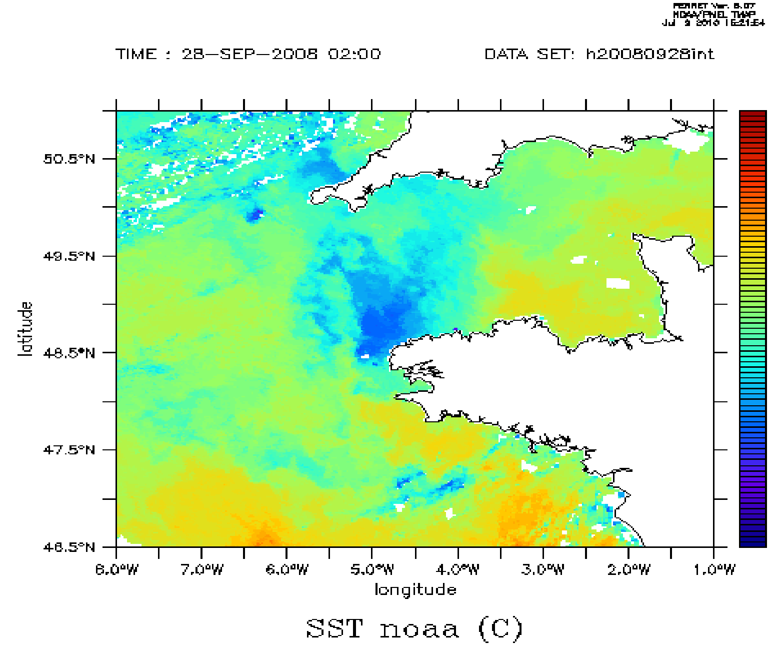
# *The Ushant Front*

**Environmental parameters:**
Tides
Atmospheric flux
Topography




SST NOAA 09.20.2008

**High variability in scale and time**

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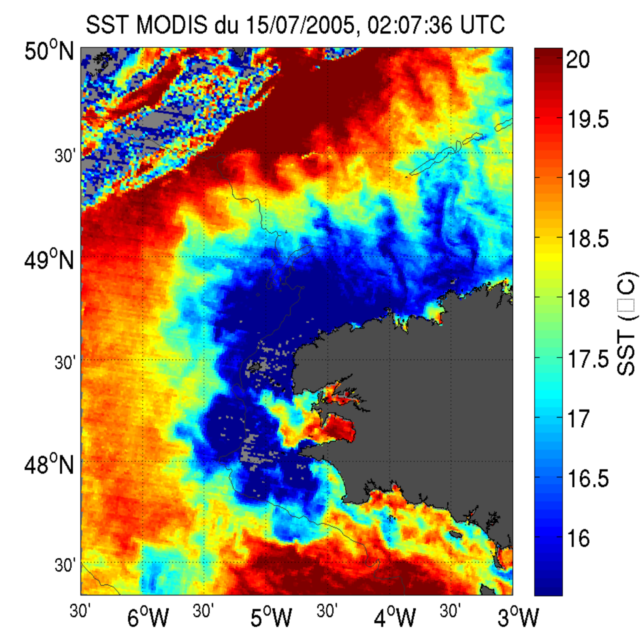



SST NOAA 07.15.2005

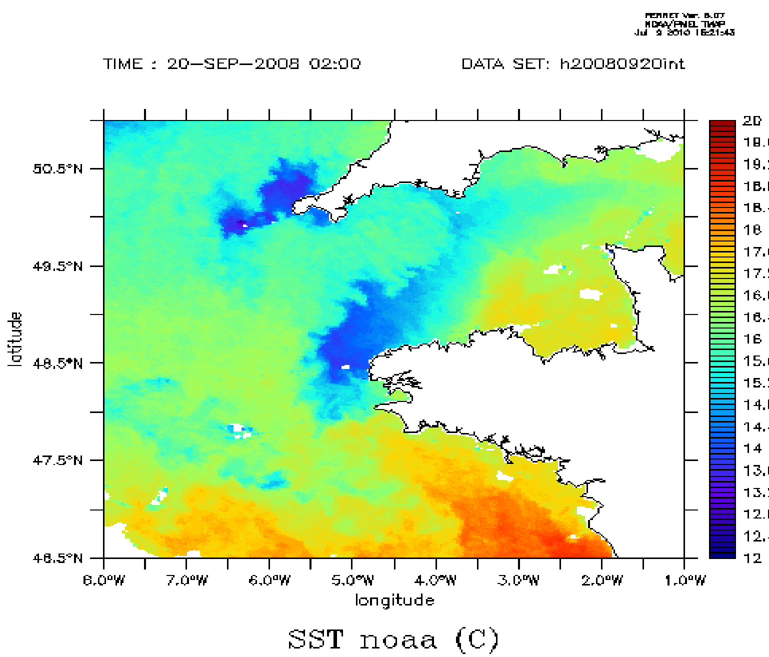
# *The Ushant Front modeling*

**Configuration parameters:**
Diapycnal mixing and barotropic current
Stratification
Bottom friction
Sloping topography

**Environmental parameters:**
Tides
Atmospheric flux
Topography

Understanding of front extension mechanisms with MICOM *( sensitivity studies such as in Schiller and Kourafalou, 2010)*

Efficiency of HYCOM to model the Ushant Front?

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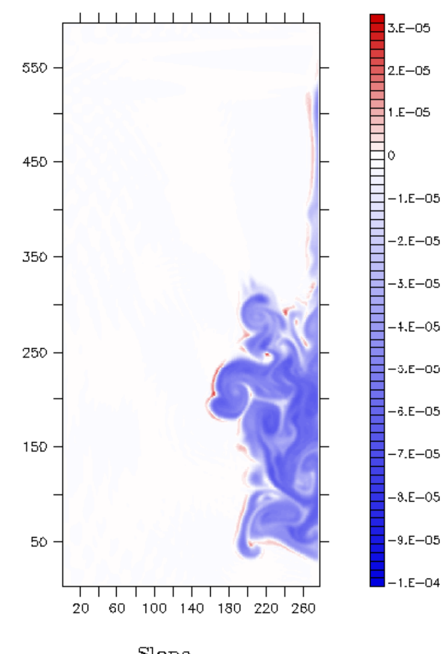
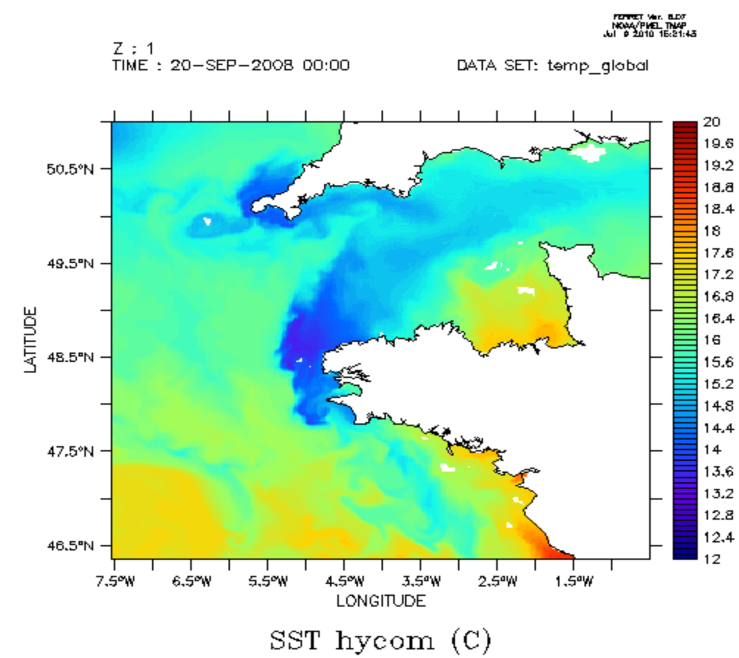


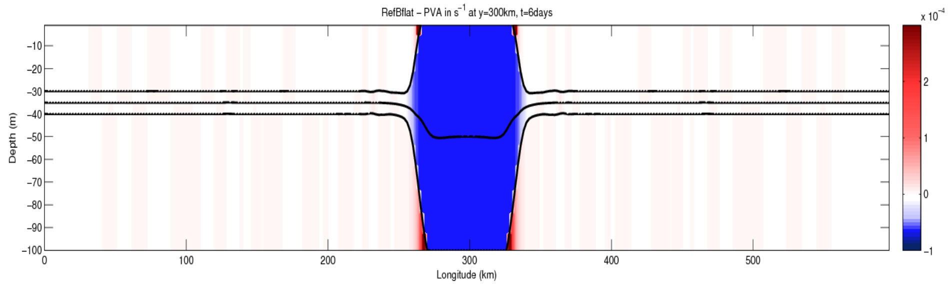

PVA in mixed water layer, MICOM

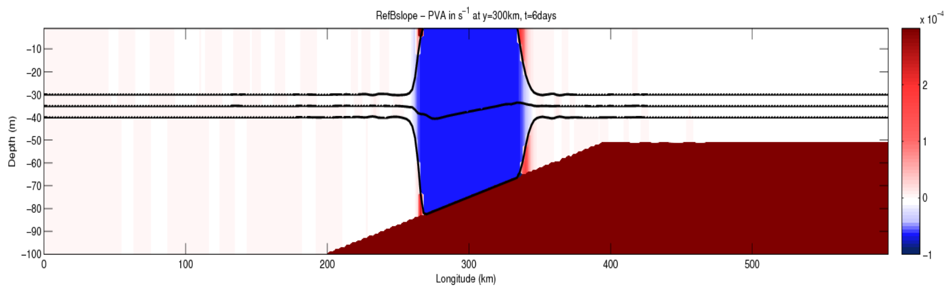



SST HYCOM 09.20.2008

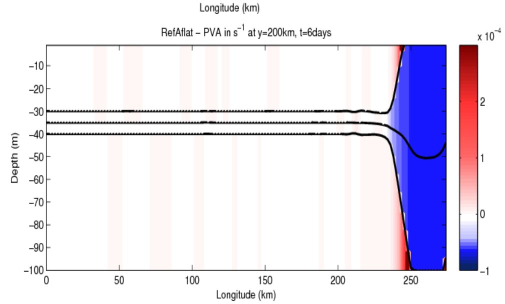
# *Dispersion of homogenized water*
## *MICOM academical sensitivity studies*

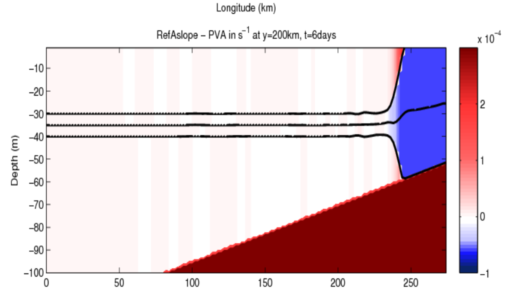
### Reference experiments




PVA at t=6 days:
Centered conf. (top)
Coastal conf. (bottom)




**Initial configuration parameters:**
Diapycnal mixing: $K_v$= 0.005 m²/s
Stratification: $\Delta\varrho$ = 0.5 o/oo
No bottom friction (*Cd* =0)
Slope: $\alpha$= 0 or 25/100000

**Baroclinic instability and frontal initial configurations**

PVA $\leftrightarrow$ mass flux in 2$^{nd}$ and 3$^{rd}$ layers
*(Haynes and Mac Intyre, 1987, 1990; Morel and Mac Williams, 2000)*

Baroclinic instability production and hetons emergence from the ZMP *(Charney Stern Criterion; Morel and Mac Williams, 2000)*

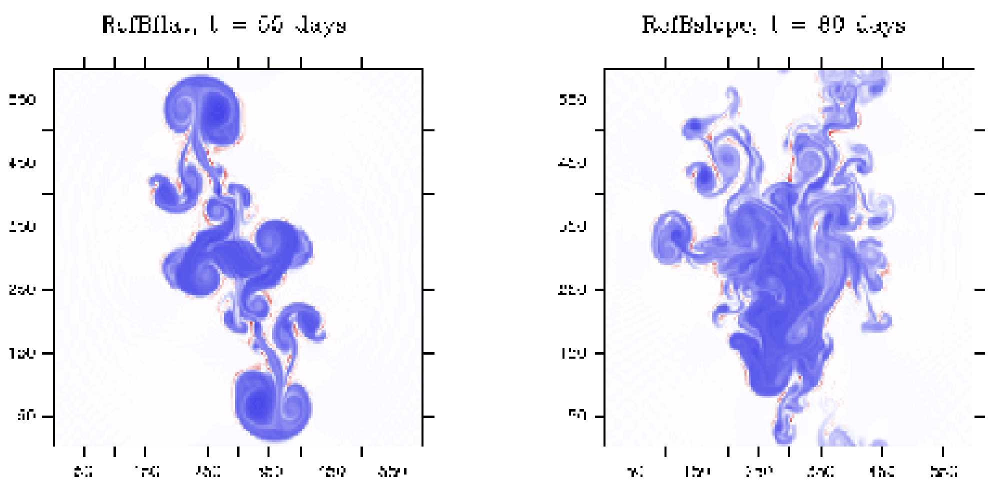
# *Dispersion of homogenized water*
## *MICOM academical sensitivity studies*

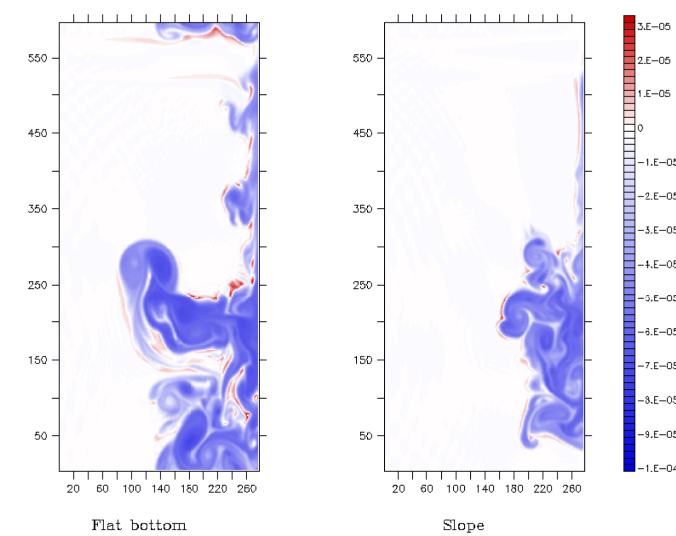
**Production rate**

Continuous homogenization of the ZMP ruled by *Kv*
Size of structures of instabiliy depending on $\Delta\varrho$

**Dispersion mechanisms**

| | |
|---|---|
| Dipolar interactions | $\alpha$, $\Delta\varrho$, *Kv*, *Cd* |
| Mirror effects (near vertical wall) | *d (distance from wall)* |
| Topographic beta effects | $\alpha$, $\Delta\varrho$ |
| Kelvin waves | $\alpha$ |






PVA in 2nd layer, centered (flat,slope)

PVA in 2nd layer, coastal (flat,slope)

# *Dispersion of homogenized water*
## *MICOM academical sensitivity studies*

**Dispersion assessment**

Properties to consider :

- Production rate

- Dispersion rate $r_i(t) = \frac{1}{S_{ZMP}} \partial_t (V_2 + V_3)$

- Global rate of dispersion = time averaged $r_i(t)$

- Preferential direction of dispersion mechanisms

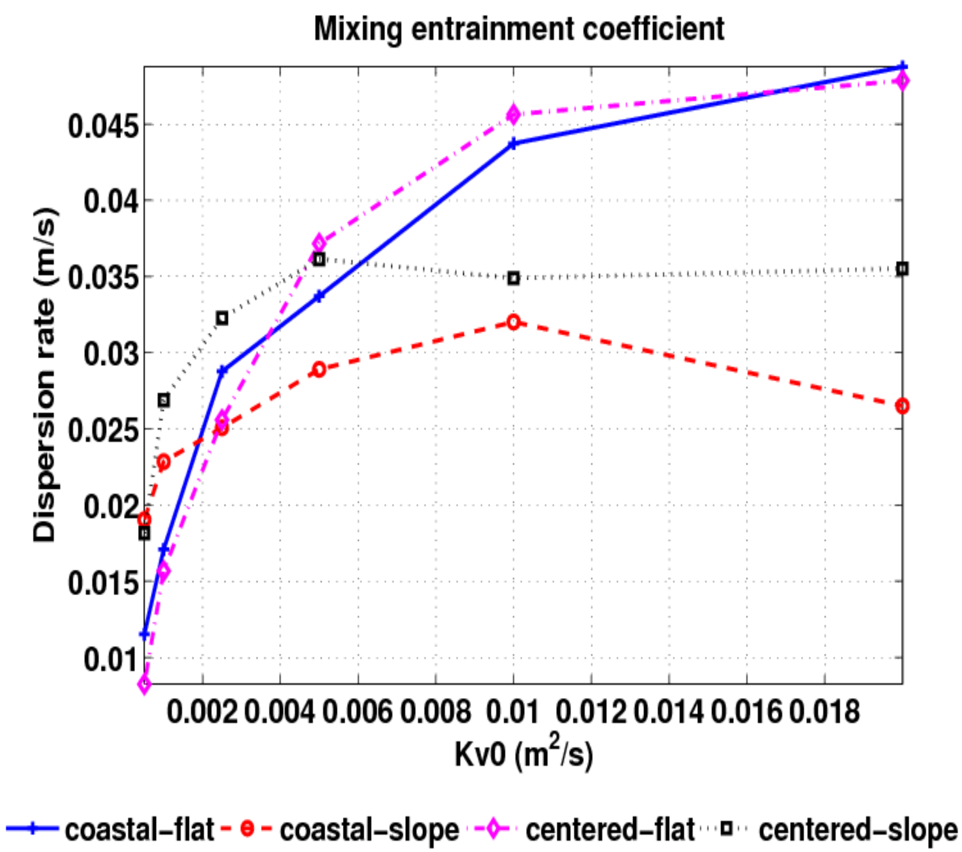
***Global dispersion rate $r_d$ ~ 0.01 – 0.1 m/s***

# *Dispersion of homogenized water*

*MICOM academical sensitivity studies*

**Global dispersion**

*Diapycnal mixing*




$$\hat{T} = \frac{T_{clearing}}{T_{homogenization}} = C_1 \frac{LKv}{r_d}$$

Three regimes:

T << 1 → Kv limits the dispersion rate, ***sub productive regime***

T ~ 1 → Dispersion and production equilibrate, ***efficient regime***

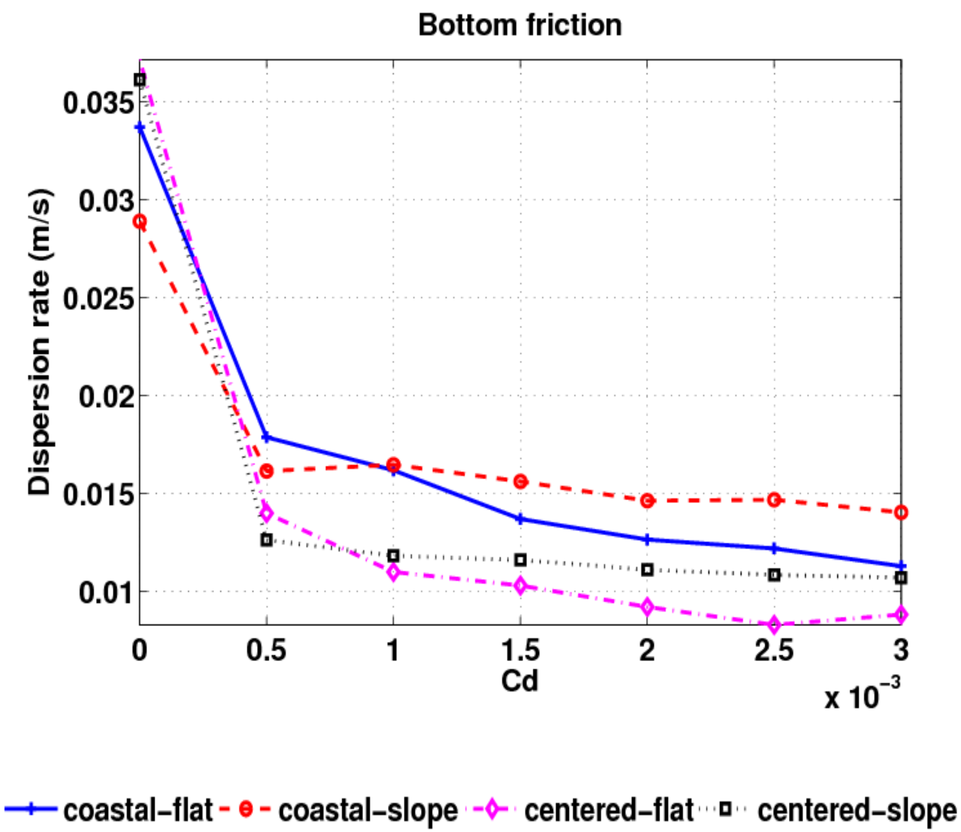
T >> 1 → dispersion mechanisms limits the dispersion rate, ***auto restrictive regime***

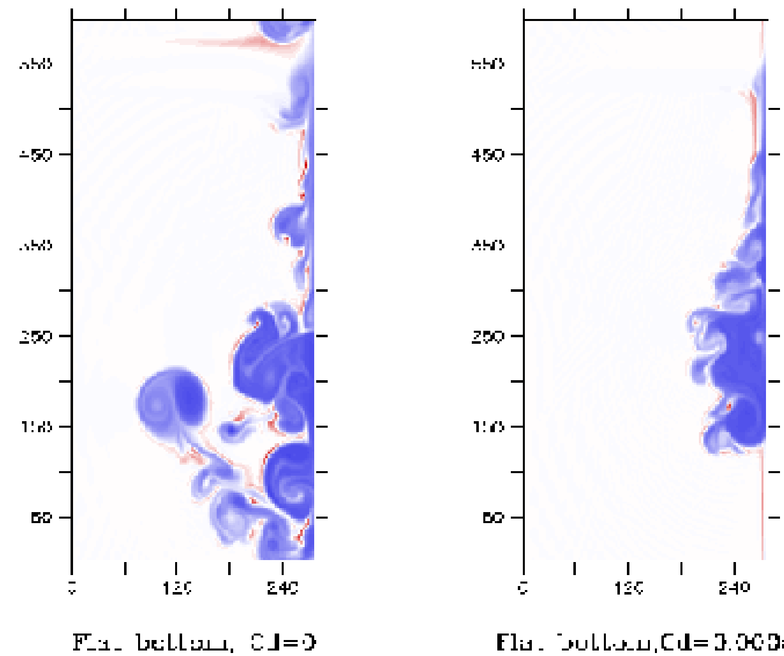
***The diapycnal mixing impact on dispersion is limited by dispersive mechanisms ability to clear the ZMP from mixed water.***

# *Dispersion of homogenized water*
*MICOM academical sensitivity studies*

**Global dispersion**

*Diapycnal mixing and bottom friction*



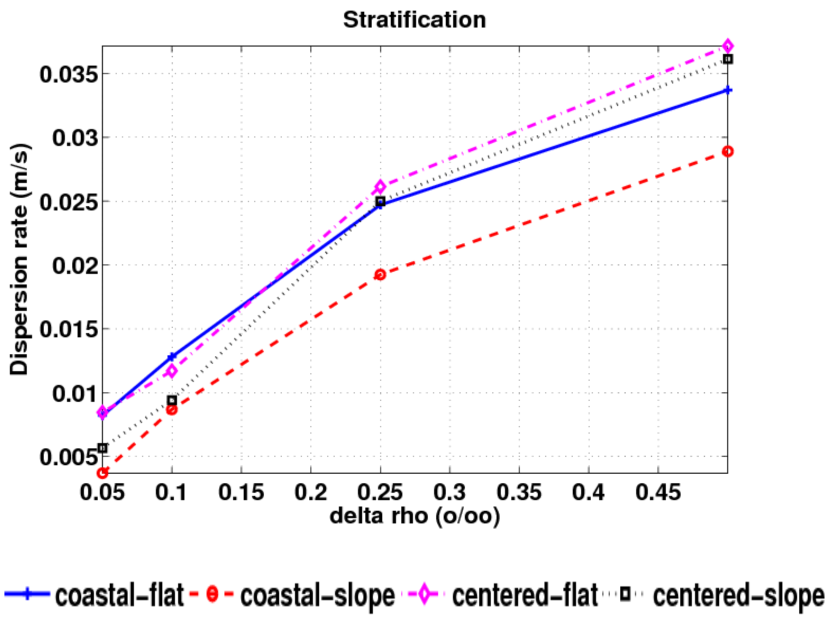



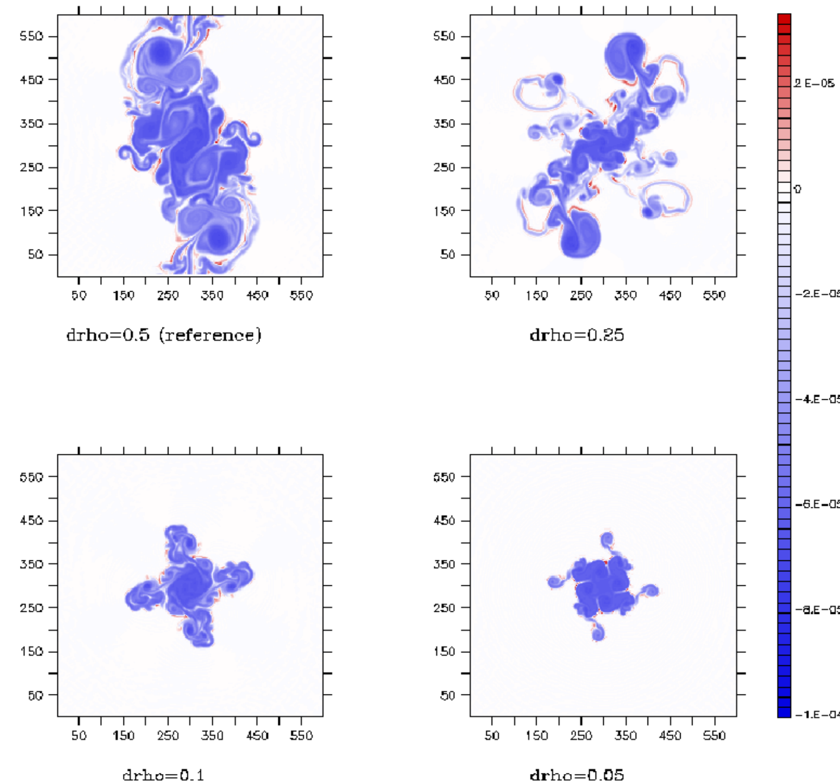
PVA in the 2$^{nd}$ layer above a flat bottom cd=0 (left), cd=0.0005 (right)

***Most of the friction effect is reached for cd=0.0005, with half of the dispersion rate damped.***

# *Dispersion of homogenized water*
## *MICOM academical sensitivity studies*

**Global dispersion**
*Stratification*



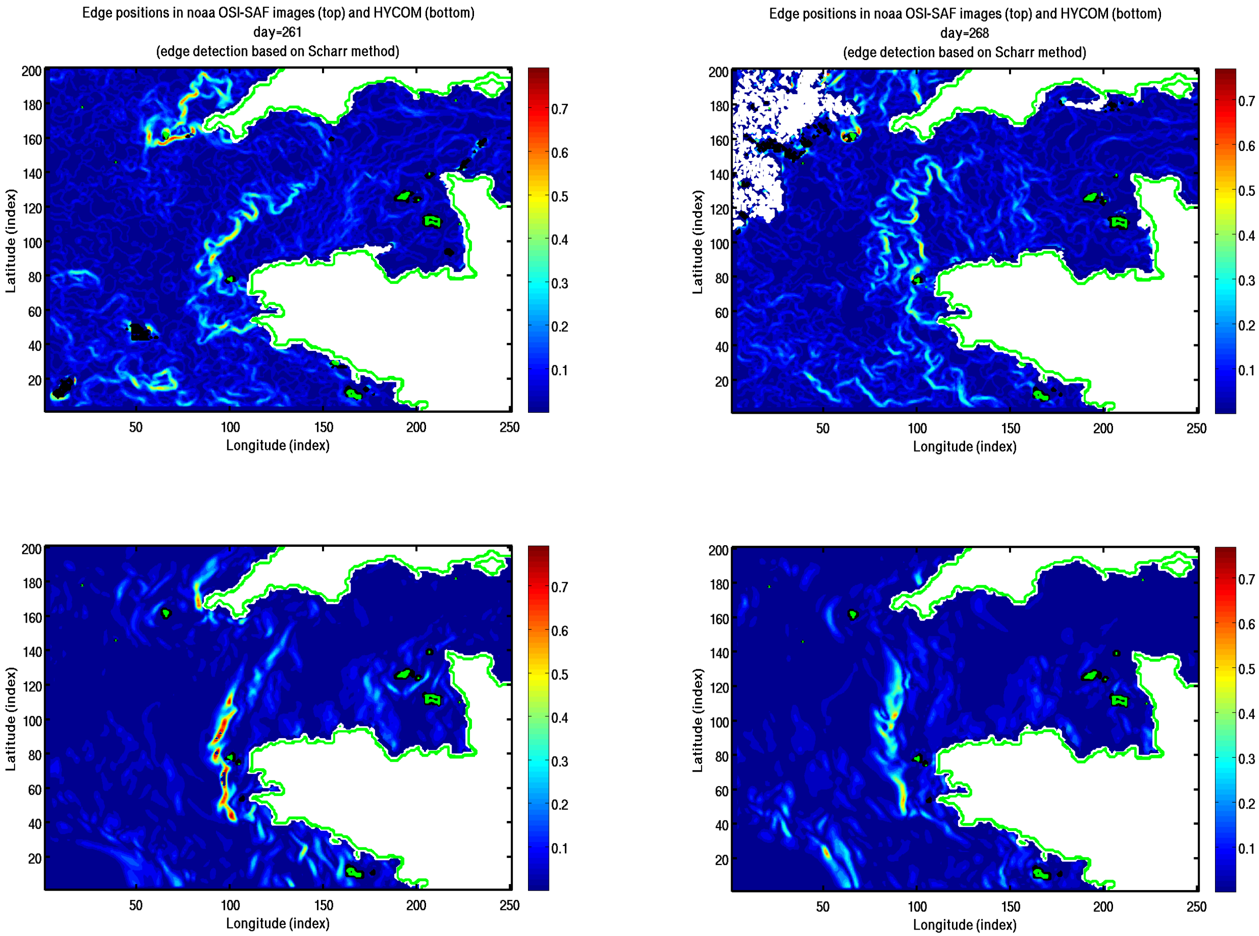

2nd layer PVA, centered flat experiment

Increasing the stratification :
1. Enhances the production rate and the size of structures
2. Weakens the coupling between layers

***A stronger stratification favors dispersion mixed water.***

# *Dispersion of homogenized water*

## *Application to the Ushant Front in realistic configurations*




09.20.2008

09.28.2008

**HYCOM parameters**
32 layers
Grid step: 1.7 km
KPP
Atmospheric forcing CEP
Nesting Mercator

**Aim**
1. Correlation between environmental forcings and different front dispersion patterns using HYCOM outputs

2. Assessing the impact of configuration parameters in HYCOM on the front edges

Edge detection based on a Scharr method, on satellite images (top) and Hycom outputs (bottom)

# *Conclusion*

Academical studies give information on the impact of  realistic environmental parameters on the Ushant Front:

 A sloping topography reduces dispersion and shapes the dispersed water in a plume that follows slope gradients

 Strong tides have a limited impact on the front extension in areas where dispersive mechanisms are weak

The stratification strengthening in summer is necessary for the front to form and to develop.

Weak uncertainties on bottom friction parametrization can drastically impact the model efficiency to reproduce frontal dynamics.