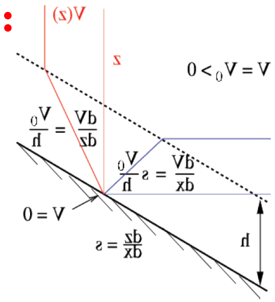
Topographic generation of submesoscale

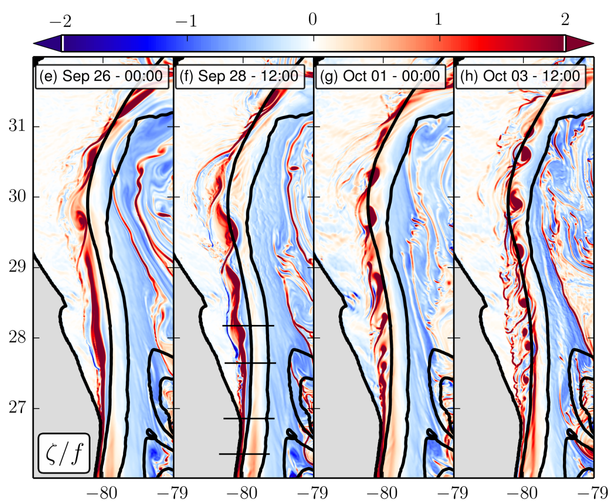
Positive vorticity generation :



Current flowing in the opposite direction of topographic waves [with the coast on its left in the Northern hemisphere]

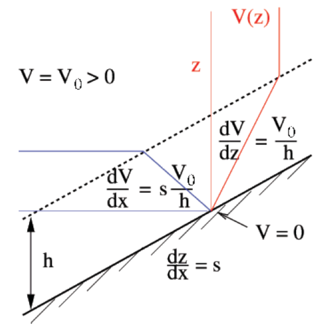
- Horizontal shear instability
- Formation of submesoscale cyclones

e.g.: *Gulf Stream along the slope*



[Gula et al., GRL, 2015]

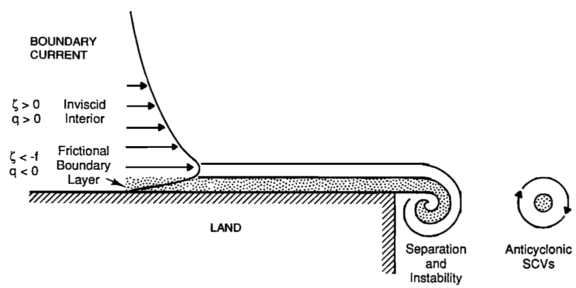
Negative vorticity generation:



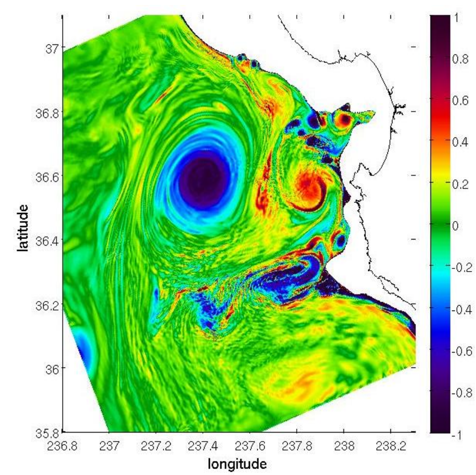
Current flowing in the direction of topographic waves [with the coast on its right in the Northern hemisphere]

- Centrifugal instability
- Small-scale turbulence, mixing and dissipation
- Formation of submesoscale anticyclones

e.g. *California Undercurrent (formation of Cuddies)*



[D'Asaro, JGR, 1988]

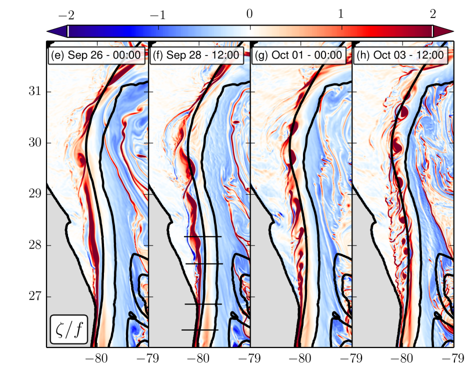


[Molemaker et al., JPO, 2015]

Topographic generation of submesoscale

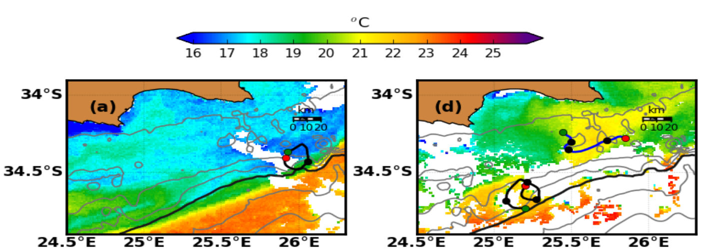
Positive vorticity generation :

- *Gulf Stream along the continental slope*



[Gula et al., GRL, 2015]

- *Agulhas Current*

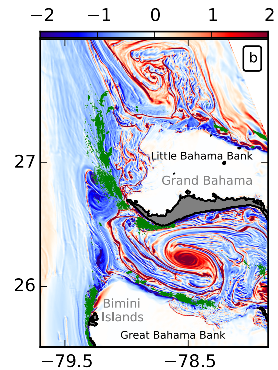


[Krug et al., GRL, 2017]

+ stage M2 P. Tedesco (with P.Penven)

+ Demande thèse ARED-Labex (with P.Penven)

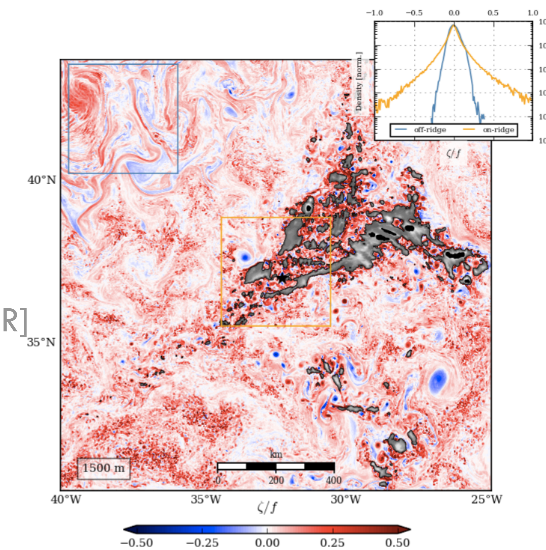
Negative vorticity generation:



- *Gulf Stream along the Bahamas*

[Gula et al., NC, 2016]

- *Deep currents on the Mid-Atlantic Ridge*

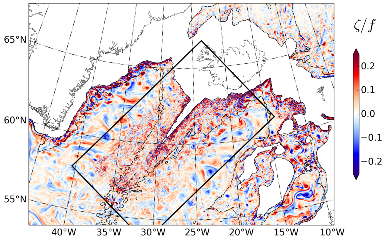


[Vic et al., to be submitted to DSR]

+ Postdoc N. Layahe

(18 month starting Feb. 17,

with G. Roullet)



- *Flow topography interactions on the Reykjanes Ridge*

+ PhD M. LeCorre,

(with A.M. Tréguier)

Topographic generation of submesoscale

Directions:

- Keep on investigating topographic processes and generation of SCV's in different regions, test Non-hydrostatic effects *[Regional modelling, NH modelling]*

- Find more observations of bottom boundary layer processes and SCV's *[Moorings + gliders + floats + dedicated experiments]*
  - Some ongoing work and projects: SCV's in the Gulf Stream, SCV's in the North Atlantic Subpolar Gyre, SCV's in the DWBC

- Quantify the impact of topographic submesoscale processes in the global energy budget *[basin-scale or global simulations at high-res (< 1km)]*

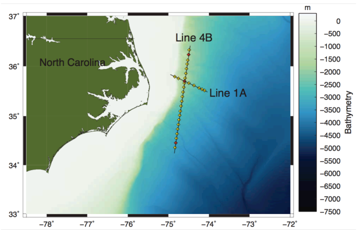
- Quantify the rate of formation of the SCV's and determine how important they are to the ventilation of the interior ocean and to the transport of water masses *[basin-scale or global simulations at high-res (< 1km)]*

Topographic generation of submesoscale

Some ongoing work and projects:

- SCV's in the Gulf Stream
- SCV's in the North Atlantic Subpolar Gyre
- SCV's in the DWBC
- Topographic generation of PV

1. SCV's in the Gulf Stream

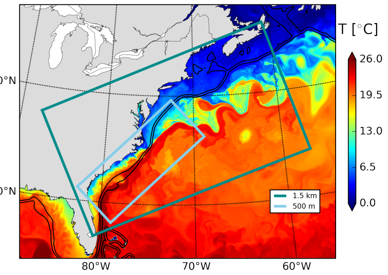


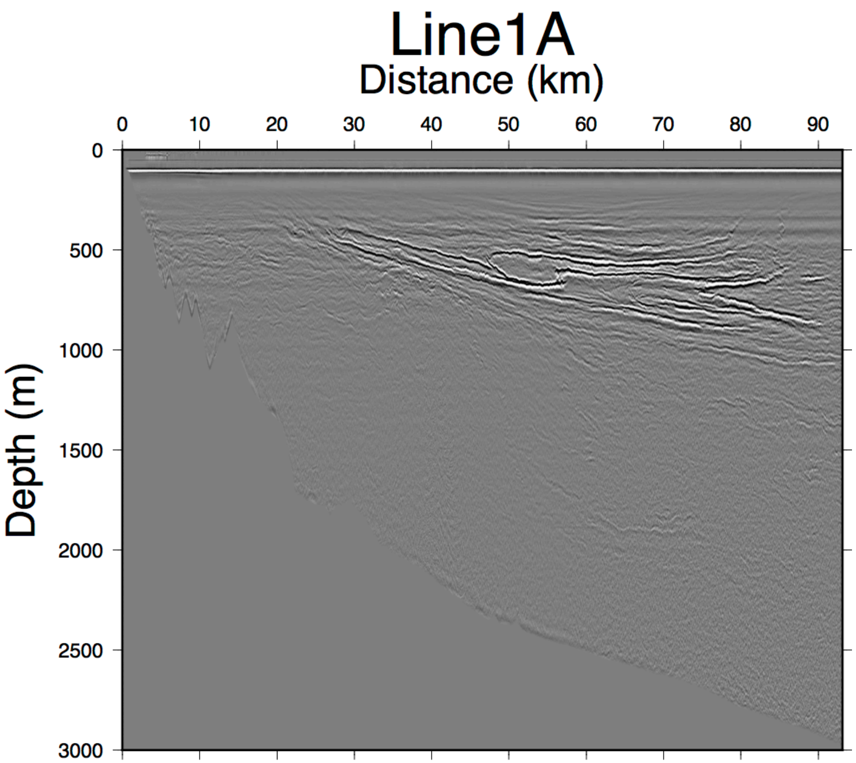
Seismic Data

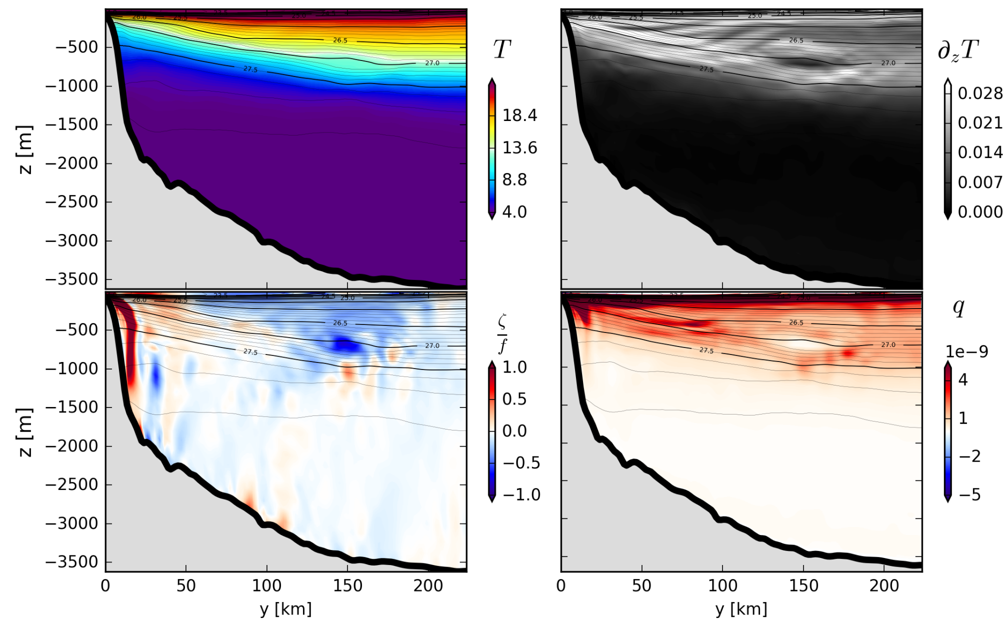
[T. Blacic, MSU]

ROMS model

$$\Delta x = 1.5\,\mathrm{km}$$







SCV's generation requires an intermittent source of low PV

1. SCV's in the Gulf Stream: Generation Process

Relative vorticity $(\pm f)$

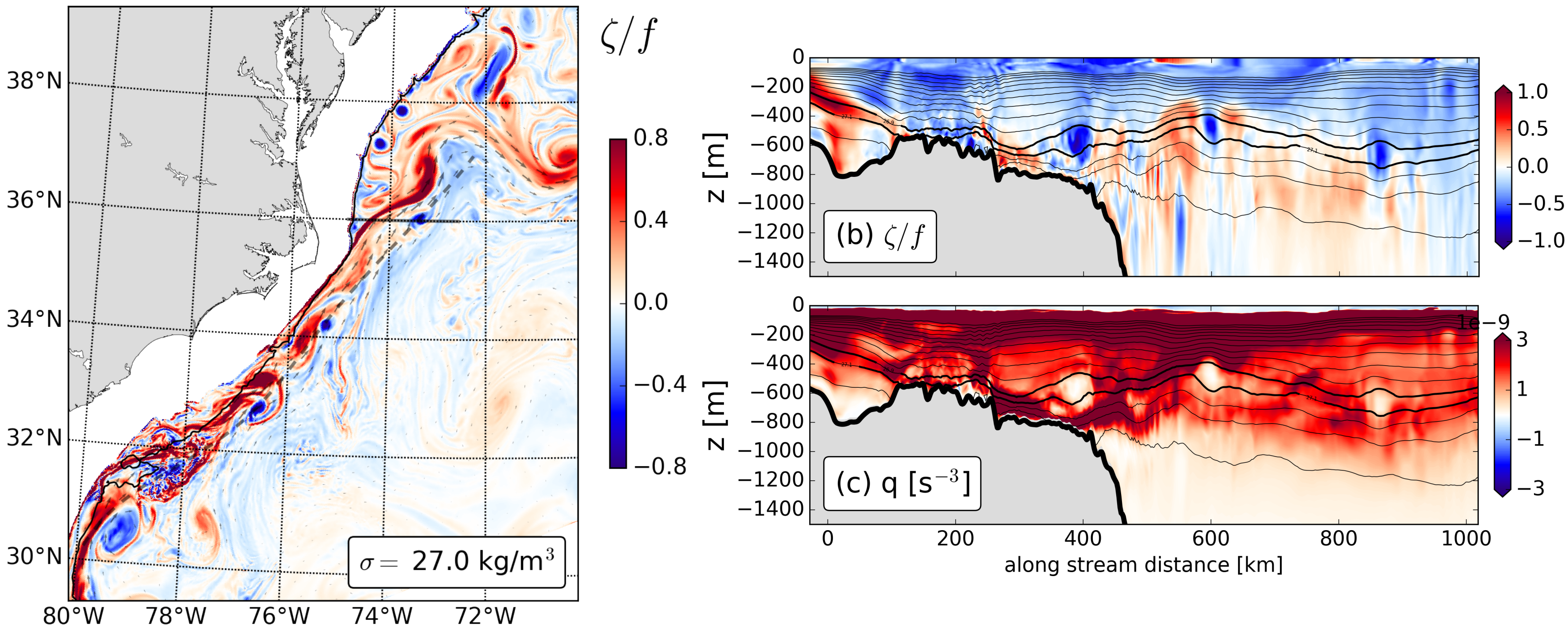
On the isopycnal $\sigma = 27\,\mathrm{kg\,m^{-3}}$

ROMS model

$\Delta x = 1.5\,\mathrm{km}$

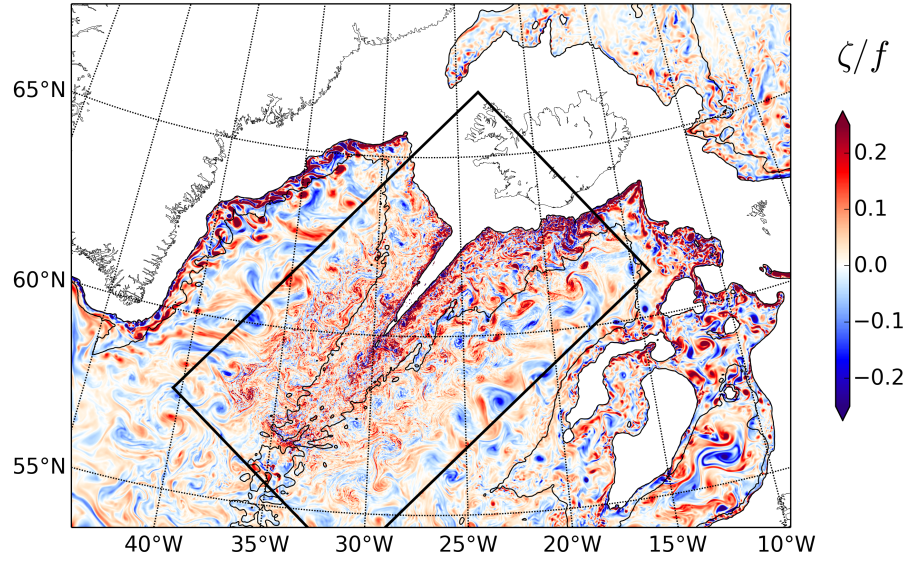
$200\,\mathrm{km}$

1. SCV's in the Gulf Stream: Generation Process

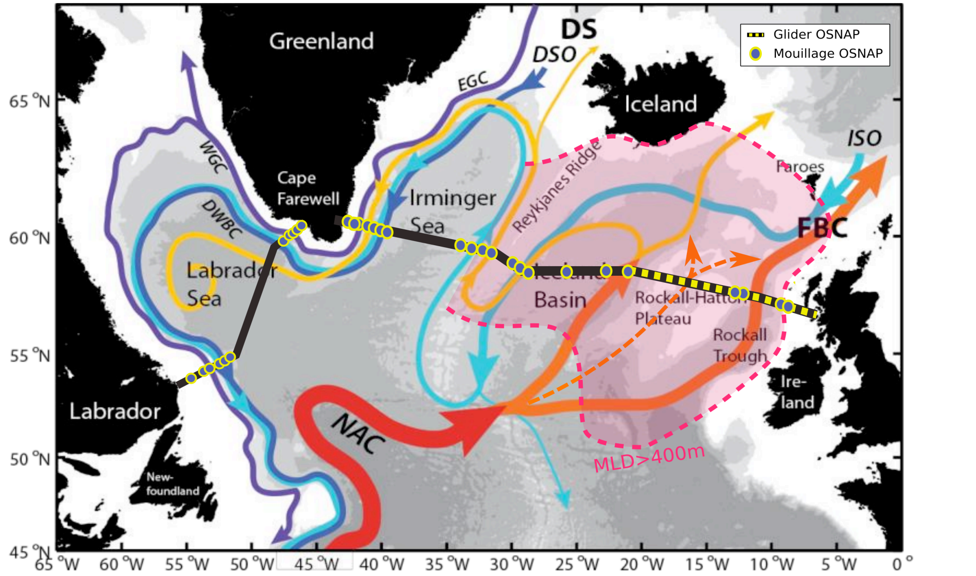


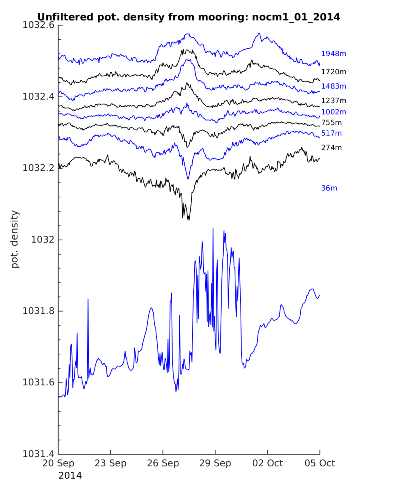
Negative vorticity / low PV generation = Gulf Stream interaction with the Charleston Bump

2. SCV's in the North Atlantic Subpolar Gyre



Model (1.5 km – 500 m)



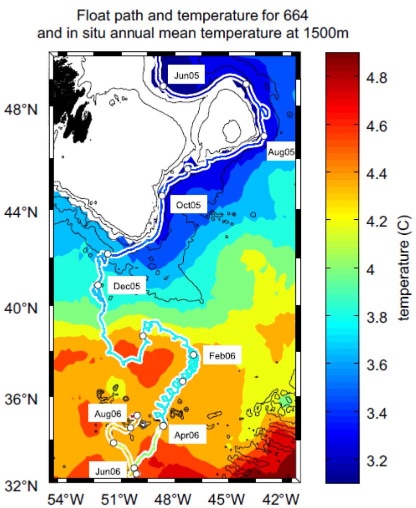


Moorings + gliders (OSNAP)
L. Houpert (SAMS, Scotland)

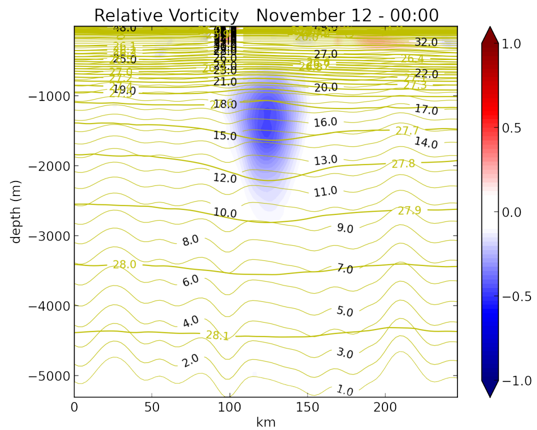
- Characterize the vertical structure and the dynamic of SCV's crossing the OSNAP mooring array + Statistics of SCV
- Comparison with model results

[Stage M2 - E. Duyck]

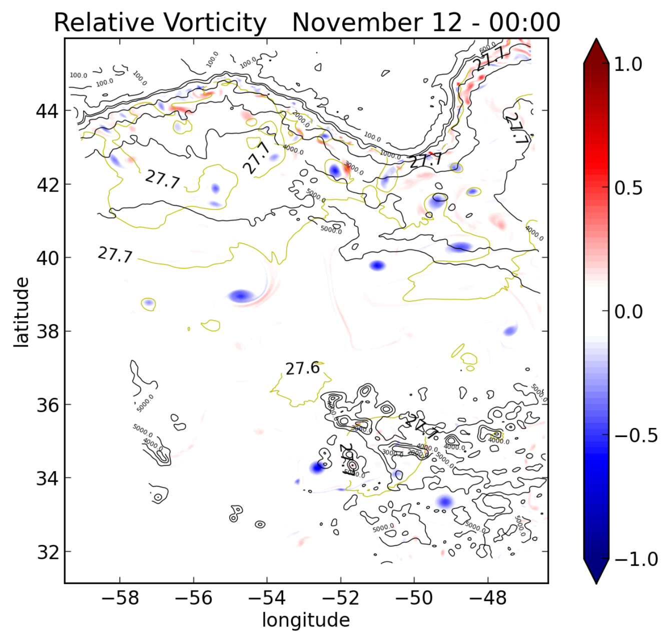
3. SCV's in the DWBC

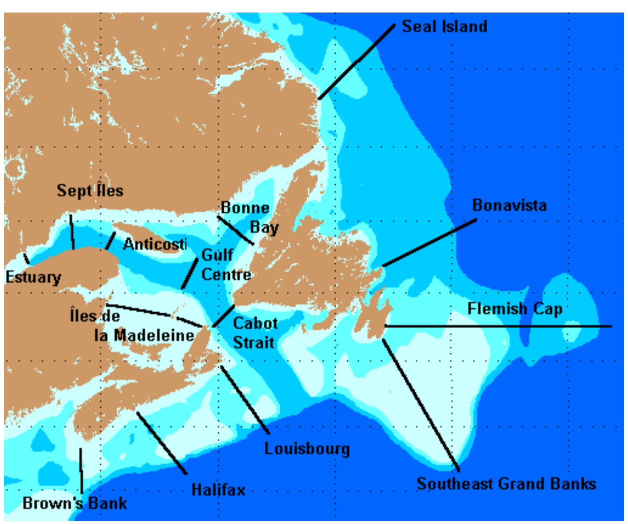


[Bower et al., DSR, 2013]



Model (2.5 km)



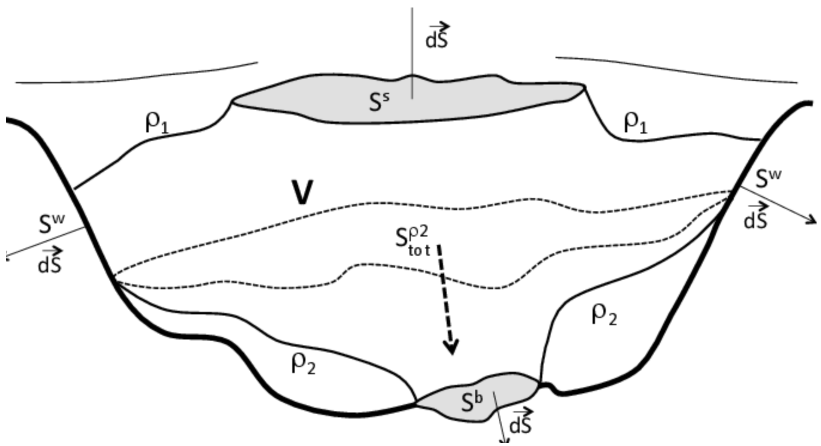


Moorings + Cruise + glider?

F. Cyr (DFO, Newfoundland)

4. Topographic generation of Potential Vorticity

With Y. Morel and A. Ponte



$$\frac{\partial q}{\partial t} + \vec{\nabla}.[\underbrace{q\vec{u}}_{\text{adv.}} - \underbrace{\vec{\omega_a}.\frac{D\chi}{Dt}}_{\text{diab.}} + \underbrace{\vec{\nabla}\chi \times \vec{F}}_{\text{nonconser.}}] = 0$$

Generation of PV at the bottom boundary layer by frictional effects and diapycnal mixing.

Theory + idealized experiments