Overview of the SHOM activities

Process studies to operational modeling

Flav Gouillon, Cyril Lathuilière,

and the SHOM team

LOMW, 2013

Outline

1. Process Studies

2. Model improvement

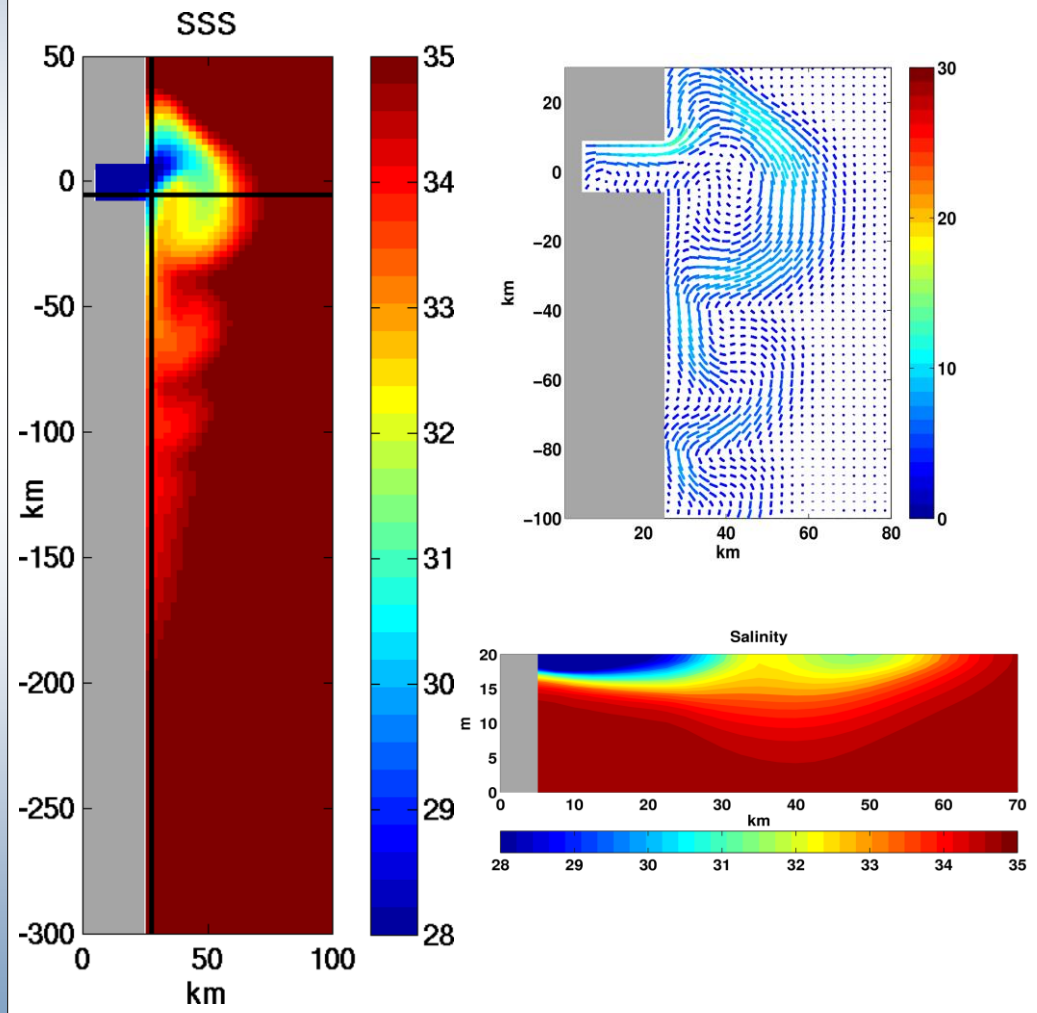
3. Ongoing configurations

4. Perspectives

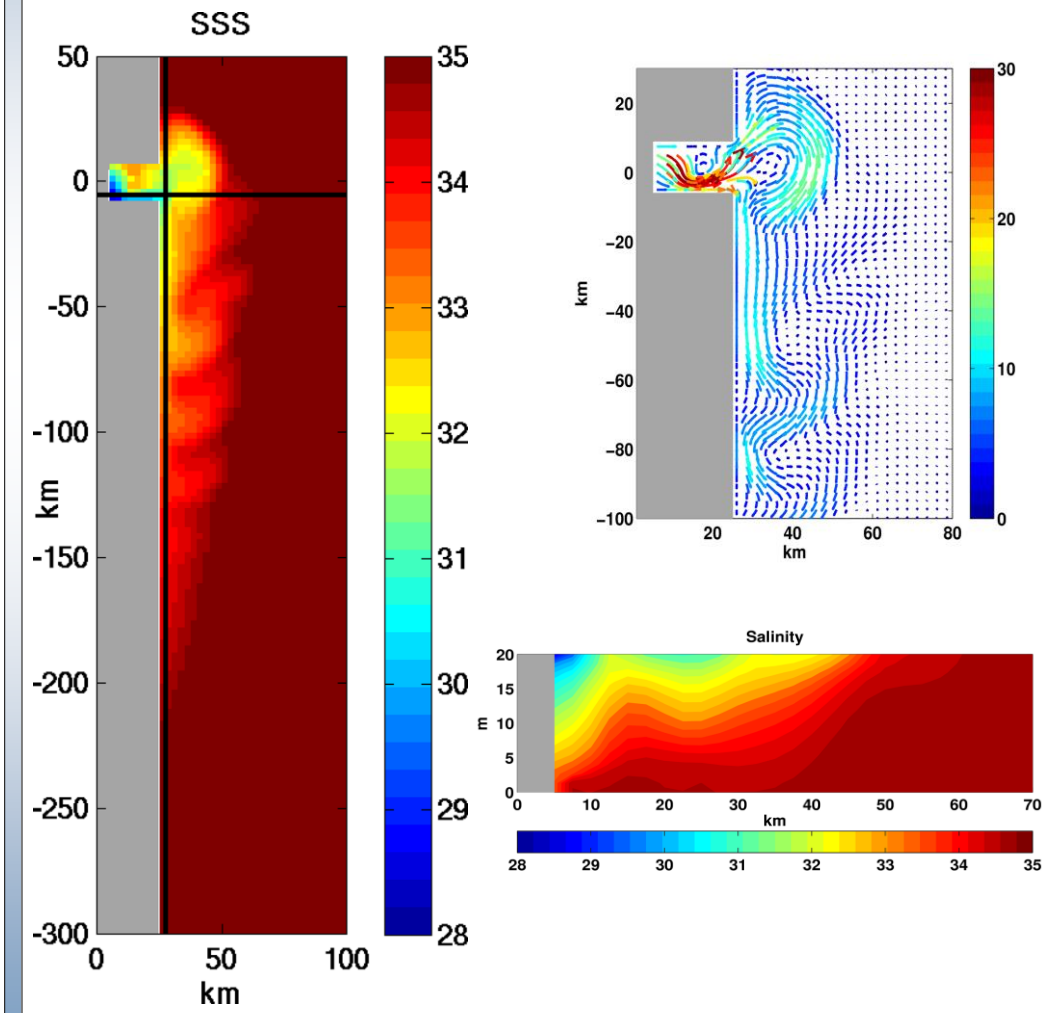
River Plume

F. Gouillon, *M. Boutet, R. Baraille, C. Lathuiliere, Y. Morel, V. Kourafalou*

Salinity relaxation



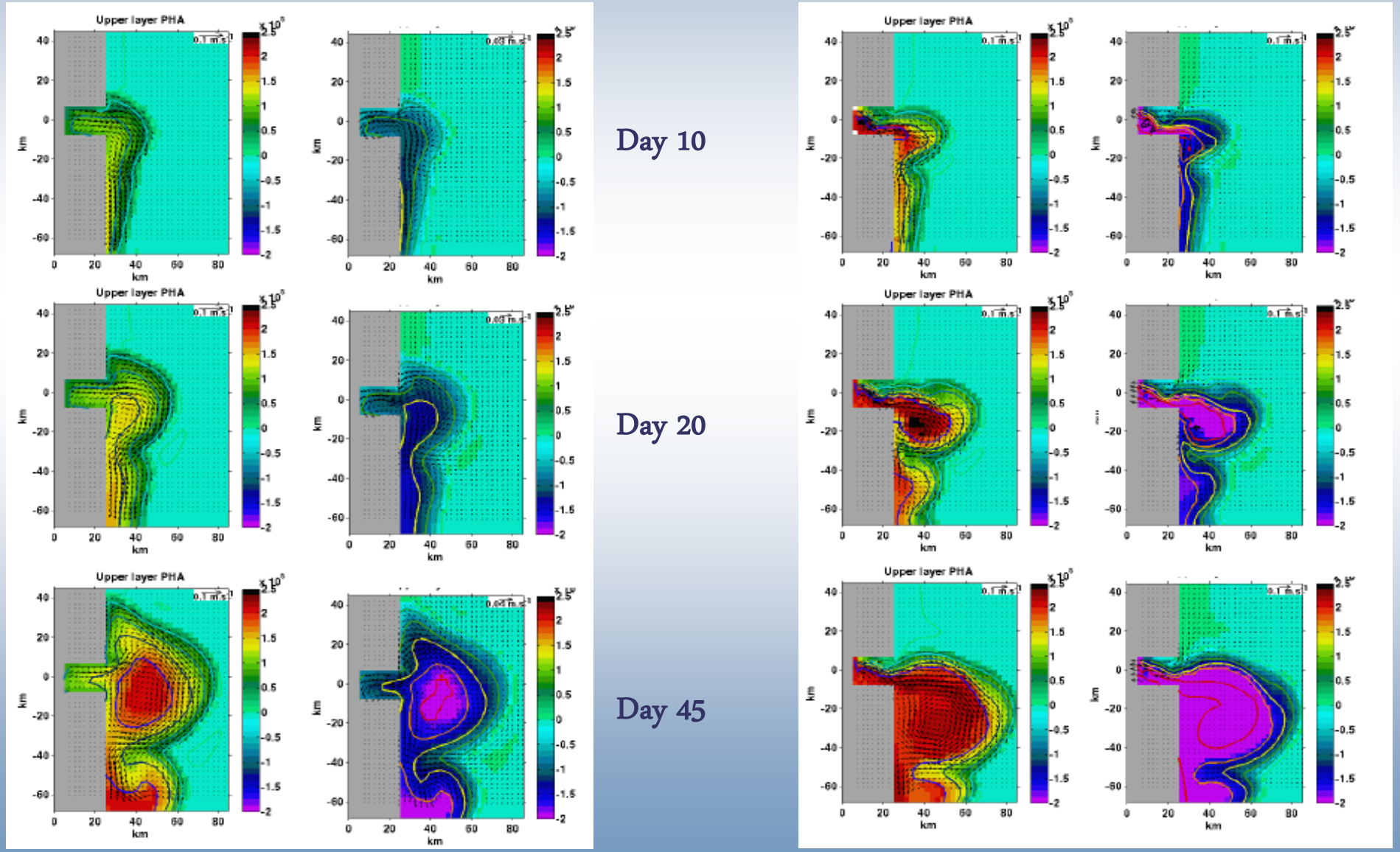
Mass Flux



River Plume

F. Gouillon, *M. Boutet, R. Baraille, C. Lathuiliere, Y. Morel, V. Kourafalou*

Salinity relaxation | 1/PV | **Mass Flux**



Potential vorticity diagnostics for river plume modeling (Gouillon et al., in prep)

Super-inertial tides over irregular narrow shelves (PhD work from Luis Quaresma)

L. Quaresma, A. Pichon

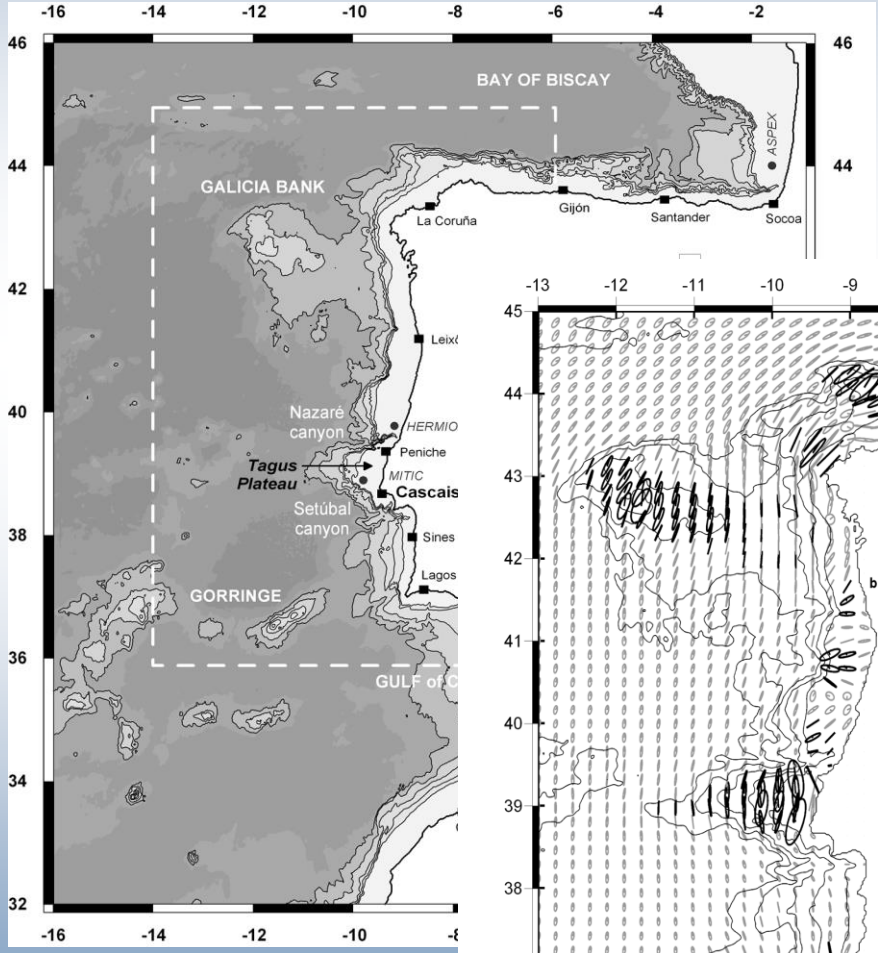
HYCOM in pure isopycnal configuration

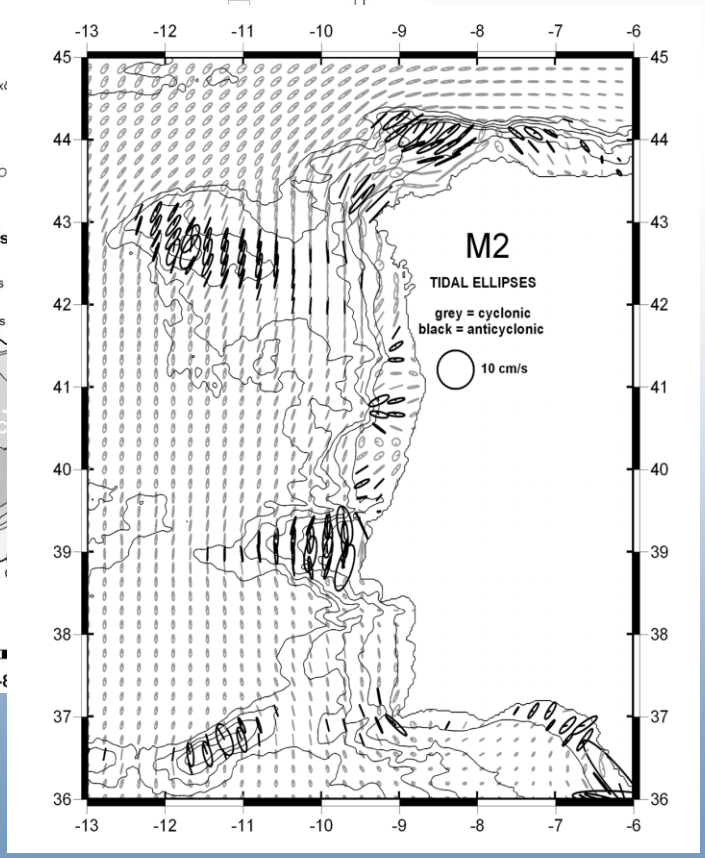
Bathymetry:
WIBM2009 (New DTM product from HIDROGRAFICO and SHOM hydrographic database)

Tidal Forcing:
Optimized polychromatic harmonic ensemble from MOG2D (*Lyard et al.* 2006) & TPXO (*Egbert et al.* 1994) M2 S2 N2 K2 ; K1 O1 P1 Q1
Including local tidal potential and nodal corrections

Spatial resolution: 1 arc-minute

Parameterization:
Bottom, lateral and eddy viscosity parameterization





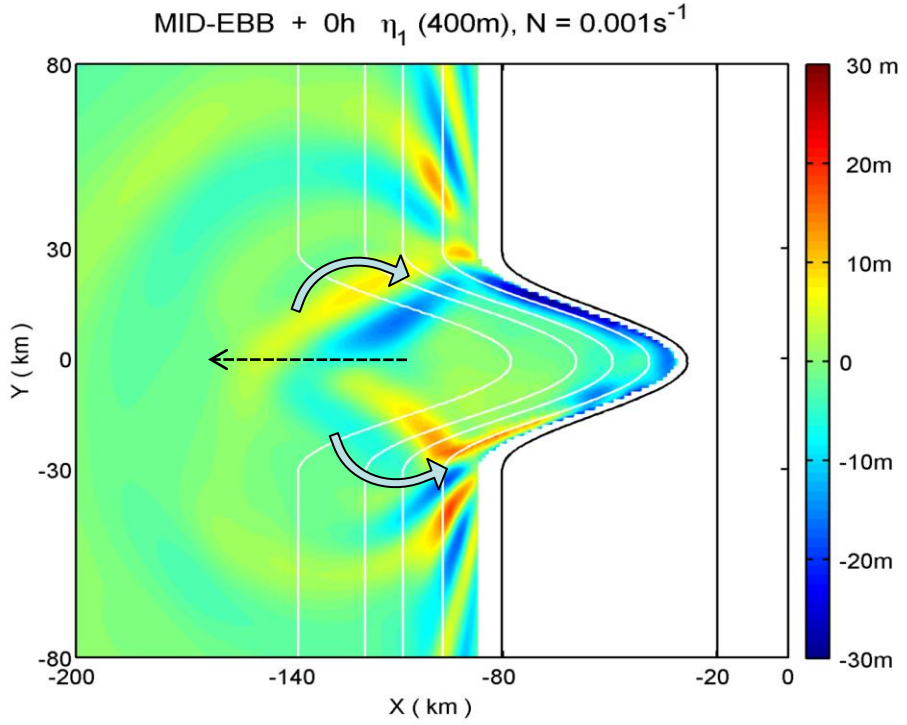
Quaresma & Pichon JMS 2013

Super-inertial tides over irregular narrow shelves (PhD work from Luis Quaresma)

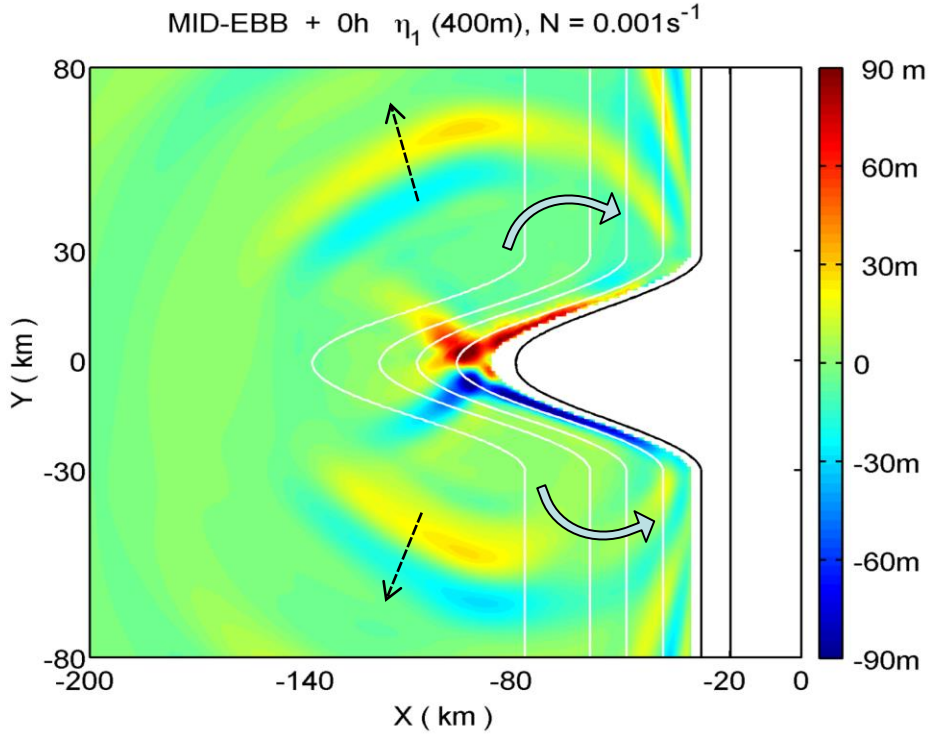
L. Quaresma, *A. Pichon*

Baroclinic tides: Results with continuous vertical stratification : N=cte

Submarine canyon



Promontory

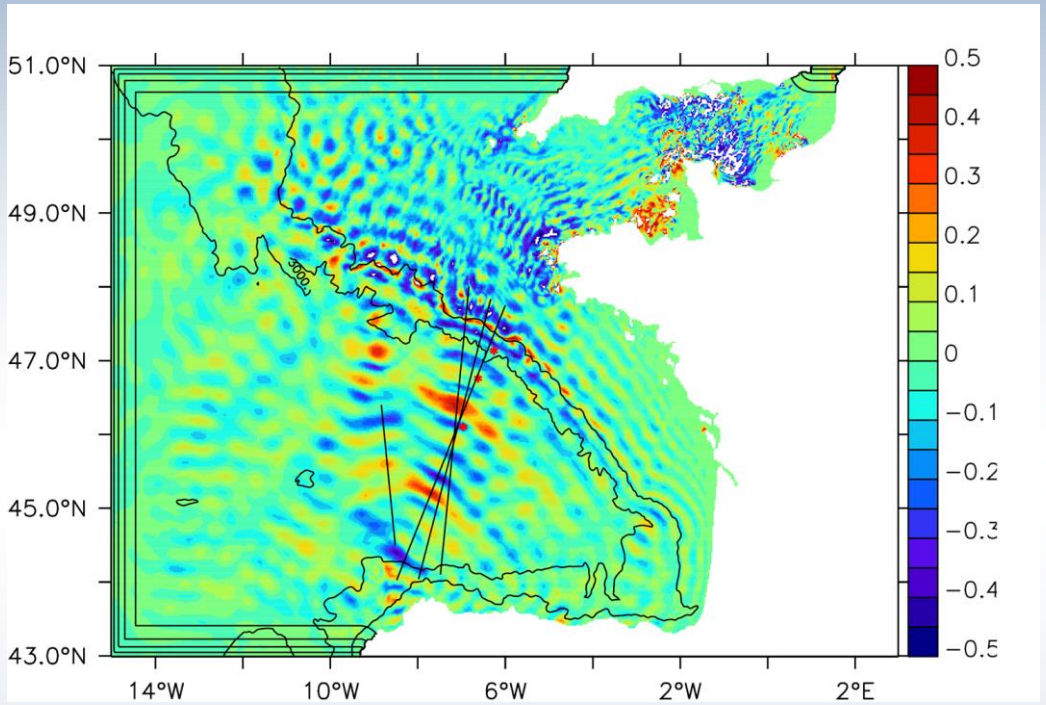


Both configurations scatter internal tidal beams perpendicularly to their rim.
Refraction processes occur over the slope deflecting waves on-shelf

Quaresma & Pichon submitted to JPO 2013

Internal tides in the Bay of Biscay

A. Pichon, F. Floc'h



North-South Baroclinic component in the surface layer.

ITs (from HYCOM) are amplified over the shelf break and along a section crossing the Bay of Biscay as seen on SAR imagery

To improve comparison with SAR imagery, non hydrostatic effects have to be introduced → production of ISWs.

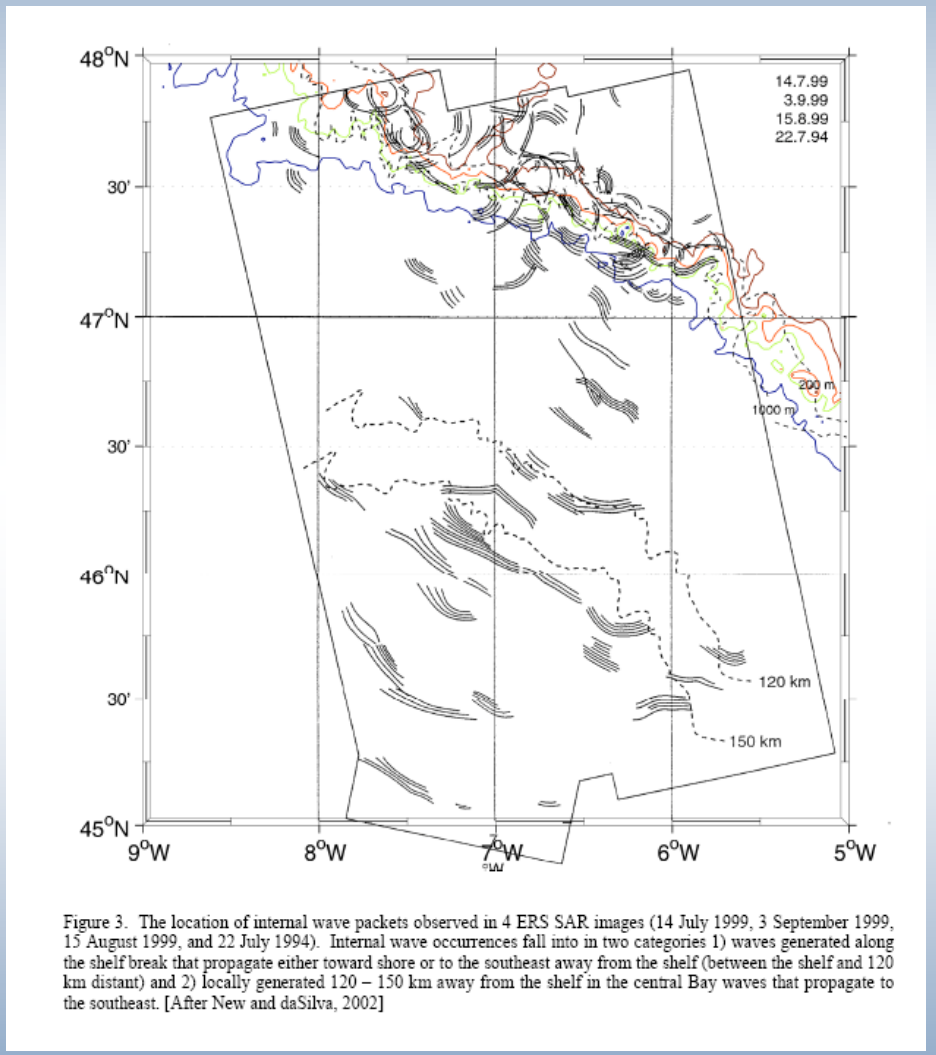


Figure 3. The location of internal wave packets observed in 4 ERS SAR images (14 July 1999, 3 September 1999, 15 August 1999, and 22 July 1994). Internal wave occurrences fall into in two categories 1) waves generated along the shelf break that propagate either toward shore or to the southeast away from the shelf (between the shelf and 120 km distant) and 2) locally generated 120 – 150 km away from the shelf in the central Bay waves that propagate to the southeast. [After New and daSilva, 2002]

Compilation of several SAR images issued from Atlas of Oceanic Internal Solitary Waves (ONR 2004).

HYCOM Internal Tide modelling compared with observations *(A.Pichon et al. JMS 109-110, 2013)*

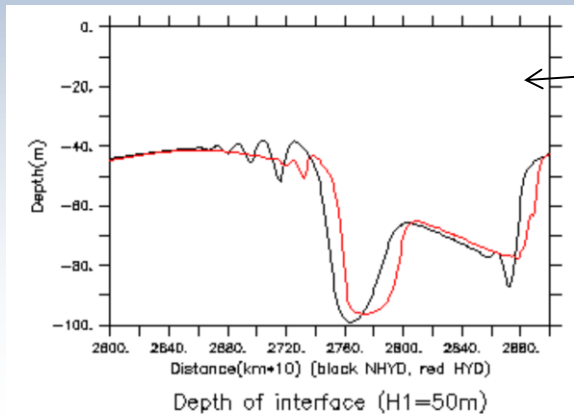
Non-hydrostatic effects

A. Pichon, F. Floc'h

Non hydrostatic (NH) effects are introduced in non linear (NL) momentum equations *Diebels et al.* (1994)

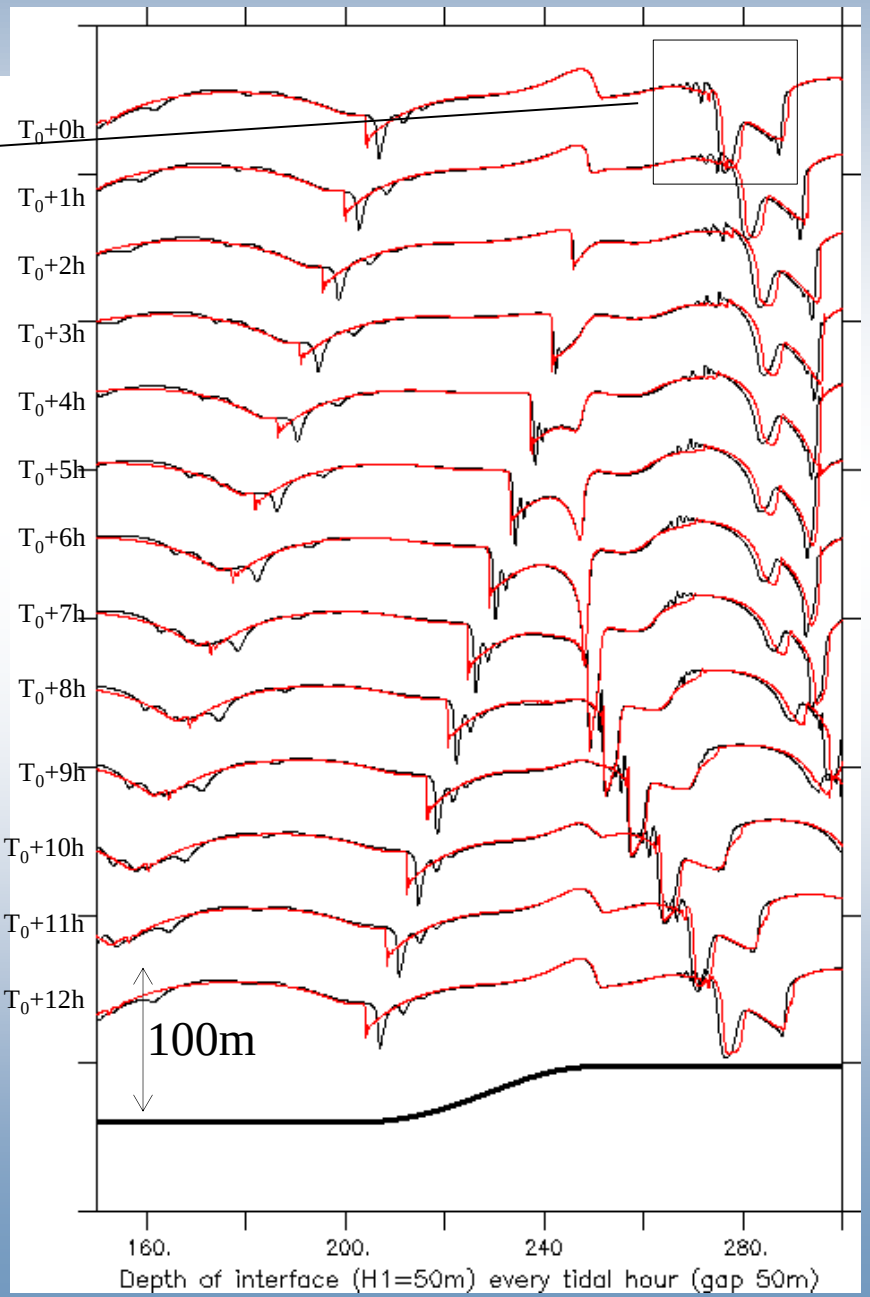
Weak NH and NL effects

Horizontally momentum equations are expressed by a vertical average over each layer where cross non NL/NH terms are neglected.



Weakly Non-Hydrostatic

Hydrostatic



For more details see the poster

Bottom friction optimization for barotropic tidal modelling using HYCOM: twin experiments

M. Boutet, *C. Lathuiliere, H. Son, R. Baraille, Y. Morel*

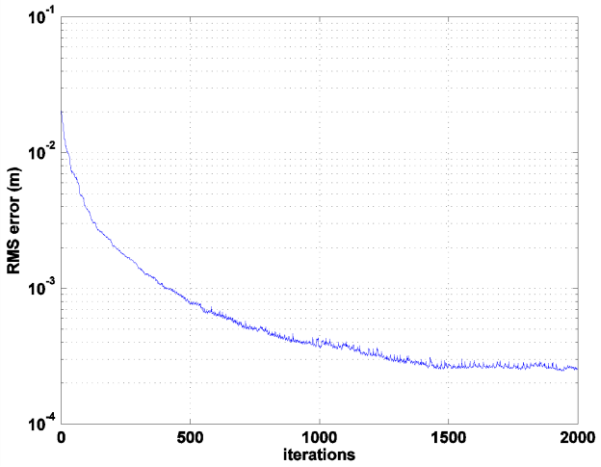
Bottom friction representation in HYCOM:

$$\tau = \frac{C_D \, u \, u}{H} \qquad C_D = \left[\frac{\kappa}{\ln\left(\frac{H}{z_0}\right) - 1} \right]^2$$

K: Von Kármán's constant
H: water height
z_0: bottom roughness

Development of stochastic methods for parameter estimation: Simultaneous Perturbation Stochastic Approximation algorithm (SPSA)

- Reference bottom roughness: uniform z_0=8mm
- Correct estimation for coastal areas
- Weak sensibility in pelagic areas



Model benchmark

C. Lathuiliere, F. Gouillon, R. Baraille

COMODO Research project (specific talk tomorrow)

—Improve the assessment of the numerical properties of ocean models.

—Improve the numerical scheme and guide the choice we do to model a specific process

Test cases panel

—A panel of case studies is build.

—We plan to automate this benchmark after every code modification (runs and diagnostics).

—We need to introduce new features for some academic cases (linear friction, constant vertical mixing, ...)

Waves – currents interactions

C. Ody, *C. Lathuiliere, J.F. Filipot, R. Baraille, A. Pichon*

Implementation of 3D waves forcing terms using Generalized Lagrangian Mean theory (*Andrews and McIntyre* 1978) and following *Ardhuin et al.* (2008) approach (vortex force)

1. derivation of the Hycom equations including GLM terms.

2. Implementation of the extra terms

3. Validation using test cases

3 main modifications to the code:

- advection by Stokes drift

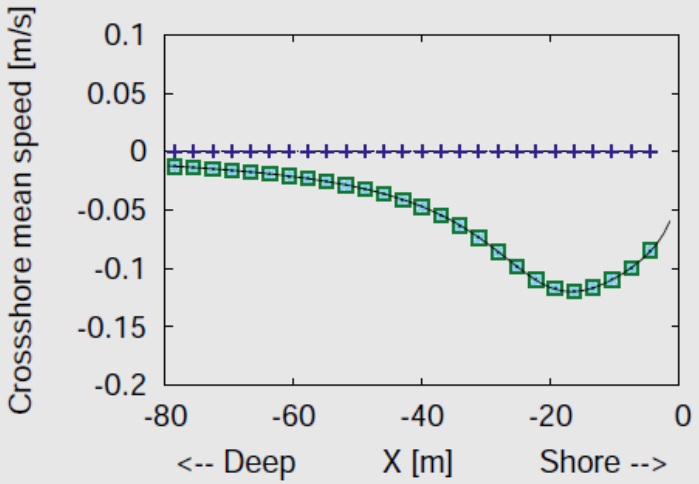
- vortex force

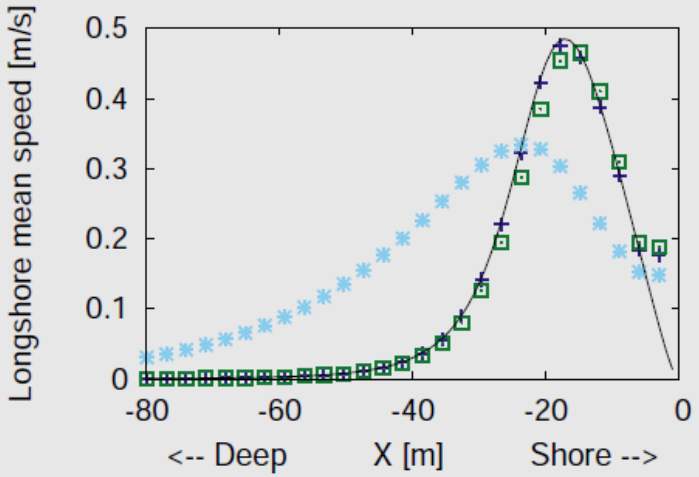
- forcing/dissipation terms

Waves – currents interactions

C. Ody, *C. Lathuiliere, J.F. Filipot, R. Baraille, A. Pichon*

Validation using test cases (a plane beach)





Plane beach :

1 layer

Diabatic test

$\Delta x = 4\text{m}$, $\Delta t = 0.25\text{s}$

$H_s = 0.5\text{m}$, $T_p = 20\text{s}$

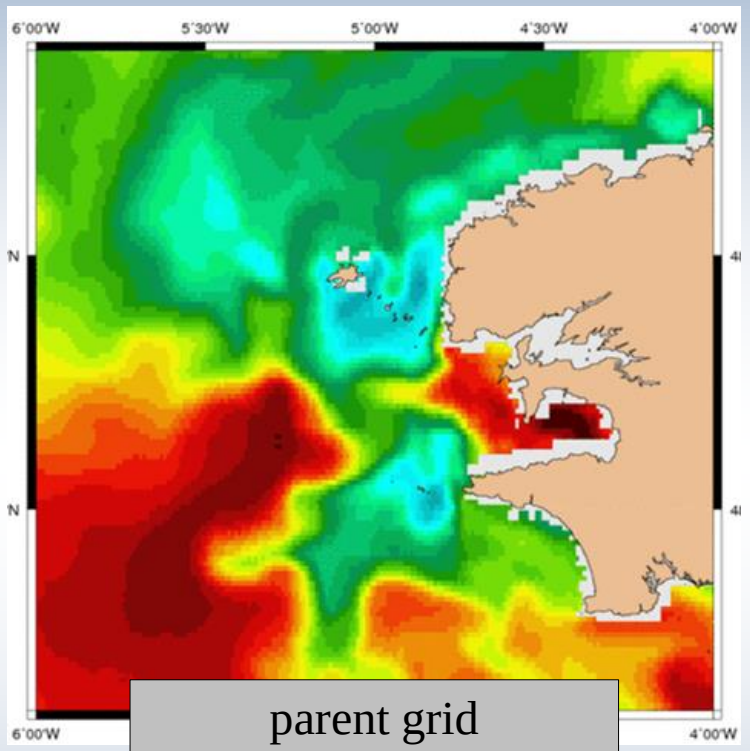
N.B. Specific drag (u_{orb})

–	Analytical solution*
+	$\overline{\boldsymbol{u}}^S$ OFF
*	$\overline{\boldsymbol{u}}^S$ ON, vortex force OFF
❑	$\overline{\boldsymbol{u}}^S$ ON, vortex force ON

* see Uchiyama & al. 2010

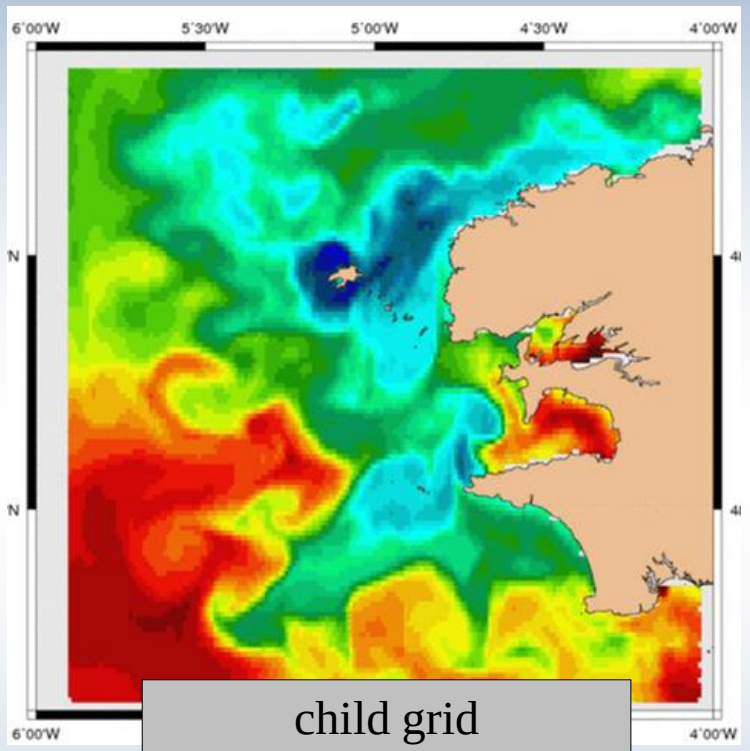
Agrif – mesh refinement

S. Louazel, *R. Duarte, R. Baraille*

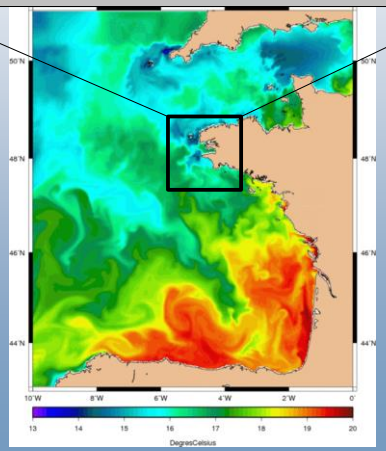


SST

parent grid

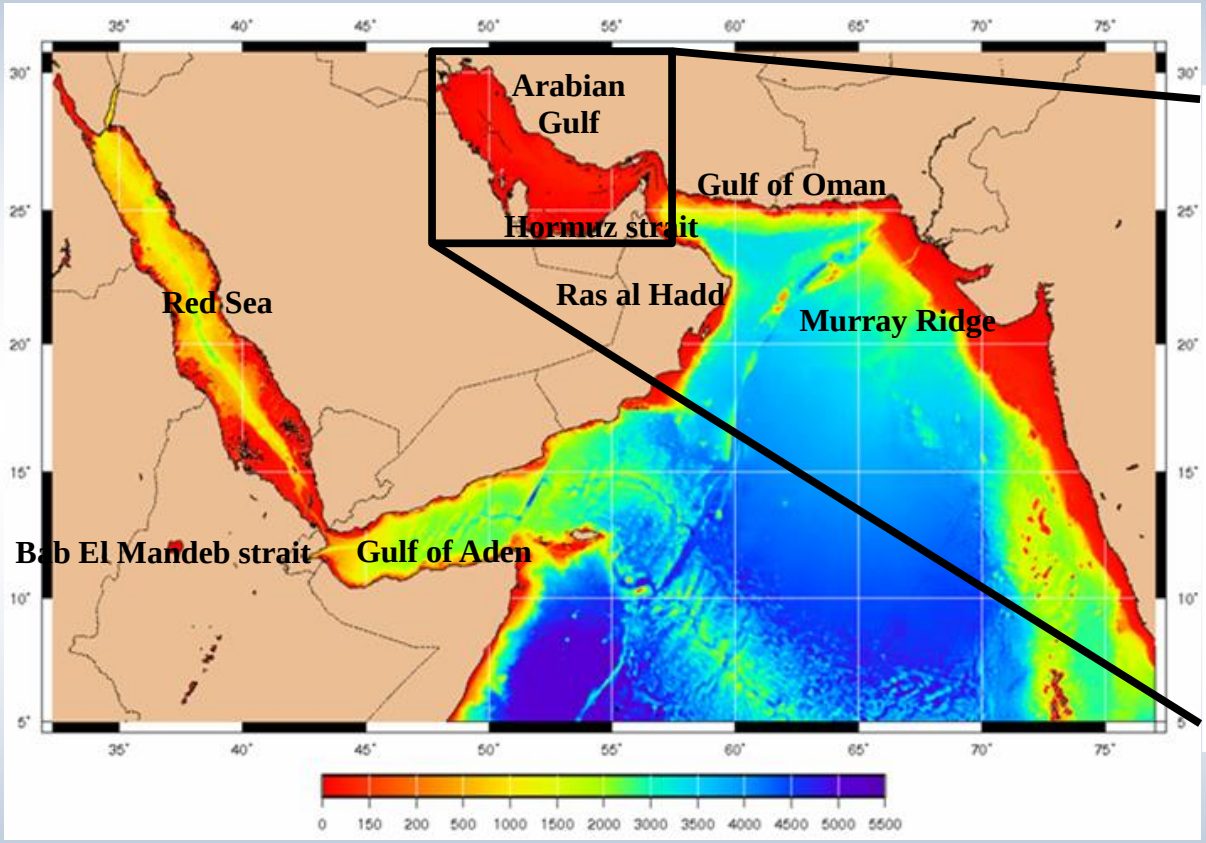


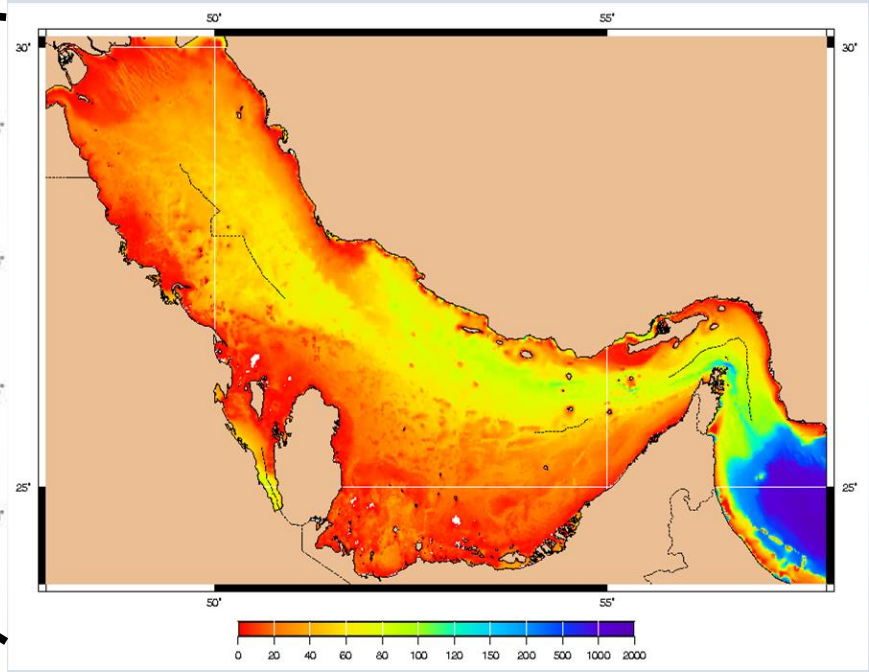
child grid



Indian Ocean

S. Correard, R. Baraille





32.3°E – 77° E 5°N – 30.1°N

1/20° (~5 km)

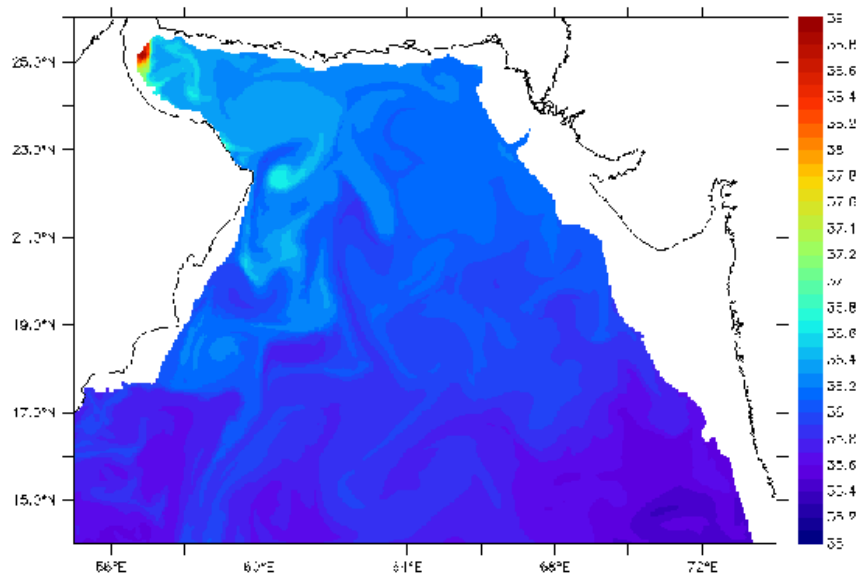
40 layers

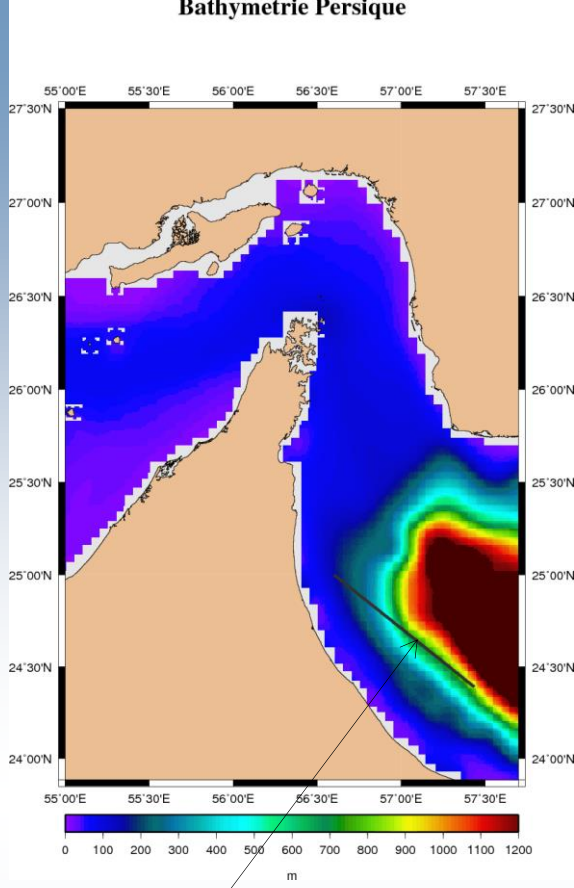
Same resolution
Sensitivity studies
(friction, vertical mixing, bathy, nesting,...)
Climatic run

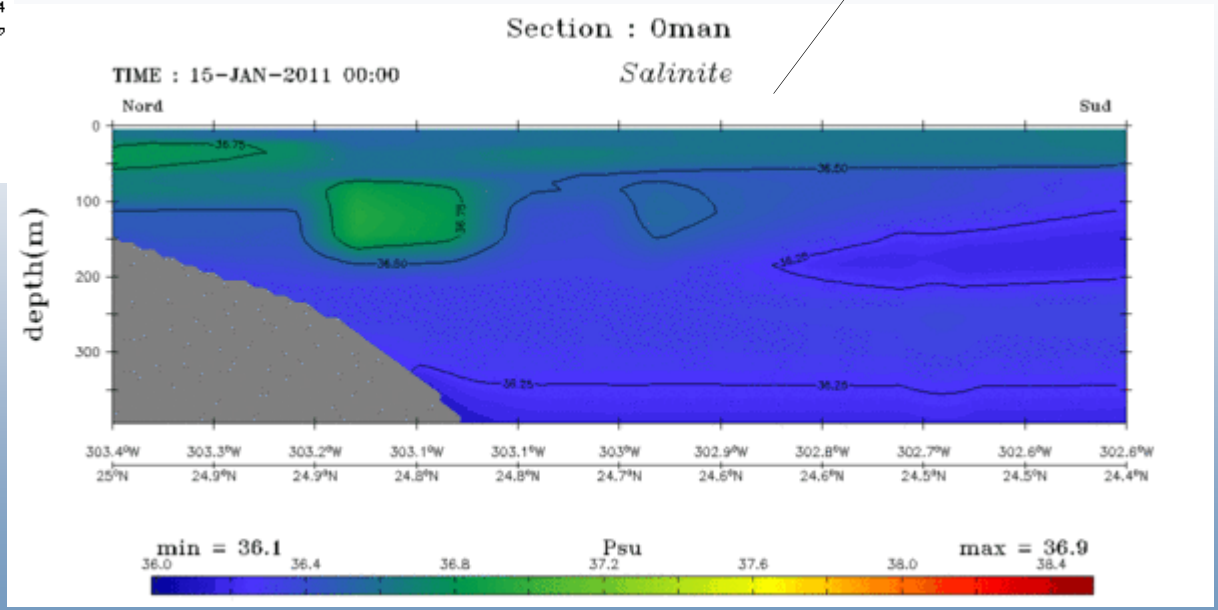
Indian Ocean

S. Correard, *R. Baraille*

Max of Salinity between 100m and 500m

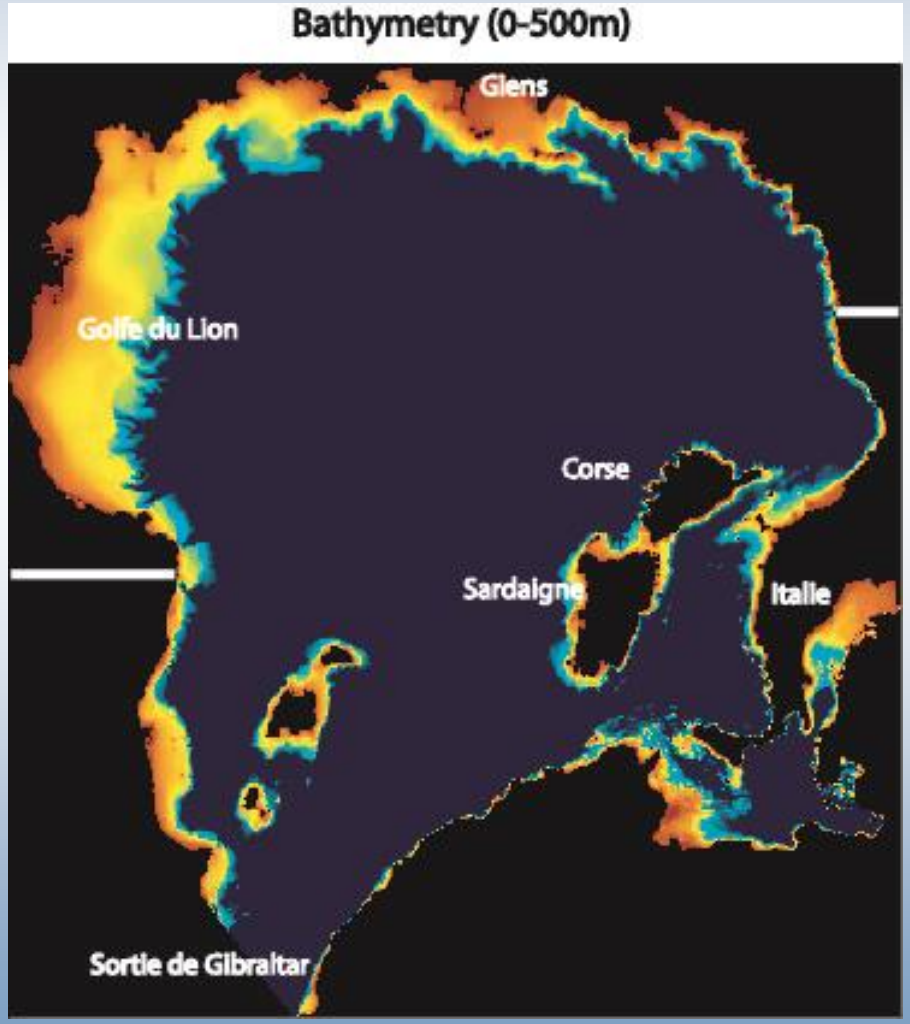


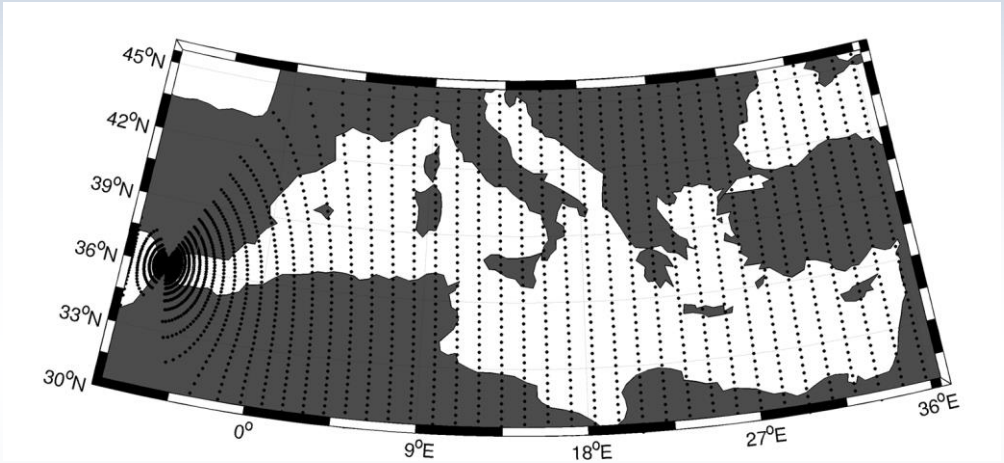


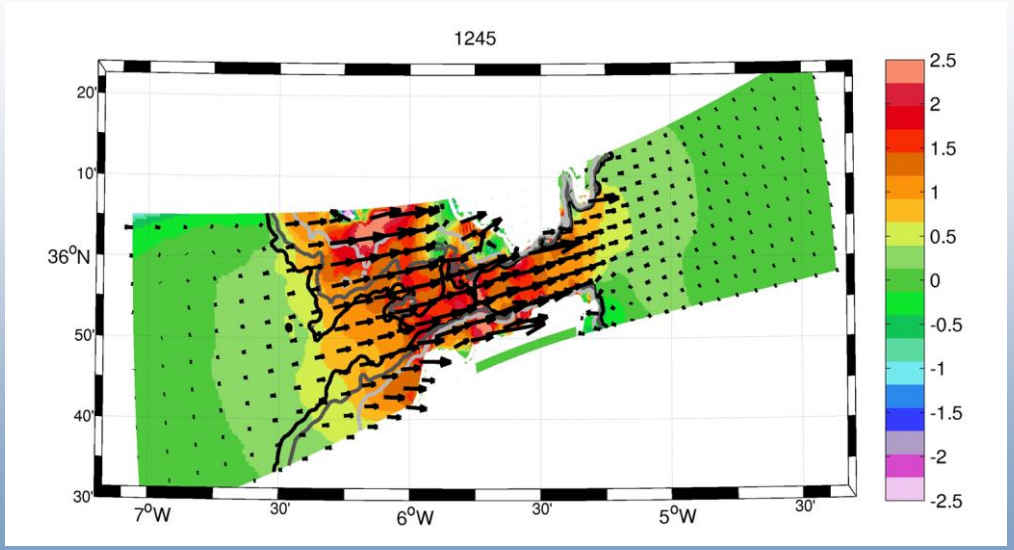


Mediterranean Sea (homonim project: 2D; navy: 3D)

F. Gouillon, *S. Correard,* *R. Baraille*



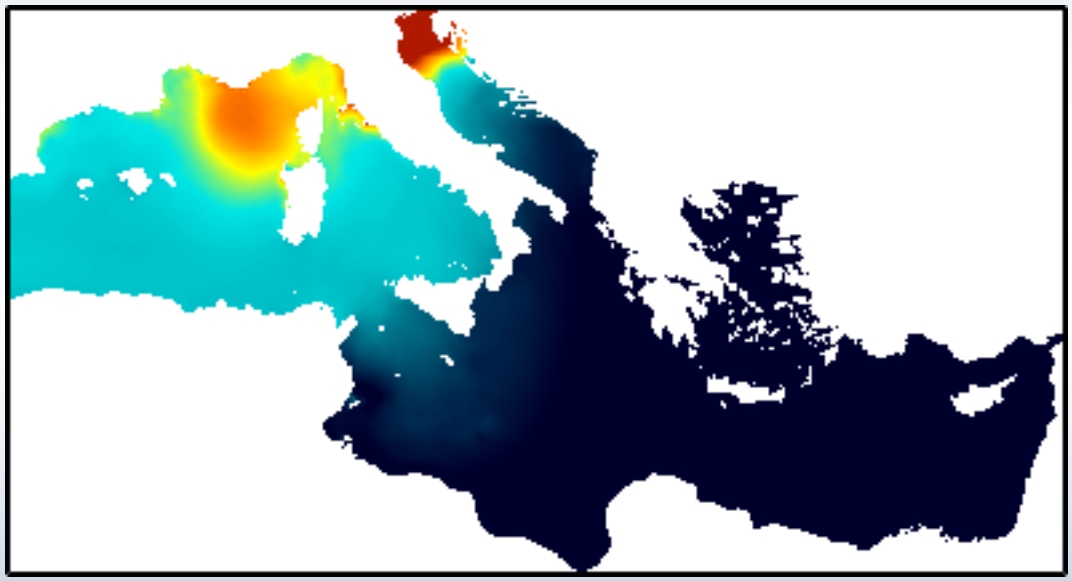




Mediterranean Sea

F. Gouillon, *A. Pasquet, S. Correard, R. Baraille*

Storm surge (0m to 0.4m) – 02/2010



Perspectives

✔ Strengthen the operational system in various regions including very high resolution zooms

✔ Build an operational storm surge forecast system in close collaboration with the French meteorological forecast institute (modeling and observations)

✔ Achieve a full coupling between Hycom and WW3 wave model

✔ Develop the coupling between Hycom and biogeochemical and sediments transports models (turbidity/visibility applications)