

Recent results on tides, shelf circulation and river plume modelling in the COCTO project

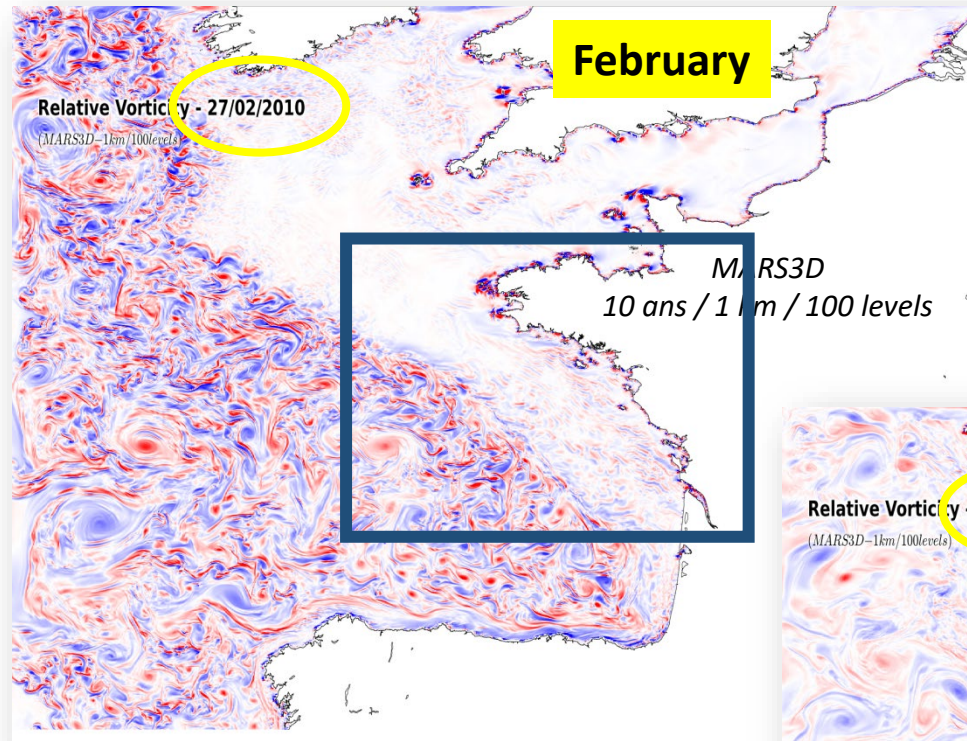
Objectives of COCTO : to better understand the dynamics and the exchange in the estuary-shelf-deep ocean continuum:

- understand the dynamics at the small-scale (1-10 km) on the shelf and the continental slope
- identify the SSH signature of these processes
- characterize the potential input of SWOT observations by data assimilation

This talk :

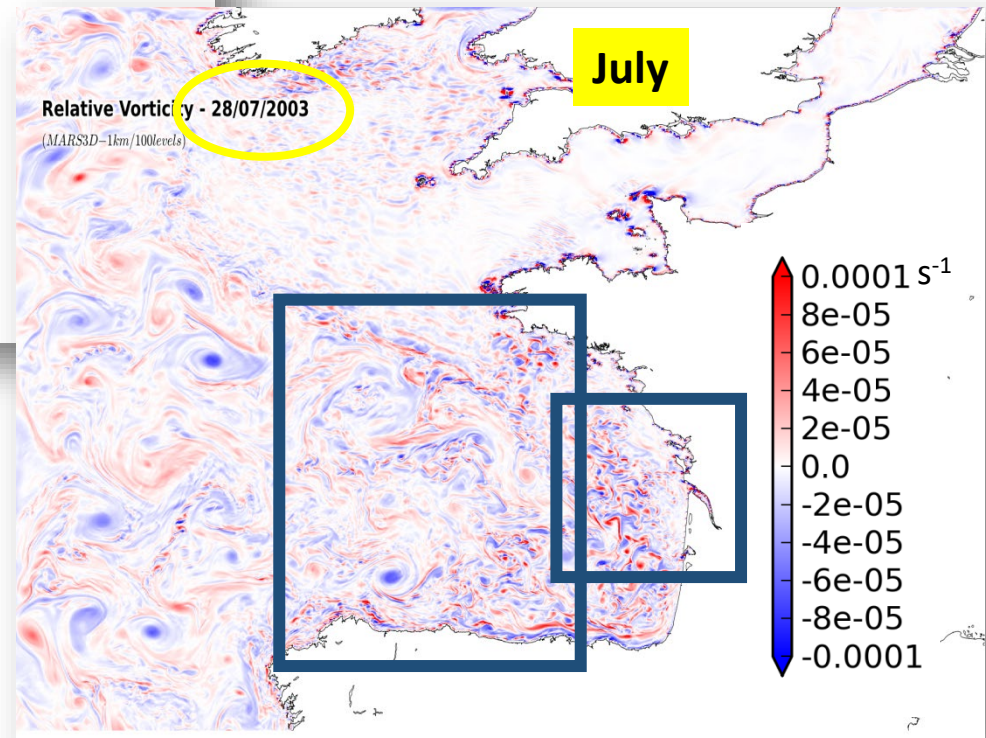
- **characteristics of the small scale dynamics over the shelf and continental slope (first results)**
- **impact of modeling strategies**

**in the Bay of Biscay/Gironde Estuary
in the Southern China Sea/Red River Delta**



Surface relative vorticity

as an indicator of the meso- and submeso-scales activity

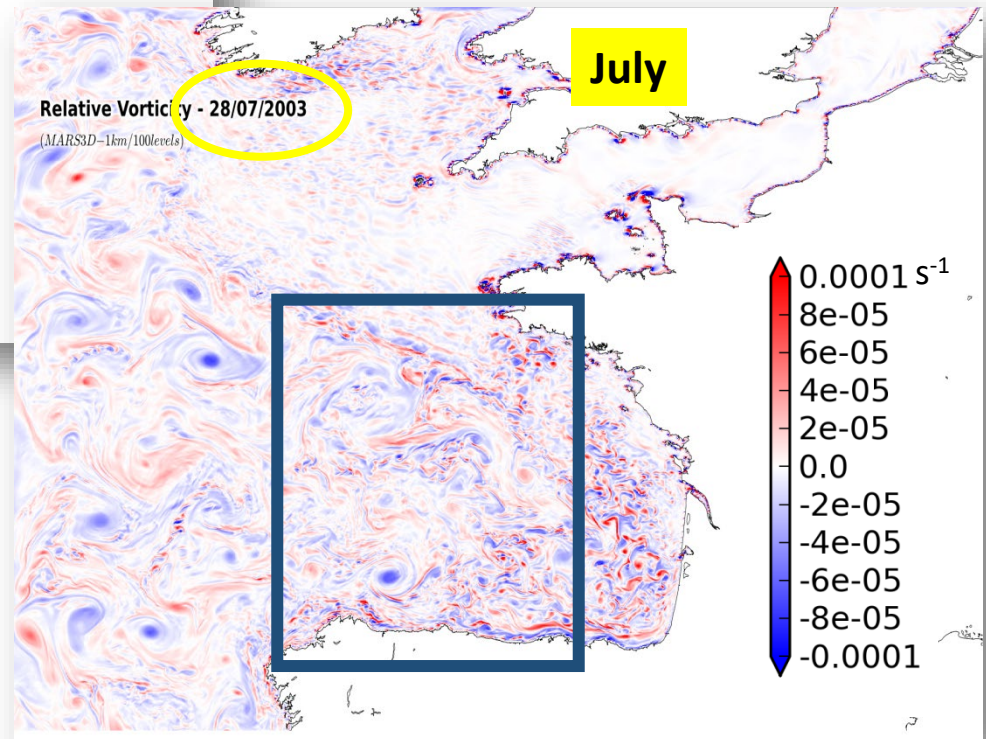
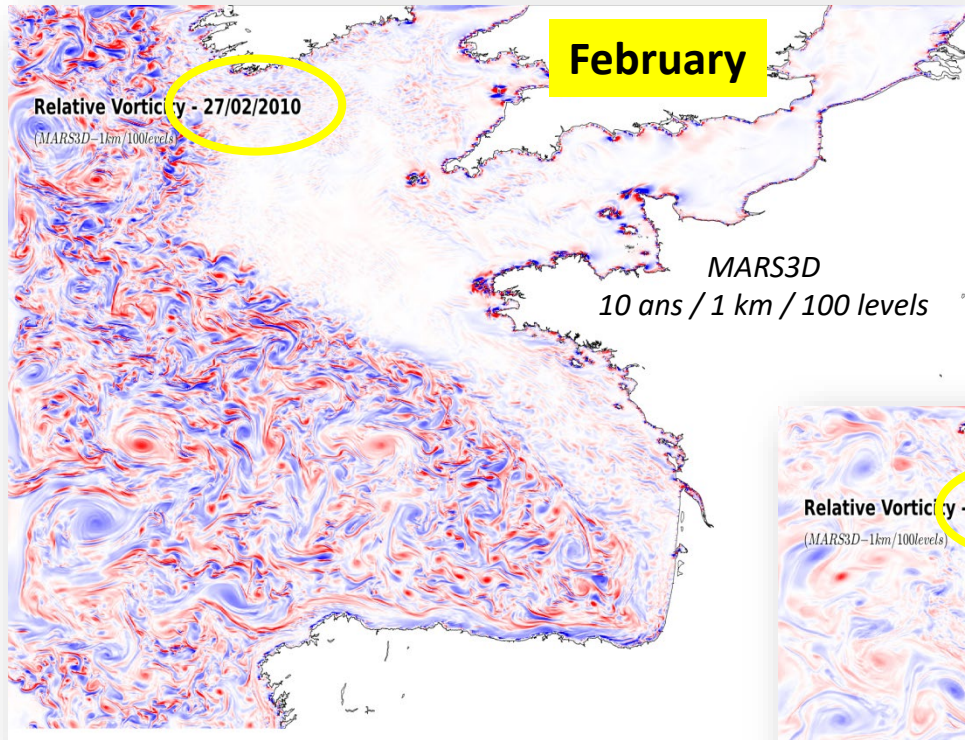


MARS 3D model
10-year simulations



Charria et al., 2017

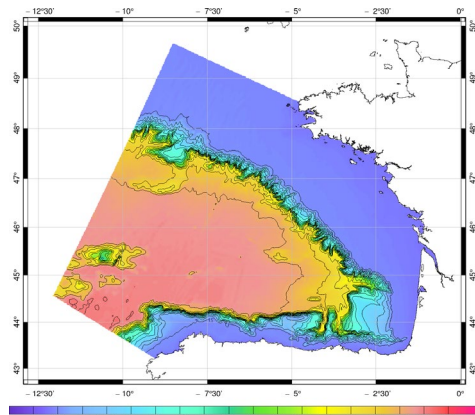
Small scale dynamics in the Bay of Biscay



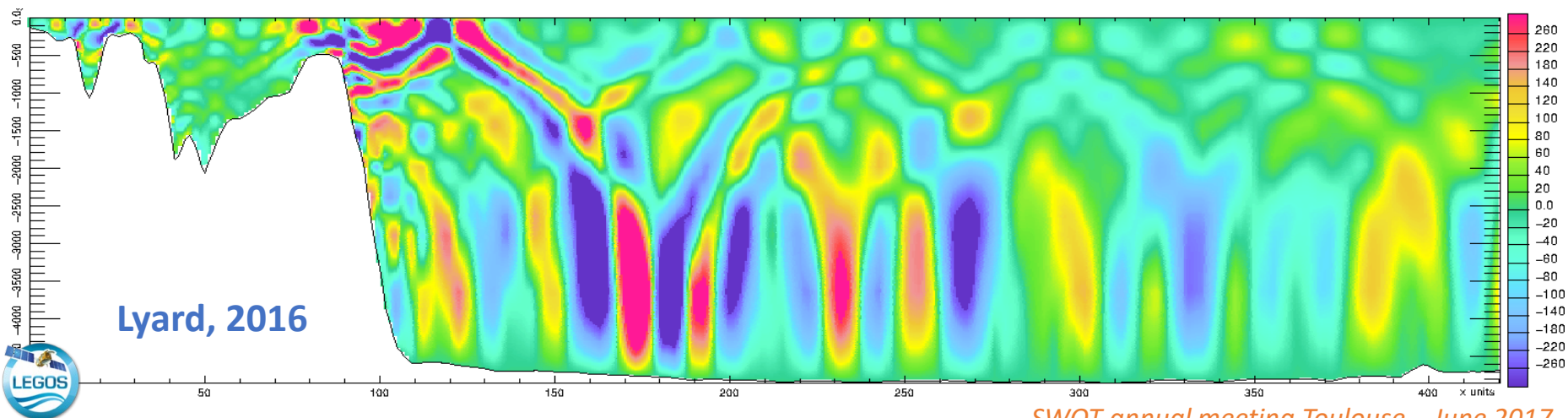
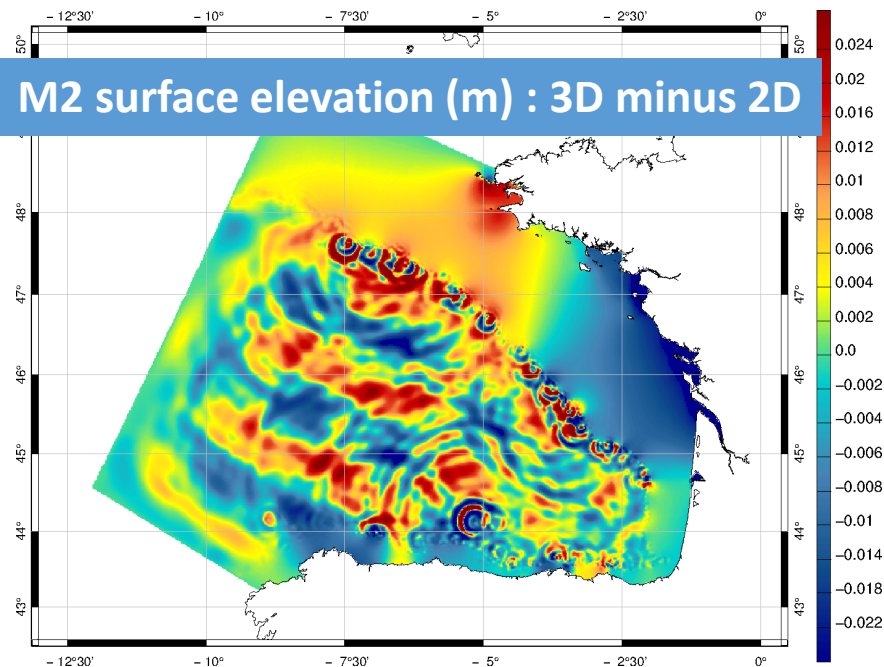
Internal tides generated at the slope

3D spectral simulations with T-UGO:

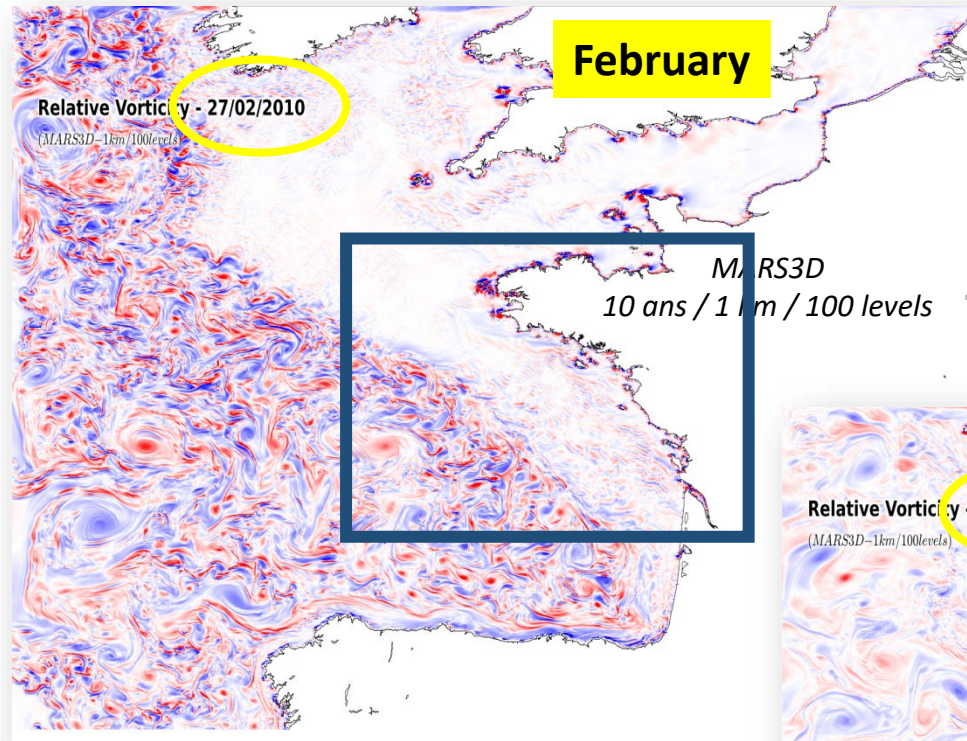
- difficulty to separate 'barotropic' and baroclinic tides
- interference between IT generated at different sites



M2 surface elevation (m) : 3D minus 2D

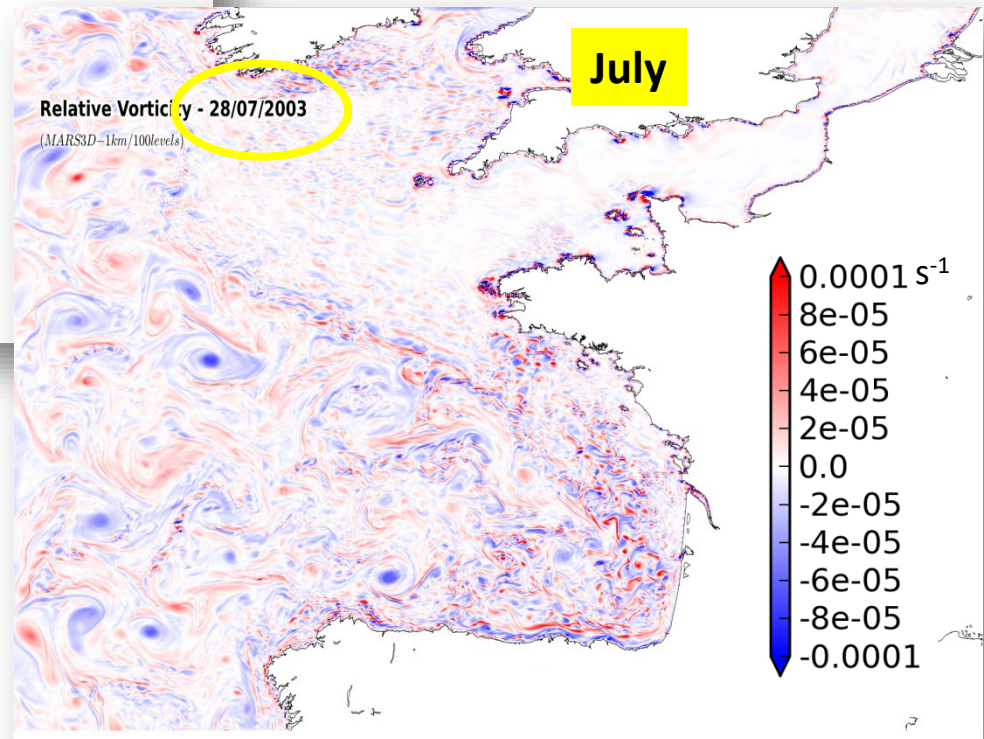


Small scale dynamics in the Bay of Biscay



Surface relative vorticity

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MARS 3D model
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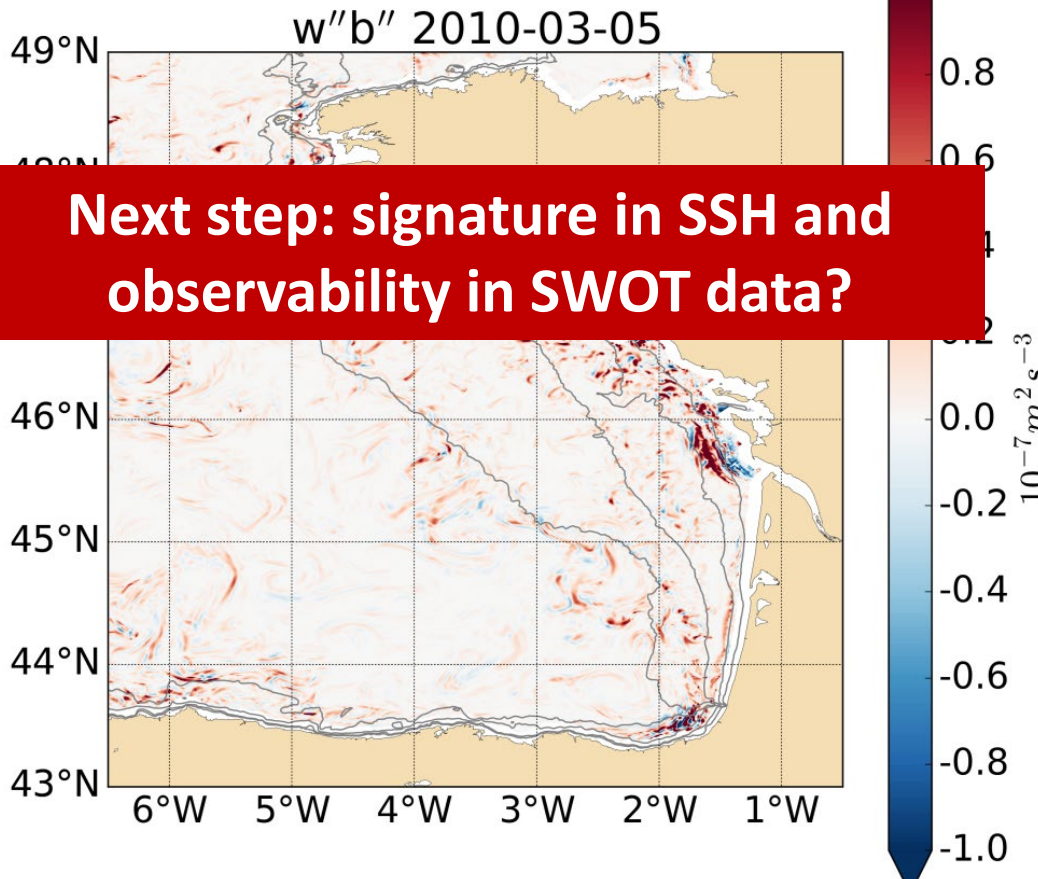
Charria et al., 2017

Frontal activity in the Region Of Freshwater Influence (ROFI)

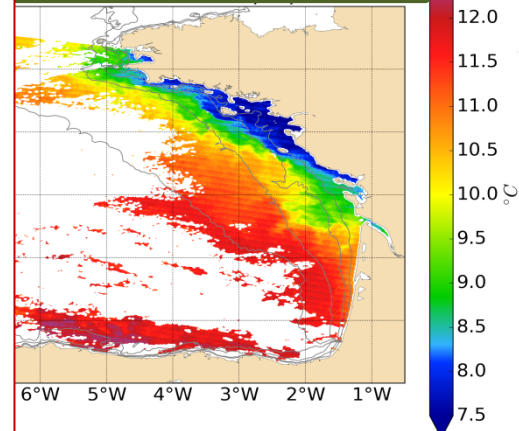
Yeleski, Charria et al., CSR, 2017



Simulated vertical buoyancy flux

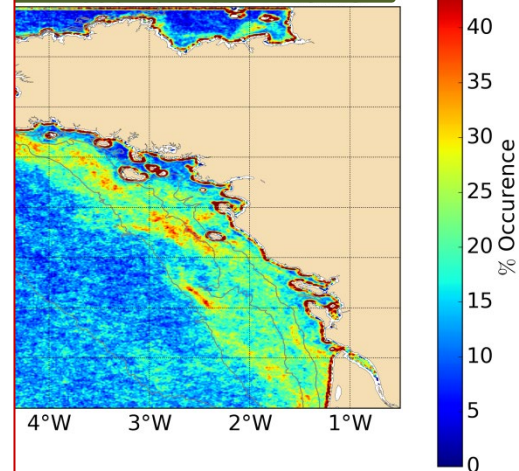


SST (Mar. 3, 2010)



OBSERVATIONS

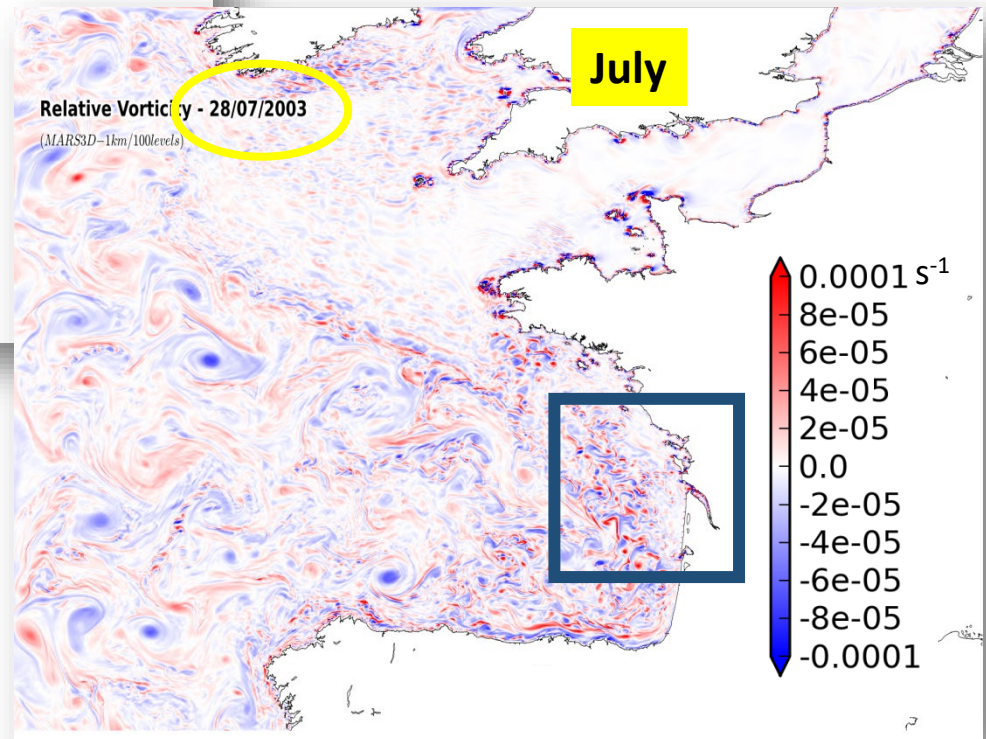
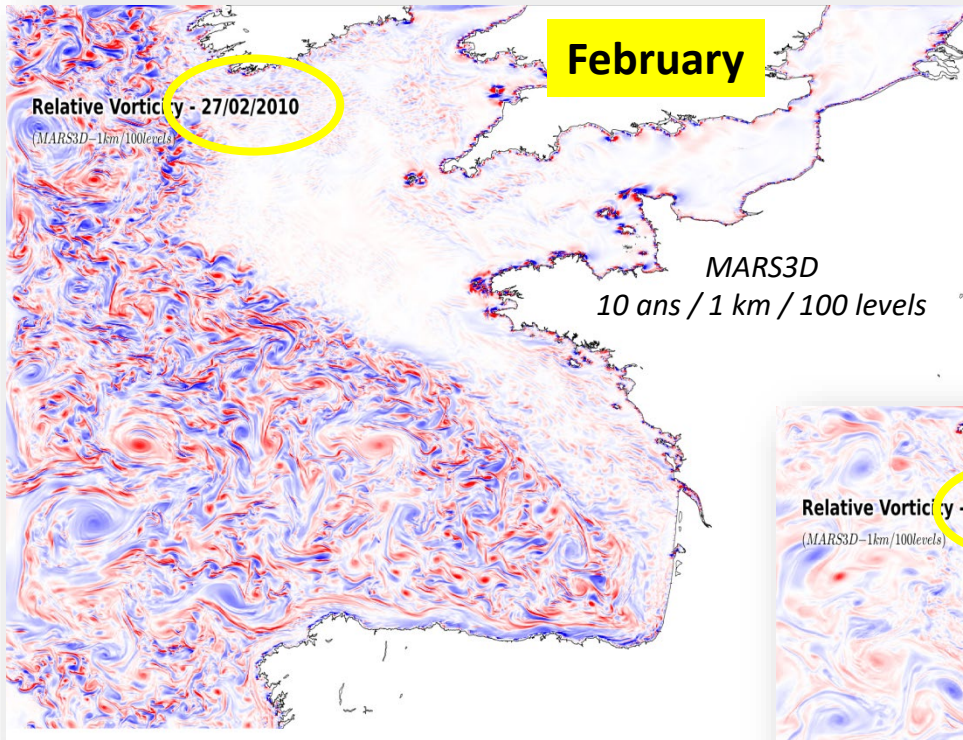
- 2008-2010



Next step: signature in SSH and observability in SWOT data?

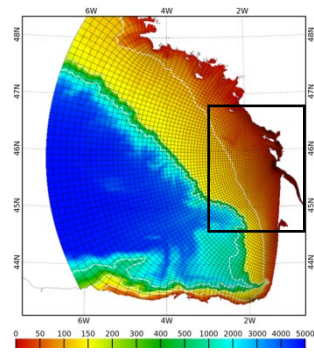
baroclinic instabilities at the river plume edges

Small scale dynamics in the Bay of Biscay



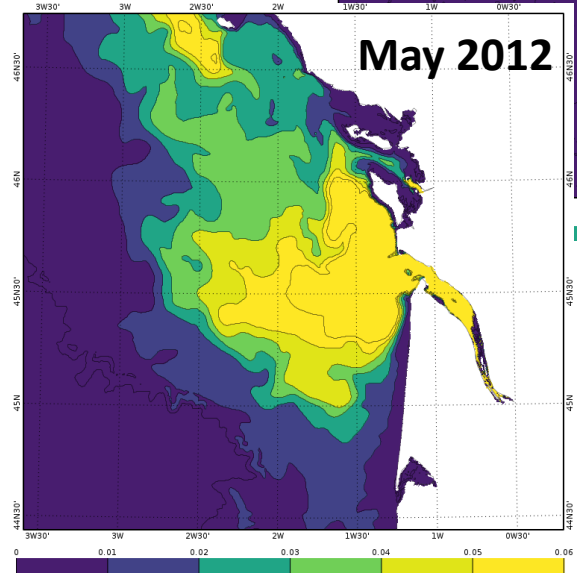
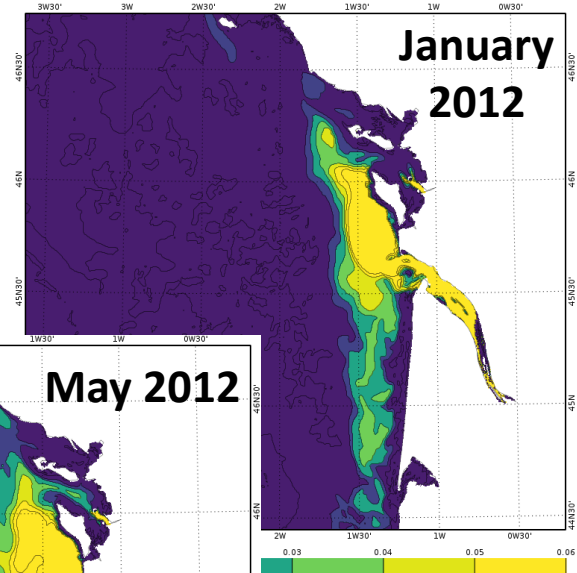
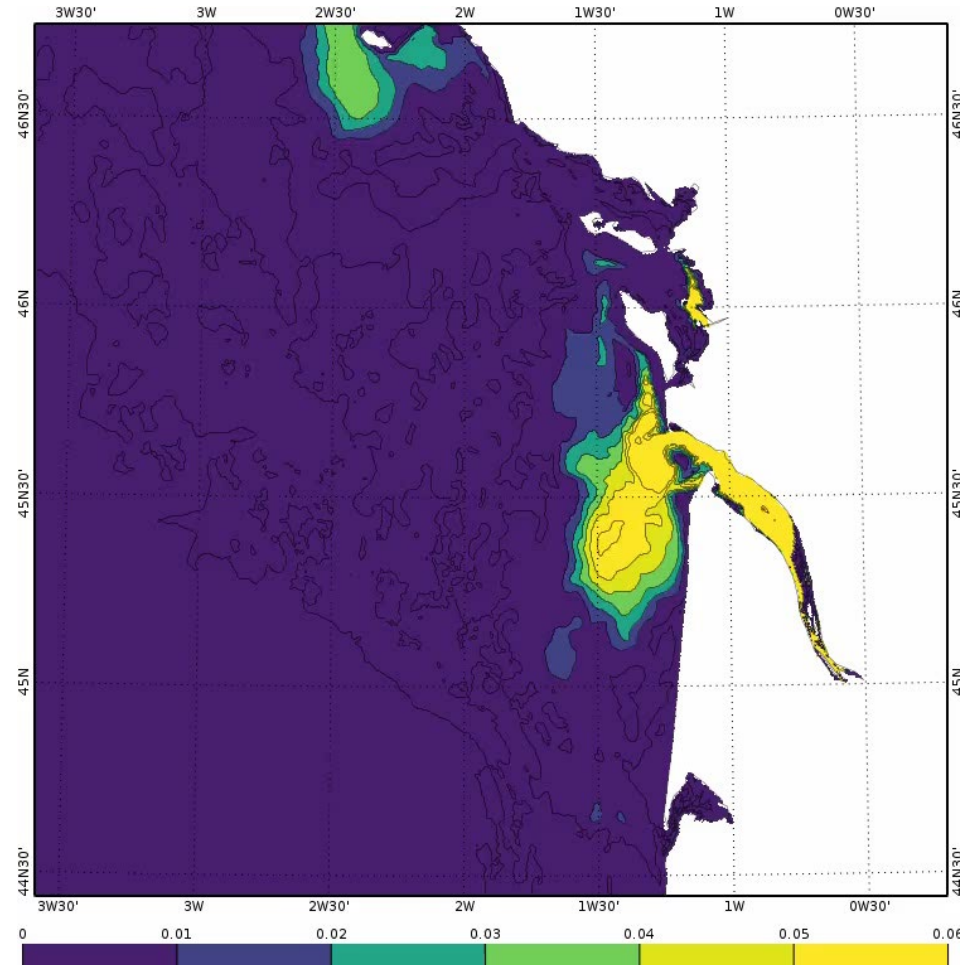
Gironde river plume: seasonal variability

Interactions between the plume dynamics, tides and the wind induced circulation over the shelf: a numerical study based on the Symphonie 3D model (*Toublanc et al., in prep*)



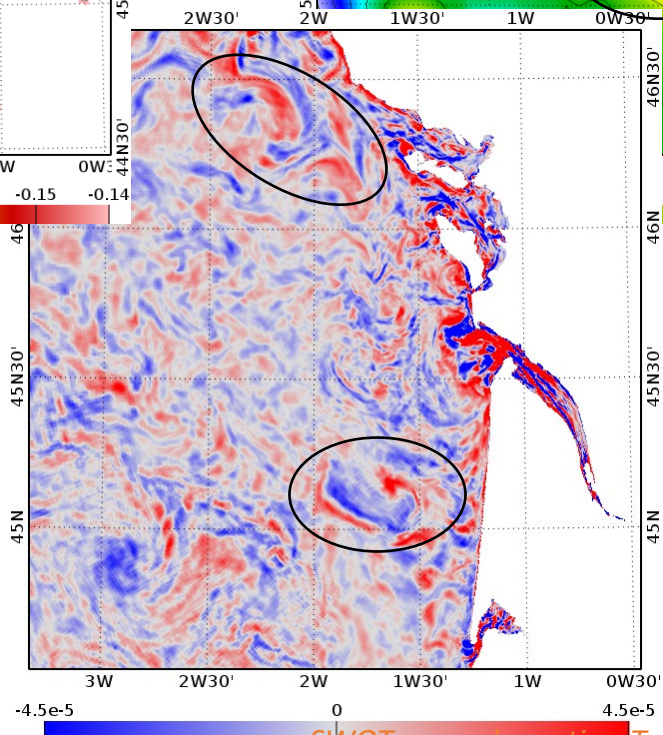
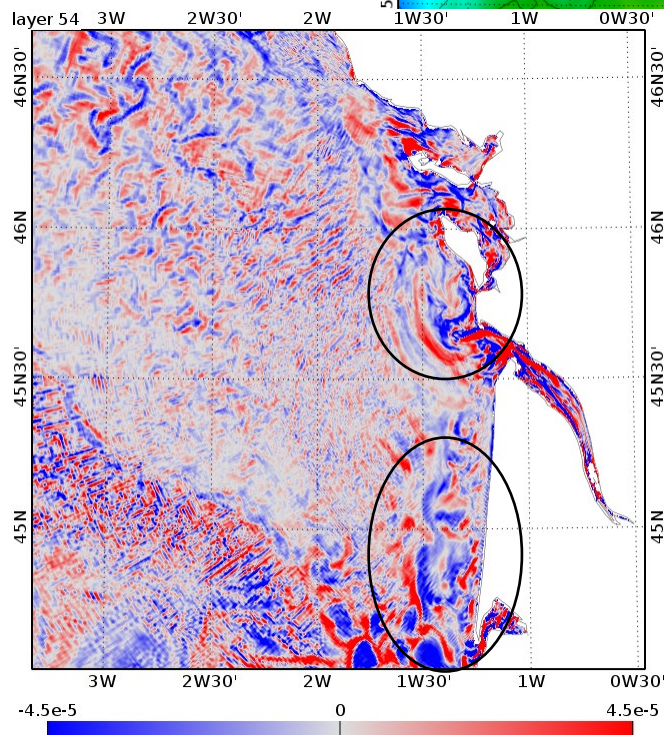
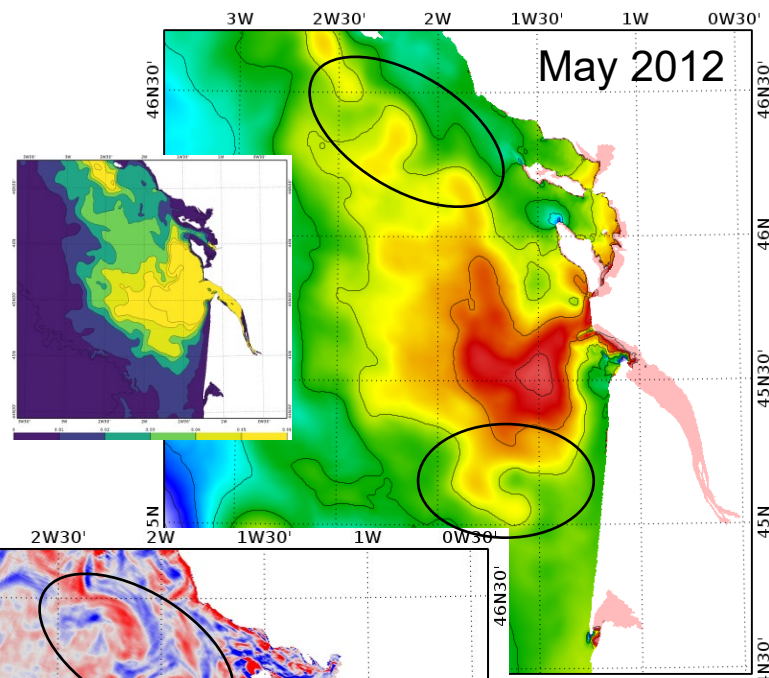
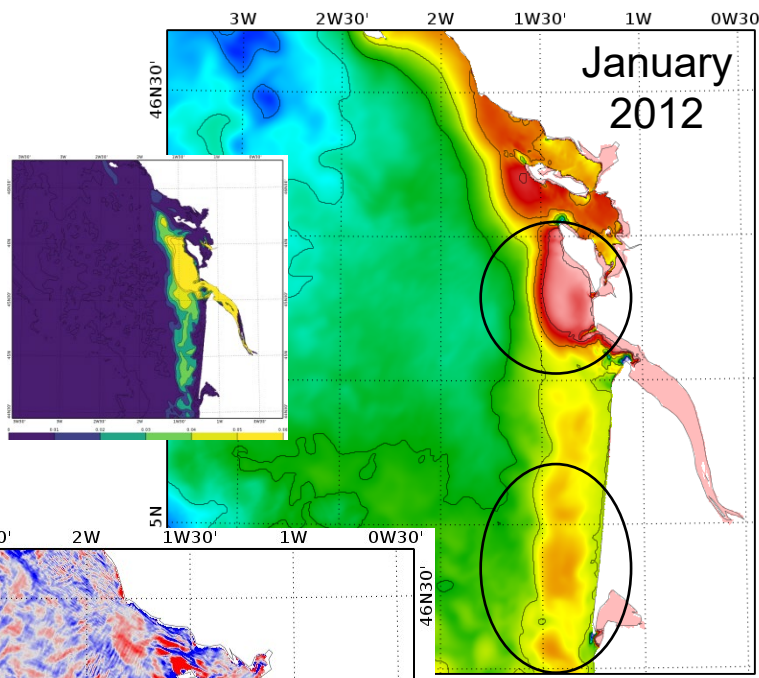
Stratification index
(Hansen & Rattray, 1996)
used as a proxy of the
plume extension

=> SSH
signature ?



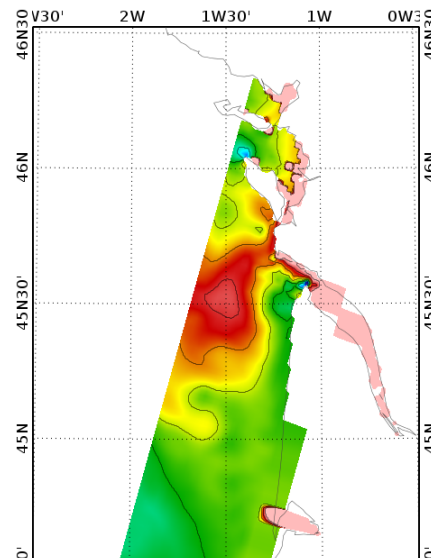
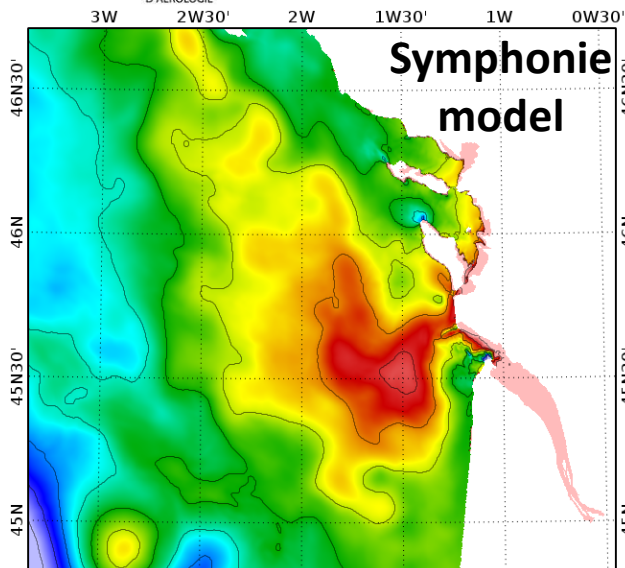
Gironde river plume: SSH and vorticity signature

SSH

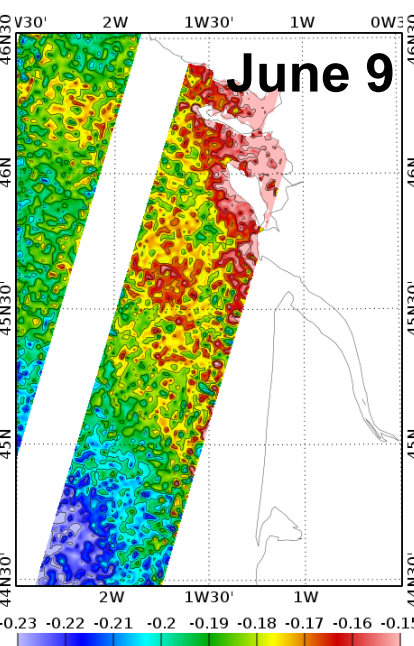
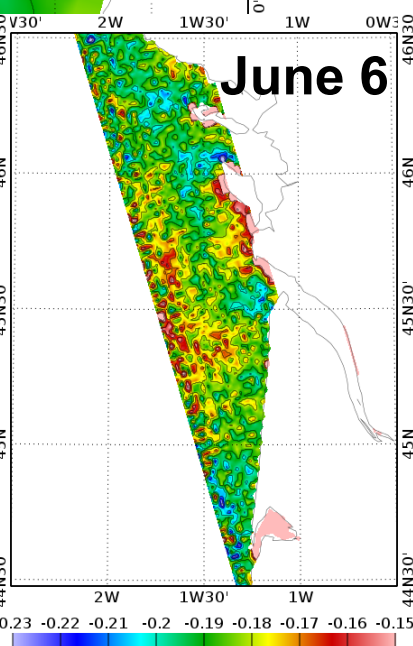
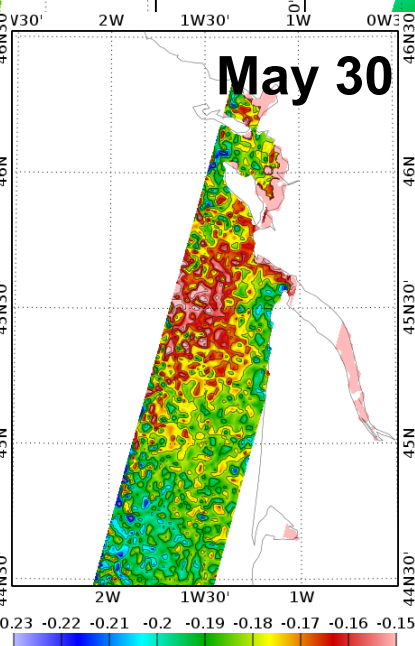
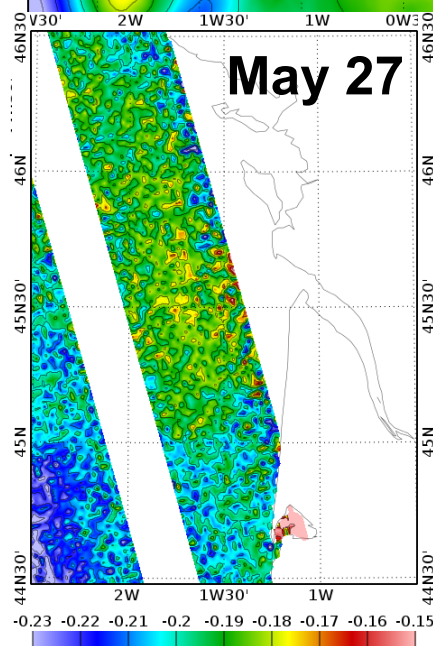


Vorticity

Gironde river plume: observability in SWOT data?

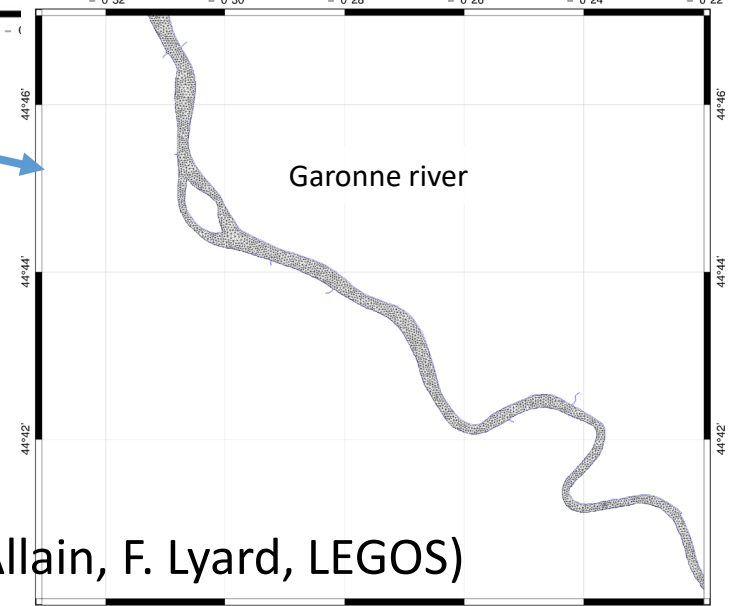
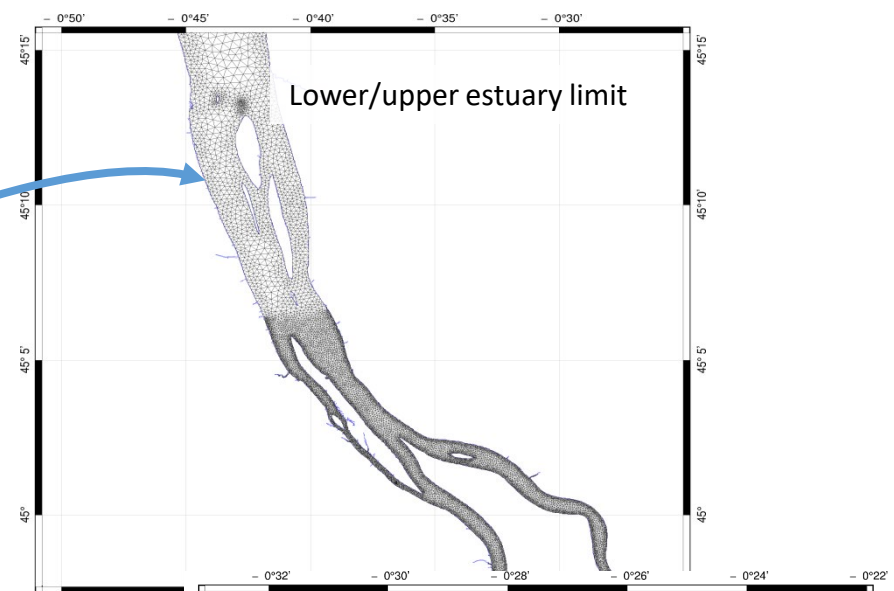
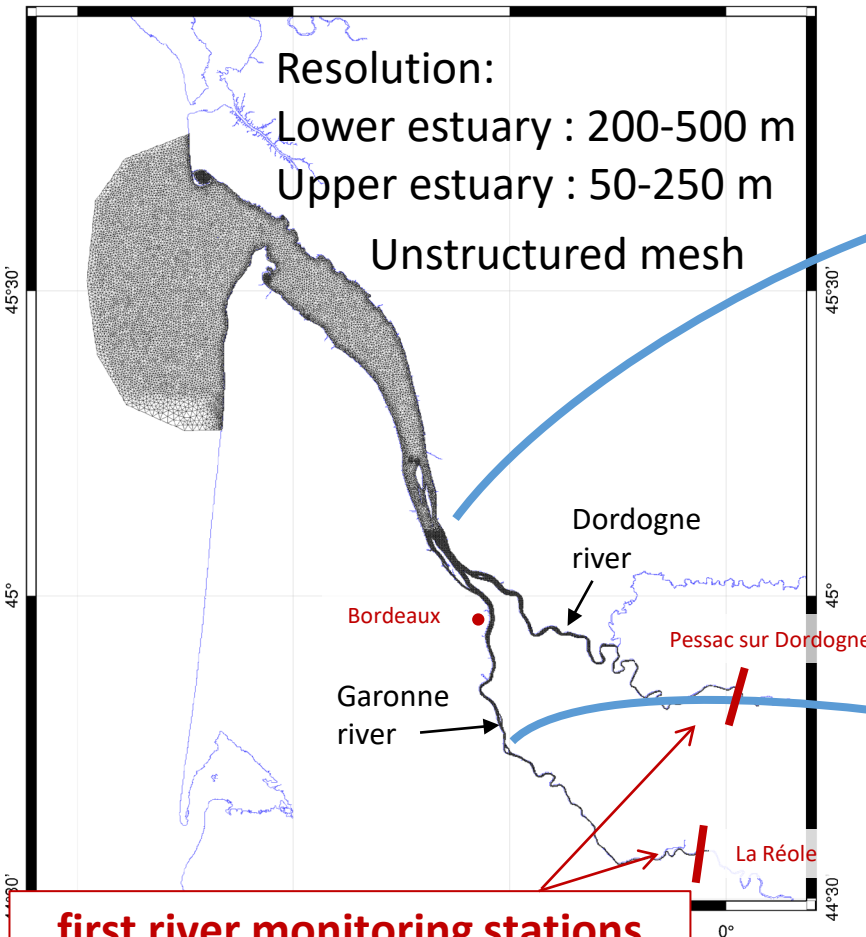


SWOT simulator output
Successive passes over the area



Gironde estuary modeling

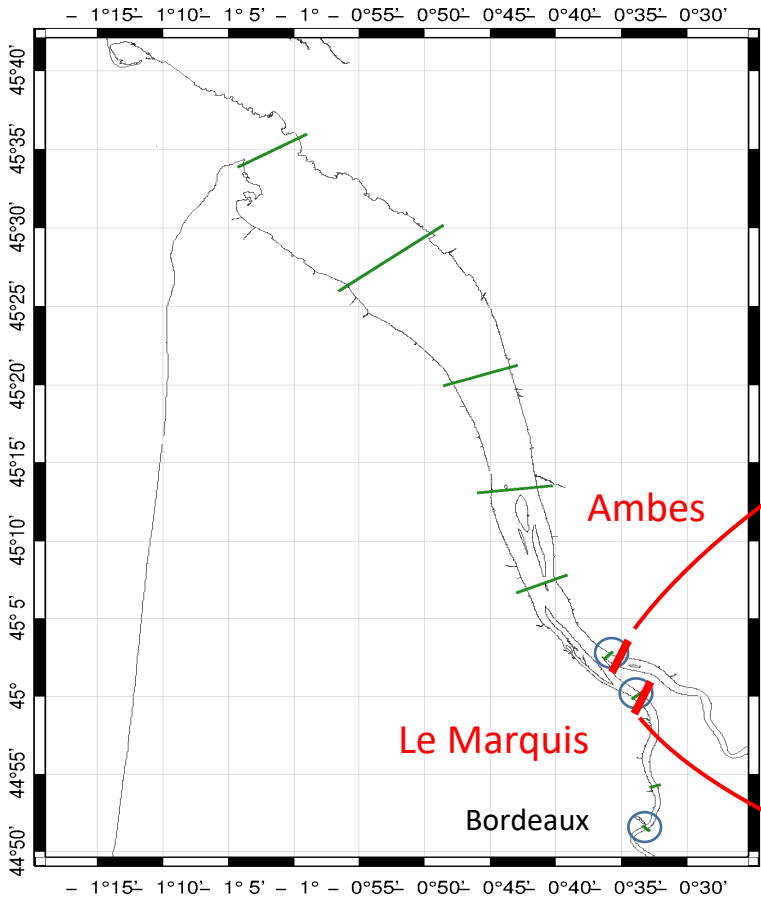
A collaboration with hydrologists, L. Chevalier & B. Laignel from Univ. of Rouen



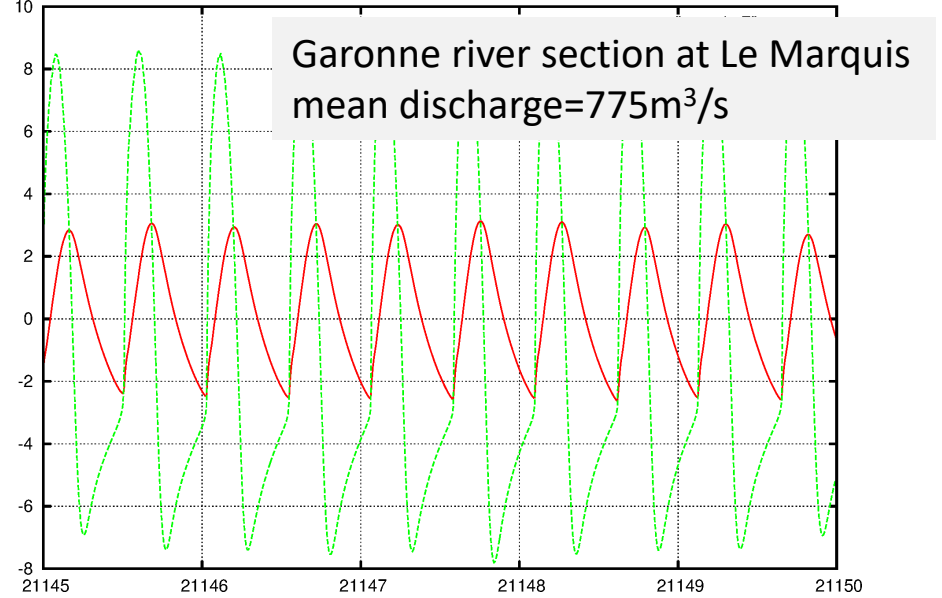
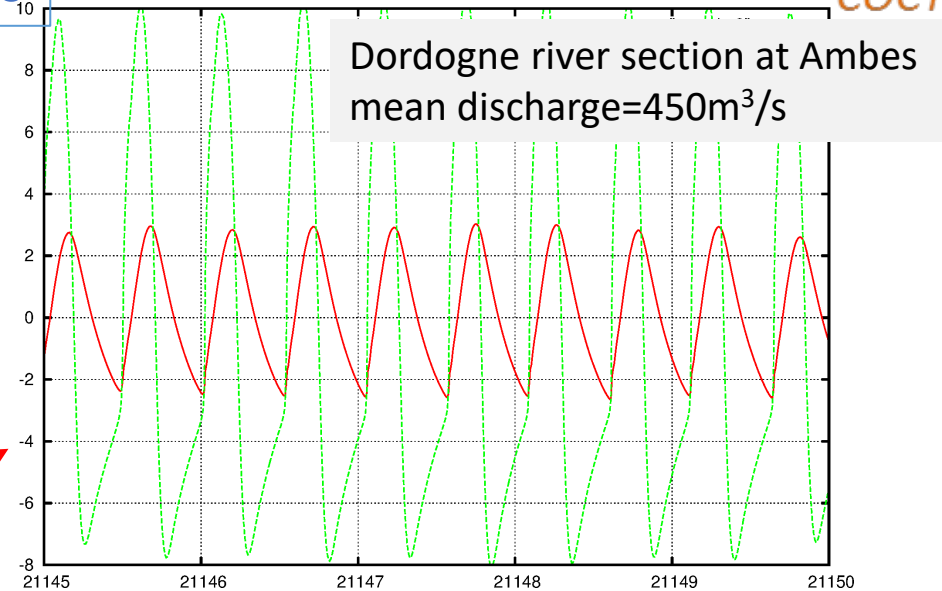
**first river monitoring stations
upstream tide propagation limit**

Mesh generation (L. Chevalier, Univ. Rouen):
Mesh-limits and mesh-generation softwares (D. Allain, F. Lyard, LEGOS)

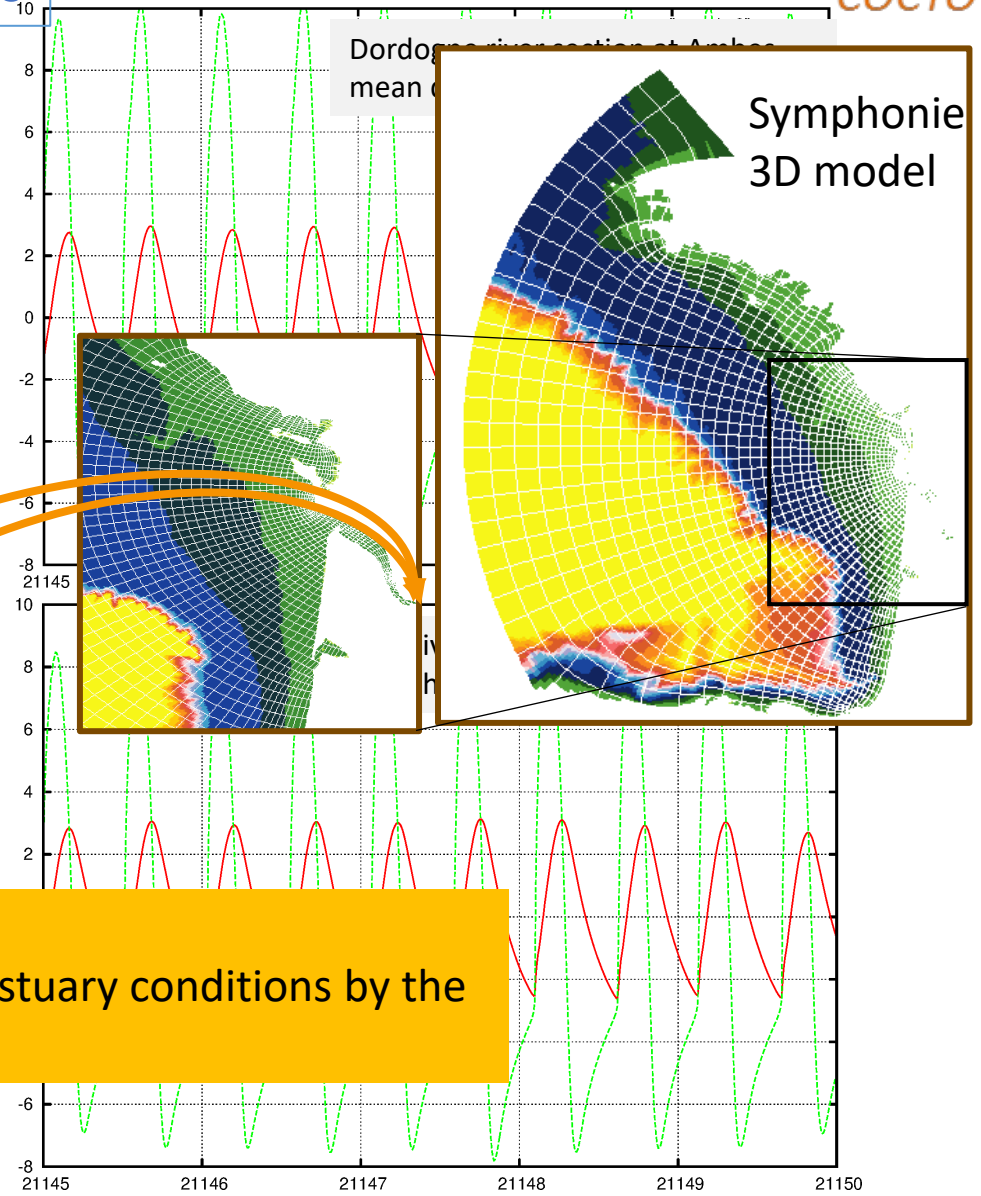
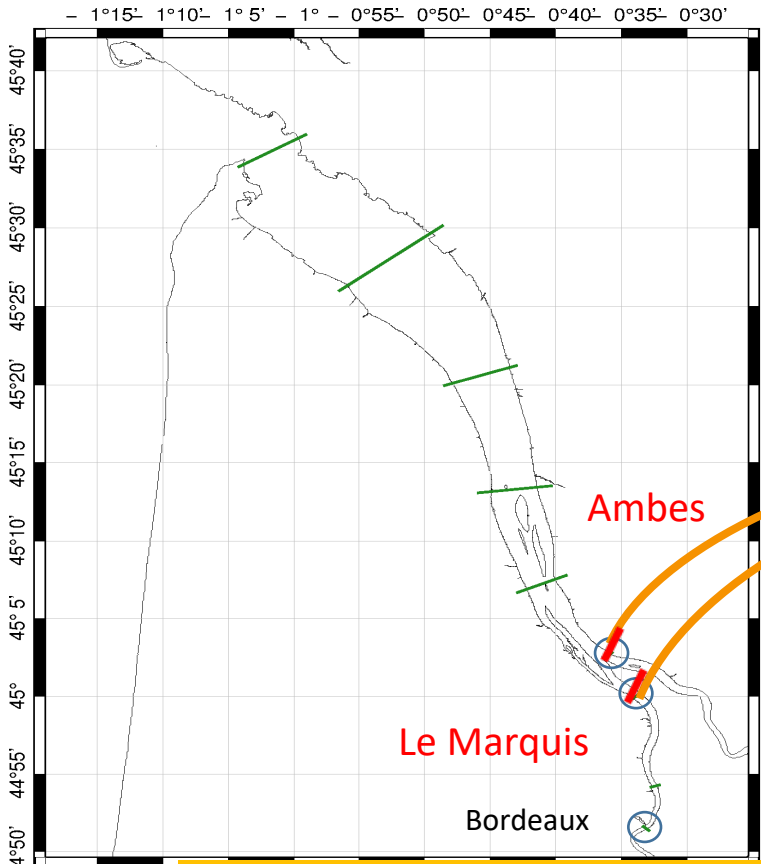
Estuary discharge – T-UGOm simulations



- surface elevation (m)
- river discharge ($\times 10^3 \text{ m}^3/\text{s}$)



Estuary discharge – T-UGOm simulations

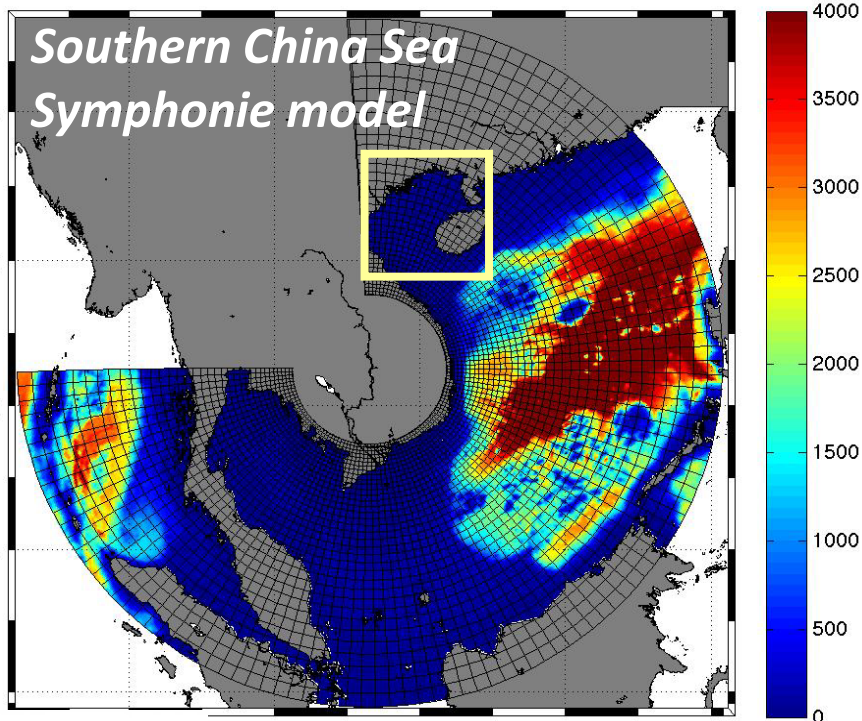


On-going work:
force Symphonie in the upstream estuary conditions by the
T-UGO simulated discharge

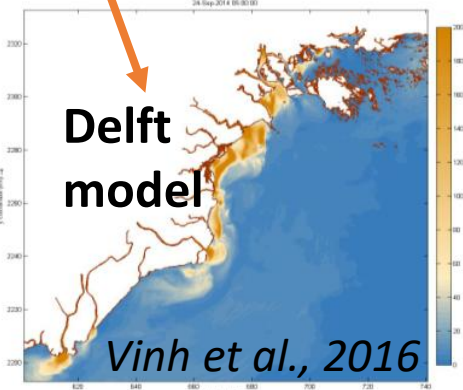
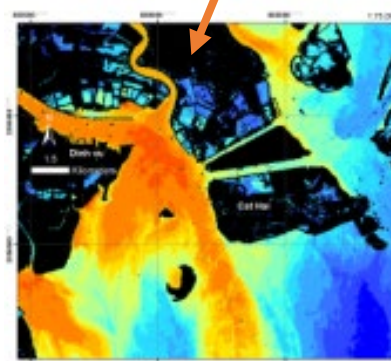
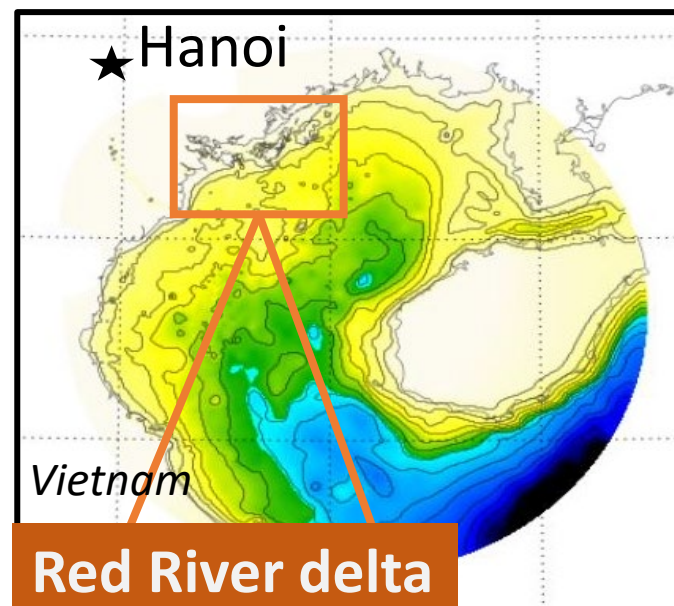
COCTO in the Gulf of Tonkin

From the Bay of Biscay to the Gulf of Tonkin:
similar approach to model the
delta-shelf-open ocean continuum

M. Herrmann et al.



*Gulf of Tonkin configuration
Symphonie + TUGO models
(V. Piton , PhD thesis)*

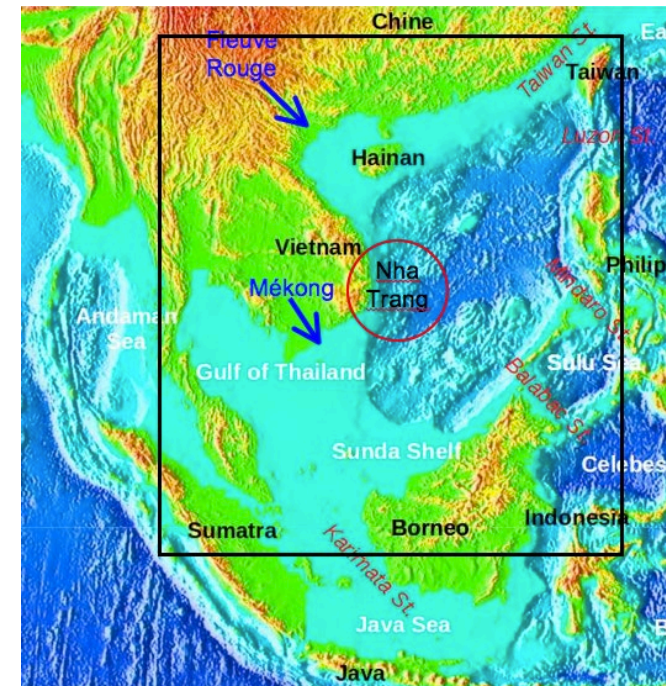


Suspended matter concentration from Landsat-8 data, Vu Huu Long et al., 2008

SWOT annual meeting Toulouse – June 2017

General theme : Water and matter cycles in the river-estuary-ocean continuum in South East Asia regions: functioning, variability and evolution

- understand the **physical mechanisms** involved in the transport/mixing of water and matter
- study **their influence on the sediment compartment and planktonic ecosystem**
- characterize and explain their **answer to different sources of variability** (natural/anthropogenic, extreme event to climate change)
- *Contacts: Marine Herrmann and Sylvain Ouillon, LEGOS*



Small scale dynamics over the shelf in the Bay of Biscay

- freshwater front due to several river runoffs and frontal instabilities (Yelecki et al., 2017, Charria et al., in revision 2017)
- variability of the Gironde plume and the interactions with tides and shelf circulation; impact of the plume on the mesoscale activity over the shelf (Toublanc et al., in prep.)

On-going work:

- comparison of simulations with in situ data (A. Akpinar post-doc, LOPS)
- sensitivity to the atmospheric forcing product in numerical models
- sensitivity to upstream boundary conditions in the estuary in the Symphonie model (D.T Nguyen master thesis, LEGOS)

Observability of the shelf small-scales dynamics in altimetric data

- On-going work : use of the JPL SWOT-ocean simulator to explore the observability of the Gironde plume variability and of the mesoscale over the shelf

Next steps:

- analysis of high-resolution along-track altimetric data from Jason and Sentinel-3
- comparison of numerical simulations with HF radars

Concluding remarks and perspective (2/2)



Modeling studies in the 2 regions of studies:

- detailed work on the bathymetry and coastline in the Gulf of Tonkin and Red River delta
- study on tidal downscaling approaches based on TUGO and Symphonie 3D models
 - Toubanc et al., to be submitted

On-going work:

- 3D simulations with the Symphonie model in the Gulf of Tonkin
- set-up of HR (~200-500m) configuration with ROMS/CROCO in the Bay of Biscay to study small-scales and their impact on vertical mixing
- set-up and tuning of spectral runs of internal tides