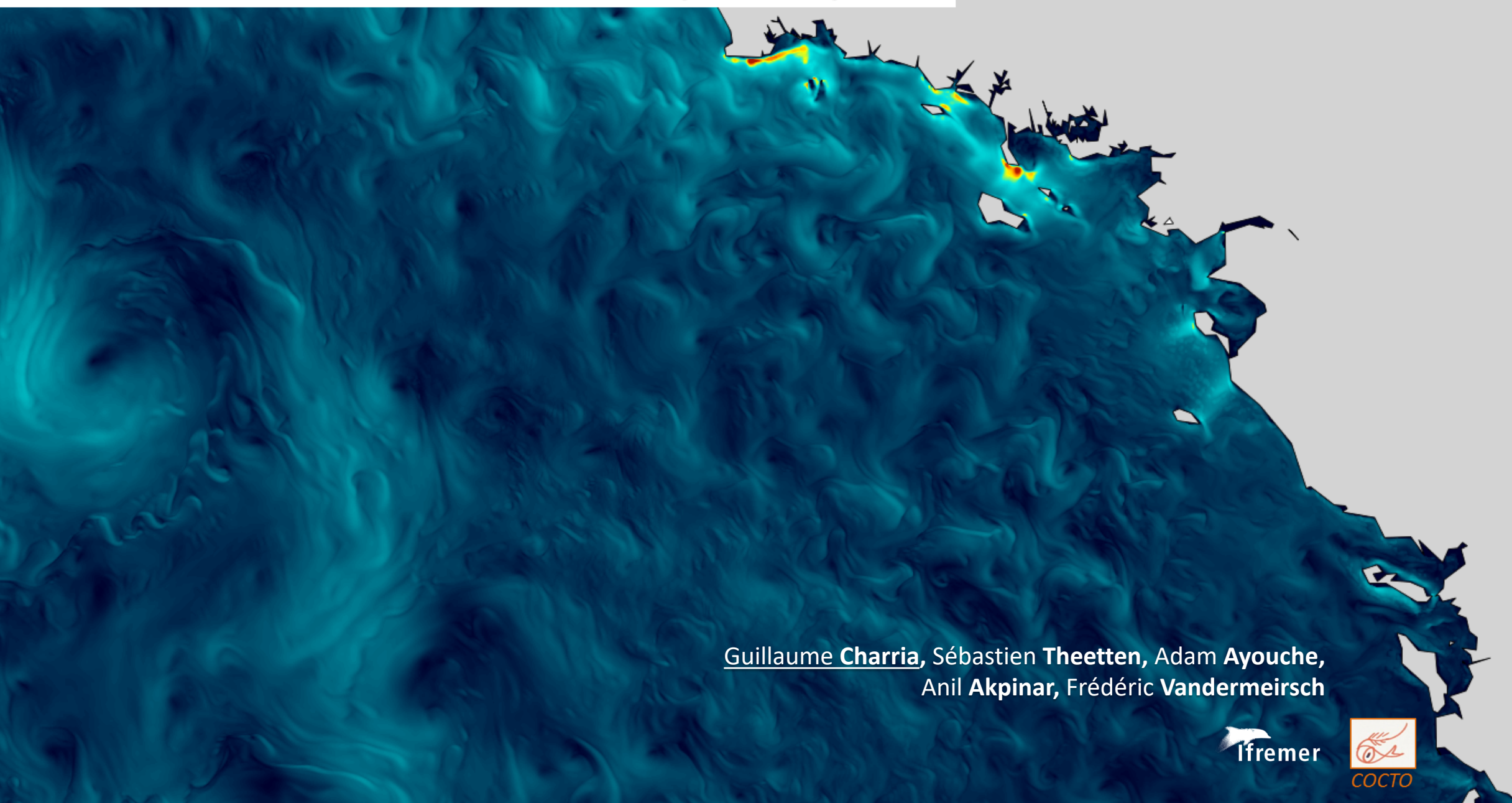


Multi-scale coastal circulation in the Bay of Biscay



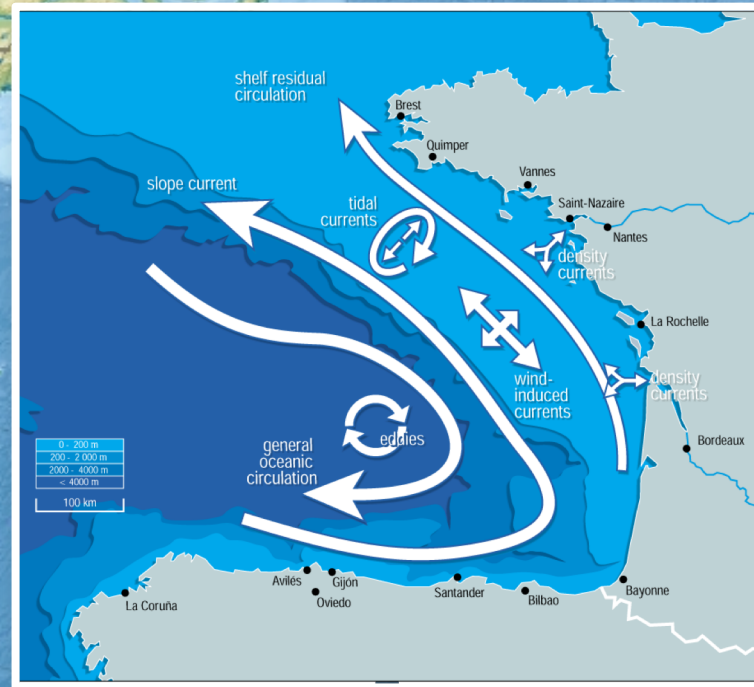
Guillaume Charria, Sébastien Theetten, Adam Ayouche,
Anil Akpinar, Frédéric Vandermeirsch



Background & Objectives

Multi-scale interactions (spatial and temporal) in the Bay of Biscay
linked with large scale circulation and interannual evolutions

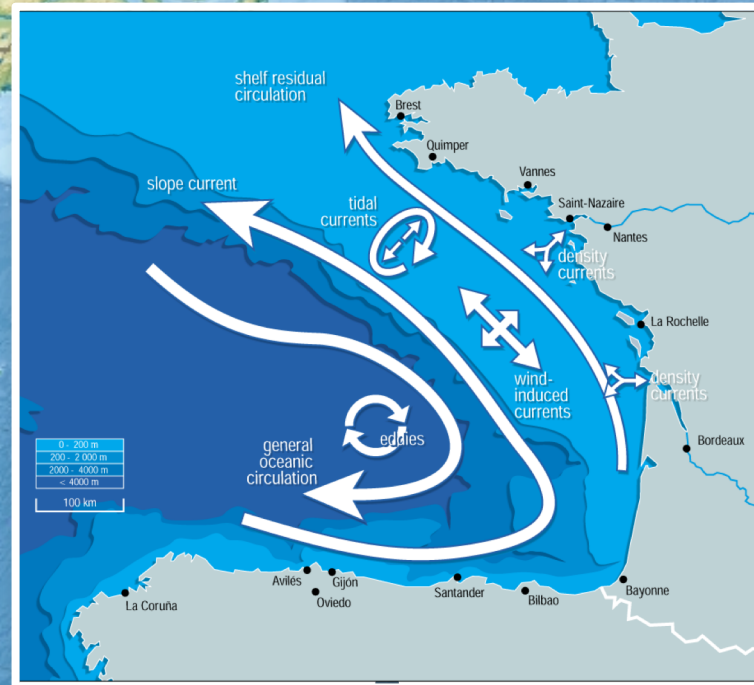
Ferrer et al., 2007



Background & Objectives

Multi-scale interactions (spatial and temporal) in the Bay of Biscay
linked with large scale circulation and interannual evolutions

Ferrer et al., 2007



Coastal numerical modelling to understand spatial and temporal scales interactions

Hindcasts to explore multi-scale coastal circulation

MARS3D primitive equation model (<http://wwz.ifremer.fr/mars3d>)

Resolution

Horizontal: 1km and 4km

Vertical: 40 and 100 sigma levels

Temporal: daily outputs

4 simulations

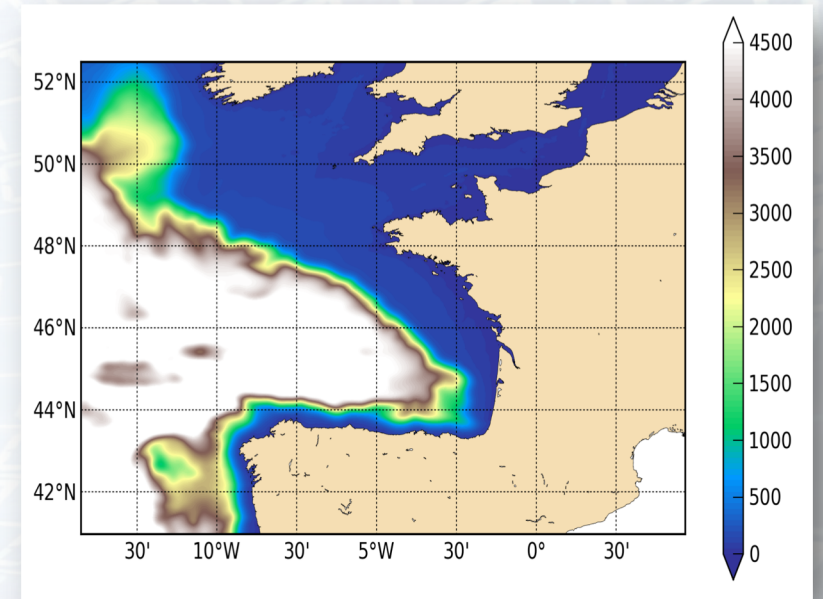
Open Boundary Conditions

DRAKKAR NEMO global simulations $1/4^\circ$ & $1/12^\circ$

Time Frame

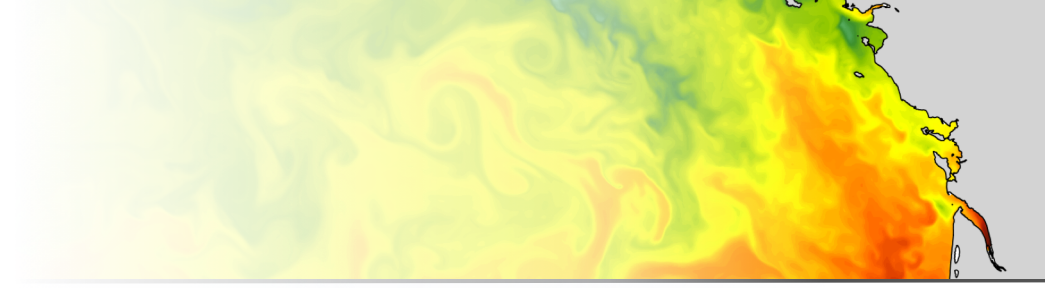
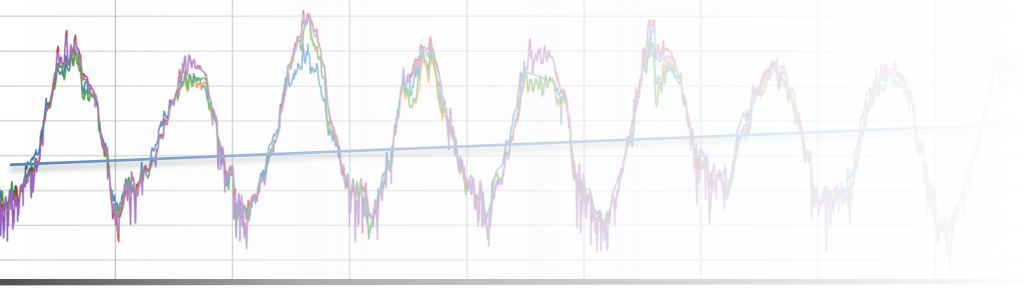
01/2001 (= > 10 years)

Model domain



12/2010

Atm. Forcings: ERA-Interim



Fine scale dynamics ...

... and interannual variability

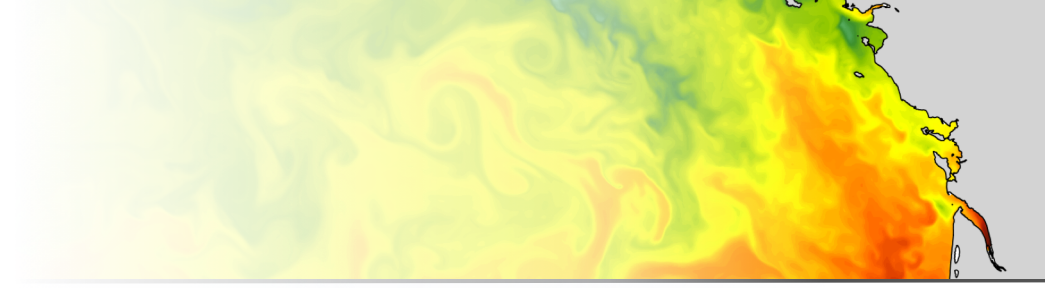
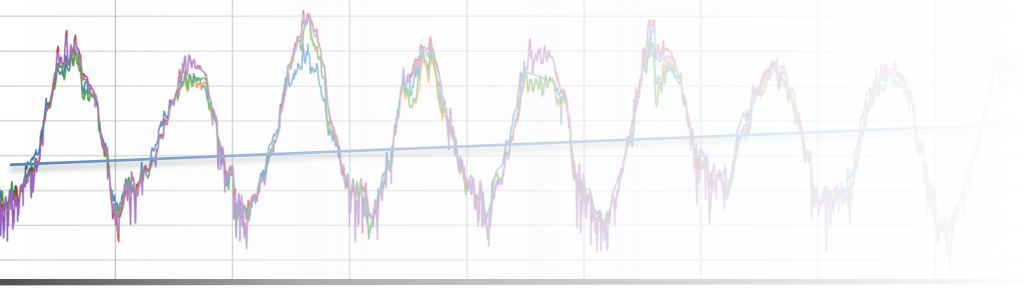
1

... and interannual variability (impact of spatial resolution)

2

... and trends

3



Fine scale dynamics ...

... and interannual variability

1

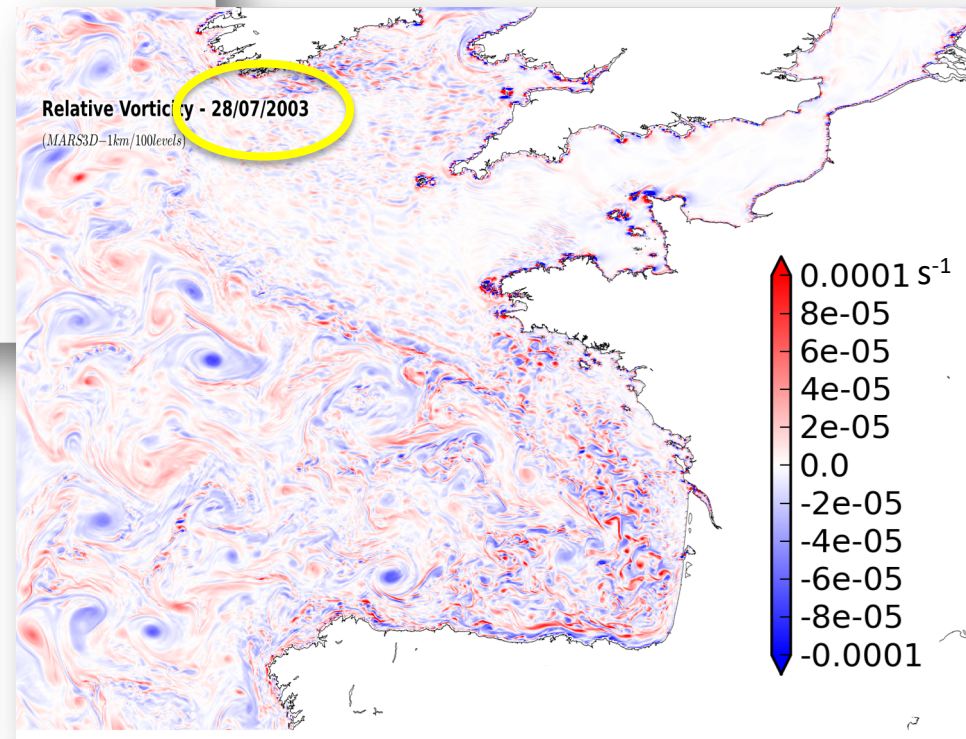
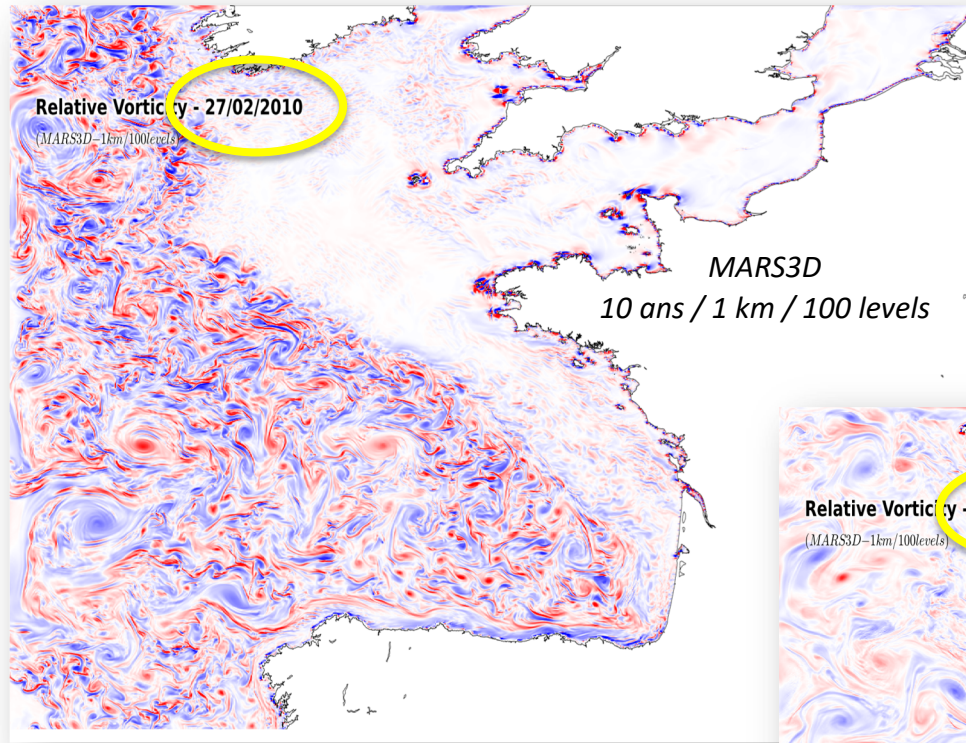
... and interannual variability (impact of spatial resolution)

2

... and trends

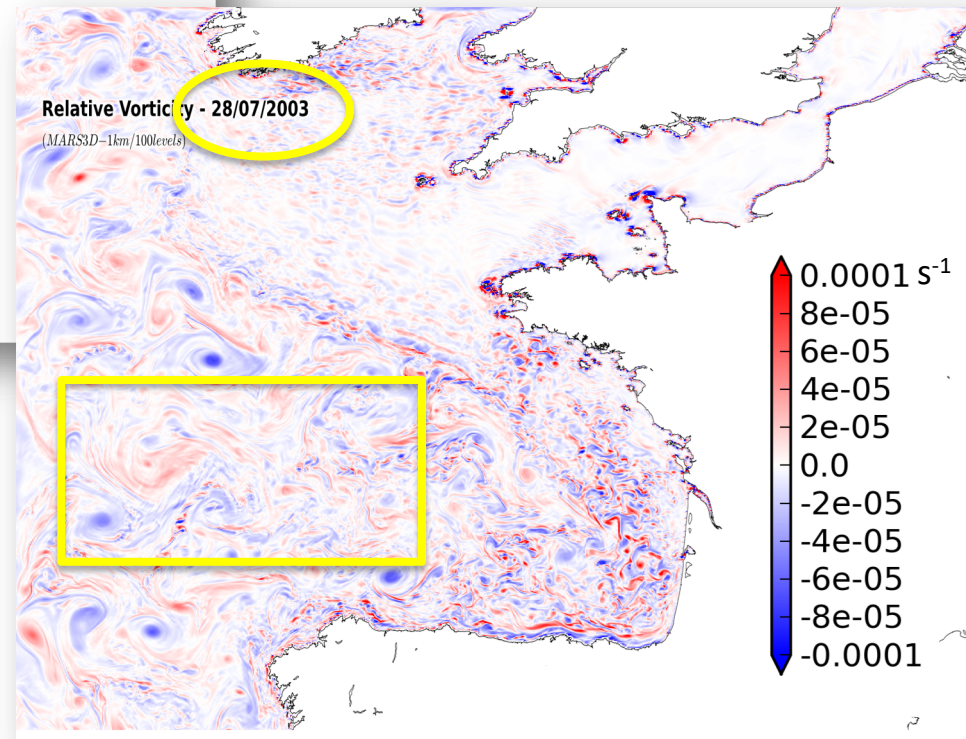
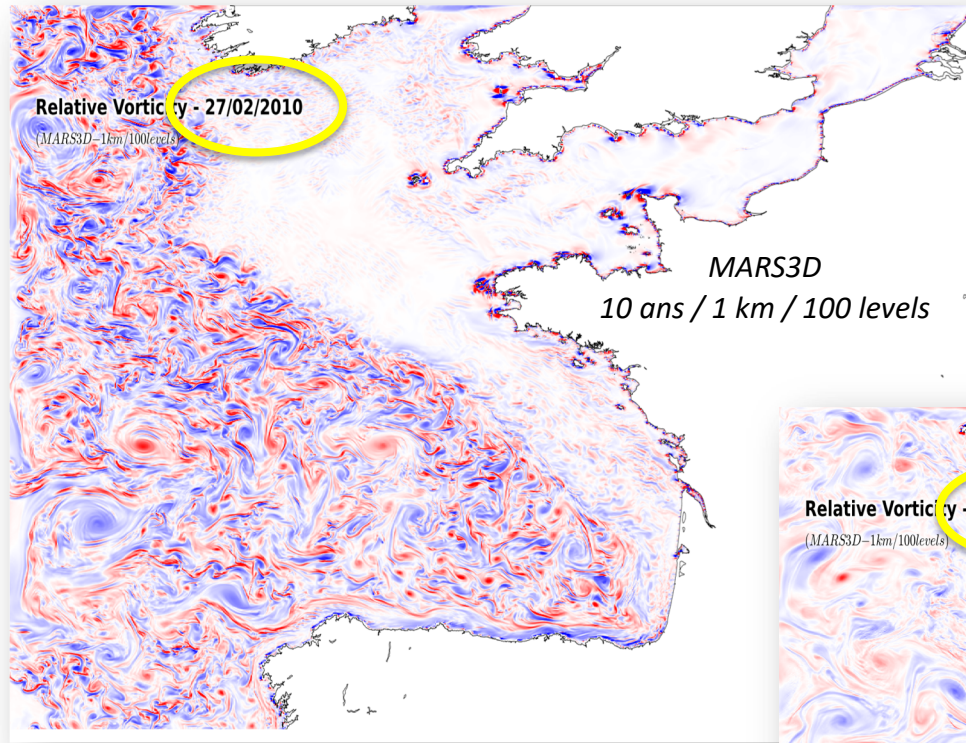
3

From seasonal to interannual variability in the Bay of Biscay



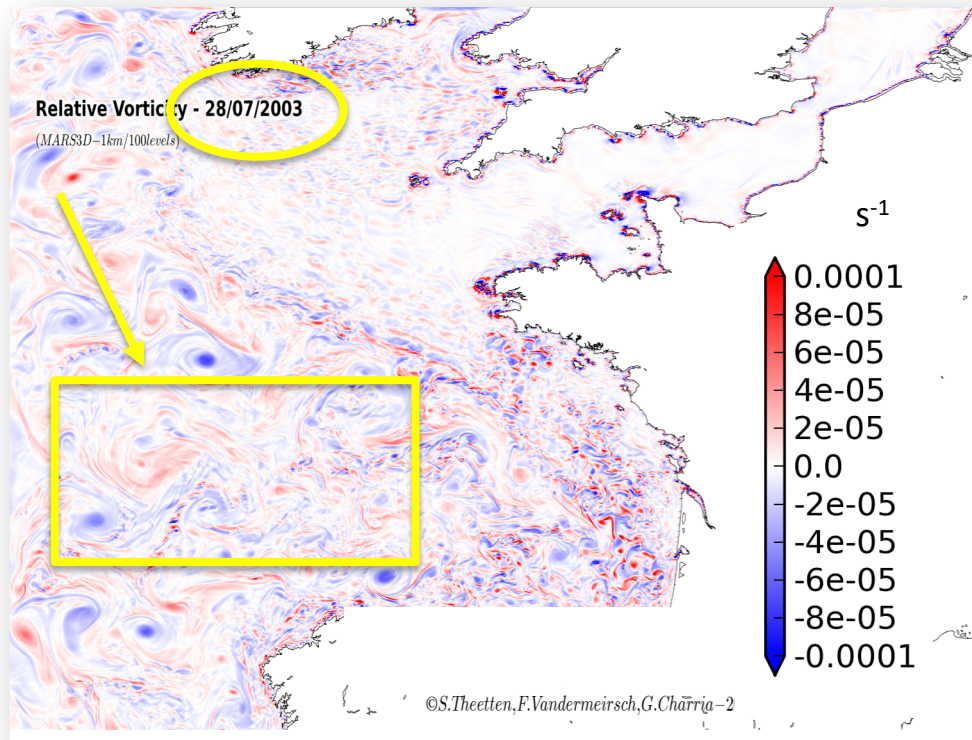
$$\xi = \frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}$$

From seasonal to interannual variability in the Bay of Biscay

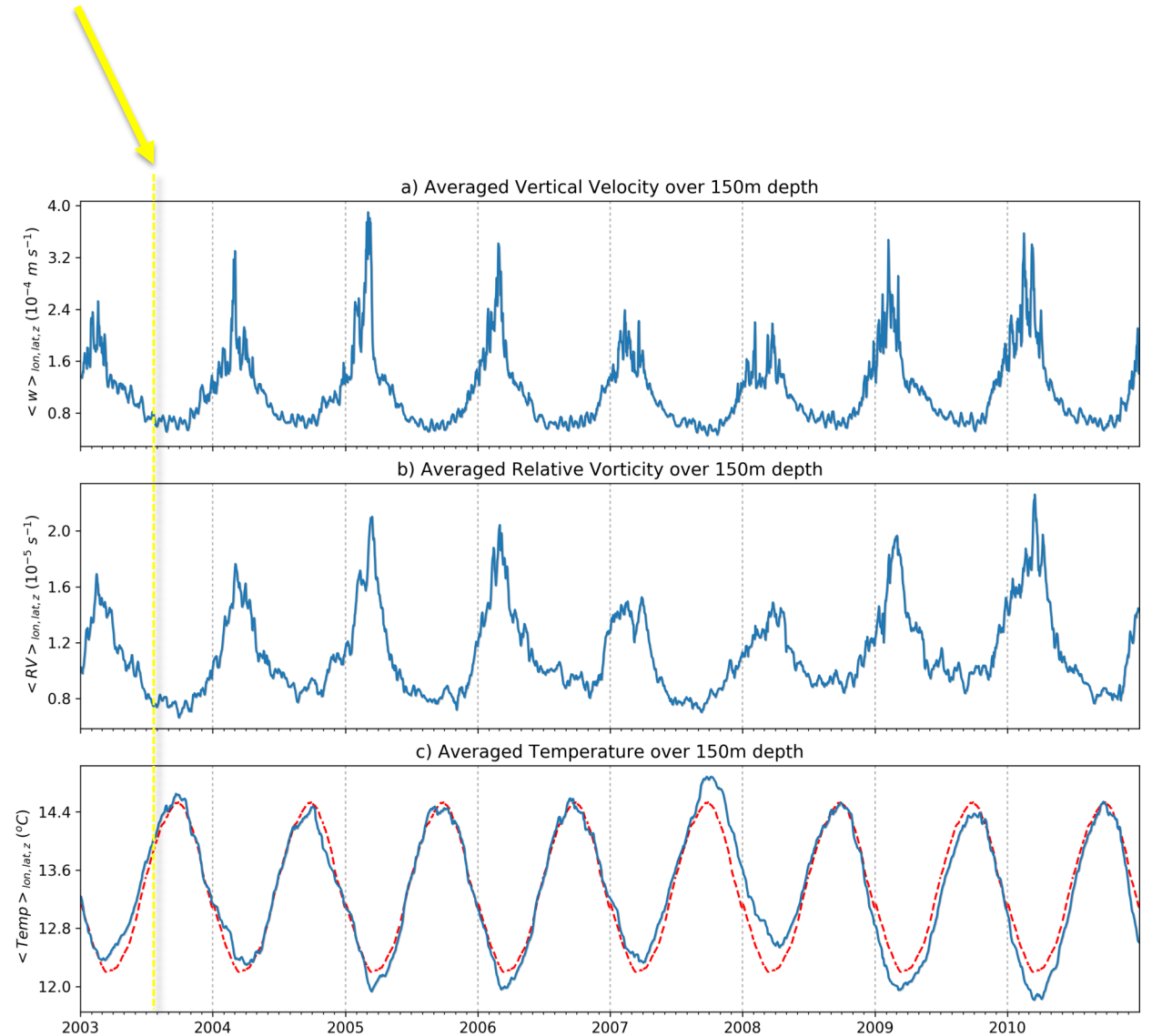


$$\xi = \frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}$$

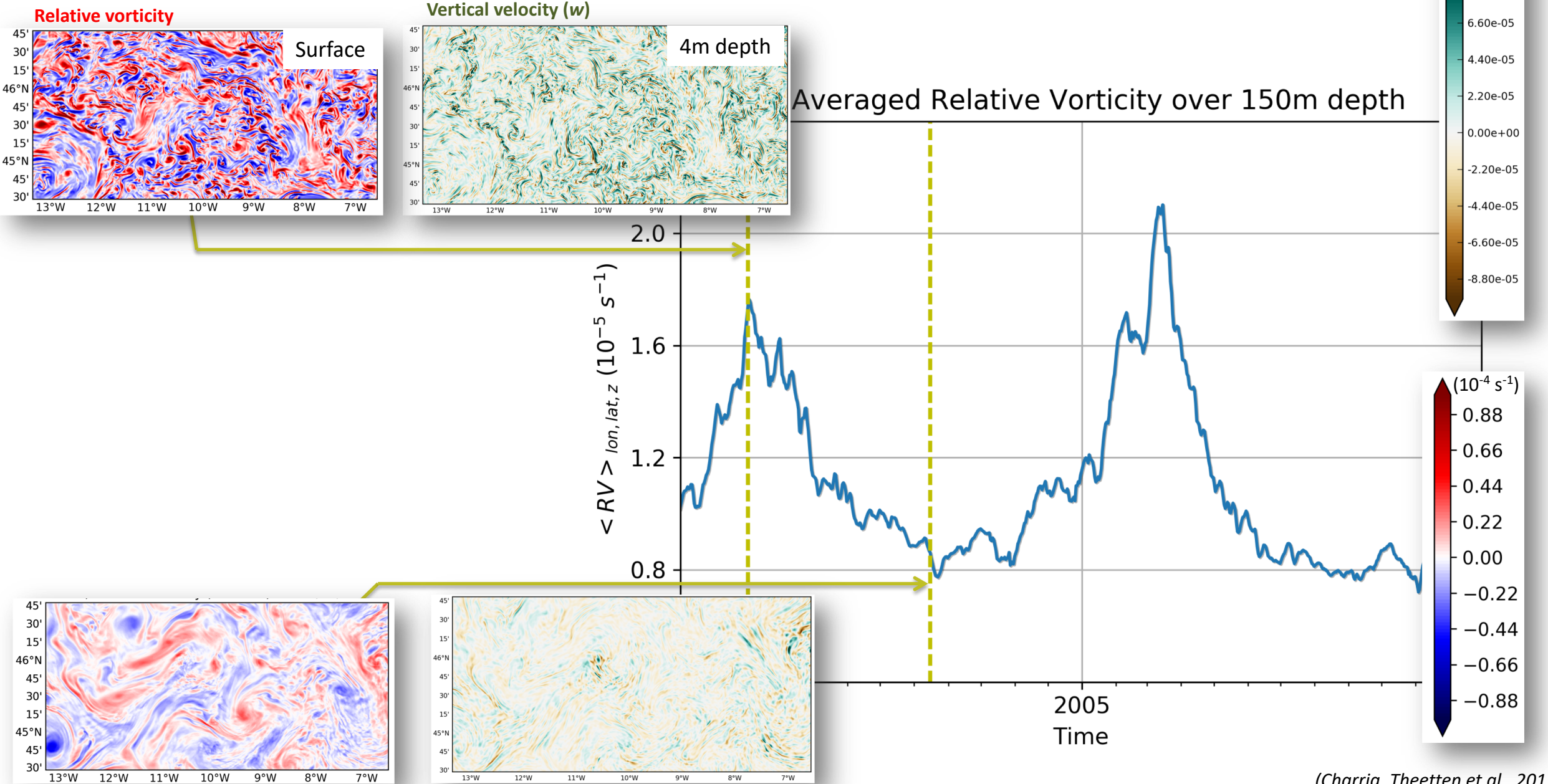
From seasonal to interannual variability in the Bay of Biscay



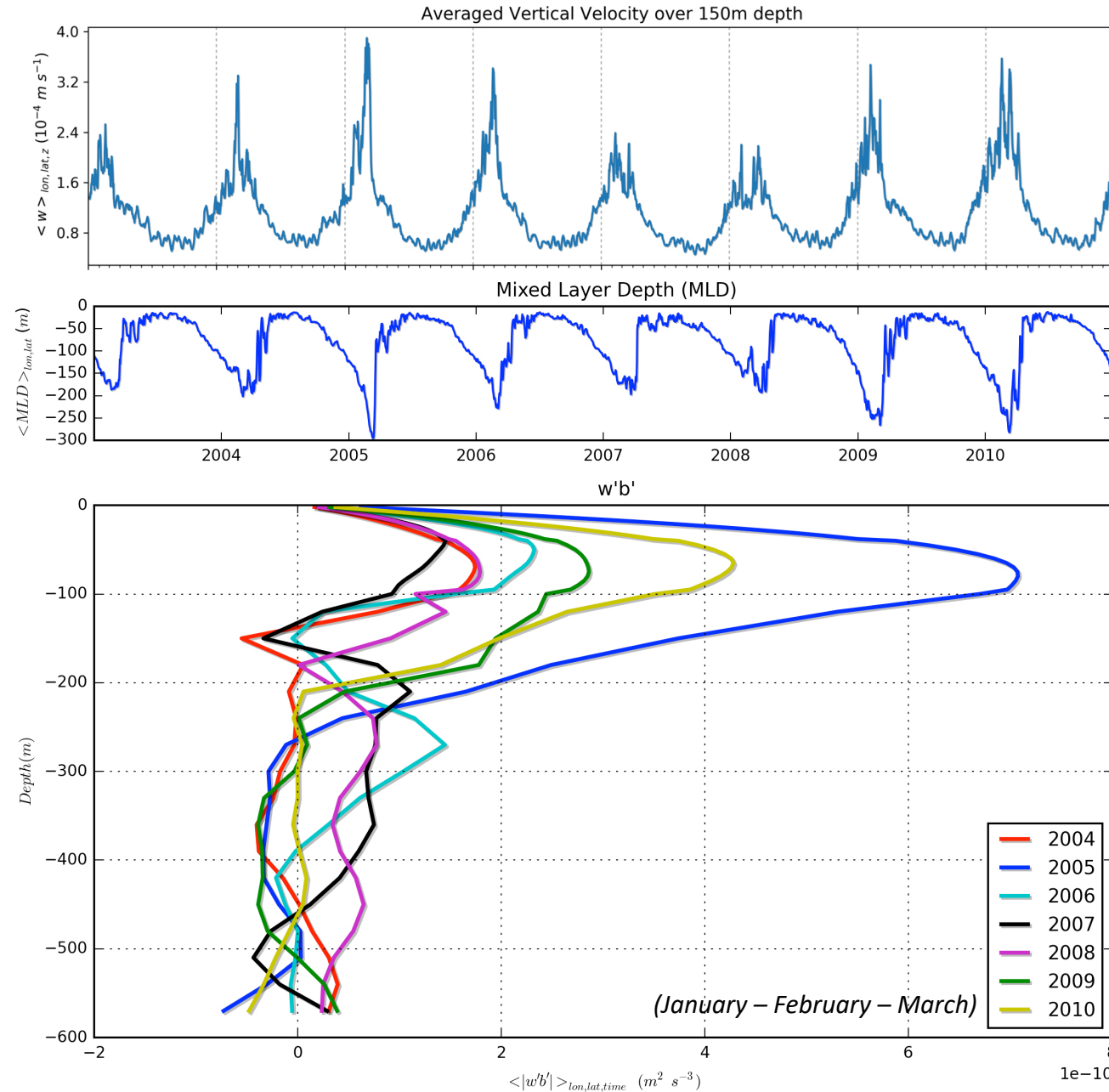
Links between fine scales and seasonal to interannual variability ?



Seasonal variability – surface relative vorticity and vertical velocity

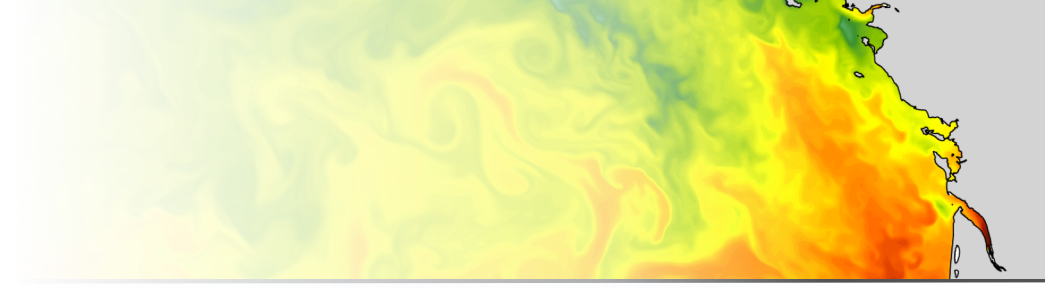
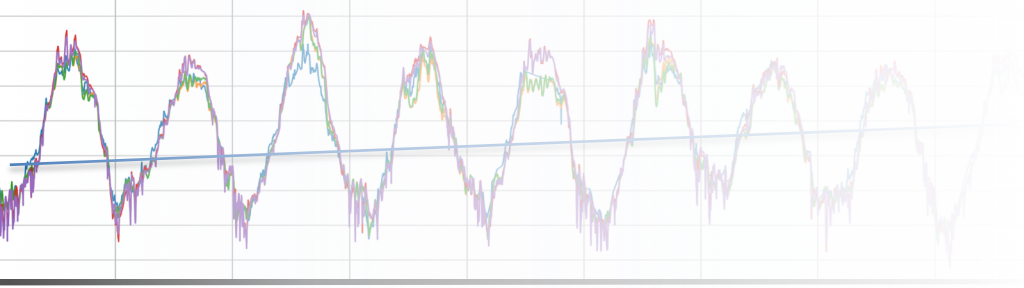


Interannual evolutions and (sub)mesoscale instabilities



A dynamics driven by
mixed layer
instabilities end of
winter

Interannual variability
constrained by large
scale events
(e.g. dry and cold
winter in 2005 –
Somavilla et al., 2009)



Fine scale dynamics ...

... and interannual variability

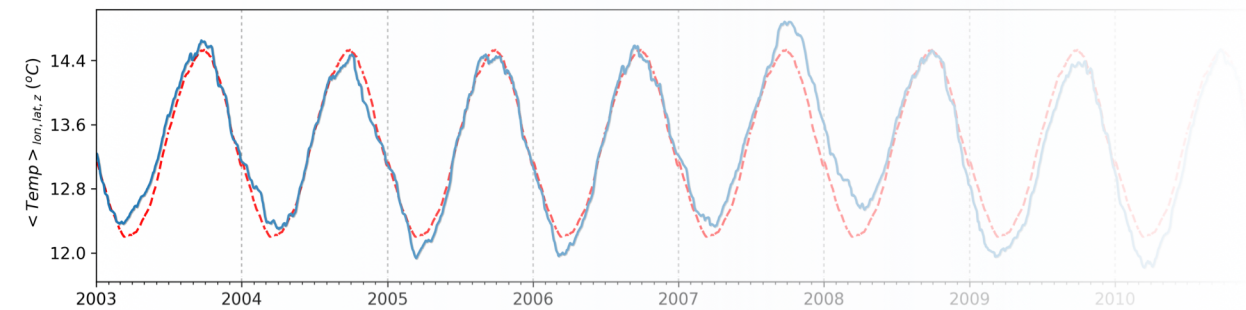
1

... and interannual variability (impact of spatial resolution)

2

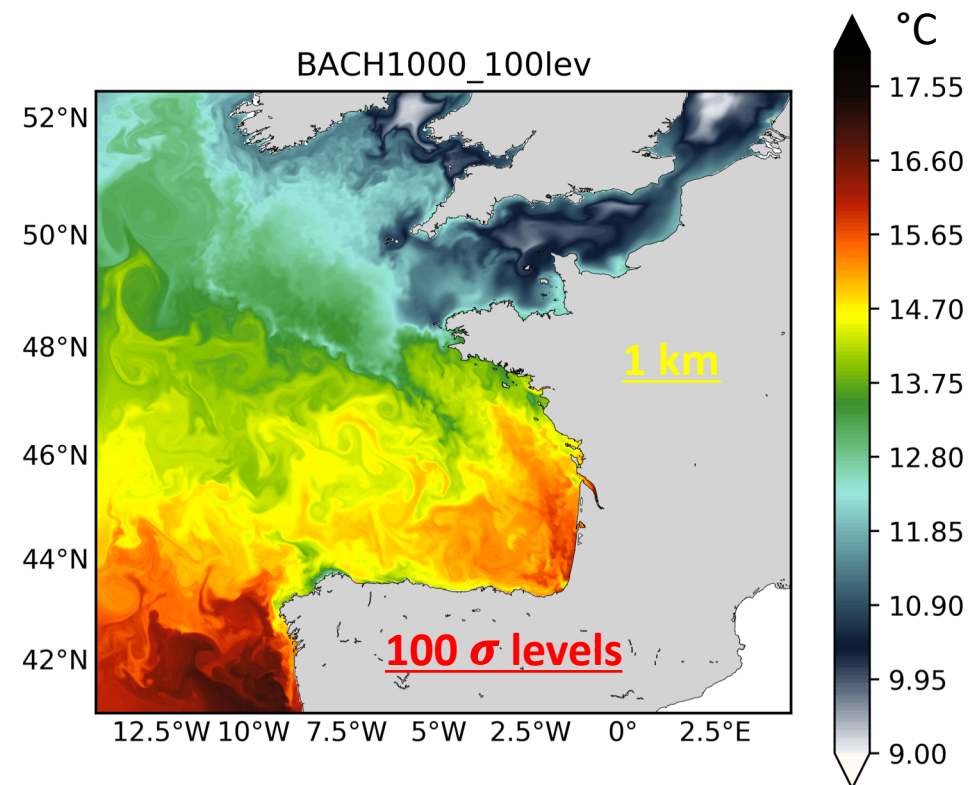
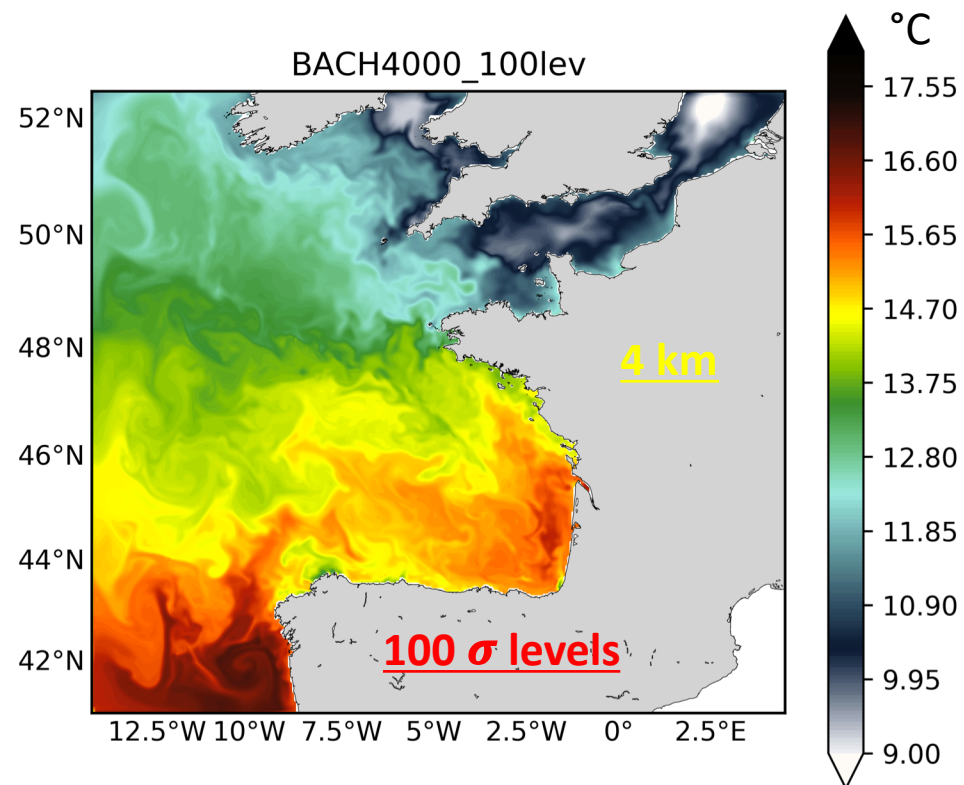
... and trends

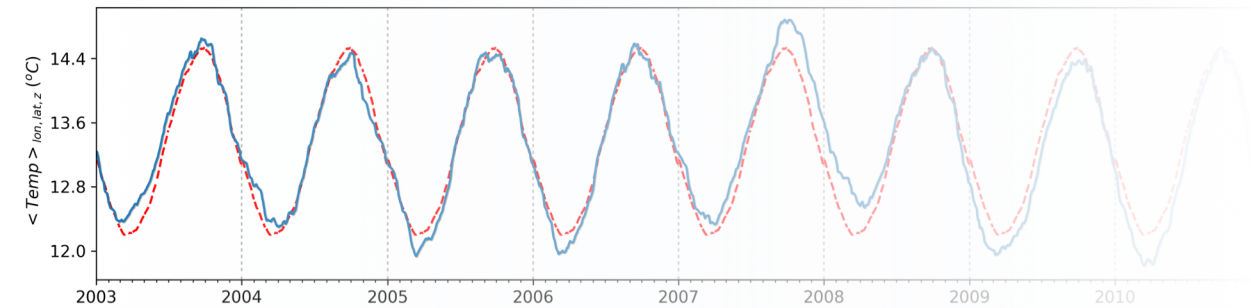
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Sea Surface Temperature

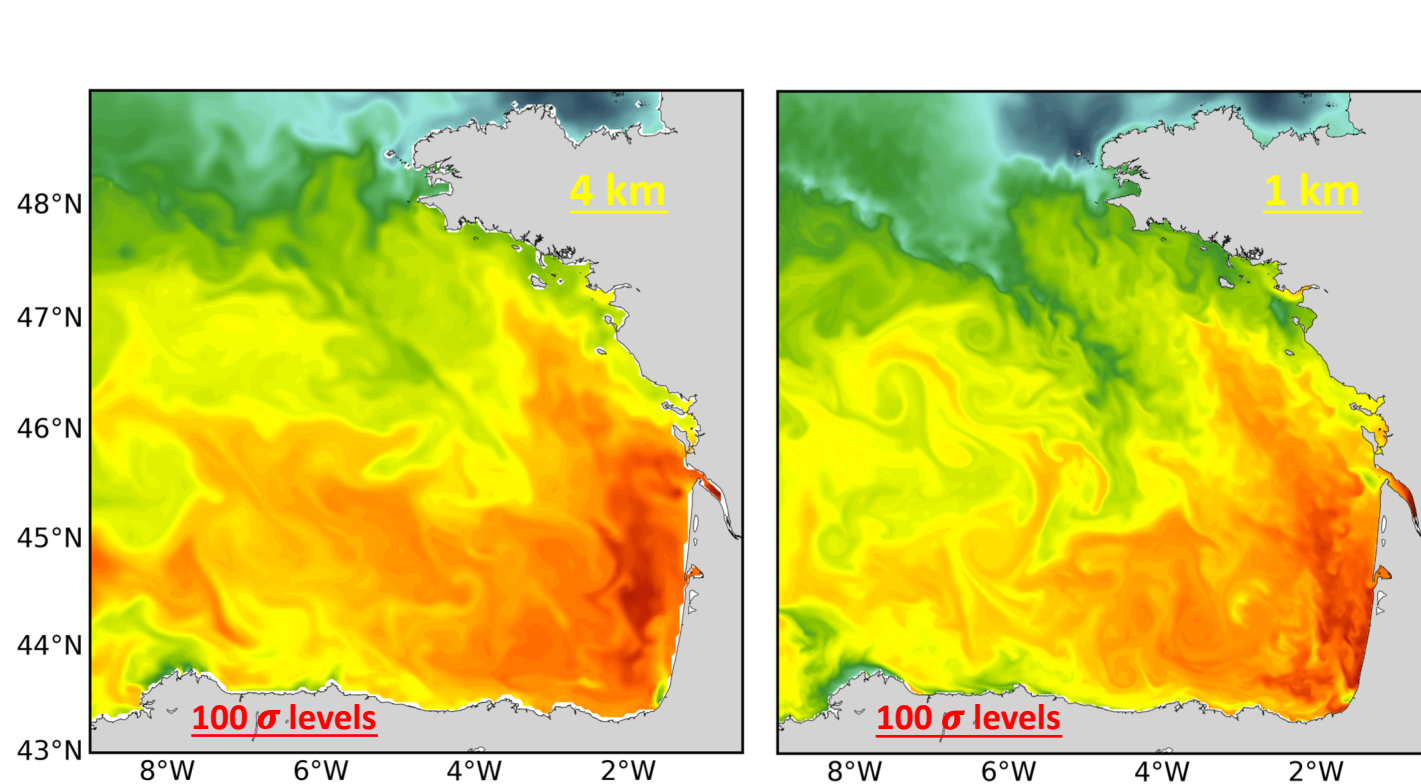
... 23th May 2010



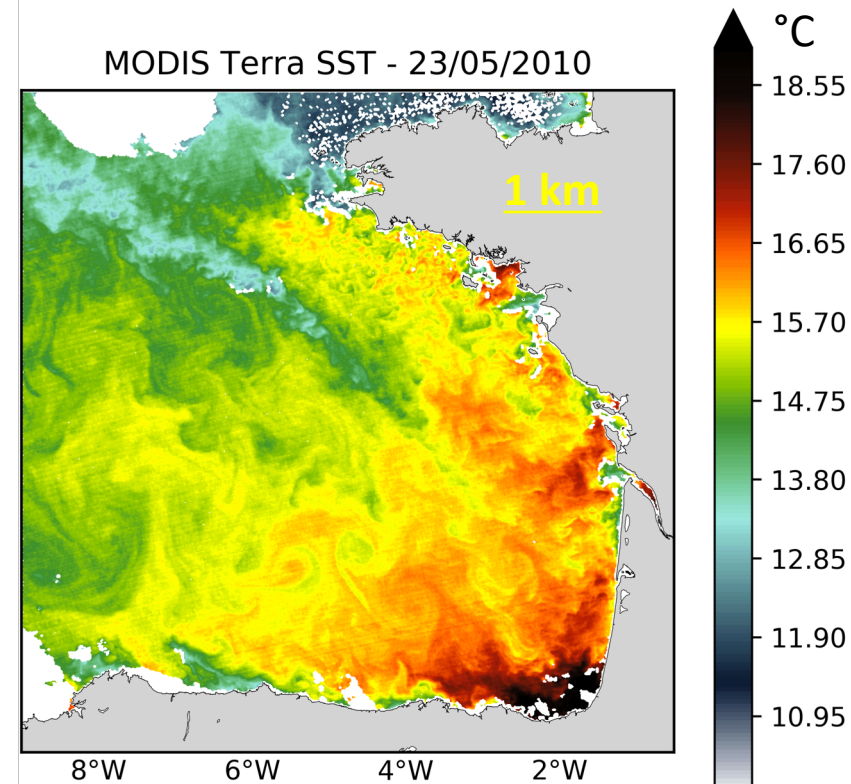
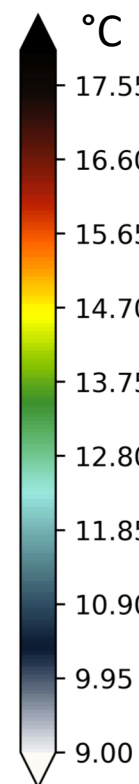


Sea Surface Temperature

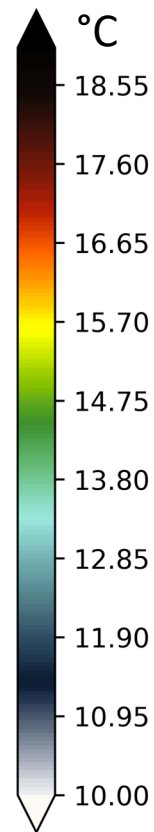
... 23th May 2010



Model

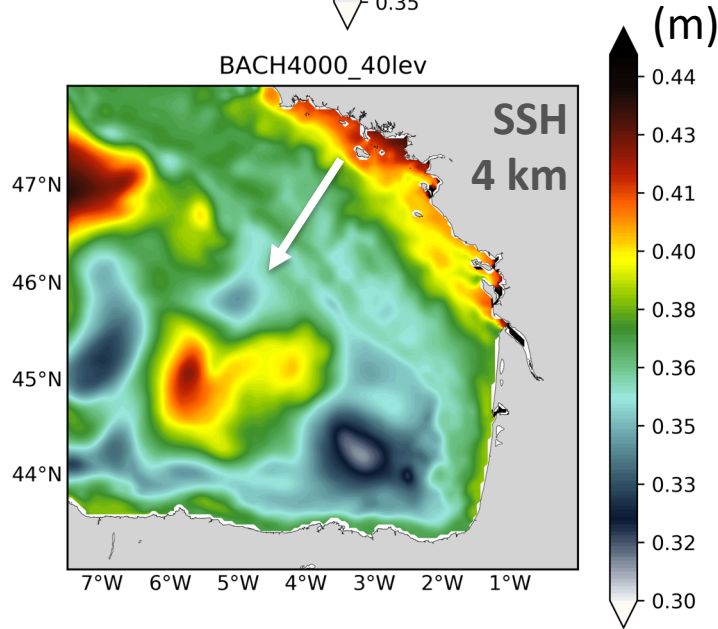
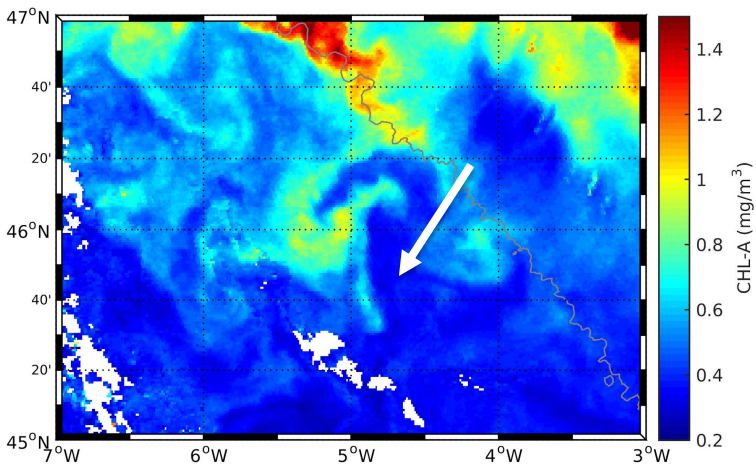
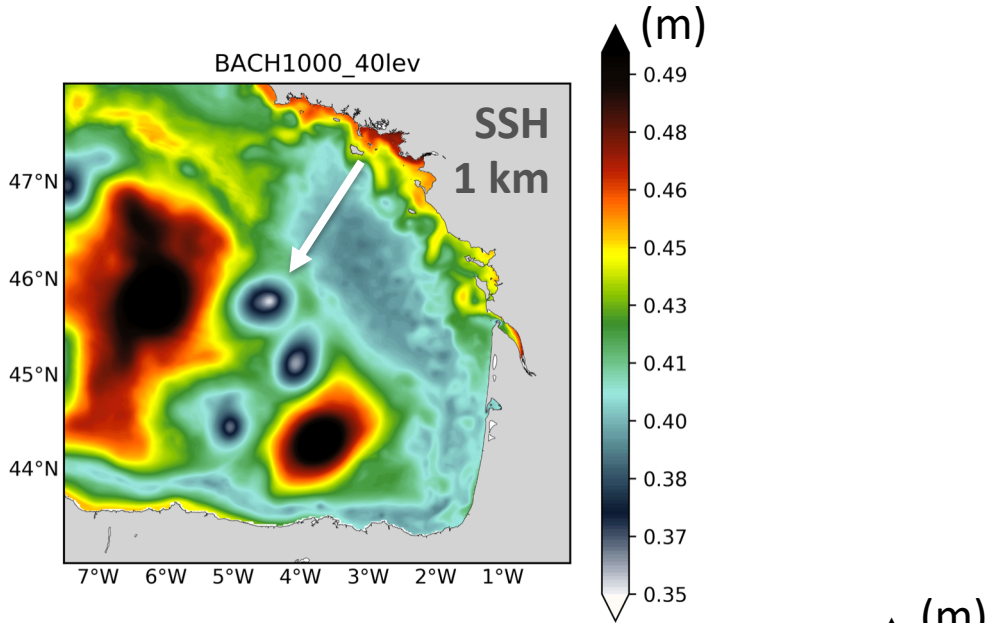
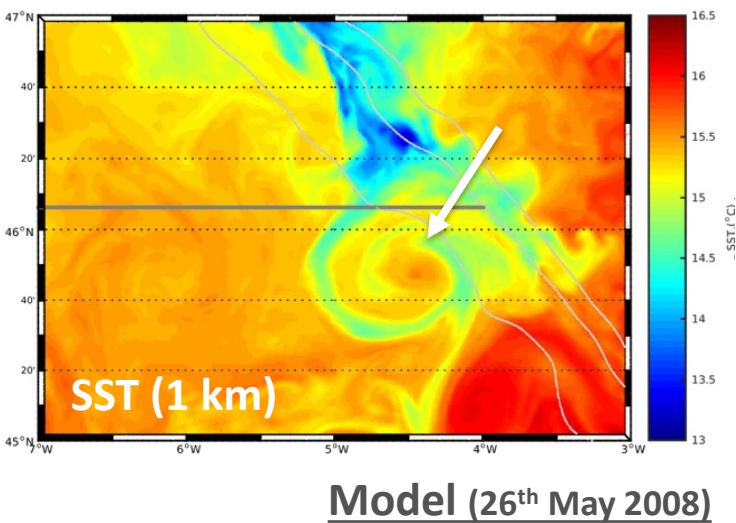
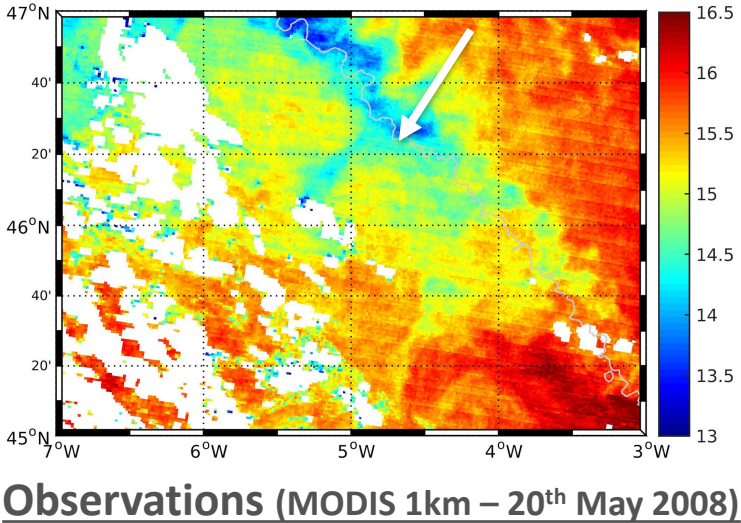


Observations

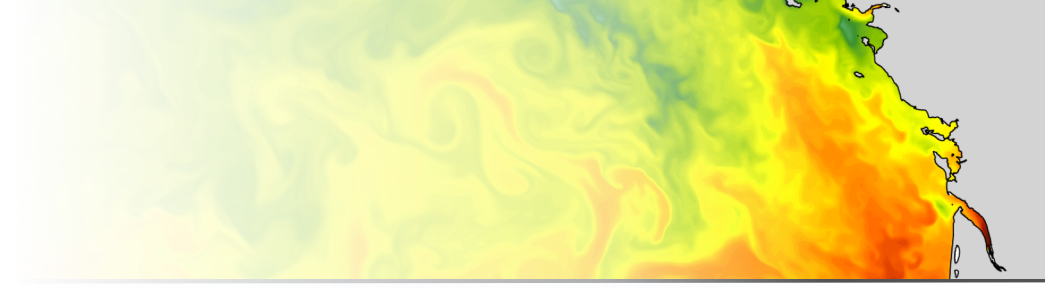
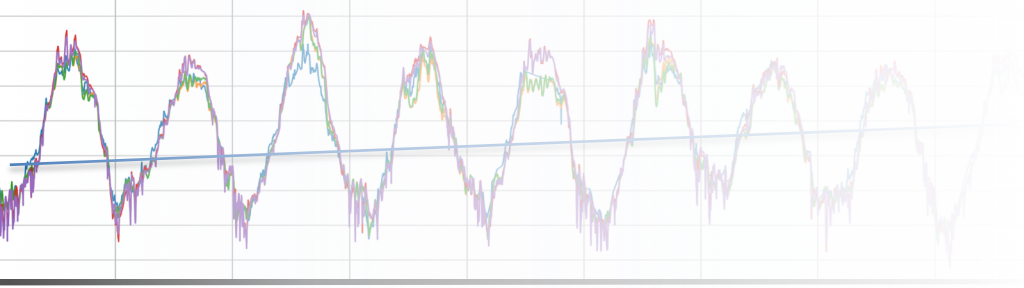


Cross-shelf exchanges

Sea Surface Height ... May 2008



(Akpınar et al., submitted, 2019)



Fine scale dynamics ...

... and interannual variability

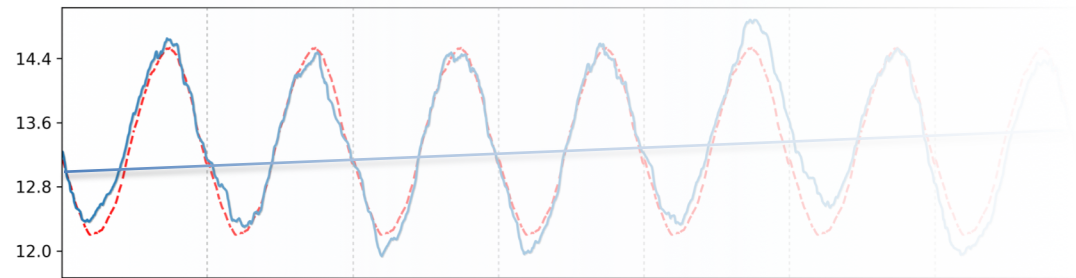
1

... and interannual variability (impact of spatial resolution)

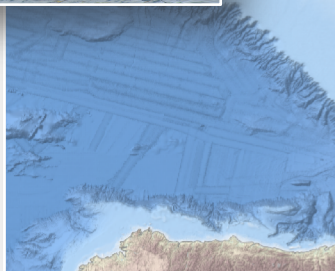
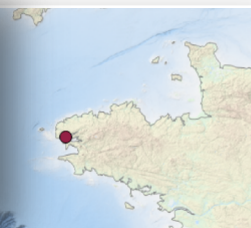
2

... and trends

3



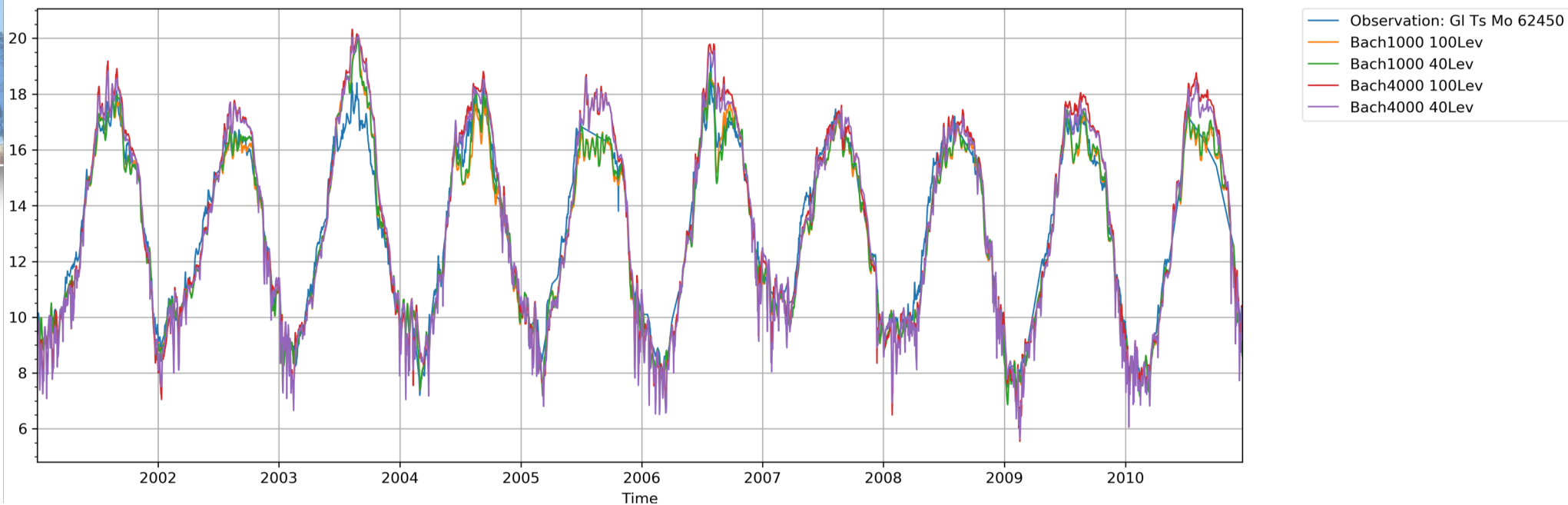
Fine scale dynamics and trends

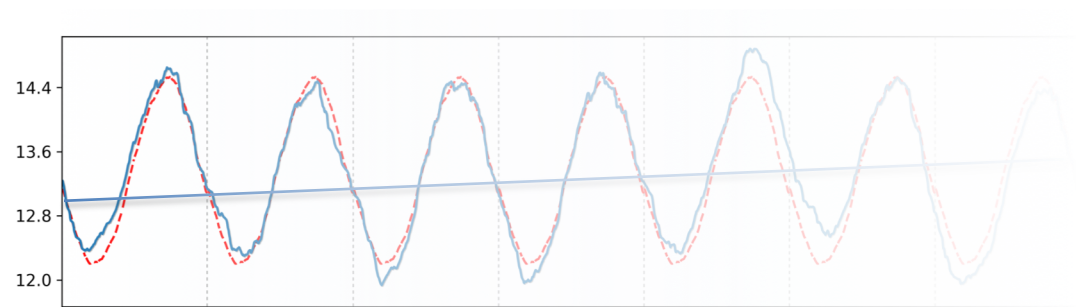


1 *in situ* reference

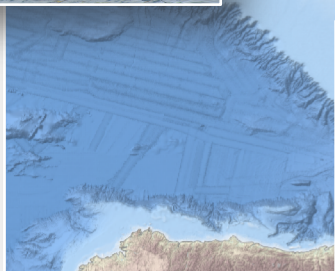
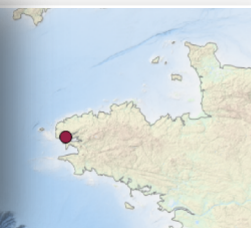
4 simulations

Temperature (observed and simulated)





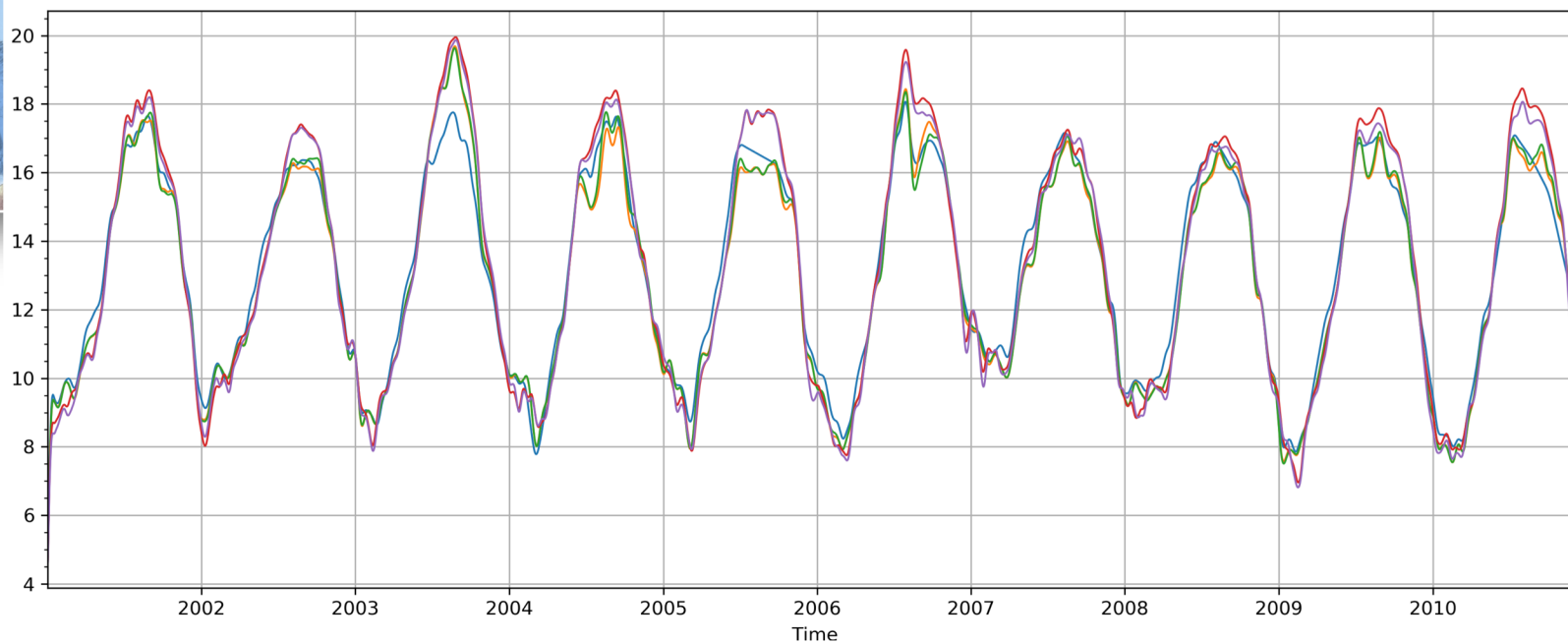
Fine scale dynamics and trends



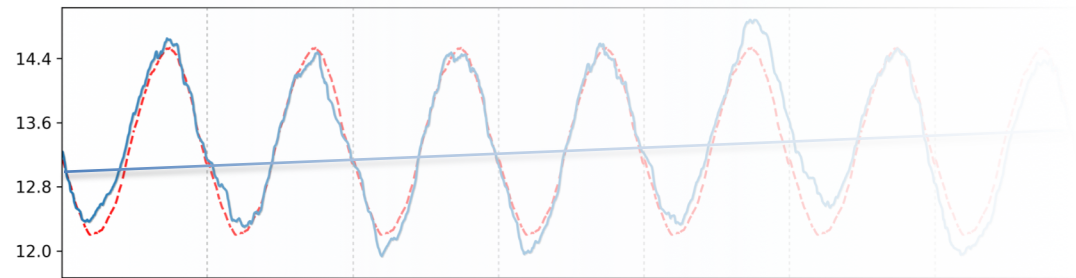
1 *in situ* reference

4 simulations

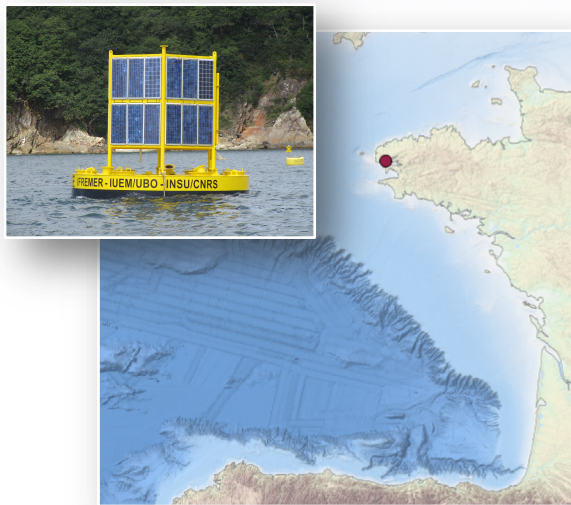
Temperature (filtered – 30 days)



- Observation: GI Ts Mo 62450
- Bach1000 100Lev
- Bach1000 40Lev
- Bach4000 100Lev
- Bach4000 40Lev



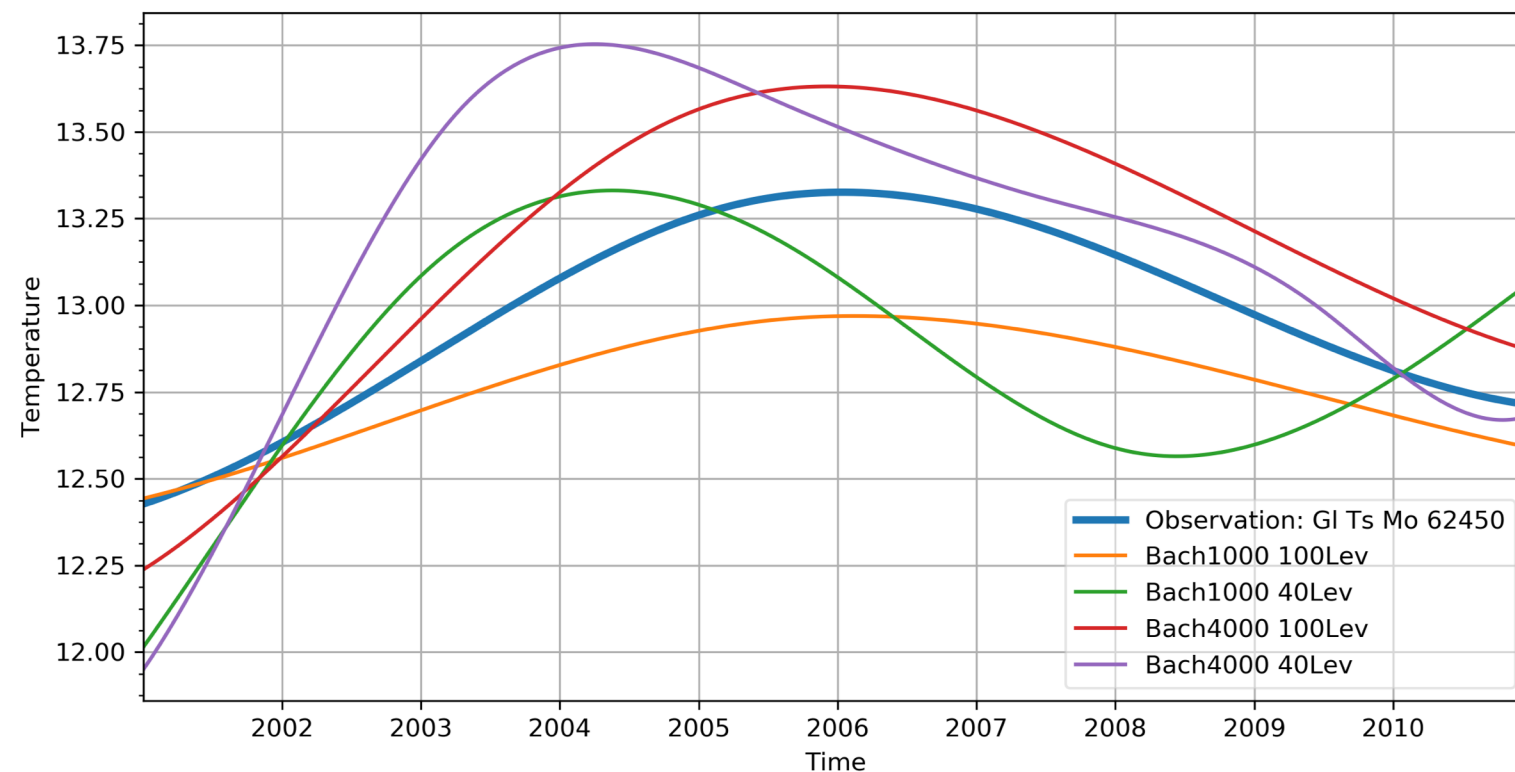
Fine scale dynamics and trends



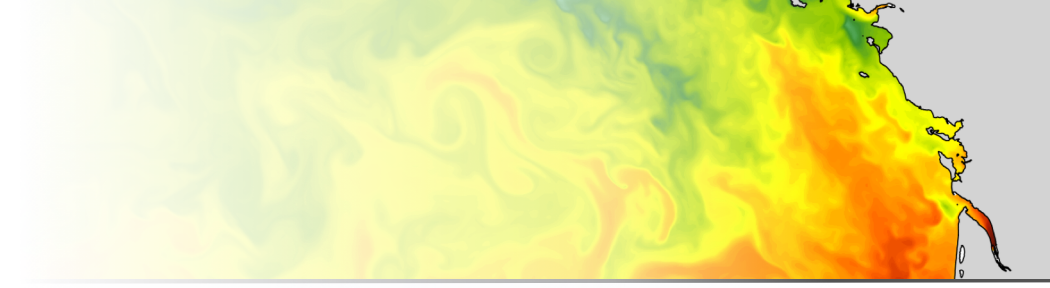
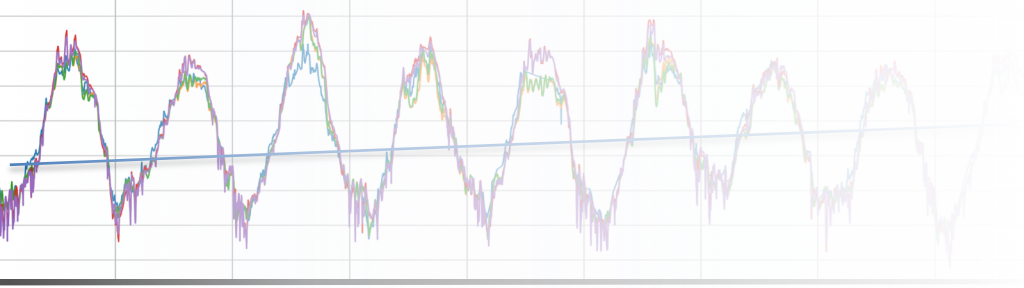
1 *in situ* reference

4 simulations

Residual from EMD* algorithm (= temperature trends)



*EMD: Empirical Mode Decomposition (e.g. Kbaier Ben Ismail et al., JMS, 2016)



Conclusions

Bay of Biscay: a multi-scale laboratory

We need

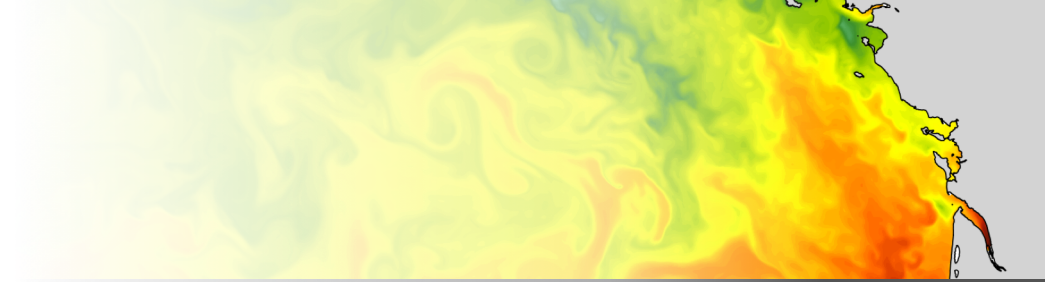
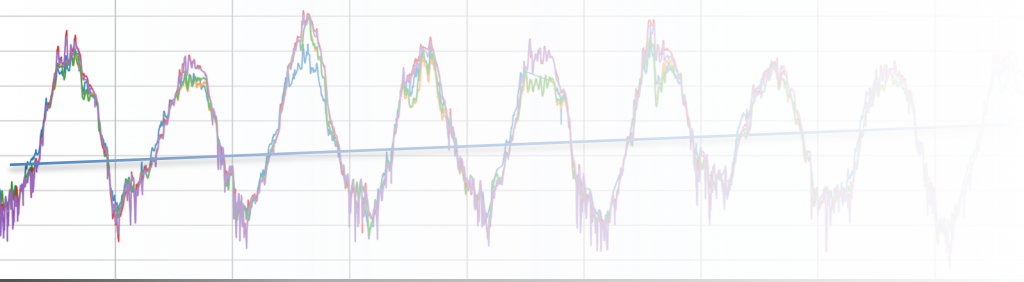
To increase model spatial resolution

- To simulate long-term trends
- To explore instability dynamics (source of vertical mixing) including the shelf with length scales around 6-8 km
- To improve our understanding of fine scale dynamics

We (are beginning to) quantify

The impact of **interannual large scale** forcings on **fine scale dynamics**

The sensitivity of **interannual trends** to **fine scale simulated processes**



Thanks for your attention

