FINE-RESOLUTION ALTIMETRY DATA FOR A REGIONAL APPLICATION IN THE BAY OF BISCAY

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SUMMARY :

- *Altimetry has been continually improved over years :*
  ➔ ***Centimetric** precisison; **coastal** processing; **high frequency** sampling; **submesoscale** evidences in A/T data and maps.*
- ***Bay of Biscay** (hereafter **BoB – fig. 1**), with its intense dynamics, is an ideal **experimental laboratory** for high resolution altimetry.*
- *Bay of Biscay **Slope Water Eddies (SWOddies)** play an important role for North Atlantic Ocean circulation by exporting slope water from the shelf edge to offshore areas.*
- *From **2002** to **2005**, with 4 satellites flown, processes down to **20-30km** may be resolved in **2D**.*

Objectives : ***➔ Examine the possibility of mapping fine mesoscale processes within the BoB***

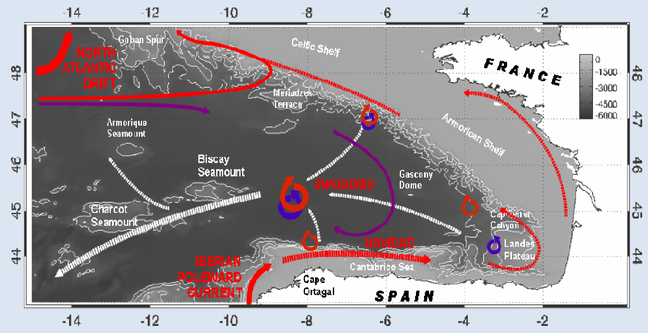


Figure 1. Schematic view of ocean circulation in the Bay of Biscay

A fact : Lower level of variability on AVISO RMS maps

+ Less LW errors (orbits)
+ Less tidal aliasing on merged datasets on shelf
- **Smoothed variability (in time and space) ?**

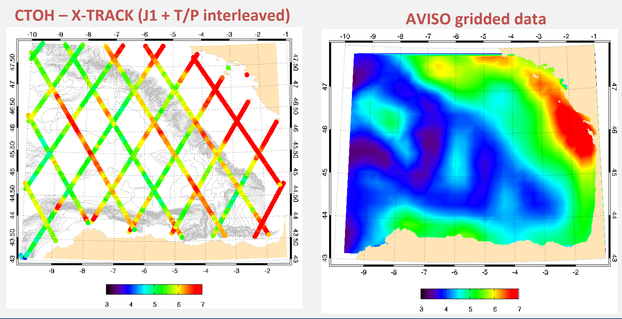


Figure 2. RMS maps for the Oct.2002 – Sep.2005 period. On left, X-TRACK along-track data (J1). On right AVISO DUACS data (DT-Updated). Color scaling is in **cm**.

➔An illustration at a given time

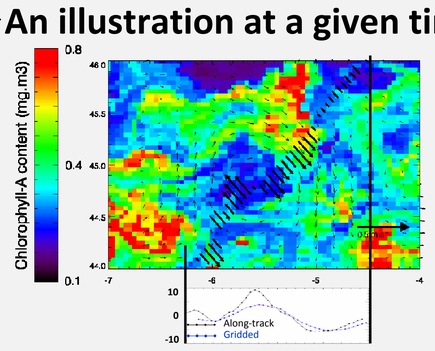


Figure 3. MODIS Chlorophyll a data from 19/03/2003, with thin arrow (gridded velocities), bold arrows (along-track velocities).

The data : what has been used for this study

	Along-track X-TRACK dataset	Gridded AVISO altimetry dataset
Period	Oct. 2002- Sep. 2005	Oct. 2002- Sep. 2005
Availability of atmospheric corrections to the coast	Latest available radiometer correction interpolated to the coast using model variability in **coastal zone**	50 km (radiometer mask)
Tidal correction	MOG2D barotropic tidal **regional** model (finite elements)	GOT4.7 global tidal model
Atmospheric forcing correction	MOG2D global model (HF+LF)	MOG2D global model for HF + ECMWF for LF
Initial resolution	**1Hz** ~ 7 km	**1Hz** ~7 km
Spatial filtering	**3 pts** Loess filter (~20km)	**3pts** Median filter + **60km** Lanczos filter
Mapping lengthscales	-	~**115 km** & **12** days
Final effective resolution[1]	**~30 km**	**~115 km**

[1] Spatial resolution is defined as the break in exponential growth rate of the spatial spectrum.

Describing the mesoscale : The use of along-track Wavelet Analysis

•A/T Wavelet analysis [*Lilly et al.*, 2003], [*Dussurget et al.,* in prep.]:

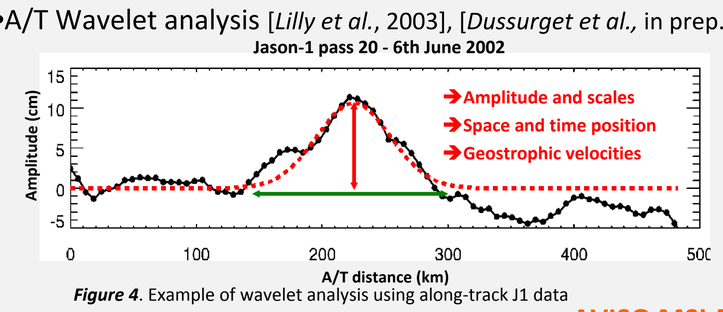


Figure 4. Example of wavelet analysis using along-track J1 data

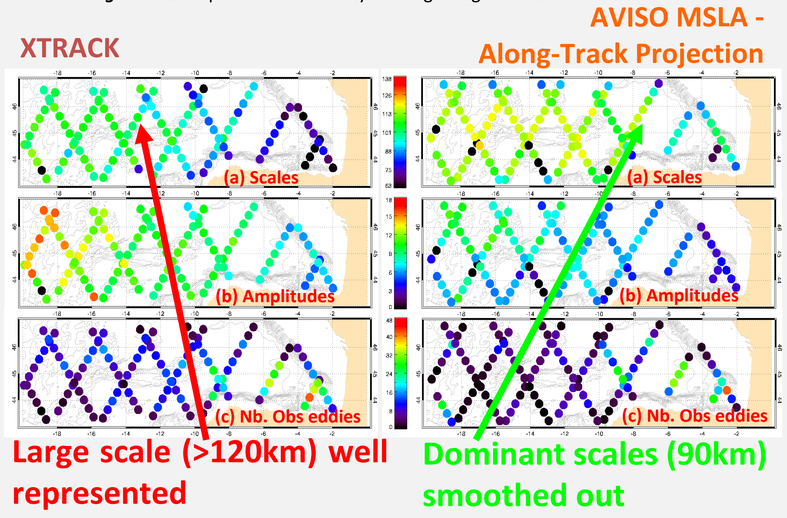


Figure 5. Mapping of scales(top), amplitudes (middle) and nb. of observed eddies (bottom) for X-TRACK (left) and AVISO grid (right)

- **Spatial evolution visible from A/T data and maps.**
- **MSLA : Smoothing within BoB of 25km + 2cm**
  ➔ Ugeo maps = 1/2 Ugeo A/T data

KEY POINT :

➔ Onshore / Offshore evolution of spatial properties :

Geostrophic turbulence in the Bay of Biscay ?

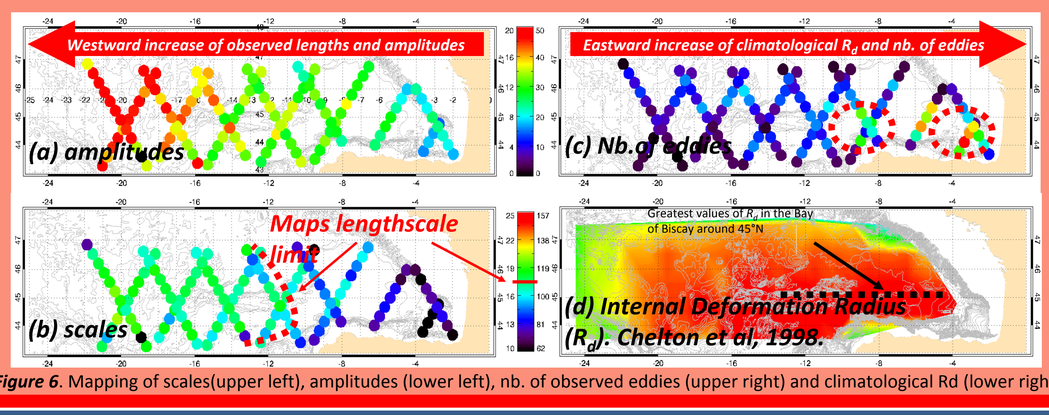
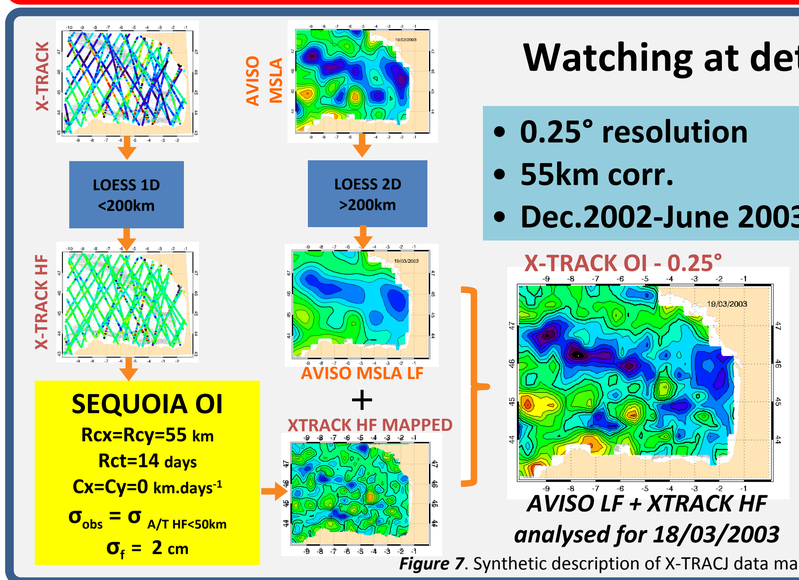


Figure 6. Mapping of scales(upper left), amplitudes (lower left), nb. of observed eddies (upper right) and climatological Rd (lower right) for A/T data

To answer :

➔ **Study links between offshore variability and slope current dynamics.**
➔ **Resolving the smaller mesoscale field in generation regions (variable scales in OI)**

Watching at details : Improving mapping in regional seas



- **0.25° resolution**
- **55km corr.**
- **Dec.2002-June 2003**

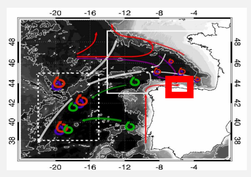
- X-TRACK 1Hz data - 4 satellites (2002-2005)
- Maintain full resolution of the input data:
  - o No low pass A/T filtering
  - o No subsampling of A/T data
  - o No subsampling within « influence bubble »
- Long Wavelength Errors :
  - o AVISO maps best solution for LF scales
  - o Add information at HF scales (< 200km)
- Sequoia assimilation platform [*De Mey,* 2007]: Kalman Filter - testing variable mapping parameters

Figure 7. Synthetic description of X-TRACJ data mapping system

On the edge : Mapping the slope current

- *« Navidad »* : warm intrusion of the slope current along the Northern Spanish coast.
- ***High resolution grid*** in a well sampled zone (***fig.8***)

High res. Grid : 0.06° 55km / 14 days



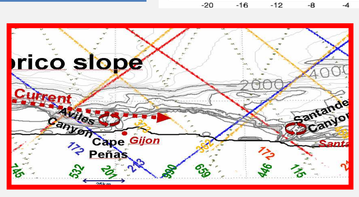


Figure 8. Localisation of the high resolution grid in the Bay of Biscay (top) and altimetric sampling (bottom)

➔ HF altimetry maps cleary shows (***fig.9***), a ***geostrophic flow*** anomaly, well aligned with the ***bathymetry.***
➔MODIS SST image (***fig.9***), displays a ***similar behaviour*** some days later
➔Other structures may be seen:

A ***coastally trapped recirculation*** (MODIS shows cold water tongue along the coastline)

A ***cyclonic feature*** at ~6°W, with a warm anomaly apperently advected from the slope

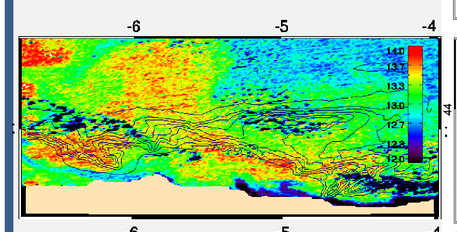


Figure 9. MODIS Aqua SST image on **13/03/2003**. Colors are scaled in °C.

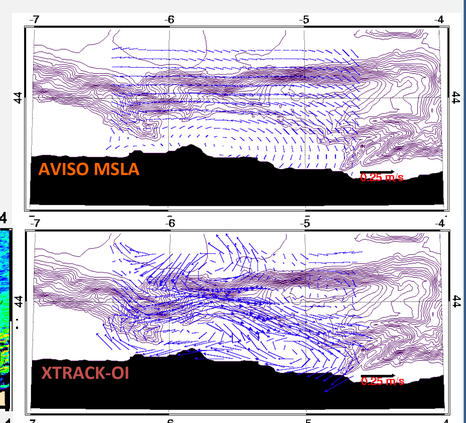


Figure 10. Analysed Geostrophic velocities on **01/01/2003** for AVISO (upper panel) and XTRACK HF map (lower panel)

What's new? Some examples of resolved fine mesoscale

Inspect **consistency** of data:

- In **space** (MODIS imagery) – ***fig.11***
  - •Good agreement of small scale features with image
  - •Resolution of near slope features
- In **time** (time series) – ***fig.12***
  - •Cyclonic propagation of an eddy signal along the shelf, consistend in time, then partly captured on AVISO maps by April 2003 (red arrow on ***fig.12***)

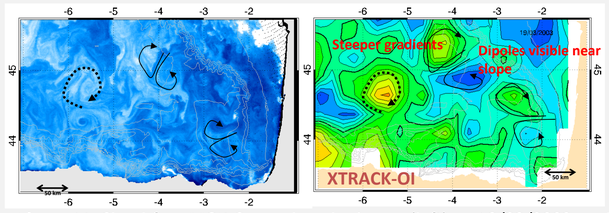


Figure 11. Cloud-free MODIS pseudo-color image (left) on 18/03/2003, and HF altimetric map on 19/03/2003. SLA contours are given each cm (zero contours is bolded). Corresponding AVISO map can be found in ***fig.12***.

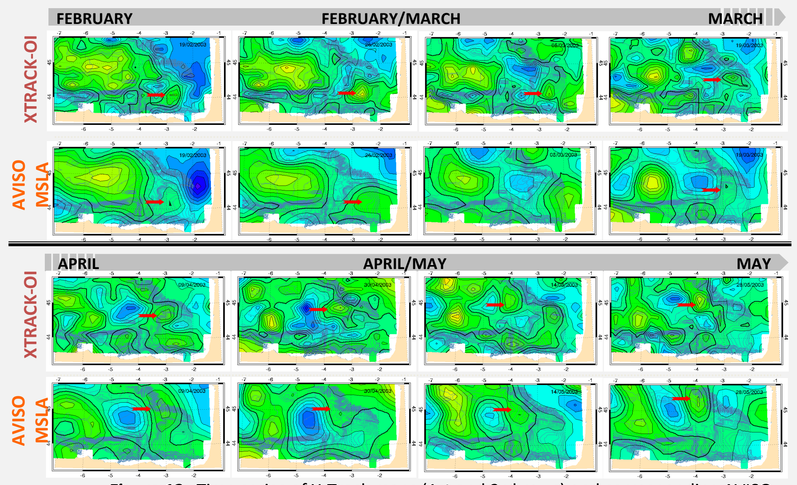


Figure 12 . Time series of X-Track maps (1st and 3rd rows) and corresponding AVISO maps (2nd and 4th rows). Period covers February to March (upper panel), then April to May (lower panel). Contours are given each cm (zero contours is bolded).

Conclusions:

Study have shown the importance of **maintaining fine mesoscale structures**:

- **Wavelet Analysis** is a useful tool for deriving local statistics on the mesoscale
- **Mapping of fine scale** structures have been shown to be **feasible** and **consistent** both in space and time
- **Systematic validation** with independant datasets is now required
- **Improvements of mapping** may include **potential vorticity** (in slope areas), **evolutive correlation radius** (as shown as along-track analysis), and also include **20Hz altimetry** data to get closer to the coast.

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