High resolution altimeter gridded fields for coastal and regional studies: applications in the Western Mediterranean

Romain Escudier[1], Ananda Pascual[1], Jérôme Bouffard, Juan Manuel Sayol[1], Alejandro Orfilla[1]

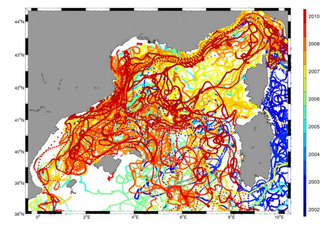
[1]IMEDEA(CSIC-UIB), Esporles, Spain, contact: romain.escudier@imedea.uib-csic.es
[2]LOPB, Marseille, France

Abstract

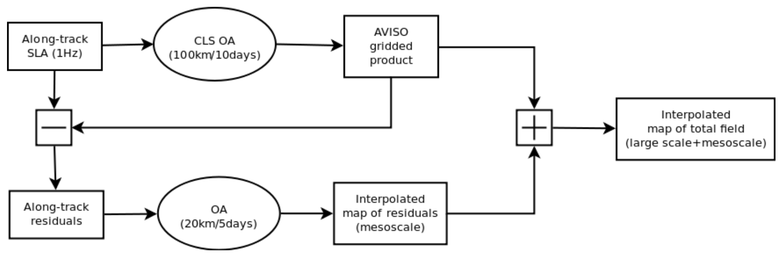
Previous studies (Pascual et al. 2006) have shown that the merging of multiple altimeter missions provide improved description of the mesoscale variability but they have also pointed out that the present configuration still lacks of enough resolution for correctly sampling regional and coastal features. In this context, we develop and test alternative methods to generate high resolution altimeter maps by using a two step method in which smaller scales are added close to the altimeter tracks.

Data

- **Altimetry : 2002- 2010**
  - **4 satelites (envisat/tp/j1/j2)**
    - Along Track data
    - AVISO interpolated regional product (Pujol et al., 2005)
      - 100 km and 10 days space and temporal correlation radius.
      - 1/8º, weekly
- **Auxiliary data:**
  - **In-situ measurements:** drifters (Poulain, pers. comm. 2010) and tide gauge (IMEDEA/SOCIB).
  - **SST data**: MODIS (NASA) & MERGED (IFREMER, CERSAT)
  - **Bathymetry:** Smith & Sandwell Topography v9.1 (UCSD).



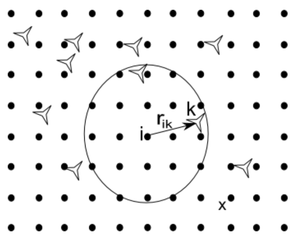
Method



- **Different methods for second mapping**
  - Optimal interpolation :
    - Sensitivity study of spatial and temporal correlation scales
      results did not present important sensitivity for small changes in the parameters
  - Optimal interpolation with bathymetry constraint

- **Optimal interpolation**

$$f_a(r_i) = f_b(r_i) + \sum_{k=1}^{K} W(r_{ik})[f_O(r_k) - f_b(r_k)]$$

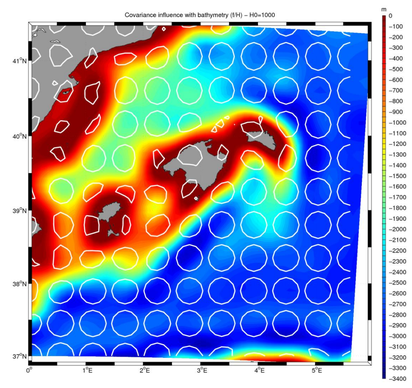


With W calculated using the background error covariance.

Standard form for the background error covariance (function of space and time) :

$$C_{ij} = e^{-\frac{|r_i - r_j|^2}{2L^2}} e^{-\frac{\Delta t^2}{T^2}}$$

- **Bathymetry**



Modified correlation function for background error covariance (Davis, 1998)

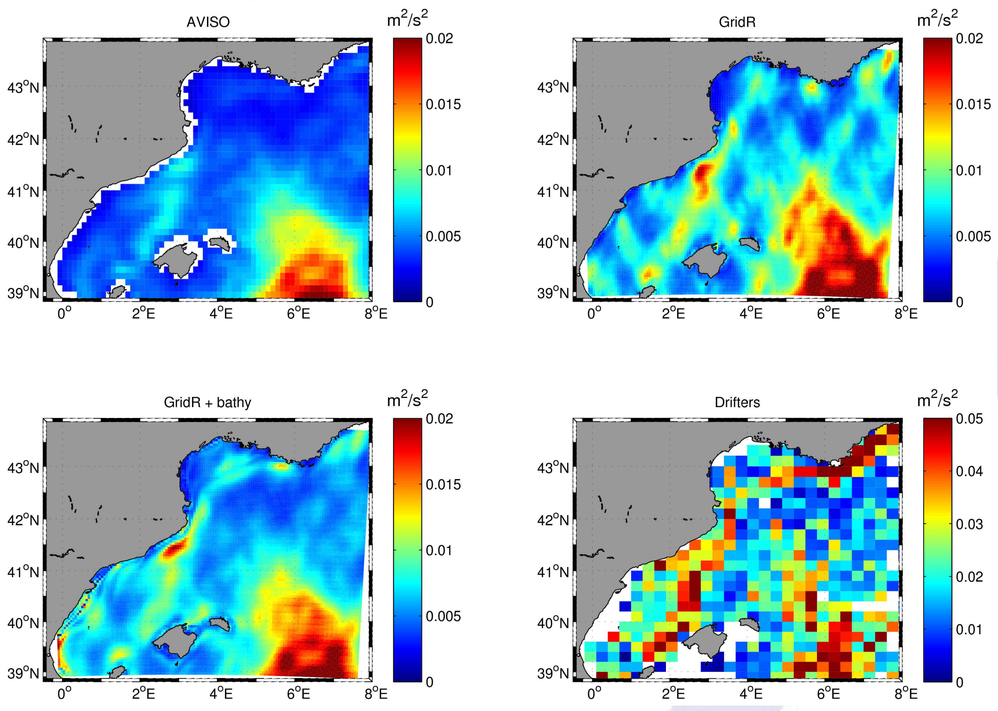
$$C_{ij} = e^{-\frac{|r_i - r_j|^2}{2L^2}} e^{-\frac{\Delta t^2}{T^2}} e^{-\frac{F^2}{\Phi^2}}$$

with

$$F = \frac{\left|PV_i - PV_j\right|}{\sqrt{PV_i^2 + PV_j^2}}$$

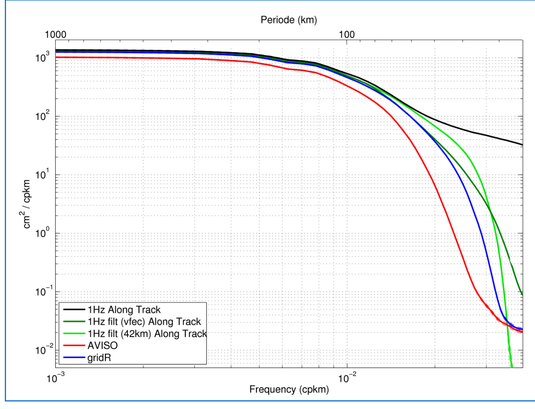
$$PV = f / H$$

Mean kinetic energy



The mean Eddy Kinetic Energy is, as expected higher for the new product and when compared to the mean EKE of drifters (for the period 2002-2010), it presents very similar pattern. Yet, the energy is still under evaluated.

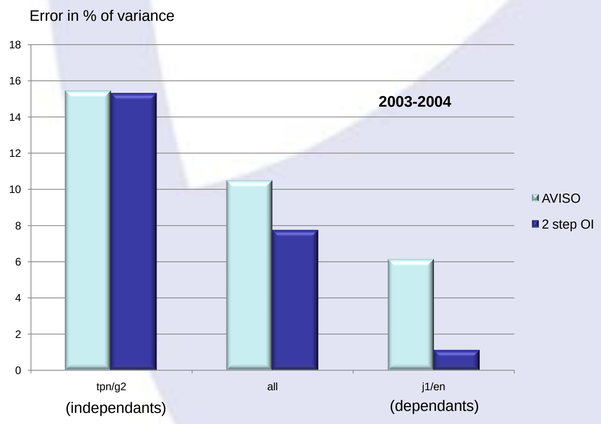
Spectral analysis



The mean power spectra (averaging all tracks and passes) shown on the left presents an increase in energy of the two step OI method (GridR, blue) with respect to AVISO (red) for wavelengths smaller than 100 km getting closer to the level of energy of the filtered along-track data (green).

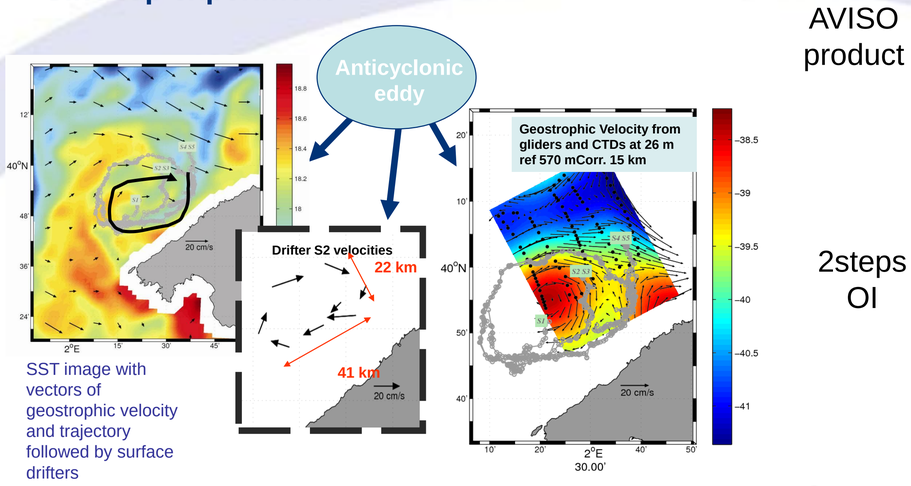
Crossvalidation

A comparison of gridded fields with along track altimeter data, shows no change of the differences between interpolated maps (ref) and along track measurements when compared to independent data probably due to the small area of influence of the OI. Yet, a net error decrease is observed when using all the along-track data which was expected.



Case study

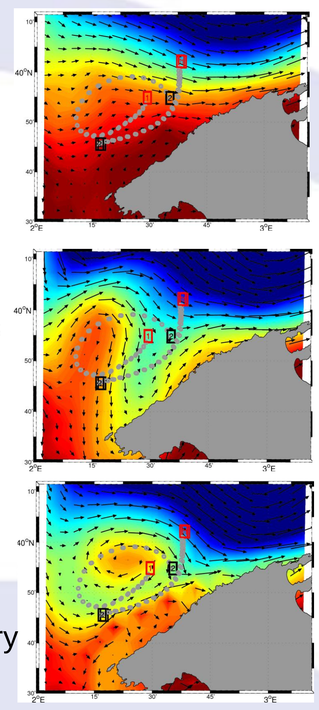
- **Sinocop experiment**



AVISO product

2steps OI

2steps OI with bathymetry



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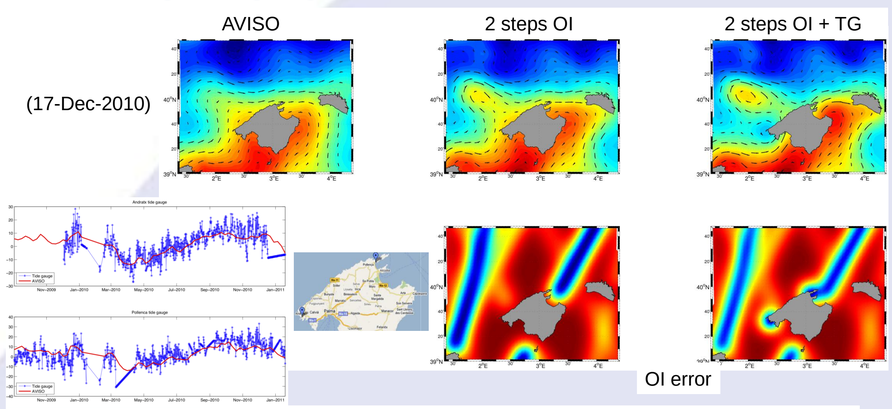
The dataset is compared to independent data such as drifters launched in the area, several campaigns with in-situ data and glider information, revealing an improvement in the resolution of some small scale features.

- **Adding tide gauge observations**



The good agreement between tide gauge observations (blue) and AVISO (red) allows to perform a combined OI analysis.

We explore the potential of combining altimeter data with tide gauges (TG) located along the Mallorca coast in order to improve coastal features.

In the example, the eddy revealed by SST (bottom) on the North of Mallorca is better reproduced by the 2steps OI and even better when adding tide gauge information.

Summary

- We have developed and tested alternative methods for improving the HR mesocale variability description from altimetry.
- The tested area is the WMED –Balearic Sea, a challenging area due to the low signal to noise ratio but were expertise and independent in situ data are available.
- Both spectral analysis and EKE maps of the new fields show higher levels of energy than AVISO, which is consistent with the observations (along track and drifters).
- Crossvalidation shows an improvement when it is estimated taking into account both independent and dependent along track data.
- In particular cases the methods are able to improve the standard aviso products (e.g. SINOCOP experiment),with even better results if other information (*e.g.* tide gauges) is added.

References

Davis, R.E., 1998. Preliminary results from directly measuring middepth circulation in the tropical and South Pacific. *Journal of Geophysical Research*, 103(C11), p.PP. 24,619-24,639.

Pascual, A. et al., 2006. Improved description of the ocean mesoscale variability by combining four satellite altimeters. Geophysical Research Letters, 33, p.4 PP.

Pujol, M.-I. & Larnicol, G., 2005. Mediterranean sea eddy kinetic energy variability from 11 years of altimetric data. Journal of Marine Systems, 58(3-4), p.121-142.