PERFORMING GLIDER MISSIONS ALONG ALTIMETER TRACKS: WHAT CAN WE LEARN?

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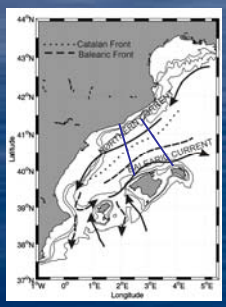
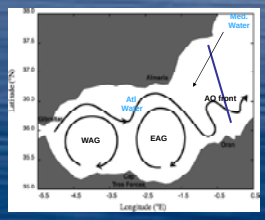
ABSRACT

One of the objectives of the OSTST project 'Improvement, validation and merging of altimeter products for coastal and regional applications', deals with the validation of altimeter data in coastal areas.

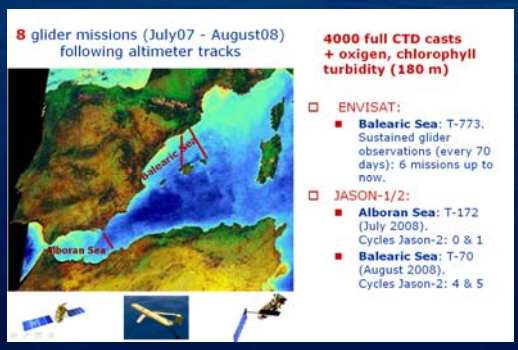
To achieve this objective, an intensive observational program has been conducted in the Western Mediterranean by running coastal glider missions along selected altimeter (Envisat, Jason-1/2) tracks. The goal of this experiment is twofold: i) to investigate the limitations and potential improvements of altimetry data in the coastal area and ii) to test the feasibility of new technologies to study coastal dynamics.

AREAS OF STUDY





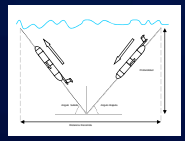
General circulation and selected altimeter tracks in the two areas of study (Balearic Sea and Alboran Sea).



DATA SETS

Glider data

- **Variables:**
  P, T, S, oxig., chl., turb.
- **Vertical extension:**
  10-180 m
- **Horizontal resolution:**
  400 m



Envisat / Jason data

- Along track SLA (AVISO/CLS) + MDT (Rio et al.)
- Delayed time product (ENVISAT) / real-time (JASON-1/2)
- Horizontal resolution: 7 km

METHODOLOGY

Optimal Statistical Interpolation

(Daley, 1991)

- Background: Climatology / polynomial fitting

$$\phi_i^a = \begin{pmatrix} C_{x_1} & C_{x_2} & \dots & C_{x_n} \end{pmatrix} \begin{pmatrix} \sigma_1^2+\gamma_{11} & C_{12} & \dots & C_{1n} \\ C_{21} & \sigma_2^2+\gamma_{22} & \dots & C_{2n} \\ \dots & \dots & \dots & \dots \\ C_{n1} & C_{n2} & \dots & \sigma_n^2+\gamma_{nn} \end{pmatrix}^{-1} \begin{pmatrix} \phi_1^o \\ \phi_2^o \\ \dots \\ \phi_n^o \end{pmatrix}$$

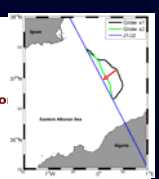
- Correlation Scale: Gaussian model

$$R(x) = e^{-\frac{x^2}{2L^2}} \qquad L=15 \text{ km}$$

- Noise-to-signal ratio:

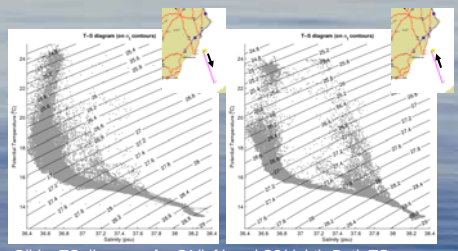
$$\gamma^2 = \frac{\sigma_o^2}{\sigma_b^2} \qquad 10^{-5}$$

Direct Projectio

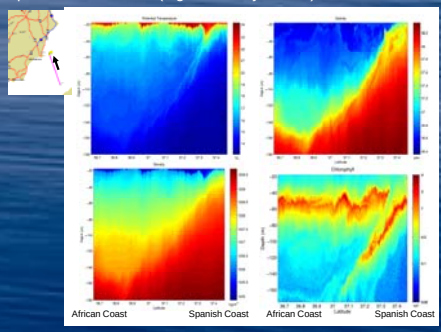


- Projection of the glider observation position onto the closest track point.
- Observation values are not modified.
- Along track Lanczos filter (7 km)
- An estimate error is provided by computing rms differences between the values at the original and projected positions using numerical model outputs.

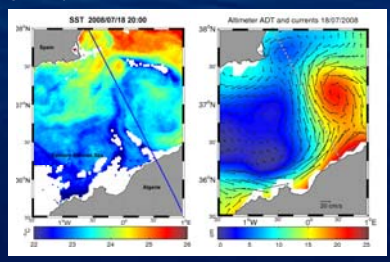
ALBORAN MISSION



Glider TS diagrams for S1(left) and S2(right). Both TS have a branch of recent AW, while only S2 reveal the presence of old AW (higher salinity values).



Vertical sections of potential temperature, salinity, density and chlorophyll. Hydrographic variables reveal the presence of an intense front, as a result of the convergence between recent and old AW. The chlorophyll section depicts strong subduction, indicative of ageostrophic motion.



Left: SST image. Data provider: EUMETSAT. Right: ADT (cm) and geostrophic currents (cm/s) from real time altimetry merged maps. Data provider: AVISO.

ABSOLUTE CURRENTS

We combine glider geostrophic velocities and integrated GPS currents (dead reckoning) to obtain an estimate of absolute surface velocities. These absolute velocities may include ageostrophic, barotropic and deep baroclinic signals which are missing in the geostrophic velocities (estimated with a reference level of 180 m).

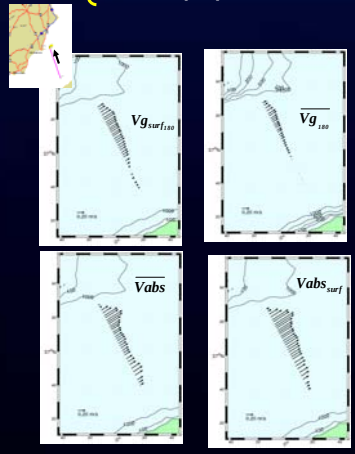
$$Vabs_{surf} = Vg_{surf_{180}} + Vg_{180_{bottom}} + V_{bar} + V_{ag}$$

$$\overline{Vabs} = \overline{Vg_{180}} + Vg_{180_{bottom}} + V_{bar} + \overline{V_{ag}}$$

$$Vabs_{surf} = Vg_{surf_{180}} + \overline{Vabs} - \overline{Vg_{180}}$$

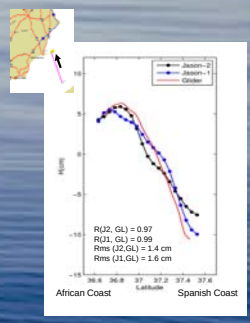
$\bar{}$ denotes vertical average over the upper 180 m

Assuming : $\overline{V_{ag}} \approx V_{ag}$



Estimated absolute surface currents from the Alboran mission carried out in August 2008.

GLIDER VS JASON-1/2

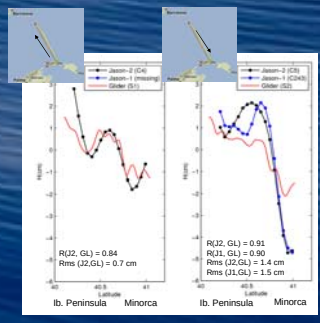


Alboran Sea:

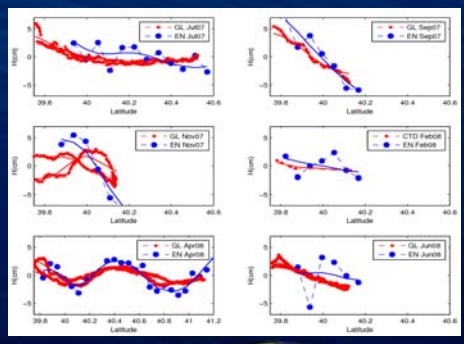
- Filtered Jason-1(duacs, C2), Jason-2 (interim, C1) and glider (dynammic height, S2) along track 172 data. For the glider measurements, both sections (go and return) are displayed when available.
  - Intense gradients. Very good correlation between altimetry and glider data is obtained.
  - Jason-1 (IGDR) and Jason-2 (DUACS) ADT profiles correlate well (0.96).

Balearic Sea:

- Weaker gradients than in the Alboran Sea (large noise to signal ratio).
- Important variability between two subsequent samplings. Problem of sinopticity with the glider?
- Agreement between altimetry and glider data is lower than
- Reference level of 180 m might not be appropriate.
- Sensitivity to the ref. level in DH computation and mean dynamic topography



GLIDER VS ENVISAT



Raw (dashed-dotted) and filtered (continuous) glider and ENVISAT data. For the glider measurements, both sections (go and return) are displayed when available.

Reasonable coherence between absolute dynamic topography from ENVISAT and dynamic height from the glider CTD data. Altimetry observations near the coast are often missing. High noise to signal ratio.

SUMMARY

- Successful glider missions: data collection, real-time processing.
- Alboran Sea 2008: Preliminary results show the existence of strong convergence between Atlantic and Mediterranean Waters. The very high resolution shows the existence of strong interleaving features and in the northern part.
- We have developed a methodology to estimate absolute velocities by combining geostrophic currents with integrated currents by the glider (GPS locations every 6 hours).
- The agreement between altimetry and glider dyn. H. in the Balearic Sea, where the gradients are weak, is reasonable, although ENVISAT observations near the coast are often missing.
- In the Alboran Sea, there is very high correlation between altimetry and glider data. Jason-1 and Jason-2 correlate very well.

Ongoing and future work:

- Application of specific altimetric algorithms (retracking, corrections, editing, etc) for coastal areas.
- Validation of absolute currents with currentmenter data.
- Glider data assimilation into ROMS model.

ACKNOWLEDGEMENTS

We would like to extend our acknowledgment to the Search and Rescue 801 Squadron based in Palma and the Almirante de la Fuerza de Acción Marítima de la Armada both from Ministerio de Defensa, also to SASEMAR (Palma de Mallorca), FAM and D.G. Marina Mercante (Capitanía de Palma) from Ministerio de Fomento and finally to Ports de les Illes Balears (Port de Soller, Port de Pollença and Calanova) whose collaboration has been instrumental for the success of the missions.