Vertical velocities in the upper ocean from glider and altimetry data[1]

In this poster we show results on the combination of new glider technology data with altimetry observations to diagnose vertical velocities.

We used a Slocum coastal glider that collected 1311 profiles (CTD, fluorescence and turbidity) between the surface and 180 m. The mission took place from July 4 to 18, 2008 and was designed to cross the eastern Alboran Sea (Western Mediterranean), from approximately 30 miles east of the Spanish Coast of Cartagena and towards 20 miles off the Algerian coast. The along-track glider data resolution is about 0.5 km. All variables gathered have been averaged vertically to 1 dbar bins. The glider trajectory was established to be coincident with the altimetry satellite track 172 of the tandem mission Jason-1 and Jason-2.

At the beginning of July 2008, SST images (Figure 1) reveal the presence of a relative cold jet flowing along the African coast (Atlantic jet) and a mesoscale instability developing between 0º and 0.5ºE (beginning of the Algerian current). After 2 weeks, this instability becomes an antyciclonic eddy of about 90 km diameter with a clear eastward displacement and secondary filaments interacting with warmer Mediterranean Water in the edge of the eddy. Altimetry maps, with associated horizontal geostrophic velocities of about 50 cms^{-1}, confirm the evolution of these structures.

[1] The content of this contribution has been published in Geophysical Research Letters journal. The complete citation is: Ruiz, S., A. Pascual, B. Garau, I. Pujol, and J. Tintoré (2009), Vertical motion in the upper ocean from glider and altimetry data, Geophys. Res. Lett., 36, L14607, doi:10.1029/2009GL038569.

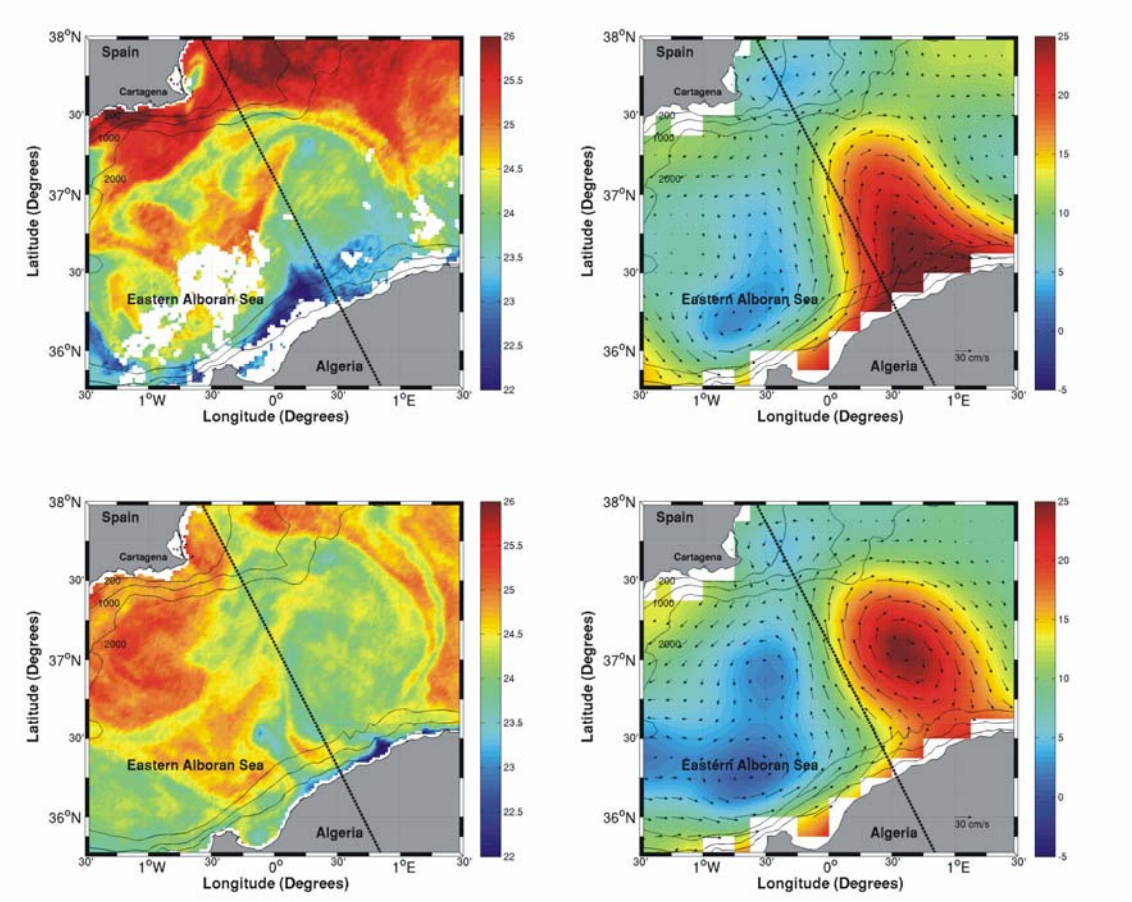

Figure 1. Night AVHRR SST images for 7 and 23 July (left). The temperature scale is in °C and interpolated altimeter maps of ADT for same date with surface geostrophic currents overimposed (right). From Ruiz et al. (2009).

First, we show that the high resolution DH derived from the new autonomous vehicle and the ADT from Jason-1 and Jason-2 tandem mission reveals high correlations along the track followed by the three platforms (Figure 2). Based on these correlations, our method blends along-track glider data with gridded altimeter fields to provide a consistent and reliable 3D DH field. With the reconstructed field and using the QG theory, results show that Mediterranean Surface Water (MSW) is advected westwards along the Spanish coast subducting in the frontal region below the recent Atlantic Waters at an estimated rate of -1 m day^{-1}.

The vertical motion diagnosed in our work is consistent (although the magnitude is smaller) with previous observational [Allen et al., 2001a, Sherman et al., 1999] and modeling [Strass, 1994; Allen et al., 2001b] studies in adjacent areas and may provide a local mechanism for the subduction of the chlorophyll tongue observed by the glider. Note that the vertical motion reported in this work is associated with the large-scale field observed in the study area. Tintoré et al. [1991] also found vertical velocities of +/- 1 mday^{-1} associated with the large scale circulation (~90 km diameter eddies observed in the Alboran Sea) and 20-25 mday^{-1} related to the meso and submesoscale circulation. Thus, in the present work, we find coherent values of vertical velocities (+/-1 mday^{-1}) associated with the large scales resolved by altimetry (diameter ~100 km).

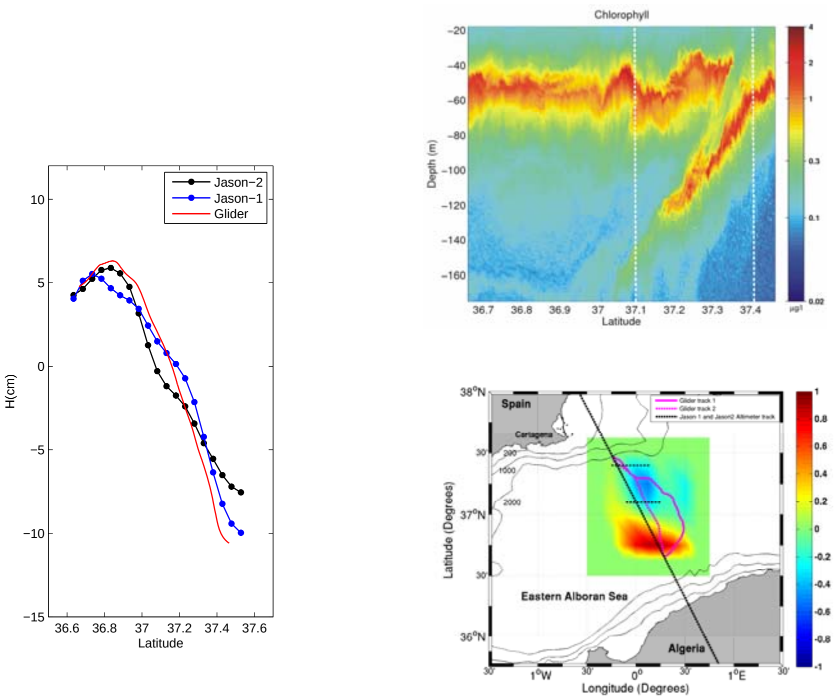

Figure 2. Left: Dynamic height computed along glider track and Abslolute Dynamic Topography along 172 Jason-1 and Jason-2 altimeters track. Right, top: Vertical section of chlorophyll from glider section 2. White dashed lines define sub-section in the northern part of the domain. Right, bottom: Quasi-Geostrophic vertical velocity at 75 m. Units are m day^{-1}**,** positive/negative values indicate upward/downward motion. From Ruiz et al. (2009).

This work has demonstrated the mature state of the altimetry providing high quality and reliable data just 2 weeks after Jason-2 mission was launched. Moreover, we show the potential benefit of combining the altimetry monitoring with in-situ data from autonomous underwater vehicles for a better understanding of the dynamics in the upper ocean. The major limitation of the proposed method comes from the horizontal scales resolved by the altimeter gridded fields. By increasing the number of altimeters merged in the analysis [see for instance Pascual et al., 2006], the mesoscale activity is better described, smaller features can be resolved and more accurate values of vertical velocities could be estimated. In the longer term, high-spatial resolution of the ocean surface topography will be available thanks to the SWOT mission and the proposed method could be improved and would provide a better characterization of the vertical motions associated with eddy fields in the open ocean and coastal regions. Alternative ways to proceed would be to use SST measurements from high resolution infrared images to complement altimeter data as it has been shown by LaCasce and Mahadevan [2006].

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