The Solomon Sea observed by glider and altimetry

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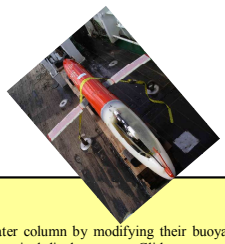
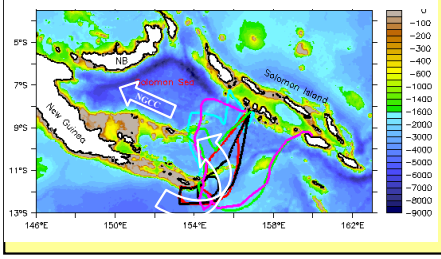


1.Introduction

The Solomon Sea with intense western boundary currents like the New Guinea Coastal Current is a key region for the tropical/subtropical connexion and for the feeding of the Equatorial Under current with possible effect on ENSO modulation. The sharp Papua-New Guinea coastline and the Solomon Sea with its narrow straits to the north impose strong topographic constraints on the flow that is little documented so far (Fig.1).

Fig.1: Solomon Sea bathymetry with the first 5 glider surveys



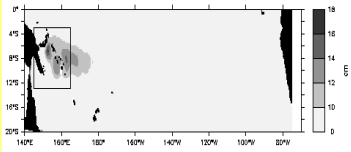


Fig.2: RMS of SLA over the south tropical Pacific for the 1993-2007 period

Gliders are autonomous underwater platforms that are moved over the water column by modifying their buoyancy and "glide" using wings that confer a horizontal velocity associated with their vertical displacements. Gliders are expected to be an important contribution to monitor boundary current, especially in regions of difficult accessibility. An experimental glider monitoring of the LLWBC within the Solomon Sea is currently tested to understand how the inflow distributes within the Solomon Sea. Five glider missions have been operated from August 2007 to January 2009 showing the huge variability of the transports in relation with ENSO conditions and eddy activities.

Satellite altimetry has the advantage to continuously provide synoptic pictures of Sea Level Anomaly in an area where the Solomon Sea exhibits the highest levels of sea level variability of the whole South Tropical Pacific Ocean (Fig.2). The 1/3° x 1/3° gridded AVISO data product provided every 7 days is used. At a given time, SLA provides some insights on the anomalies of geostrophic surface current.

Glider, and satellite date provide information on current that are highly complementary. A glider mission takes 4 months to sample at high resolution (5 km) a specific trajectory whereas satellite provide a synoptic view of the Solomon Sea circulation at the surface for a given time. To really interpret the glider data requires placing them in a larger view as given by altimetry. Before to attempt this interpretation it is first necessary to test if the glider and satellite information are compatible. This is the motivation of this poster.

2. Estimation of current

Two complementary types of data are produced by the glider: profiles of temperature and salinity comparable to ARGO float data, and an estimate of absolute depth-averaged velocity derived from the difference between vehicle motion as measured by GPS fixes and the distance travelled through the water. Therefore the glider provides an estimate of the vertically averaged absolute velocity, and the cross-track geostrophic relative velocity.
On the other way, altimetry provides fields of surface geostrophic current anomalies referenced to the 1993-1999 period that limit its use of our purpose These different datasets are presented below for the fifth Solomon mission (Fig. 3).

The difference between the vertical average of cross-track geostrophic velocity and of glider-measured absolute velocity gives the reference level cross-track velocity and thus the absolute geostrophic cross-track velocity at the different vertical levels.
Adding a Mean Sea Surface Height to the altimetric SLA is necessary to get absolute sea level. The MSSH used comes from a model simulation at 1/12° resolution of the Solomon Sea (Melet et al., 2009). The absolute sea level is interpolated in space and time on the glider track, and provides an estimation of cross-track geostrophic current at the surface as for the glider (Fig.4).

Original data (Fig.3)

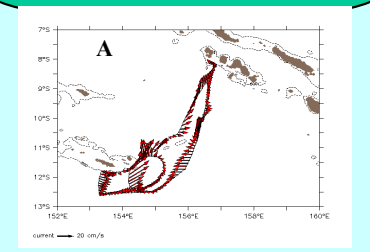
Reconstructed data (Fig.4)

Vertical average (0-700m)

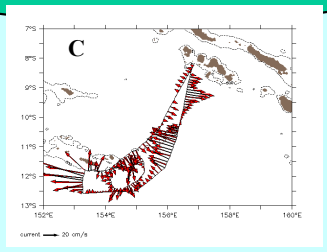
Surface layers

Absolute cross track geostrophic current for the surface layers

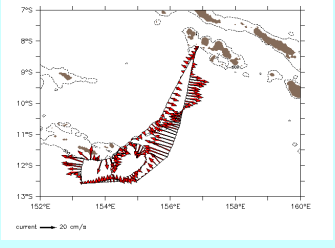
Absolute current from the glider drift



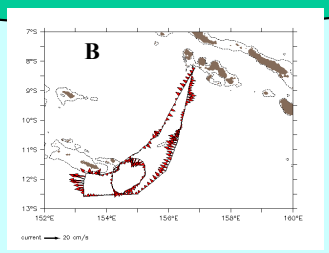
Cross track geostrophic current referenced to 700 m depth



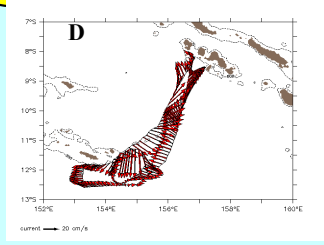
Glider = **A – B + C**



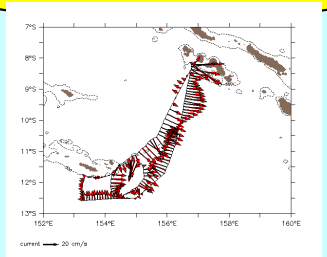
Cross track geostrophic current referenced to 700 m depth from the T S profiles



Anomalies of surface geostrophic current from Altimetry



Altimetry: **D + MSSH** (1/12° model: Melet et al., 2009)



3. The Solomon 5 mission (November 10, 2008 – February 2, 2009)

The Solomon 5 mission was held during November, 10 2008 to February, 1 2009. The deployment and the recovery were from Gizo, a small island in the Western province in Solomon Islands. The glider crossed twice the Solomon Sea. It reached to the west the Louisades archipelago at the southern east extremity of Papua New Guinea where it sampled twice the New Guinea Coastal Current and Undercurrent (NGCC/NGCU). More than 500 profiles of temperature and salinity have been recorded for a distance of 1900 km. The absolute geostrophic cross-track current estimated for the surface layers in the upper thermocline by the glider is shown on Fig.4. The time/space interpolation of the altimetric estimated velocity is very consistent with the in situ estimate from the glider. It is notable that the velocities are rather different during the round trip. The southern section presents relatively high velocities (0.2 m/s) exiting the Solomon Sea in its eastern part and entering the Solomon in its western part whereas the northern section shows lower velocity with opposite direction. Also the different sections through the NGCC in the west show zonal velocity in opposite direction: westward for the western section and eastward for the eastern section.

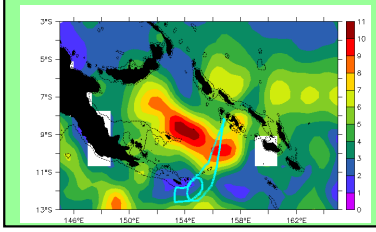


Fig.5: RMS of SLA during the Solomon 5 mission (unit in cm). Superimposed is the glider track

The variability of SLA during the 3 months of the mission shows that the glider trajectory went through a patch of high variability in its eastern part (Fig. 5). Thanks to the altimetry, it is possible to follow the time evolution of the structures crossed by the glider (Fig. 6). Snapshots for both altimetry and glider provides consistent pictures. In November, the Northwest velocities are associated with cyclonic circulation in the area, whereas in January the southeast velocities are associated with larger scale circulation.

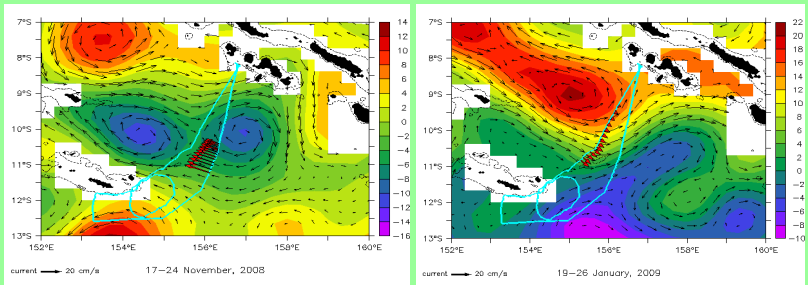


Fig.6: Snapshots of the circulation as deduced from altimetry and the corresponding glider velocity for the 17-24 november 2008 period (left), and for the 19-26 January 2009 period (right)

4. Conclusion

Despite a supposed high variability of the surface currents, it is very encouraging that the estimation of absolute geostrophic cross-track current at the surface from altimetry shows similar structures that those from the glider even if some discrepancies exist between their magnitudes. The good similarity between the estimation of currents averaged over the upper thermocline and the surface currents from altimetry tell us that the surface information from altimetry can be extended in depth until the upper thermocline (around 200 m depth). Therefore altimetry will be useful to follow the time evolution of the structures during the glider mission and might help to interpret the observations from the glider. The intrinsic variability during the time of the mission is at the origin of inaccuracy in the estimation of transport entering the Solomon Sea from the glider, and altimetry could be useful to estimate such inaccuracy

References: Melet A., L. Gourdeau, W. Kessler, J. Verron and J.M. Molines, Thzrmocline circulation in the Solomon Sea: A modeling study, Submitted to J. Physc. Oceanogr., 2009.