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Diagnosing ocean vertical velocities off New Caledonia from a SPRAY glider

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A SPRAY glider has been operated in the Coral Sea (South-Western tropical Pacific ocean) since 2011, with the primary goal of monitoring the boundary currents and jets. In this presentation, we will describe how oceanic vertical velocities can be estimated from SPRAY glider measurements, with application to the observation of internal waves off New Caledonia in May-June 2012.

Pressure measurements by the glider allow estimating the vertical velocities of the glider (relative to ocean bottom) at each time. These vertical velocities are the sum of the vertical velocities of the glider relative to the water body (governed by the laws of motion of the glider) and of the oceanic vertical velocities (due to ocean internal dynamics). If we solve the laws of motion of the glider (via an adequate flight model), we can thus retrieve oceanic vertical velocities. On account of their small magnitude, the retrieval of ocean vertical velocities would be tricky – if not impossible – through other conventional instruments such as ADCPs.

Following a couple of similar previous studies on the SLOCUM and SEAGLIDER gliders, we describe a simplified flight model for the SPRAY glider. This model has three parameters that only depend on the characteristics of the glider: the compressibility and thermal expansion coefficients (that are constant) and the drag coefficient (that is allowed to change dive after dive, because of potential fouling of the hull). We estimate these parameters under the assumption that the absolute vertical water velocity average to zero over a long enough spatio-temporal window (typically: a profile or a group of profiles). Unlike previous studies, our flight model takes into account the vehicle roll to assess its impact on the flight model and oceanic vertical velocity retrieval. We apply this approach to a 40-day/250 dives/800km mission performed in May-June 2012 along 167°E south of New Caledonia. Dramatic water vertical velocities variations (up to 3-4 cm/s with periods of tens of minutes) were observed at all depths (from surface down to 1000 m), above a steep topographic slope in the northern part of the transect. Further offshore, these velocities were found to significantly weaken, though remaining significant, as the SPRAY started to navigate out of this topographic feature. These observations indicate a strong link between local topography and the amplitude of oceanic vertical velocities, an interesting result that remains to be further investigated in the light of internal waves generation/propagation theory.