Cross slope flow through Celtic Sea canyons

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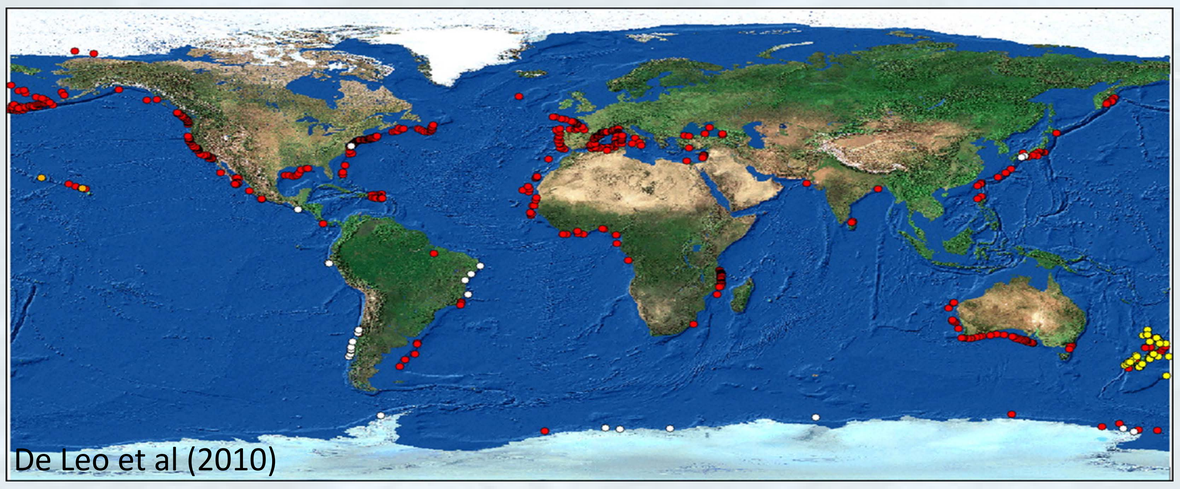
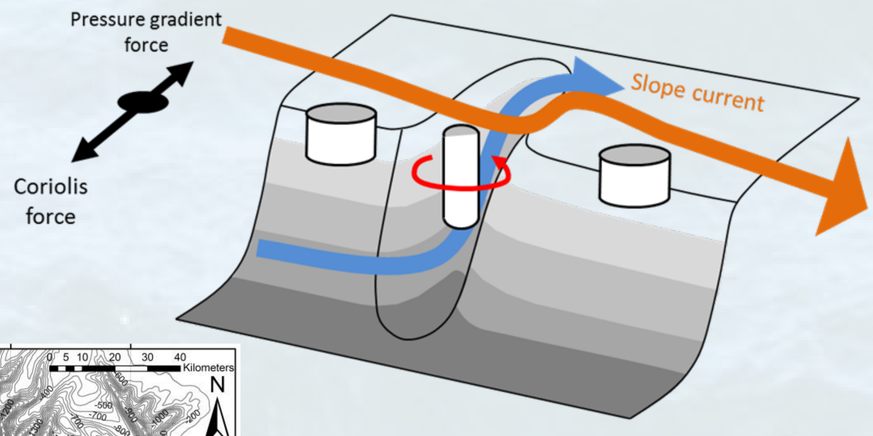
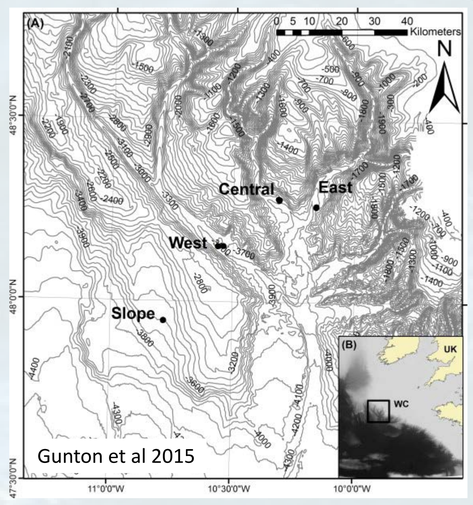


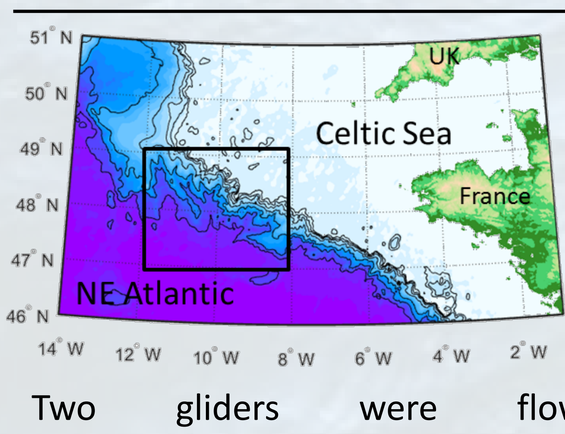
Submarine canyons, shown here by the coloured dots are abrupt changes in bathymetric contours, often incising the shelf break. Currents that would normally follow these contours, are disrupted by the canyons, which can create instabilities potentially providing pathways for exchange between the shelf seas and deep ocean.

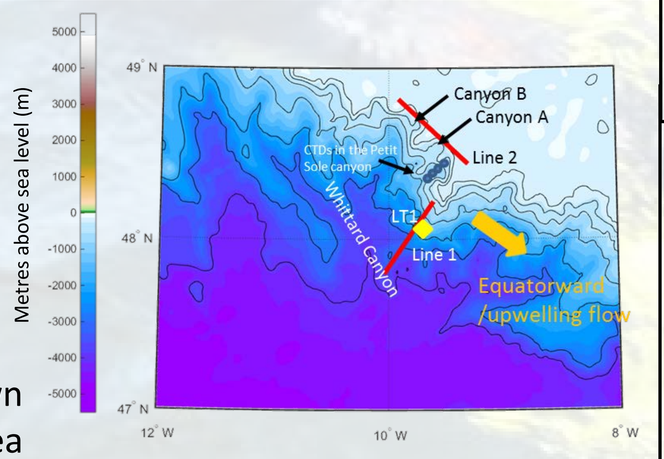




The presence of a canyon disrupts geostrophic flow allowing the pressure gradient force to dominate, in equatorward flow, this combined with increased vorticity leads to up canyon flow

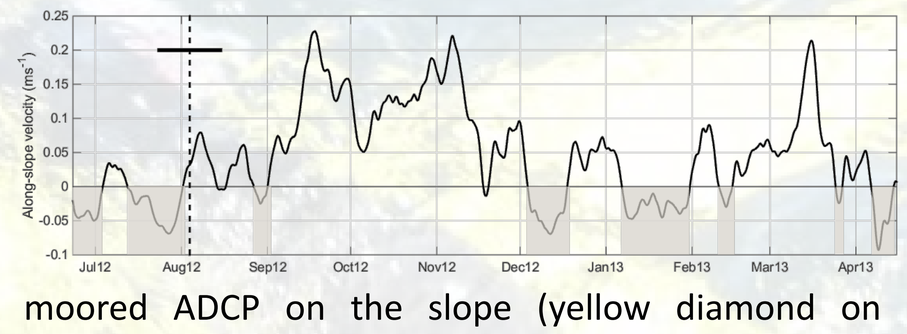
The Whittard canyon on the Celtic Sea slope is a biodiversity hotspot. As such, understanding the local flow regime is important on multiple scales (Gunton, Laetitia M., et al. "Benthic polychaete diversity patterns and community structure in the Whittard Canyon system and adjacent slope (NE Atlantic)." *Deep Sea Research Part I: Oceanographic Research Papers* 106 (2015): 42-54.)



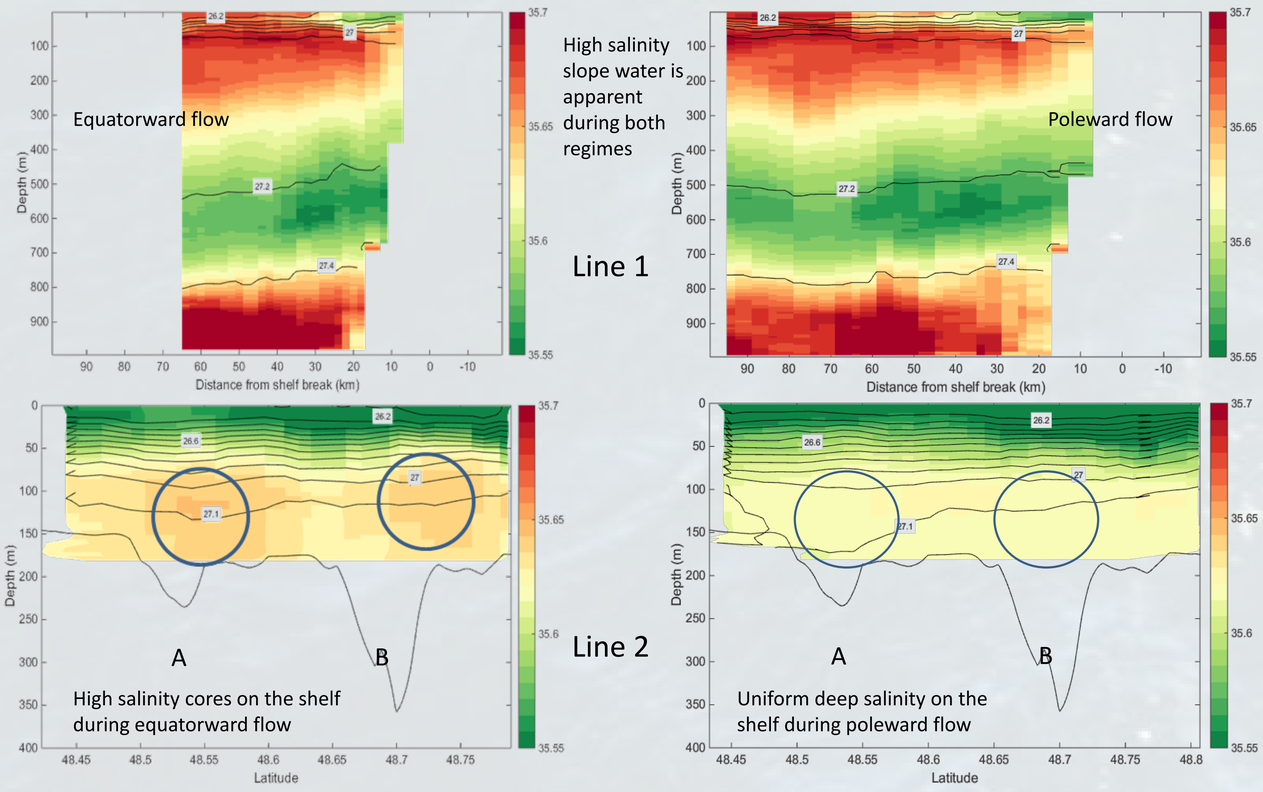


Two gliders were flown simultaneously in the Celtic Sea between 24/7/12 and 15/8/12. One across the slope and one on the shelf, across the top of the canyons.

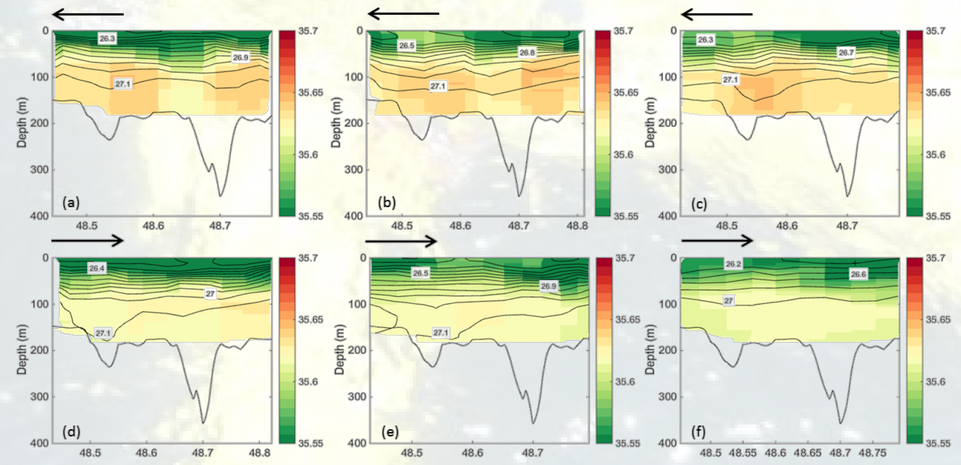
Glider tracks are shown in red, a long term mooring site in yellow and the CTD/nutrient line in blue.



A moored ADCP on the slope (yellow diamond on map) recorded the slope current during the glider mission. The predominantly along-slope flow can be seen to switch between equatorward and poleward a number of times through the year.



Here salinity can be used as a tracer of slope water on the shelf. Anomalously high salinity features on the shelf must be advective as they have no local source. Glider sections during an equatorward flow regimes indicate high salinity cores at the top of the canyons suggesting advection through these. Such cores are absent during poleward flow.



Individual transects show the deterioration of the salinity cores as the equatorial slope current slows and eventually reverses (the black arrows indicate the average slope current direction with equatorward, left).

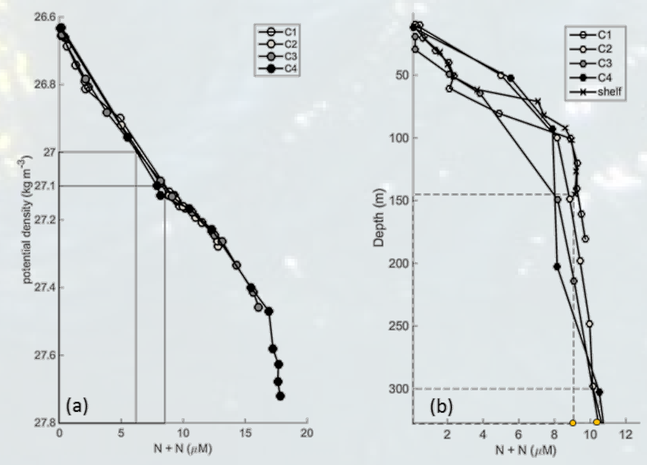
Discussion and summary

During periods of equatorward slope current flow we see evidence of submarine canyons acting as conduits that upwell high salinity water from the slope onto the shelf.

The deeper slope water has higher nutrient content and when upwelled through the mechanism introduced here can provide a sub-pycnocline input of nutrients to the shelf seas throughout the year.

Impact on nutrients

(a) Potential density profiles of Nitrate + Nitrite at 4 points along the Petite Sole canyon (C1:C4, where C1 is on the shelf and C4 at the mouth of the canyon). The solid lines indicate the background shelf density (27 kg m^{-3}) and the density within the salinity cores (27.1 kg m^{-3}), with N+N values recorded from the mid point of the 4 profiles. (b) Nitrate + Nitrate at the same 4 points in the canyon and on the shelf, shelfward of the canyon (shelf). The dashed line indicate



the maximum upwelling depth and the depth of the centre of the salinity cores, the yellow dots show where the C4 and shelf profiles intersect the y-axis.

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