2012 Project Summary

A Crossroads of the Atlantic Meridional Overturning Circulation: The Charlie-Gibbs Fracture Zone

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Recent Results

(1) Observations—In 2010, an array of eight tall moorings was deployed from the R/V Meteor along 35W in the Charlie-Gibbs Fracture Zone to measure the transport of Iceland-Scotland Overflow Water (ISOW) and its variability over a two-year period. This represents part of a collaborative effort to simultaneously measure the eastward (North Atlantic Current and Labrador Sea Water [LSW]) and westward (ISOW) flows through the Charlie-Gibbs and Faraday Fracture Zones with M. Rhein (University of Bremen, Germany) and B. Klein (BSH, Germany). Half of the moorings are instrumented with current meters and microcats from the seafloor to 500-m depth, while the other half extend to 1500-m depth. Moored profilers are installed on three of the moorings to obtain continuous profiles across the interface separating LSW and ISOW.

(2) Modeling—Exchanges between islands and gappy ridges forced by wind and/or buoyancy are being studied with idealized numerical models. Initial calculations aimed at understanding the zonal influences of gaps in ridge systems have been carried out. In the linear limit, the flow through a gap is provided by a zonal flow that extends all the way to a western boundary, no matter how far to the west the boundary is located. The flow through the western gap connects to this eastward flow via a viscous western boundary current. Somewhat surprisingly, model calculations show that even for very strong flow through the western gap (much faster than the baroclinic Rossby wave speed), the flow still generally follows the western boundary all the way to the latitude of the eastern gap before flowing through the eastern gap as a zonal jet. The implication is that, even for very nonlinear flows, the ocean feels the presence of a gap in topography even very far to the west of the ridge. In separate calculations, the effect of wind-forcing on the exchange through gappy ridges and island chains is being explored, with focus on the ability of topography to block exchange between adjacent basins.

(3) The deep circulation forced around an island with a topographic skirt, or a mid-ocean ridge with two gaps, has also been explored with both linear and nonlinear models. The forcing is represented in the theory by a vertical momentum flux, parameterizing the nonlinear vertical momentum flux found in the nonlinear model calculations that result from baroclinic instability. It is found that resonant deep circulations can be forced around the topography that are intermediate in strength compared to the upper ocean wind-driven flow and the weaker abyssal circulation forced away from the closed topographic contours.

Bibliography
