Denmark Strait Overflow Water: A New Paradigm for the Origin of the Deep Western Boundary Current

PIs: R. Pickart and M. Spall
Woods Hole Oceanographic Institution, Woods Hole, MA

The objective of this program is to directly measure the pathways and properties of the source waters for the Denmark Strait Overflow Water (DSOW). Specifically, we seek to determine the origin, pathway, and transport of the newly discovered North Icelandic Jet (NIJ), the dynamics that are responsible for its formation, and its contribution to the flow through Denmark Strait.

Recent results

A mooring array was deployed across the northern part of the Denmark Strait, roughly 200 km upstream of the sill, from August 2011 to August 2012. The array consisted of 12 moorings positioned between the Greenland shelf and the Iceland shelf. This was a collaborative effort between four institutions (three of them international), and the data return was excellent. One of the primary aims of the array was to identify the major currents in the strait and quantify the equatorward flux of dense water comprising the DSOW.

On the western side of the strait the surface-intensified East Greenland Current (EGC) flows equatorward along the shelfbreak (Figure 1). On the Iceland slope the separated branch of the EGC also flows equatorward, alongside the NIJ, which is mid-depth intensified (centered near the 650 m isobaths). In the mean, the NIJ and separated EGC appear as a single current, but synoptically they are often separate features (the separated EGC meanders laterally in time). All three currents transport DSOW equatorward. The mean transport of overflow water above the sill depth is 1.2 Sv for the shelfbreak EGC, 0.6 Sv for the separated EGC, and 1.2 Sv for the NIJ. The sum (3.0 Sc) is on par with the transport of DSOW measured at the sill (Jochumsen et al. 2012). Contrary to the previous notion that most of the overflow water is transported southward along the Greenland slope, our results indicate that 60% of the dense water approaches Denmark Strait from the Iceland slope. The two branches of the EGC advect Atlantic-origin water, while the NIJ transports Arctic-origin water. Notably, while the total overflow transport remains constant throughout the year, the fraction of Atlantic-origin water versus Arctic-origin water varies significantly in time. This suggests that hydraulic processes may be dictating the amount of water being drawn into the strait via each component in order to keep the net transport constant.

We have also published results related to air-sea exchange and convection in the Labrador and Nordic Seas, the role of wind-driven upwelling in the formation of under-ice blooms in the Arctic Ocean and the influences of ridges or islands in a basin interior on the mean and time-dependent behavior of western boundary currents.

Bibliography

Moore, G. W. K., R. S. Pickart, I. A. Renfreq, and K. Vage, 2014: What causes the location of the air-sea heat flux maximum over the Labrador Sea? *Geophys. Res. Lett.*, **41,** 3628-3635, doi:10.1002/2014GL059940.

Moore, G. K. W., K. Vage, R. S. Pickart, and I. A. Renfrew, 2015: Open-ocean convection becoming less intense in the Greenland and Iceland Seas. *Nat. Geosci.,* submitted.

Spall, M. A., R. S. Pickart, E. T. Brugler, G. W. K. Moore, L. Thomas, and K. R. Arrigo, 2014: Role of shelfbreak upwelling in the formation of a massive under-ice bloom in the Chukchi Sea. *Deep Sea Res II.,* **105**, 17-29, doi: 10.1016/j.dsr2.2014.03.017.

Spall, M. A., 2014: Some influences of remote topography on western boundary currents. *J. Mar. Res.,* **72,** 73-94, doi: 10.1357/002224014813758968.