Analysis of Eddies, Mixing and Dense Overflows of Meridional Circulation in the Climate System

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This observational study of the hydrography and circulation near the polar front of the North Atlantic, between Iceland and Norway and in the Labrador Sea, completed its first analysis phase of roughly 20,000 vertical profiles of hydrography, bio-optics, oxygen, and derived velocity fields. The observations span six years, from 2003 to 2009, were the first to use gliders to explore dense overflows in the ocean. The provide top-to-bottom sections on the Iceland-Faroe Ridge and Faroe Bank Channel, which together account for about half (3 Sv of 6 Sv) of the dense overflows that enter the Atlantic from the Nordic Seas and Arctic, and 7 Sv/8 Sv of the warm Atlantic Water flow northward as part of AMOC. The warm branch at latitudes 60^0 - 67^0N thus carries nearly half of the peak ~ 17.5 Sv AMOC volume transport into the Nordic Seas along with about 0.3 pW temperature transport, which are more than usually seen in either climate models or high resolution ocean models. The remainder of the ~ 17.5 Sv of warm northward flow recirculates round the cyclonic subpolar gyre. The sloping interface between lower and upper AMOC waters is the polar front.

Our Seaglider observations show polar front instabilities developing in winter at the time of deep convection and enhanced westerly winds. The annual cycle of cross-frontal mixing is quite strong, and its impact on the warm AMOC branch is being investigated with high-resolution HYCOM model simulations and track-line altimetric surface currents. The dense overflows at the Iceland-Faroe Ridge (Figure1a-1d) are variable in time, and may be influenced by the strongly barotropic eddy field accompanying frontal instability. The dynamical balance in the exquisitely thin, turbulently mixing blanket of overflow water on the southern flank of the Ridge (Figre 1e) is being explored in both observations and models. HYCOM simulations by Xu and Chassignet, with lateral resolution as fine as 1/50 degree (1.5 km) are providing the numerical support. Sites of diapycnal mixing are mapped using fine-scale vertical velocity (Figure 2) and vertical strain measurements from the Seagliders, and used to improve parameterized entrainment in the model.

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