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Dissipation rate and vertical mixing inferred from Seagliders

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The University of Washington recently completed three years (2006-09) of repeat Seaglider sections between Iceland and Scotland. The project returned close to 18,000 full-depth profiles on the Greenland-Scotland Ridge, resolving several of the important exchange pathways between the Nordic Seas and the North Atlantic. The observations include temperature, salinity, dissolved oxygen and bio-optical variables, as well as fine-scale vertical velocity. The latter estimate relies on an accurate vehicle flight model. One glider (sg005) was coordinated with a dedicated Faroe Bank Channel overflow mixing and entrainment study in 2008, conducted by the University of Bergen, which included shipboard turbulence measurements as well as mooring data. Here we report on a new method by which dissipation rate of turbulent kinetic energy, ε, can be estimated from the Seaglider data.

Profiles of ε are obtained from Taylor scaling, i.e., $\epsilon \sim q^3\ell^{-1}$ where q and ℓ are the velocity and length scale, respectively, of large eddies contributing to turbulence. We use the vertical velocity, w, to define the scales q and ℓ, and determine the proportionality constant from a comparison of average profiles from sg005 and the 2008 cruise. The length scale ℓ is taken to be the decorrelation length scale of w from a dive or climb profile and q is the r.m.s. w fluctuation over ℓ. Glider-inferred dissipation profiles capture the observed variability in turbulence, which spans four orders of magnitude within and above the energetic dense overflow plume. The agreement between averaged profiles of glider-derived and measured dissipation rate, inferred eddy-diffusivity and turbulent heat fluxes is beyond expectations. This method permits mapping of ocean mixing by remote sensing through the use of gliders. When applied to the entire Seaglider data set, regions of intense mixing and water mass transformation on the Iceland-Faroe Ridge are revealed.