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North Atlantic Current variability and associated mixing at the Mid-Atlantic Ridge

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Observational evidence for enhanced turbulent energy dissipation at sites of topography-mesoscale flow interaction indicates the possible role of fronts and eddies as energy source for mixing. In consequence, changes in the (upper ocean) flow field must have an impact on stratification and circulation in the deep ocean as patterns of mixing and water mass transformation may be altered by changing the locations of flow-topography interactions. In the North Atlantic, the North Atlantic Current (NAC) that crosses the Mid-Atlantic Ridge (MAR) between 48° and 54° N is known to shift its position and develop different branch modes in response to the prevalent wind field. Strength and positioning of the branches is modulated by the slowly varying eddy field and corresponds to the gaps in the MAR: the northern branch, also known as subpolar front (SPF) crosses the ridge at the latitude of the Charlie–Gibbs Fracture Zone (CGFZ), the southern branches are less restricted and more eddy dominated, but tend to align with the Faraday or Maxwell Fracture Zones.

We use repeated observations of hydrography and currents at the SPF west of the Mid-Atlantic Ridge to investigate the temporal variability of the spatial distribution of finescale variance, vertical mixing and their relation to the position of the NAC. The CTD and lowered ADCP observations were carried out during three (summer) cruises in 2008, 2010, and 2011. During the 2008 cruise, additional microstructure data were collected at three stations, used to validate dissipation rates from a shear/strain parameterization in the upper 1200 m. The orientation of the repeat section is roughly in southeast–northwest direction, starting at about 48° N and ending near the western exit of the CGFZ. The position of the NAC shows considerable differences between the three observations. During the 2008 and 2010 transects, a single branch mode was observed, with the SPF between 50 and 51° N in 2008 and farther north at 52° N in 2010. In contrast, a two branch mode was observed in 2011, with a (stronger) southern front at 49° N, and a weaker northern front north of 50° N. The highest shear variance as well as elevated mixing was found in the vicinity of the front at mid-depth for all cruises, indicating the generation of finestructure variability by the front.