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Hydrographic and Circulation Variability in Orphan Basin, 2004-2010

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Orphan Basin (OB) is a deep (>3000 m) and broad (>200 km) indentation of the Northwest Atlantic's continental margin north of Flemish Cap. It is located in the westernmost exit pathways of the Labrador Current (LC) and Deep Western Boundary Current (DWBC) from the Labrador Sea, and thus is a reservoir for these waters prior to their interactions with subtropical flows further south. During the period 2004-2010, the Bedford Institute of Oceanography carried out a moored measurement and annual survey program to describe and understand current and hydrographic variability in the area, with focus on ocean climate variability and energetic current features relevant to oil and gas exploration.

The observations have identified seasonal and interannual variability in water mass properties that can be linked to upstream variability on the AR7W repeat-hydrography line in the Labrador Sea, thereby helping to understand the fate of Labrador Sea Water (LSW) and other components of the DWBC. In particular, the seasonal signature of LSW at depths of 600-1000 m arrives in Orphan Basin in late spring suggesting a flow speed of order 0.05 m/s. The two other components of the DWBC passing through Orphan Basin, namely Denmark Strait Overflow Water (DSOW) and Northeast Atlantic Deep Water (NEADW), show patterns of interannual variability similar to those observed in the same water masses in the central part of the Labrador Sea. The signal of DSOW on the AR7W line leads that in Orphan Basin by about a year, adding to our understanding of the connectivity of the two regions.

The moored measurements have confirmed the expectation that the seasonal-mean drift is equatorward and generally weak across the basin. There is a near-bottom intensification of the flow associated with the DWBC and a stronger barotropic intensification associated with the LC over the slope.

The moored measurements have also identified two energetic and unexpected types of current features at higher frequencies - tall and isolated mesoscale eddies, and strong upper-ocean inertial oscillations. The eddies extend over the entire water column and appear to drift with the flow in the water depth range of 2200-2800 m, with radii of order 20 km, peak (cyclonic) currents of about 0.5 m/s at mid depths, and a local occurrence rate of about one eddy every few months. The intermittent inertial oscillations penetrate to 300 m depth, with near-surface speeds up to 1 m/s, persistence over periods up to 10-30 days, and vertical coherence over distances exceeding 80 km.