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The Deep Western Boundary Current southeast of Cape Farewell, Greenland: decadal transport variability from repeat hydrography and satellite altimetry

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Recent decadal changes in the Deep Western Boundary Current (DWBC) transport southeast of Cape Farewell are assessed from hydrographic data (1991–2007), individual direct velocity measurements (2002–2006) and altimetry (1992–2007).

Following the approach used in earlier studies, we first determined that the DWBC (σ_0 >27.80) baroclinic transport (T_{BC}) referenced to 1000 m depth increased by ∼2 Sv between the mid-1990s (1994–1997) and 2000s (2000–2007). In the next step, we quantified velocity changes at the reference level (1000 m) by combining estimates of the hydrography-derived velocity changes in the water column and the altimetry-derived velocity changes at the sea surface. The inferred increase in the southward velocity at 1000 m above the DWBC in 1994–2007 indicates that the increase in the DWBC absolute transport was larger than the 2-Sv increase in the DWBC T_{BC}. This result and the observed coherence of the DWBC absolute and baroclinic transport changes between individual observations imply that the DWBC absolute transport variability in the region is underestimated but qualitatively well represented by its baroclinic component on decadal and shorter time scales.

The updated historical record of the DWBC T_{BC} (1955–2007) shows distinct decadal variability (±2–2.5 Sv) with the transport minima in the 1950s and mid-1990s, maximum in the early 1980s and moderate-to-high transport in the 2000s. The DWBC T_{BC} decadal variability is consistent with the general pattern of the recent decadal hydrographic and circulation changes in the northern North Atlantic. The DWBC T_{BC} anomalies negatively correlate (R = –0.80, 1955–2007) with thickness anomalies of the Labrador Sea Water (LSW) at its origin implying a close association between the DWBC transport southeast of Cape Farewell and the LSW production in the Labrador Sea. During the recent three decades (late 1970s – late 2000s), the DWBC T_{BC} changes were also in-phase with changes in the strength and zonal extension of the Subpolar Gyre (SPG). In particular, the SPG weakening at shallow levels in the mid-1990s – mid-2000s was accompanied by the DWBC strengthening in the Irminger Sea.

The results imply that the decadal changes in the (i) LSW production, (ii) SPG strength and (iii) DWBC transport in the Irminger Sea are linked, representing a complex coherent oceanic response to the decadal variability of the surface forcing.