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Labrador Slope Water Connects the Subarctic with the Gulf Stream

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Labrador Slope Water (LSLW) is found in the Slope Sea on the US-Canadian eastern shelf-slope as a relatively fresh and cool water mass, lying between the upper layer water masses and those carried by the Deep Western Boundary Current. It originates from the Labrador Current and has previously only been reported in the Eastern Slope Sea (east of 66°W). We here use the EN4 gridded database and the Line W hydrographic observations to show for the first time that the LSLW also penetrates into the Western Slope Sea, bringing it into close contact with the Gulf Stream. We also show that the LSLW spreads across the entire Slope Sea north of the Gulf Stream, and is both fresher and thicker when the Atlantic Meridional Overturning Circulation (AMOC) is high at the RAPID array at 26°N. The fresher, thicker LSLW is likely to contribute an additional 1.5 Sv of Gulf Stream transport. The spreading of the LSLW is also investigated in a high-resolution ocean general circulation model (NEMO), and is found to occur both as a western boundary current and through the extrusion of filaments following interaction with Gulf Stream meanders and eddies. The mechanism results in downward vertical motion as the filaments are entrained into the Gulf Stream. We conclude that the LSLW (rather than the deeper Labrador Sea Water) provides the intermediate depth water masses which maintain the density contrast here which partly drives the Gulf Stream, and that the transport of the LSLW from the Labrador shelf-slope offers a potential new mechanism for decadal variability in the Atlantic climate system, through connecting high latitude changes in the Subarctic with subsequent variability in the Gulf Stream and AMOC.