

The penetration of Labrador Slope Sea Water to Cape Hatteras and its role in Gulf Stream Dynamics

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Labrador Slope Sea Water (LSSW) exists in the Slope Sea off the US eastern shelf as a relatively fresh and cool water mass deriving from the Labrador Current further north. It is present between the upper layer water masses and the deeper Deep Western Boundary current waters, typically near 400-800m. It has a different origin from the upper Labrador Sea Water (uLSW) which instead originates from deep convection in the sub-polar gyre.

We investigate, using the EN4 database and Line W observations, the presence and properties of the LSSW in the Slope Sea, and how these change between the periods when the Atlantic Meridional Overturning Circulation (AMOC) is high and low in the RAPID array at 26°N. We firstly show that the LSSW penetrates into the Mid Atlantic Bight (MAB), having previously only been described as far west as the Gulf of Maine. We then show that it is both thicker and fresher in the AMOC high period (at Line W), and spreads to fill the Slope Sea north of the Gulf Stream. It therefore provides (rather than the uLSW) the cold water masses at these intermediate depths which support the northern side of the Gulf Stream, and the thicker LSSW in the AMOC high period probably contributes 2-3 Sv of additional Gulf Stream transport.

The spreading of the LSSW is also investigated in a high-resolution ocean general circulation model, and this is shown to occur through the ejection of filaments through interaction with Gulf Stream meanders and eddies.

Finally, we caution against the use of EN4 in regions of strongly sloping isopycnals such as the Gulf Stream.