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Meridional connectivity between the Labrador Sea and the subtropical AMOC

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We attempt to reconcile two seemingly conflicting paradigms regarding the north-south connectivity in the Atlantic overturning: 1) Labrador Sea buoyancy anomalies impact the subtropical Atlantic Meridional Overturning Circulation (AMOC); and 2) water mass transformation in the eastern subpolar gyre plays an overwhelmingly dominant role in AMOC variability in the subpolar regions. We thus analyze mechanisms that link the Labrador Sea with meridionally coherent adjustment in the transport along the lower limb of the AMOC throughout the North Atlantic, from the south-eastern coast of Greenland to the subtropics. The first connectivity mechanism that we identify involves a passive advection of surface buoyancy anomalies from the Labrador Sea towards the eastern subpolar gyre by the background North Atlantic Current (NAC). The second connectivity mechanism that we analyze plays a dominant role and involves a dynamical response of the NAC to surface density anomalies originating in the Labrador Sea. The adjustment of the NAC modifies its northward transport of salt and heat and affects water mass transformation in the eastern subpolar gyre. This exerts a strong positive feedback amplifying the upper ocean buoyancy anomalies that spin the subpolar gyre up or down on a timescale of several years and drive a redistribution of Lower North Atlantic Deep Water (LNADW). During the course of this subpolar adjustment, boundary-trapped waves rapidly communicate the signal to the subtropics and facilitate a meridionally coherent response in the transport of LNADW. We find evidence in the ECCO ocean state estimate that these connectivity mechanisms have affected recent historical AMOC variability.