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Observation-based estimates of volume, heat and freshwater exchanges between the subpolar North Atlantic interior and its boundary currents

Sam Jones, Stuart Cunningham, Neil Fraser, Mark Inall, and Alan Fox
Scottish Association for Marine Science, Oban, UK (sam.jones@sams.ac.uk)

The Atlantic Meridional Overturning Circulation (AMOC) transports heat and salt between the tropical Atlantic and Arctic oceans. The interior of the North Atlantic Subpolar Gyre is responsible for the much of the water mass transformation in the AMOC, and the export of this water to intensified boundary currents is crucial for projecting air-sea interaction onto the strength of the AMOC. However, dynamical drivers of exchange between the gyre interior and the boundary remains unclear.

We present a novel climatology of the Subpolar Gyre boundary using quality controlled CTD and Argo hydrography tracking the 1000 m isobath north of 47° N. The net geostrophic transport into the SPG perpendicular to this boundary section is only around 2.3 Sv. Surface Ekman flow drives net transport out of the Subpolar Gyre in all seasons and shows pronounced seasonality, varying between 2.45 Sv in the summer and 7.70 Sv in the winter. Bottom Ekman transport associated with the boundary currents flows into the Subpolar gyre and is between 2.8 and 4 Sv.

We estimate heat and freshwater fluxes into and out of the Subpolar gyre interior and compute the magnitude of water mass transformation (overturning) within the gyre. Heat advected into the Subpolar Gyre is between 0.10 PW and 0.19 PW. Freshwater exported from the gyre is between 0.06 Sv and 0.13 Sv. These estimates approximately balance the surface heat and freshwater fluxes into the region. Overturning varies between 6.20 Sv in the autumn and 10.17 Sv in the spring, meaning that approximately 40 % of the observed overturning in the subtropics can be attributed to water mass transformation in the interior of the SPG.