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A climatology of the North Atlantic subpolar gyre boundary

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Circulation at the boundary of the subpolar North Atlantic influences both the horizontal (gyre) and vertical (overturning) components of the flow structure. While boundary current transport projects directly onto subpolar gyre strength, recent modelling studies have highlighted that buoyancy fluxes between the basin interior and the boundary, followed by rapid buoyancy export by boundary currents, are crucial steps in projecting air-sea interaction onto the strength of the Atlantic Meridional Overturning Circulation (AMOC). This work seeks observational insights into these key boundary processes.

To achieve this, we have constructed a robust boundary climatology from quality controlled CTD and Argo hydrography since the turn of the millennium. Following the 1000 m isobath north of 47 °N and aggregating data into 100 km bins, we build a picture of the typical large-scale temperature and salinity structure for each month.

This product will allow us to identify where and when important interior-boundary buoyancy fluxes take place over a seasonal cycle. A first step is to evaluate geostrophic flow into the boundary, and hence describe the vertical structure of advective buoyancy exchange. By appealing to satellite altimetry and Argo trajectories, we can also estimate turbulent eddy fluxes both at the surface and 1000 m depth. Models indicate these parameters are key in dictating the pathways for the AMOC lower limb, and we will place our observational findings in the context of these results.

Boundary current strength is another key parameter dictating the export of dense water from the subpolar gyre. We will appeal to satellite altimetry to build corresponding climatologies for barotropic boundary flow. Furthermore, along-slope density gradients give rise to a baroclinic boundary current forcing term, which we aim to investigate here. Water density generally increases as we follow the gyre counter-clockwise, with the notable exception of the West Greenland Current section, and our product allows us to partition the spatially-varying contribution of temperature and salinity towards these density gradients. For example, we can evaluate the impact of cooling along the eastern boundary, or surface freshening around southern Greenland, on the dynamics of boundary flow. Ultimately, we would like to understand the evolution of the dynamical balance experienced by a hypothetical fluid parcel traversing the entire subpolar gyre.