The importance of wind and buoyancy forcing for the boundary density variations and the geostrophic component of the AMOC at 26N

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It is widely thought that both changes in the buoyancy and wind-stress drive variability in the Atlantic Meridional Overturning Circulation (AMOC), but that they drive variability on different timescales. For example, wind forcing dominates short term variability through Ekman and coastal upwelling, but buoyancy forcing is important for longer time-scales (multi-annual and decadal). However, the role of the wind forcing on multi-annual to decadal timescales is less clear. Here we present an analysis of ocean-only simulations of the NEMO model with the aim of explaining the important drivers of the zonal density gradient at 26N. In the experiments, only one of either the wind stress or the buoyancy forcing is allowed to vary in time, whereas the other remains at its seasonally varying climatology.

On sub-annual time-scales the density gradient, and AMOC minus Ekman, is driven largely by local wind forced coastal upwelling on both the west and eastern boundary. On decadal time scales the buoyancy forcing related to the North Atlantic Oscillation dominates the AMOC. However, interestingly it is found that the wind forcing also plays a role at longer timescales, primarily impacting on the interannial variability though the excitation of Rossby waves in the central Atlantic, which propagate westward to interact with the western boundary, but also by slowly modulating the decadal time scale buoyancy-driven density anomalies on the western boundary via coastal upwelling.