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Dynamical constraints on the choice of the North Atlantic subpolar gyre index

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The North Atlantic Subpolar Gyre (SPG) has been widely implicated as the source of large-scale changes in the subpolar marine environment. However, inconsistencies between different indices of SPG strength based on Sea Surface Height (SSH) observations have raised questions about the active role SPG strength and size play in determining water properties in the eastern subpolar North Atlantic (ENA). Here, by analyzing SSH-based and various other SPG-strength indices derived from observations and a global coupled model, we show that the interpretation of SPG strength-salinity relationship is dictated by the choice of the SPG index. Our results emphasize that SPG indices should be interpreted cautiously because they represent variability in different regions of the subpolar North Atlantic. Idealized Lagrangian trajectory experiments illustrate that zonal shifts of main current pathways in the ENA and meridional shifts of the North Atlantic Current (NAC) in the western intergyre region during strong and weak SPG circulation regimes are manifestations of variability in the size and strength of the SPG. Such shifts in advective pathways modulate the proportions of subpolar and subtropical water reaching the ENA, and thus impact salinity. Inconsistency among SPG indices arises due to the inability of some indices to capture the meridional shifts of the NAC in the western intergyre region. Overall, our results imply that salinity variability in the ENA is not exclusively sourced from the subtropics, instead the establishment of a dominant subpolar pathway also points to redistribution within the SPG.