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A Low Frequency Subpolar Gyre Signal Identified in the Atlantic Inflow to the North Sea

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While the influence of the subpolar gyre (SPG) strength on the thermohaline variability in the eastern subpolar North Atlantic is well documented, the extent and timescales of its impact on North Sea is not well understood. Here, we assess the hydrographic variability in the North Sea in a global model, since regional models of the North Sea tend to discount open-ocean signals at their boundaries due to the imposed boundary conditions. The analysis is carried out in a 156-year simulation with the Max Planck Institute Earth System Model (MPI-ESM1.2-LR) in its rotated grid configuration with one pole over Greenland, which allows moderate resolution in the Northwestern European Shelf. While earlier investigations emphasize atmospheric forcing associated with the North Atlantic Oscillation as the main cause of large scale hydrographic changes in the North Sea, the present contribution focuses on watermass variability. Salinity anomalies rise earlier in key regions, Rockall Trough and Faroe-Shetland-Channel (FSC), and are eventually advected into the North Sea one year after they peak in the upper layers of the Rockall Trough. Thus advective processes are seen as the dominant control on northern and central North Sea salinity variability. Strong co-variability between Rockall Trough and North Sea salinity as compared to the FSC and North Sea points towards a direct access of remote oceanic perturbations to the North Sea in the model. Waxing and waning of a saline core embedded in the Atlantic Inflow through the key regions and the northern North Sea reveals a close connection with the Subpolar Gyre (SPG) strength, which modulates the recruitment of subtropical/subpolar water in the eastern subpolar North Atlantic. Periods of weak SPG strength are associated with higher than normal penetration of high salinity subtropical water into the northern North Sea. The SPG signal identified in the northern North Sea salinity has a statistically significant period of 30-40 years, mirroring the low frequency variability in the SPG circulation in the model. Overall, we find that the properties of the Atlantic Inflow to the North Sea convey open-ocean signals while the winds, which drive the total volume transport, tend to obscure such signals.