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Decadal prediction of the North Atlantic subpolar gyre in the HiGEM high-resolution climate model

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The North Atlantic subpolar gyre is one of the regions that benefits most by initialising from observations in decadal predictions. However, the reasons behind successful predictions has only been studied in a few low-resolution models, and usually for only one specific case-study. Here, an analysis of initialised decadal hindcasts of the North Atlantic subpolar gyre (SPG) will be presented using the HiGEM model, which was performed as part of the SPECS project. HiGEM has a nominal grid-spacing of 90km in the atmosphere, and 1/3 degree in the ocean. HiGEM decadal predictions (HiGEM-DP) exhibit significant skill at capturing 0–500m ocean heat content in the SPG, and outperform historically forced transient integrations and persistence for up to a decade ahead. An analysis of case-studies of North Atlantic decadal change, including the 1960s cooling, the mid-1990s warming, and the post-2005 cooling, show that changes in ocean circulation and heat transport dominate the predictions of the SPG. However, different processes are found to dominate heat content changes in different regions of the SPG. Specifically, ocean advection dominates in the east, but surface fluxes dominate in the west. Furthermore, compared to previous studies, we find a smaller role for ocean heat transport changes due to ocean circulation anomalies at the latitudes of the SPG, and a greater role for surface fluxes in driving the 1960s cooling. HiGEM-DP also predicts the observed positive state of the North Atlantic Oscillation in the early 1990s. These results support an important role for the ocean in driving past changes in the North Atlantic region, and suggest that these changes were predictable. Finally, to elucidate the role of the SPG as a source of skill over the wider North Atlantic region results from addition experiments, where the SPG is initialised from climatology, will also be shown.