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The role of subpolar North Atlantic as a source of predictability

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The subpolar North Atlantic (SPNA) is a region experiencing substantial decadal variability, which has been linked to extreme weather impacts over continents. Recent studies have suggested that the connectivity with the SPNA may be a key to predictions in high latitudes. To understand the impact of the SPNA on predictability of North Atlantic-European sectors and the Arctic, we use two climate prediction systems, EC-Earth3-CPSAI and NorCPM1, to perform ensemble pacemaker experiments with a focus on the subpolar extreme cold anomaly event in 2015. This 2015 cold anomaly event is generally underestimated by the decadal prediction systems. In order to force the model to better represent the observed anomaly in SPNA, we apply nudging in a region of the SPNA (i.e., 51.5°W - 13.0°W, 30.4°N - 57.5°N, and from surface to 1000 m depth in the ocean). Here ocean temperature and salinity is restored to observed conditions from reanalysis in both model systems. All other aspects of the setup of this pacemaker experiment follow the protocol for the CMIP6 DCPP-A hindcasts and initialized on November 1, 2014. The restoration is applied during the hindcasts from November 2014 to December 2019. Multi-member ensembles of 10-year hindcasts are performed with 10 members for the EC-Earth3-CPSAI and 30 members for the NorCPM1.

The time evolution of ensembles of the initialized nudging hindcasts (EXP1) is compared with the initialized DCPP-A hindcast ensembles (EXP2) and the uninitialized ensembles (EXP3). The prediction skills of the three sets of experiments are also assessed. It can be seen that restoring the ocean temperature and salinity in the SPNA region to the reanalysis improves the prediction in the region quickly after the simulation starts, as expected. On the interannual to decadal time scales, the areas with improved prediction skills extend to over almost the entire North Atlantic for both models. The improved skill over Nordic Seas is particularly significant, especially for EC-Earth3-CPSAI. For NorCPM, the regions with improved skills extend to the entire Arctic. Our results suggest the possible role of the SPNA as a source of skillful predictions on interannual to decadal time scale, especially for high latitudes. The ocean pathways are the critical source of skill whereas our results imply a limited role of coupled feedbacks through the atmosphere.