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Two tales of initializing decadal climate predictions experiments with ECHAM5/MPI-OM model

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Decadal climate predictions aim to forecast the internally-generated decadal climate variability in addition to externally-forced climate change signal and thus, need to be started from the best estimate of the current climate state. Since predictability at decadal timescale is thought to reside mainly in the ocean, an accurate ocean initialization is fundamental to skillful decadal prediction. In this study we investigate the impact of different ocean initialization strategies on the forecast skill of decadal prediction experiments performed with the ECHAM5/MPI-OM atmosphere-ocean-sea-ice coupled model. The ocean initializations employed here assimilate the full 3D temperature and salinity anomalies from two different ocean state estimates: in the first case, provided by an ocean synthesis product (GECCO), and in the second, taken from an ensemble of MPI-OM ocean experiments forced with the NCEP-NCAR atmospheric forcing. The results show that North Atlantic and Mediterranean sea surface temperature (SST) variations can be skilfully predicted up to a decade ahead and with a far greater skill than both the radiative-forced and the persistence forecasts. The regional distribution of SST predictive skill is in general similar in both initialization approaches. However, we found that a higher skill is obtained for NCEP-forced hindcasts in the first pentad and for GECCO hindcasts in the second pentad of the hindcast experiments. Skilful prediction of surface air temperature (SAT) are obtained over North-Western Europe, Northern Africa and Central-Eastern Asia. The increase in SAT predictability with forecast lead time suggests that it originates from both atmospheric teleconnections from the North Atlantic and radiative-forced warming trend. The North Atlantic Subpolar Gyre region stands out as the region with the highest predictive skill beyond the warming trend in both SST and upper ocean heat content predictions. Here the NCEP initialization delivers the best results. The dominant mechanism for the North Atlantic climate predictability in our decadal prediction system is of dynamical origin and can be attributed to the initialization of the Atlantic Meridional Overturning Circulation.