



## **Time dependency of the prediction skill for the North Atlantic subpolar gyre in initialized decadal hindcasts with MPI-ESM**

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We analyze the time dependency of decadal hindcast skill in the North Atlantic subpolar gyre within the time period 1961-2013. We compare anomaly correlation coefficients and interquartile ranges of total upper ocean heat content and sea surface temperature for three differently initialized sets of hindcast simulations with the global coupled model MPI-ESM. All initializations use weakly coupled assimilation with the same full-field nudging in the atmospheric component and different assimilation techniques for oceanic temperature and salinity: (1) ensemble Kalman filter assimilating EN4 and HadISST observations, (2) nudging of anomalies to ORAS4 reanalysis, (3) nudging of full values to ORAS4 reanalysis. We find that hindcast skill depends strongly on the evaluation time period, with higher hindcast skill during strong multiyear trends and lower hindcast skill in the absence of such trends. While there may only be small differences between the prediction systems in the analysis focusing on the entire hindcast period, these differences between the hindcast systems are much more pronounced when investigating any 20-year subperiod within the entire hindcast period. For the ensemble Kalman filter high skill in the assimilation experiment is generally linked to high skill in the initialized hindcasts. Such direct link does not seem to exist in the hindcasts initialized by either nudged system. In the ensemble Kalman filter initialized hindcasts, we find significant hindcast skill for up to 5 to 8 lead years, except for the 1970s. In the nudged system initialized hindcasts, hindcast skill is consistently diminished in lead years 2 and 3 with lowest skill in the 1970s as well. Overall, we find that a model-consistent assimilation technique can improve hindcast skill. Further, the evaluation of 20 year subperiods within the full hindcast period provides essential insights to judge the success of both the assimilation and the subsequent hindcast skill.