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Seasonal-decadal prediction with the EnKF and NorESM: a twin experiment

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The potential for seasonal to decadal predictions are investigated using an advanced flow dependent data assimilation method together with the Norwegian Earth System model (NorESM). NorESM is a fully coupled system based on the Community Climate System Model version 4, which includes an ocean, an atmospheric, a sea-ice and a land model. A twin experiment methodology is employed in order to demonstrate the capability of the initialisation method in absence of model biases. A coarse version of the model is used (3.6° ocean grid) and the system is tested for assimilating synthetic sea surface temperature (SST) over 10 cycles. Each cycle consists of a 10-year assimilation phase followed by a 10-year prediction phase. The deterministic Ensemble Kalman Filter assimilates monthly SST (EnKF-SST) and its accuracy is compared to an ensemble free run and a perfect initialisation ensemble run. The results indicate that EnKF-SST improves sea level, ice concentration and 3D hydrography compared to the free ensemble run. Improvements are largest near the surface, but are retained for a longer period at depth. Benefits in salinity are also retained for a longer period than compared to temperature. Near-surface improvements are largest in the tropics, while improvements at intermediate depths are found in regions of large-circulation currents, zone of convection, and at the Mediterranean Sea outflow. However, the benefits are small compare to the perfect initialisation - in particular at depth - suggesting that more observations should be assimilated in addition to SST. The EnKF-SST system is also tested for standard indices - AMOC, SPG, STG, AMO and NINO3. EnKF-SST has skills for all indices in analysis mode. The predictive skill of EnKF-SST for these indices is compared to the perfect initialisation and persistence. EnKF-SST outperforms persistence for AMOC and also for SPG if the initial bias is corrected. It also outperforms persistence for NINO3 for the first five months. EnKF-SST, persistence and perfect initialisation shows no skill for AMO and STG beyond 1-year lead-time.