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Decadal hindcasts in MPI-ESM initialized from coupled oceanic EnKF assimilation and atmospheric nudging

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We present results of three decadal hindcast experiments with the global coupled Max Planck Institute for Meteorology Earth System Model (MPI-ESM), initialized from three coupled assimilations of atmospheric re-analysis data and oceanic sub-surface observations within the period 1958 to 2014. In all three coupled assimilations, the atmospheric component of MPI-ESM is nudged to full values of ERA40/ERAInterim re-analysis. The oceanic component of MPI-ESM is constrained in three different ways: monthly assimilation of sub-surface temperature and salinity profiles by a localized variant of the singular evolutive ensemble Kalman filter (SEIK), monthly assimilation of sub-surface and surface oceanic temperature and salinity by a global variant of SEIK, no assimilation of oceanic observations, thus atmospheric nudging only. With the localized SEIK assimilation oceanic observations have a stronger impact within the coupled assimilation and on the initialization than with the global SEIK assimilation. In hindcasts initialized by the localized SEIK assimilation we find increased 2-5 year correlation skill in surface temperatures over the North Atlantic, the Tropical Pacific and the Indian subcontinent when compared to hindcasts initialized by atmospheric nudging only. These improvements are less pronounced or not visible at all in hindcasts initialized by the global SEIK assimilation. However, the localized SEIK assimilation may introduce stronger imbalances in the oceanic state variables, and as a result the Atlantic meridional overturning circulation is, when compared to atmospheric nudging only, much more changed by the local than by the global SEIK assimilation, not only during assimilation, but also within all hindcasts. We therefore conclude that the skill of decadal hindcasts may benefit from initialization by oceanic localized SEIK assimilation, but only if the overall coupled assimilation setup is carefully chosen.