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Full-field versus anomaly initialization in the MiKlip decadal prediction system: An initial shock in the North Atlantic

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Our decadal climate prediction system, which is based on the Max-Planck-Institute Earth System Model, is initialized from a coupled assimilation run that utilizes nudging to selected state parameters from reanalyses. We apply full-field nudging in the atmosphere and either full-field or anomaly nudging in the ocean. Full fields from two different ocean reanalyses are considered. This comparison of initialization strategies focuses on the North Atlantic Subpolar Gyre (SPG) region, where the transition from anomaly to full-field nudging reveals large differences in prediction skill for sea surface temperature and ocean heat content (OHC). We show that nudging of temperature and salinity in the ocean modifies OHC and also induces changes in mass and heat transports associated with the ocean flow. In the SPG region, the OHC tendencies from the ocean reanalyses are adopted quite well by the prediction system, regardless of using full fields or anomalies. The resulting ocean transport, on the other hand, reveals considerable differences between full-field and anomaly nudging. In all assimilation runs, ocean heat transport together with net heat exchange at the surface does not correspond to OHC tendencies, the SPG heat budget is not closed. Discrepancies in the budget in the cases of full-field nudging exceed those in the case of anomaly nudging by a factor of 2-3. The nudging-induced changes in ocean transport continue to be present in the free running hindcasts for up to five years, a clear expression of memory in our coupled system. In hindcast mode, on annual to inter-annual scales, ocean heat transport is the dominant driver of SPG OHC. Thus, we ascribe a significant reduction in OHC prediction skill when using full-field instead of anomaly initialization to an initialization shock resulting from the poor initialization of the ocean flow.