What explains skillful decadal prediction of North Atlantic SST?

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Perfect model predictability simulations as well as coupled decadal prediction simulations initialized from observations consistently suggest that sea surface temperature (SST) in the North Atlantic (NATL), and in the subpolar gyre (SPG) in particular, is highly predictable on decadal timescales. Slowly-varying ocean heat transport associated with the Atlantic Meridional Overturning Circulation (AMOC) is generally invoked as the "mechanism" that explains NATL SST prediction skill.

Here, we present a deeper examination of the mechanisms at work in a state-of-the-art decadal prediction system that exhibits particularly high and long-lasting skill for NATL upper ocean heat content and SST. The 40-member CESM Decadal Prediction Large Ensemble (CESM-DP-LE) is the initialized counterpart to the CESM Large Ensemble of 20th Century simulations (CESM-LE; Kay et al. 2015). Comparing CESM-DP-LE and CESM-LE underscores the importance of internal (as opposed to externally-forced) mechanisms in the NATL domain. The internal mechanisms are probed by quantifying the relative roles of various terms in the upper ocean heat budget. The budget analysis highlights where (and when) large-scale circulation anomalies contribute significantly to skillful prediction of SST' via the V'T terms of the advective heat convergence. The analysis reveals that highly predictable V'T in the south central SPG is related to low-frequency changes in the strength of the thermohaline-driven gyre associated with flow-topography interactions near the Mid-Atlantic Ridge. Overturning-related heat convergence appears to play a lesser role in predicting heat content tendency and SST'.