Skilful near term predictions over the North Atlantic region – role of ocean dynamics

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The recently emerged field of near-term (decadal) climate prediction aims at skilfully predicting the regional climate variations for a time horizon of up to 30 years (Meehl et al., 2014). Initialized decadal climate predictions attempt at capturing both the internally generated (due to the slow varying climate components, mainly ocean) and forced predictability (due to changes in atmospheric composition). Various methods exploring the predictive potential in the state-of-art global ocean-ice-atmosphere coupled models indicate significant internally generated multi-year predictability over the Northern-hemisphere mid-to-high latitudes and forced potential predictability over the Arctic. Both the pre-CMIP5 and CMIP5 suites of decadal predictions have shown robust multi-year predictive skill for the global mean surface temperature variations over the historical period and over the North Atlantic region (Bellucci et al., 2014; Doblas-Reyes et al., 2013) . However, the high predictive potential over the North Pacific has not been materialized.

Across various model resolutions, initialisation procedures and skill measures, a robust decadal predictive skill and statistically significant added value from the ocean initialization is found over the North Atlantic Subpolar Gyre, eastern subtropical North Atlantic and Western Mediterranean basin (Matei et al, 2012b). Especially, the SPG region stands out as a hot spot, exhibiting the highest surface and subsurface decadal predictability beyond the warming trend. The dominant mechanism for the North Atlantic climate predictability is of dynamics origin and can be attributed to the initialization of the AMOC, thus explaining the reoccurrence of high predictive skill within the second pentad of the hindcasts experiments. Recent results indicate that such a mechanism may be at play at even higher latitudes, bringing predictability up to a decade ahead to the Atlantic domain of the Nordic Seas (where the North Atlantic Water has its main imprint on the ocean surface) and even up to Barents Sea. In our study (Langehaug et al. 2015), the region exhibiting high predictive skill appear to move as forecast time advances from south to north within the Atlantic domain, indicative of a northward advection of SST anomalies along the flow path of the Atlantic Water and therefore, of a potential connection between predictability in the subpolar North Atlantic and the Nordic Seas.

The predictive horizon of various climate quantities and processes is set by both an accurate initialisation and intrinsic ocean predictability. On average, key oceanic dynamical quantities, such as AMOC (Matei et al., 2012a, Pohlmann et al., 2013), meridional heat transport, SPG strength (Wouters et al., 2013, Lohmann and Matei, 2015), LSW and overflows transports, exhibit multi-year predictability in the range of 3-to-5 years. Especially the ability to predict AMOC and SPG strength fluctuations has proved to be crucial in forecasting the full evolution of abrupt extreme events (Robson et al., 2012; Lohmann and Matei, 2015), such as the strong mid1990s SPG warming shift, with a couple of years in advance.

The last couple of years have brought some observational and modelling indications (McCarthy et al., 2012; Robson et al., 2013) that the North Atlantic region might currently undergo some significant changes. Our (still experimental) ensemble forecast exercise does also show a robust cooling tendency of the North Atlantic Subpolar Gyre over the next five years driven by a decrease in the heat transport convergence (Matei et al., 2015, in preparation). However, no multi-decadal phase change transition is foreseen by our ensemble predictions for the next two decades.

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