Title: "A multi-model comparison of the ocean contributions to multidecadal variability in the North Atlantic"

Authors: Pablo Ortega[1], Jon Robson[1], Rowan Sutton[1], Agathe Germe[2], Adam Blaker[2], Bablu Sinha[2], Joel Hirschi[2] and Leon Hermanson[3].

[1]NCAS-Climate, Department of Meteorology, University of Reading, Reading, UK; [2]National Oceanography Centre, Southampton, UK; [3]Met Office Hadley Centre, Exeter, UK

Abstract:

In this study, we analyse the inter-relationships between the Labrador Sea densities, the boundary currents, the AMOC and, more generally, the wider climate of the North Atlantic across an ensemble of climate models. Six different simulations have been considered in this analysis; including, two 300-year long high-resolution coupled control simulations (with HadGEM3-GC2 and HiGEM, respectively), surface forced ocean-only simulations at ¼ and 1/12 of a degree, which cover the last 40 years, and the DePreSys3 assimilation experiment. This heterogeneous ensemble allows us to evaluate the robustness and realism of the results, as well as their sensitivity to the model configuration and resolution.

We have characterised the mean state of the North Atlantic and the main modes of Labrador Sea density variability across these models. The leading EOF of Labrador Sea density is reasonably consistent across the ensemble. All models show a fairly uniform vertical structure, with maximum positive density values near the surface that slowly decrease with depth. However, there is some difference regarding the depth that these density anomalies reach, with the forced ocean simulations showing deeper anomalies. Although density anomalies reach different depths, both the control and historical experiments show comparable multidecadal variability in Labrador Sea density. There is also a good agreement between density evolution in the ocean-only forced and the assimilation experiments; all depict an increase in the Labrador Sea densities from the 60s to the mid 90s, followed by a decreasing trend up to the present. These coherent Labrador Sea density changes are encouraging, but do not appear to translate to coherent changes in the AMOC strength. Only two of the ocean-only forced runs show first an increase (until the mid90s) and subsequently a decrease in the AMOC strength at 45N. Also, the assimilation experiment does not exhibit any clear multidecadal variability. These discrepancies between the AMOC evolutions are enhanced at 26N. To try to account for these differences, we finally look at the link of Labrador Sea densities with the western boundary currents, trying to establish if results are dependent on the choice of the forcing setup, the model version and resolution.