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

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MOTIVATION

Previous studies with the HadGEM3-GC2 model (Robson et al 2016, Ortega et al 2017) have identified the Labrador Sea density (LSD) as a key indicator of multidecadal decadal variability, linked to important changes in the Atlantic Meridional Overturning Circulation (AMOC) and the western boundary densities (WBD) and, more generally, to the climate of the wider North Atlantic (Fig. 1). These results show a great potential for decadal climate prediction. For example, decadal decreasing trends in the Labrador Sea densities lead 4-10 years later to decadal coolings in the Eastern Subpolar Gyre, and to positive phases of the North Atlantic Oscillation (NAO).

However, it remains yet to be determined if these relationships are also reproduced in other models.

Main Goal:

To test the consistency of the LSD relationships across an ensemble of climate models

1. EXPERIMENT SELECTION

- PC Control Simulations
  - HadGEM3-GC2
  - CMIP5 ensemble
- Ocean-forced & Historical
  - ORCA025-IAF/DFS
  - ORCA12-DFS
  - NCAR-IAF
  - DFS3 Assimilation run

2. LSD: AN INDEX OF MULTIDEcadAL VARIABILITY

The 1st mode of Labrador Sea Densities (PCI-LSD) behaves as a red-noise process with enhanced variance at 12-30 yrs. Its EOF has a coherent structure across models.

3. LSD LINK WITH THE OCEAN CIRCULATION

PC1-LSD decadal trends are strongly linked to those of the AMOC at 45°N and the Subpolar Gyre strength in all models, but their connection with the decadal trends of the LSD at 26°N is highly model dependent, both in terms of magnitude and lag of maximum correlation (Fig. 3).

4. CAUSES OF MODEL SPREAD IN LINK WITH SUBTROPICS

The diversity in the simulated links with the AMOC at 26°N could be potentially explained by differences in the representation of the southward propagation of western boundary densities (WBD), as illustrated in Fig. 5 for G2C and HIGEM.

5. LAGGED CONNECTIONS WITH THE ESPG

All models support a link between the decadal trends in PCI-LSD and the equivalent trends in the top 700 m average ocean temperature in the Eastern Subpolar Gyre (ESPG 1700) delayed by 3 to 10 years (Figure 8).

CONCLUSIONS

- Models consistently show a strong link between the Labrador Sea Densities and the AMOC at subpolar latitudes (45°N), but show little coherence regarding their relationship with the subtropical AMOC.
- This model diversity relates to a different representation of the boundary densities as they propagate southwards from the Labrador Sea, as well as to the density stratification in Labrador Sea (not shown).
- Regardless of these differences, models show a coherent delayed LSD link with the ESPG temperatures, with encouraging prospects for predictive purposes.

REFERENCES
