Assessment of temperature fingerprints in the North Atlantic for the reconstruction of deep water formation

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1 Motivation

Direct observations of the Atlantic Meridional Overturning Circulation (AMOC) are only available from 2004 onwards\cite{O'Reilly, Zhang, Zahn, Bühler, Caesar}. Because of the importance of the AMOC for the thermohaline circulation and the global climate system, indirect reconstructions are necessary to study long-term variability\cite{Moffa-Sánchez, Collins, Thornalley, Caesar}. Suggested indirect reconstruction methods often use a temperature dipole in sea surface or subsurface temperatures of the North Atlantic\cite{Thornalley, Caesar, Moffa-Sánchez} which are however subject to a multitude of forcings\cite{Moffa-Sánchez, Collins, Caesar}. We test whether these dipole methods are reliable for reconstructions on all time scales.

Please let me know if you have questions or ideas on the project!

2 Methods and Data

For two palaeoclimate model simulations of the past millennium (HadCM3\cite{Thornalley} and the past two millennia (CESM1\cite{Caesar}) AMOC strength and ocean temperatures are compared in terms of their distribution of variance and correlation. This allows to compare AMOC and temperatures for a period longer than the short observational record of AMOC.

AMOC strength: Maximum volume transport in depth and across latitudes in the yearly averaged volume transport

Sea surface temperatures (SST) and subsurface temperatures: yearly average across subpolar gyre (SPG) region in North Atlantic

AMOC indices from temperatures assume a correlation between SST or subsurface temperatures in the North Atlantic and the AMOC strength. Often a linear regression between the two is performed\cite{Moffa-Sánchez, Collins, Thornalley, Caesar}.

3 Results

We find discrepancies in the cross-correlations and the spectral densities between AMOC and SSTs in the two models. This decreases the skill of regression indices for the AMOC especially in CESM. The differences between the models might be attributable to the spatial representation of the overturning.

4 Conclusions and Outlook

- Index reconstructions of AMOC not robust in all models
- Uniform index definition difficult due to discrepancies in cross-correlations
- Considering additional models
- Analyse spatial correlation between SST and AMOC
- Check spectrum of different AMOC strength definitions

References

\cite{Cunningham, Sirocko, Collins, Moffa-Sánchez, Rahmstorf, Zhang, Bühler, Zhong, O'Reilly}

We would like to thank all Stacy group members for their support, in particular Nils Wettzel, Moritz Kirstner, and Jean-Philippe Badouin.

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