A robust statistical link between Atlantic Multidecadal SST variability and the Meridional Overturning circulation in the MPI Grand Ensemble

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1. Motivation & Introduction

- There is an ongoing debate whether the Atlantic multi-decadal variability (AMV) is influenced by ocean dynamics.
- Recent publications (e.g., Clement et al. (2015), Cane et al. (2017)) argue that AMV-like ocean variability might only be a result of integrating white noise in the ocean-atmosphere system by the ocean.

2. Model & Experiments

- MPI-ESM-LR earth system model
  - Atmosphere: ECHAM6.1/L4
  - Ocean: MPIOM GR15L4
- MPI Grand Ensemble
  - 100 x 155 years historical
  - Transient historical greenhouse gas and aerosol forcing
  - 100 x 159 years +1% CO2

3. Results (1): A robust correlation between the AMV, AMOC and ocean heat supply

- There is a high correlation with several ocean indices in the historical ensemble.
- All correlations decline drastically under strong CO2 forcing.
- Not shown: the correlation with ocean heat supply also holds for (unfiltered) annual data.
- The simulated AMV pattern shows strong similarity to the observed AMV pattern for the historical period.
- The pattern shows crucial changes under strong CO2 forcing, particularly in the North West North Atlantic.

4. Results (2): Decline in variability is linked to Labrador Sea deep ocean density

- There is a strong correlation between ocean surface and deep ocean indices and deep ocean density in the Labrador Sea in the historical ensemble.
- This link vanishes under strong CO2 forcing.

Take Home Message (2)

- The decline in AMOC mean and its variability are very similar to that of the AMOC.
- Labrador Sea stabilizes under strong CO2 forcing.

Key questions:

- What drives the AMV in the coupled ocean-atmosphere system?
- Is there a connection between AMV and ocean variability in MPI-ESM?
- Does the connection between AMV and other climate indices change under (strong) external greenhouse gas forcing?