EGU22-4380, updated on 09 Aug 2022
https://doi.org/10.5194/egusphere-egu22-4380
EGU General Assembly 2022

Unforced AMOC variations modulated by Tropical Indian Ocean SST

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A potential future slowdown or acceleration of the Atlantic Meridional Overturning Circulation (AMOC) would have profound impacts on global and regional climate. Recent studies have shown that AMOC responds, among many other processes, to anthropogenic changes in tropical Indian ocean (TIO) temperature. However, internal unforced co-variations between these two basins are largely unexplored as of yet. Here, we use the ERSST5 and HadISST4 gridded observational products for the period 1870-2014, as well as dedicated simulations with coupled climate models, to illustrate how unforced changes in TIO sea surface temperature can drive teleconnections that influence internal variations of North Atlantic climate and AMOC.

We separate the unforced observed component from the forced signal following the *residuals* method presented by Smith et al. (2019): the forced response is estimated from the CMIP6 multi-model ensemble mean and then subtracted from observed variability, leaving the unforced residual. In the absence of direct AMOC observation we estimate AMOC variability from a SST index first proposed by Caesar et al. (2018), the *Caesar Index* (CI). We find a robust observed relationship between unforced TIO and unforced CI when TIO leads by ~30 years. This time-lag is in line with a recently described mechanism of anomalous tropical Atlantic rainfall patterns that originate from TIO warming and cause anomalously saline tropical Atlantic surface water which slowly propagate northward into the subpolar North Atlantic, ultimately altering oceanic deep convection and AMOC (Ferster et al. 2021). Pre-industrial control simulations with the IPSL-CM6A-LR model confirm this relationship, indicating a time lag of ~30 years between TIO and CI variations. These simulations also confirm that the CI is representative of unforced AMOC variations when CI leads by 10 years. This work therefore indicates that an unforced pathway between TIO temperature and AMOC exists with a ~20 year lag, which opens the potential for using TIO temperature as precursor to predict future AMOC changes.

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