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Sensitivity of the Atlantic meridional overturning circulation (AMOC) to the tropical Indian Ocean warming.

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The Arctic and North Atlantic Ocean play a fundamental role in Earth's water cycle, distribution of energy (i.e. heat), and the formation of cold, dense waters. Through the Atlantic meridional overturning circulation (AMOC), heat is transported to the high-latitudes. Classically, the climate impact of AMOC variations has been investigated through hosing experiments, where anomalous freshwater is artificially added or removed from the North Atlantic to modulate deep water formation. However, such a protocol introduces artificial changes in the subpolar area, possibly masking the effect of the AMOC modulation. Here, we develope a protocol where AMOC intensity is modulated remotely through the teleconnection of the tropical Indian Ocean (TIO), so as to investigate more robustly the impact of the AMOC on climate. Warming in the TIO has recently been shown to strengthen the Walker circulation in the Atlantic through the propagation of Kelvin and Rossby waves, increasing and stabilizing the AMOC on longer timescales. Using the latest coupled-model from Insitut Pierre Simon Laplace (IPSL-CM6), we have designed a three-member ensemble experiment nudging the surface temperatures of the TIO by -2°C, +1°C, and +2°C for 100 years. The objectives are to better quantify the timescales of AMOC variability outside the use of hosing experiments and the TIO-AMOC relationship. In each ensemble member, there are two distinct features compared to the control run. The initial changes in AMOC (≤20 years) are largely atmospherically driven, while on longer timescales is largely driven by the TIO teleconnection to the tropical Atlantic. In the northern North Atlantic, changes in sensible heat fluxes range from 15 to 20 W m^{-2} in all three members compared to the control run, larger than the natural variability. On the longer timescales, AMOC variability is strongly influenced from anomalies in the tropical Atlantic Ocean. The TIO teleconnection supports decreased precipitation in the tropical Atlantic Ocean during warming (opposite during TIO cooling) events, as well as positive salinity anomalies and negative temperature anomalies. Using lagged correlations, there are the strongest correlations on scales within one year and a delayed response of 30 years (in the -2°C ensembles). In comparing the last 20 years, nudging the TIO induces a 3.3 Sv response per 1°C change. In summary, we have designed an experiment to investigate the AMOC variability without directly changing the North Atlantic through hosing, making way for a more unbiased approach to analysing the AMOC variability in climate models.

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