Sensitivity of the Atlantic meridional overturning circulation and climate to tropical Indian Ocean warming

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Abstract

The magnitude of the future Atlantic meridional overturning circulation (AMOC) decline remains highly uncertain as the AMOC sensitivity to climate forcing varies greatly across different models and CO2 scenarios. Accordingly, it is important to understand the key factors that control AMOC changes. Previous work has shown that the tropical Indian Ocean (TIO) is warming faster than the other tropical oceans and that this relative warming can drive changes to the North Atlantic through remote atmospheric and oceanic teleconnections. Following these ideas, here we study the AMOC sensitivity to TIO warming using the latest coupled-model from Insitut Pierre Simon Laplace (IPSL-CM6). To that end, we conduct ensemble experiments nudging the surface temperatures of the TIO by -2◦C, -1◦C, +1◦C, and +2◦C; the experiments last for several hundred years. We detail two mechanisms that drive AMOC changes: a "fast" and "slow" response to the relative warming of the TIO. Both mechanisms rely on atmospheric teleconnections, but drive changes directly in the mid to high-latitude North Atlantic (fast response) or through the tropical Atlantic Ocean (slow response) followed by oceanic pathways within the Atlantic Ocean. For the slow response, we find a +9.4 Sv per 1◦C AMOC sensitivity to relative TIO warming (_˜70% of the mean AMOC). The response is not fully symmetric in that a TIO warming strengthens the AMOC through increase in Labrador Sea deep water formation, while a TIO cooling slows down the AMOC via sea ice expansion over the Nordic Seas deep-water formation region. Our results display the importance of the TIO-teleconnection to North Atlantic climate and the magnitude of AMOC decline under the current and various climate scenarios.

Keywords: AMOC, Teleconnections, Climate Variability, Indian Ocean

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