

Overlooked possibility of a collapsed Atlantic meridional overturning circulation in warming climate

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Abstract

Changes in the Atlantic meridional overturning circulation (AMOC) are moderate in most climate model projections under increasing greenhouse gas forcing. This inter-model consensus may be an artifact of common model biases that favor a stable AMOC, since observationally based freshwater budget analyses suggest that the AMOC is in an unstable regime susceptible for large changes in response to perturbations. To investigate the impact of AMOC stability bias on future climate projection, we use the NCAR CCSM3 and correct model AMOC stability bias by means of flux adjustment. We find that, in the corrected model, the AMOC collapses 300 years after the atmospheric CO₂ concentration is abruptly doubled from the 1990-level. Compared to uncorrected model, the AMOC collapse brings about large, dramatically different climate response: a prominent cooling over the northern North Atlantic and neighboring areas, remarkable sea ice increases over the Greenland-Iceland-Norwegian seas and to the south of Greenland, and a significant southward rain-belt migration over the tropical Atlantic. Our results highlight the need to develop dynamical metrics to constrain models and the importance of reducing model biases in long-term climate projection.