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Overturning Pathways Control AMOC Weakening in CMIP6 Models

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Future projections indicate the Atlantic Meridional Overturning Circulation (AMOC) will weaken and shoal in response to global warming, but models disagree widely over the amount of weakening. We analyse the overturning pathways in 27 CMIP6 models to assess their impact on this weakening. The branch of the AMOC that returns through upwelling in the Indo-Pacific, but does not later upwell in the Southern Ocean, is particularly sensitive to warming, in part, because shallowing of the deep flow prevents it from entering the Indo-Pacific via the Southern Ocean. The present-day strength of this Indo-Pacific pathway provides a strong constraint on the projected AMOC weakening, explaining 81% of the variance in AMOC weakening across the CMIP6 ensemble in the SSP5-8.5 scenario. However, estimates of this pathway using four observationally-based methods imply a wide range of AMOC weakening under this scenario of 29% to 61% by 2100. Our results suggest that improved observational constraints on this pathway would substantially reduce uncertainty in 21st century AMOC decline. This could be achieved through the implementation of an Indo-Pacific Ocean array at 34.5°S, analogous to the existing SAMBA array in the South Atlantic. This would allow for monitoring of the Indo-Pacific and global-integrated MOC at 34.5°S and thus for estimation of the present-day MOC pathways.

Topic

Observational priorities –what should we measure?

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