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The effects of an AMOC slowdown on global surface warming

Levke Caesar (1,2), Stefan Rahmstorf (1,2), and Georg Feulner (1)

(1) Potsdam Institute for Climate Impact Research (PIK), Member of the Leibniz Association, P.O. Box 60 12 03, D-14412 Potsdam, Germany, (2) Institute of Physics and Astronomy, University of Potsdam, Potsdam, Germany

According to established understanding, deep-water formation in the North Atlantic and Southern Ocean keeps the deep ocean cold, compensating the downward mixing of heat from the warmer surface waters in the bulk of the world ocean. Therefore, periods of strong Atlantic Meridional Overturning Circulation (AMOC) should coincide with cooling of the deep ocean and warming of the surface waters, and therefore higher global mean surface temperatures (GMSTs). Changes in the global mean surface temperature at multi-decadal timescales – with surface we mean the lower atmosphere and upper ocean, which are well-mixed and at these timescales close to equilibrium – are forced by radiative forcing from the top and heat exchange with the deep ocean (Trenberth et al., 2010). Accounting for the effect of changes in the radiative forcing on GMST we test how AMOC variations, by affecting the heat transport to the deep ocean, correlate with the remaining part of surface temperature changes. The resulting correlation is strongly and significantly positive with warm GMST anomalies correlating with a strong AMOC.
These results agree with Knight et al. (2005) who likewise found a positive correlation between the AMOC strength and global as well as northern hemisphere temperature, but they contradict the study of Chen and Tung (2018) who suggested that during the past decades a strong AMOC coincided with warming of the deep ocean and relative cooling of the surface. The positive correlation between AMOC strength and surface warming also matches the fact that the decline of the AMOC over the last decade (Caesar et al., 2018) coincided with an increase in the rate of ocean heat uptake, and suggests a possible damping effect of a future AMOC slowdown on global surface warming.

References

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