

Bistability of the Atlantic overturning circulation in a global climate model and links to ocean freshwater transport

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The possibility of a rapid collapse in the strength of the AMOC, with associated impacts on climate, has long been recognized. The suggested basis for this risk is the existence of two stable regimes of the AMOC ('on' and 'off'), and such bistable behaviour has been identified in a range of simplified climate models. However, up to now, no state-of-the-art atmosphere-ocean coupled global climate model (AOGCM) has exhibited such behaviour, leading to the interpretation that the AMOC is more stable than simpler models indicate. Here we demonstrate AMOC bistability in the response to freshwater perturbations in the FAMOUS AOGCM - the most complex AOGCM to exhibit such behaviour to date. The results also support recent suggestions that the direction of the net freshwater transport at the southern boundary of the Atlantic by the AMOC may be a useful physical indicator of the existence of bistability. We also present new estimates for this net freshwater transport by the AMOC from a range of ocean reanalyses which suggest that the Atlantic AMOC is currently in a bistable regime, although with large uncertainties. More accurate observational constraints, and an improved physical understanding of this quantity, could help narrow uncertainty in the future evolution of the AMOC and to assess the risk of a rapid AMOC collapse.