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Historical analogues to the recently observed minima in the Atlantic meridional overturning circulation

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Recent observations of the Atlantic meridional overturning circulation (AMOC) by the 26°N array have revealed an anomalously low minimum in the northward transport over the winter of 2009/2010. This minimum in the transport is substantially lower than any observed since the start of the 26°N array in April 2004. It is also followed by a second minimum which is slightly less severe and of shorter duration than the first in the winter of 2010/2011. Output from a numerical model experiment forced with observed surface fluxes and integrated to 2011 demonstrates that the model is able to reproduce the observed minima. We next examine output from a set of ORCA025 simulations integrated over the period 1958-2001 and identify several historical events which exhibit similar characteristics to the one observed by the 26°N array in the winter of 2009/10. There are instances of individual events, and two clear examples of pairs of events which happened in consecutive years. Individual events appear to be associated with negative phases of the North Atlantic Oscillation (NAO) which are mainly confined to the North Atlantic region. In contrast, the first events occurring in pairs of consecutive MOC minima coincide with more widespread anomalous atmospheric conditions associated with a negative phase of the Arctic Oscillation (AO).

Decomposing the model AMOC into component parts equivalent to those measured by the observational array we are able to further explore the nature of these events. In all cases the absolute minimum is associated with a short, sharp reduction in the Ekman component. The minima identified all occur in late winter to early spring (January to March). In the case where there are two consecutive events some of the model runs suggest that the first minimum event is followed by a weakening of both the (southward) geostrophic component and the (northward) Florida Straits transport which reaches a minimum in late summer/autumn of the same year.