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Naturally forced multidecadal variability of the Atlantic meridional overturning circulation

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The mechanisms by which natural forcing factors alone could drive simulated multidecadal variability in the Atlantic Meridional Overturning Circulation (AMOC) are assessed in an ensemble of climate model simulations. It is shown for a new state-of-the-art general circulation model, HadGEM2-ES, that the most important of these natural forcings, in terms of the multidecadal response of the AMOC, is solar rather than volcanic forcing. AMOC strengthening occurs through a densification of the North Atlantic, driven by anomalous surface freshwater fluxes due to increased evaporation. These are related to persistent North Atlantic atmospheric circulation anomalies, driven by forced changes in the stratosphere, associated with anomalously weak solar irradiance during the late nineteenth and early twentieth centuries. Within a period of approximately 100 years the 11-year smoothed ensemble mean AMOC strengthens by 1.5Sv and subsequently weakens by 1.9Sv, representing respectively approximately 3 and 4 standard deviations of the 11-year smoothed control simulation. The solar-induced variability of the AMOC has various relevant climate impacts, such as a northward shift of the intertropical convergence zone, anomalous Amazonian rainfall, and a sustained increase in European temperatures. While this model has only a partial representation of the atmospheric response to solar variability, these results demonstrate the potential for solar variability to have a multidecadal impact on North Atlantic climate.