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Response of the meridional overturning circulation in an idealised reverse world experiment

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It is still unclear why a meridional overturning circulation (MOC) capable of significant northward heat transport is found in the Atlantic and not the Pacific, and whether this preference is accidental or a fundamental feature of the climate system. We investigate the relative importance of various geographical asymmetries in forcing the Atlantic preference of the MOC in a coupled climate model using a novel method in which the direction of rotation of the Earth is reversed. This method keeps the relative geometries of the Atlantic and Pacific basins unchanged, whilst reversing directions of the Antarctic Circumpolar Current and the water vapour transport across central America. The experiment also enables us to investigate the extent to which the previous history of the system determines its evolution under radically altered boundary conditions.

In the reverse rotation experiment, the MOC in the Atlantic collapses whilst a strong overturning cell develops in the Pacific. This is largely due to changes in the freshwater forcing of the ocean basins. The North Atlantic and Mediterranean freshen considerably in the reverse rotation experiment, leading to the shut down of the Atlantic MOC. Changes in precipitation lead to the build up of salinity in the subtropical Pacific, which facilitates deep convection and a Pacific overturning cell. The current preference for Atlantic overturning in the real world may be set by the asymmetry of ocean basins and their associated freshwater catchments.