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The role of diapycnal mixing in controlling the strength of the MOC

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Previous idealised experiments and simplified theory suggest that the strength of the meridional ocean circulation (MOC) and the ocean heat transport scale with the diapycnal diffusivity (K_v). The value of K_v sets the rate at which dense bottom water can be mixed up through the water column and thus plays an important role in the MOC. This study investigates the impact of changing the background diapycnal mixing in an ocean-atmosphere general circulation model (MPI-OM/ECHAM5 of the Max Planck Institute for Meteorology). In this model, the effective K_v is derived from the background diapycnal diffusion, wind induced mixing, the Richardson number and the convective adjustment. A set of 3 experiments is conducted with background K_v's of 0.1 cm^2/s (the control run), 0.25 cm^2/s and 1 cm^2/s. Although simple theory predicts an increase in the strength of the MOC with increasing K_v, this is not observed in our coupled model. In the run with K_v=0.25 cm^2/s, the MOC initially weakens by 10% and then recovers again over 350 years. For K_v=1 cm^2/s, there is an initial sharp increase followed by a weakening of 16% with no recovery.

This behavior is however not observed when the same experiments are conducted with the coupling to the atmosphere removed. In the ocean only model, in accordance with the simple theory, the strength of the MOC increases with increasing K_v. In contrast to the results of previous, simplified studies, we show that both ocean-atmosphere coupling and spatial variation of the diapycnal mixing have an important role to play in determining the sensitivity of modelled MOCs to diapycnal mixing parameterisations.