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Stratification-dependent mixing may increase sensitivity of Atlantic Overturning to global warming

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We use the earth system model of intermediate complexity CLIMBER-3α to investigate the effect of stratification-dependent mixing on the stability of the Atlantic Meridional Overturning Circulation (AMOC) under an idealized CO_2 increase scenario. The vertical diffusivity κ of the ocean is parameterized as $\kappa \sim N^{-\alpha}$, where N is the local buoyancy frequency. For all parameter values $0 \leq \alpha \leq 3$, we find the AMOC to decrease in response to increased CO_2 concentrations. The sensitivity of the AMOC is significantly stronger for $\alpha \geq \alpha_{\mathrm{cr}} \approx 1.5$, also after stabilization of the CO_2 concentration. This threshold behavior is explained by a halt of dense water formation in the subpolar gyre, which is caused by a positive feedback between stratification and mixing anomalies.
Our findings indicate that climate models using time-invariant vertical mixing may underestimate the sensitivity of the AMOC to global warming.