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The role of stratification-dependent mixing for the stability of the Atlantic MOC in a coupled global climate model

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By adding potential energy to the water column, diapycnal mixing is thought to be one of the driving mechanisms of the meridional overturning circulation (MOC). Today, most state-of-the-art ocean general circulation models calculate the diapycnal background diffusivity independently of the stratification. Results from conceptual models, layer models, and hemispheric models suggest that a more physical parameterization could lead to fundamental changes of the stability properties of the MOC with respect to freshwater perturbations.
A stratification-dependent mixing scheme was implemented into the 3D ocean module of the Earth System Model of Intermediate Complexity Climber3α. We show that over a wide range of parameters, the main features of the equilibrium MOC remain unchanged by this. Moreover, a set of experiments applying freshwater perturbations to the North Atlantic shows an increase of the stratification in the convectively active areas of the model, thereby reducing the overturning. The stratification of the ocean interior however proves to be very stable, leaving the upwelling independent of what mixing parameterization was applied. As a result, the stability properties of the MOC remain unaffected by the mixing scheme, even on very long timescales.