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Stratification-dependent mixing decreases the stability of the Atlantic Overturning in a coupled climate model

B. Marzeion (1), A. Levermann (2), J. Mignot(3)

(1) Nansen Environmental and Remote Sensing Center & Bjerknes Centre for Climate Research, Bergen, Norway (ben.marzeion@nersc.no), (2) Postdam Institute for Climate Impact Research, Potsdam, Germany (anders.levermann@pik-potsdam.de), (3) LOCEAN, Universite Pierre et Marie Curie, Paris, France (juliette.mignot@locean-ipsl.upmc.fr)

The Atlantic Meridional Overturning Circulation (AMOC) is contributing considerably to the mild climate of north-western Europe by transporting heat from the low latitudes northward. On long timescales, the AMOC is limited by the amount of potential energy that is put into the ocean by vertical mixing. By assuming a constant background rate of mixing, most state–of-the–art climate models do not represent the effect of vertical mixing well, since theoretical arguments and measurements indicate that the vertical mixing strongly depends on local physical parameters - above all, on stratification. We implemented stratification–dependent mixing into a coupled climate model, and found the sensitivity of the AMOC to freshwater forcing to depend critically on the coupling between stratification and mixing. Weak coupling reproduces results from previous studies that assume constant vertical mixing. Stronger (and more realistic) coupling, however, allows for a positive feedback in the high northern latitudes stopping winter deep convection. Thus, the overturning north of the Greenland–Scotland Ridge is stopped, and the heat transport into that region is weakened already at low rates of freshwater input.