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The parameterization of eddy-induced transports sets the simulated strength of the Antarctic Circumpolar Current

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Within the class of global coupled climate models used for the IPCC AR4, the strength of the Antarctic Circumpolar Current (ACC) is not well constrained. At the end of the control runs, the volume transport through Drake Passage ranges from 34 Sv to 338 Sv, compared with the observed 137 Sv (1 Sv = 10^6 m^3 s^{-1}). We have looked into which field or quantity explains best this large variation across the climate models. A simple scaling based on theoretical work by Marshall and Radko (2003) predicts a linear dependence of the ACC strength on the zonal wind stress and on the meridional density gradient, and a reciprocal dependence on the eddy-induced diffusivity coefficient used in the Gent & McWilliams parameterization of the eddy-induced transports. In our analysis of 23 climate models, the correlations of the ACC strength with the wind stress and the density gradient individually are weak, while the correlation with the eddy-induced diffusivity coefficient is strongly negative as predicted, at least for those models where this coefficient is fixed. The correlation coefficient of the ACC with the simple scaling is 0.93. The results bring out the paramount role of the Gent & McWilliams parameterization in setting the strength of the ACC in coupled climate models.