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Spin-up, adjustment and equilibrium state of the Antarctic Circumpolar Current

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An analytical model will be presented for the spin-up, adjustment and equilibrium state of the Antarctic Circumpolar Current (ACC) in a reduced-gravity ocean, forced by wind stress, buoyancy forcing and diapycnal mixing. The initial spin-up from a shallow pycnocline (consistent with Sandstrom's theorem) is controlled by diapycnal mixing, but the eventual equilibration/adjustment time-scale is controlled by the Gent and McWilliams eddy transfer coefficient. This has important implications for climate model studies, which greatly underestimate the sensitivity of eddy fluxes to changes in the mean strength of the ACC. We also find that diapycnal mixing plays an important role in setting the mean strength of the ACC, in particular in the limit of strong diapycnal mixing (10-4 m2 s-1). This is for precisely the same reasons that diapycnal mixing may be important in setting the strength of the Atlantic Meridional Overturning Circulation (AMOC). The theoretical predictions are compared with the results of numerical calculations carried out with the MITgcm, in a global configuration with parameterized eddies, and in an idealized basin/re-entrant channel configuration with partially resolved eddies. The relationship between ACC adjustment, the global pycnocline and the AMOC, as well as the possibility of exciting seiching modes between the different basins, will also be discussed.