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Dynamics of circumpolar volume transport and global ocean heat content

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The volume transport of the Antarctic Circumpolar Current is typically described in textbooks as set by a combination of wind and buoyancy forcing. However, results of eddy-permitting numerical ocean models contradict this statement, instead indicating minimal sensitivity of circumpolar volume transport to the magnitude of the surface wind stress. A simple theoretical model is developed, building on the GEOMETRIC parameterisation of ocean eddies, which relates circumpolar volume transport to three length scales divided by the residence time of Southern Ocean eddy energy and an eddy efficiency parameter, but not to surface wind stress. These parameters are estimated from a mix of observations, showing that the predicted circumpolar transport is of the correct order of magnitude. Due to the close coupling between circumpolar volume transport and global ocean heat content through thermal wind balance, it is argued that Southern Ocean eddies play a fundamental role in controlling global ocean heat content and the strength of other global currents. The latter statement is supported by calculations with a global ocean circulation model incorporating the GEOMETRIC parameterisation of ocean eddies.

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