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How Does the Antarctic Circumpolar Current Affect the Southern Ocean Meridional Overturning Circulation?

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The Meridional Overturning Circulation (MOC) in the Southern Ocean is investigated using hydrographic observations combined with satellite observations of sea-surface height. A three-dimensional (spatial and vertical) estimate of the isopycnal eddy-diffusivity in the Southern Ocean is obtained using the theory of Ferrari & Nikurashin (2010), that includes the influence of suppression of the diffusivity by the strong, time-mean flows. It is found that the eddy diffusivity is enhanced at depth, reaching a maximum at the "critical layer" near 1000m.
The estimate of diffusivity is used with a simple diffusive parameterization to estimate the meridional eddy volume flux. Together with an estimate of the meridional Ekman transport and the time-mean meridional geostrophic transport, the eddy volume flux is used to reconstruct the time-mean overturning circulation. By comparing the reconstruction with, and without, suppression of the eddy diffusivity by the mean flow, the influence of the suppression on the overturning is illuminated. It is shown that the suppression of the eddy diffusivity results in a large reduction of interior eddy transports, and a more realistic eddy induced overturning circulation.
We will also use a simple conceptual model is used to show that the MOC is influenced not only by the existence of enhanced diffusivity at depth, but also by the details of the vertical structure of the eddy diffusivity, such as the depth of the critical layer.