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Topographical torques in wind-driven basin and channel models.

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Topography exerts a profound influence on the large-scale circulation of western boundary and circumpolar currents. Flow over variable topography generates topographical torques (bottom pressure torques) which can drive meridional flows and act to transfer vorticity.

The role of topography, and in particular that of bottom pressure torques, on idealised, wind-driven gyre and channel models is investigated. In gyre models with sloping side-walls, the meridional transport on the slope is locally controlled by the bottom pressure torque driving fluid across f contours, such that the transport is directed along f/H contours (where f is the planetary vorticity and H is the fluid depth). Friction is not locally important in achieving the meridional transport, but is significant in a integral sense in allowing a closed circulation, and for fluid to move across f/H contours.

In the channel model zonal jets develop at latitudes where the topography does not reach the surface. As the wind strength increases, the shielding by stratification of the topography decreases, and therefore there is a greater influence of f/H contours on the jet. Bottom pressure torques again drive meridional flows along topography. These torques return the wind-driven flow along western boundaries as in the gyre models, and can act to transfer vorticity from the wind-driven gyres into zonal jets.

In an interior, unforced layer there is a competition between sources of potential vorticity (PV) and eddies which erode these anomalies and homogenise the PV. Through steering the depth-integrated flow, the topography influences the frictional torques in the layer, and hence the location and relative magnitudes of the PV sources. Differences in these sources can lead to regional differences in the homogenised PV.