



The possibility of a steady, inviscid flow in which zonal wind stress is balanced by form stress: Simple examples and their energetics.

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Zonal wind stress is known to be balanced in the ocean by form stress at each latitude, a balance which is particularly pertinent to Southern Ocean dynamics, but also holds elsewhere. However, all analytical or numerical simulations of the ACC so far require either time dependent eddies or friction to permit that balance to hold. This has led to a tacit assumption that wind stress cannot be balanced by form stress in a steady, inviscid flow. I will give two counterexamples which demonstrate that, in certain circumstances, such a balance is possible. The first is a barotropic flow which requires a special relationship between the wind stress and the topography, and results in no net work done by wind stress. The second is a two-layer flow in which the wind stress can be quite generic, but a special condition on the mass exchange between layers must hold. In the latter case, the wind can do work, but this is balanced by an extraction of thermodynamic energy as water is exchanged between layers. Neither solution is a realistic model of the Antarctic Circumpolar Current, but the simple dynamics serves to improve our understanding of the relationship between wind stress, form stress, overturning circulation and energetics.