Title

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Midlatitude ocean gyres have long been considered to be driven by the mechanical wind stress on the ocean's surface (strictly speaking, the potential vorticity input from wind stress curl). However, surface buoyancy forcing (i.e. heating/cooling or freshening/salinification) also modifies the potential vorticity at the surface.

Here, we present a simple argument to demonstrate that ocean gyres may (in principle) be driven by surface buoyancy forcing. This argument is derived in two ways:

1. A thermal quasigeostrophic equation set, which allows both prediction of the relative sizes of wind stress vs surface buoyancy input, and can also be solved numerically to show the evolution of the system; and
2. A series of idealised eddy-resolving numerical model simulations, in which wind stress and buoyancy flux are varied independently and together, are used to understand the relative importance of these two types of forcing. In these simulations, basin-scale gyres and western boundary currents with realistic magnitudes, remain even in the absence of mechanical forcing by surface wind stress.

These results support the notion that surface buoyancy forcing can reorganise the potential vorticity in the ocean in such a way as to drive basin-scale gyres.