Abstract View

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A Continuously Stratified Nonlinear Ventilated Thermocline

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ABSTRACT

Three exact, closed-form analytical solutions for the subtropical gyre are presented for the ideal fluid thermocline equations. Specifically, the flow is exactly geostrophic, hydrostatic, and mass and buoyancy conserving. Ekman pumping and density can be chosen as fairly arbitrary functions at the surface. No flow is permitted through the ocean's eastern boundary, or through its bottom. The solutions are continuous extensions of existing layered models. The first solution, discovered simultaneously with Janowitz's solution, uses a deep resting isopycnal layer; the surface density may only be a function of latitude for this solution. A second nonunique solution requires velocities to tend to zero at great depth, giving an additional degree of freedom which permits surface density to be specified almost arbitrarily. This second solution is unphysical in the sense that depth-integrated mass fluxes and energies are infinite. However, a small change in the solution (which returns surface density to a function of latitude only) permits solutions with finite fluxes once more. A third solution requires partial homogenization of the potential vorticity of fluid layers which, while overlying a deep resting iopycnal layer, are not directly ventilated from the surface. Again, fairly arbitrary surface density and Ekman pumping are permitted. All the problems reduce to linear homogeneous second-order differential equations when density replaces depth as the vertical coordinate. The importance of the bottom boundary for closing the problem is stressed.

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