Abstract View

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Density-Driven General Circulation in a Closed Basin Using a Two-Lavel Model

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ABSTRACT

A rectangular-basin ocean, driven by buoyancy and density fluxes in its northern and southern portions, is studied using a two-level model. Only baroclinic motion is induced under the conditions of 1) no wind, 2) neither interfacial nor bottom stresses, 3) momentum equations, and 4) flat bottom. The relaxation problem, initiated by a north-south density difference, is studied first. It is found that a zonal geostrophic flow induces upwelling and downwelling near the eastern and western boundaries, resulting in alongshore flows characterized by frictional internal Kelvin waves. These flows are compensated by upwelling and downwelling near the northern and southern boundaries, reducing the meridional density gradient. The relaxation time scale is proportional to the area of the basin and inversely proportional to the square of an internal gravity wave speed.

The second problem is a steady state forced by continuous fluxes. It has qualitatively the same flow patterns as the relaxation problem. To establish a steady state with finite amplitude circulation, both relatively small vertical diffusion, and buoyancy and density fluxes to the lower level are required. Horizontal diffusion tends to spread density anomalies offshore from the eastern and western boundaries and to diminish intensified, narrow boundary currents. Upwelling and/or downwelling in a wide central area, balancing meridional velocity with planetary beta effect in the vorticity equation, plays a minor role in maintaining the density field, except in a low latitude region.

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