Abstract View

Volume 13, Issue 2 (February 1983)

Journal of Physical Oceanography
Article: pp. 169–190 | Abstract | PDF (1.26M)

A Two-Level Model of a Thermally Forced Ocean Basin

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(Manuscript received April 29, 1982, in final form October 7, 1982)

DOI: 10.1175/1520-0485(1983)013<0169:ATLMOA>2.0.CO;2

ABSTRACT

Some simple solutions (mostly analytic) are presented for the large-scale baroclinic response to thermal forcing on a mid-latitude beta-plane. Surface heat flux is parameterized as $(T_A–T_T)$/tau;, with atmospheric temperature T_A prescribed as a function of latitude, varying ocean surface temperature T_T, and equilibration time τ. For long times (decades) benthic forcing is included, using a similar representation. The model allows horizontal density variations at each level.

When there are no meridional boundaries there is only a local response to the forcing. A geostrophic baroclinic zonal flow is driven by the north–south temperature gradient, but it has no associated advection or divergence effects. This picture is greatly changed when east and/or west coasts are added. Kelvin waves pass information rapidly (about 200 km day^{-1}) along coasts, and Rossby waves travel slowly offshore, most effectively from the cut with speed $c \approx 1$ km day^{-1}. For spin-up problems (e.g., the response to a change in forcing) the long Rossby waves decay away from the eastern boundary on a scale $T\tau$. With T_A decreasing poleward this creates a broad, relatively warm eastern region with weak downwelling. A steady state requires weaker vertical motion to balance benthic forcing and a corresponding larger decay scale. The narrow western boundary layer is relatively cold on average, with upwelling. (This two-level model does not adequately describe western boundary dynamical however.)

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