Abstract View

Volume 14, Issue 7 (July 1984)

Journal of Physical Oceanography
Article: pp. 1179–1190 | Abstract | PDF (995K)

On the Maintenance of the Subtropical Front and its Associated Countercurrent

Benoit Cushman-Roisin

Mesoscale Air-Sea Interaction Group, The Florida State University, Tallahassee, FL 32306

(Manuscript received October 31, 1983, in final form May 7, 1984)

DOI: 10.1175/1520-0485(1984)014<1179:OTMOTS>2.0.CO;2

ABSTRACT

In the North Pacific and Atlantic Oceans, the Subtropical Countercurrent is an eastward flow across the Subtropical Gyre at a latitude where a classical wind-driven circulation theory would predict a westward flow. It is in geostrophic balance with the Subtropical Front, a zonal density front which runs across the ocean basin. From previous numerical models, it is argued that convergence of Ekman transports can hardly be the primary reason for the existence of such a phenomenon and that thermodynamic effects play a crucial role. To elucidate how them may be responsible for the frontal structure, a very simple analytical model is constructed where the dynamics yield motions consisting of a nondivergent wind-driven Sverdrup current and a geostrophic thermal flow that is divergent on a beta-plane. The surface temperature is governed by a nonlinear hyperbolic equation, for which the corresponding characteristics intersect, separating the basin into two distinct regions limited by a temperature discontinuity. We then show how the beta-plane convergence of the thermally driven flow is responsible for this frontal formation and how all consequent results such as location of front, temperature jump across it, flow pattern and vertical velocity compare favorably with observations and numerical models. Disagreement along the eastern boundary is recorded and explained by the absence of California Current dynamics in the present simple model. The conclusion is that, aside from convergence of Ekman transports the convergence of the thermally driven flow on a beta-plane may be the primary mechanism responsible for forming and maintaining the Subtropical Front-Subtropical Countercurrent system.

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Headquarters: 45 Beacon Street Boston, MA 02108-3693
DC Office: 1120 G Street, NW, Suite 800 Washington DC, 20005-3826
amsinfo@ametsoc.org Phone: 617-227-2425 Fax: 617-742-8718
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