Abstract View

Volume 16, Issue 11 (November 1986)

Journal of Physical Oceanography
Article: pp. 1884–1900 | Abstract | PDF (1.06M)

Eastern Boundary Conditions and Weak Solutions of the Ideal Thermocline Equations

W.R. Young

Department of Earth, Atmospheric, and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA 02139

G.R. Ierley

Department of mathematical and Computer Sciences, Michigan Technological University, Houghton, MI 49931

(Manuscript received January 16, 1986, in final form May 15, 1986)

DOI: 10.1175/1520-0485(1986)016<1884:EBCAWS>2.0.CO;2

ABSTRACT

It is argued that the ideal fluid thermocline equations have “weak” (i.e., nondifferentiable) solutions that satisfy no mass-flux boundary conditions at the East. This conclusion is based on a local analysis of the eastern “corner” of a subtropical gyre. Specifically we suppose that the surface density is uniform while the density on the eastern boundary is either uniform (but different from that of the surface) or else is linearly stratified. The surface density is injected into the interior by specified Ekman pumping. In the absence f dissipation the resulting solution would have a discontinuity is “smoothed” and becomes an internal boundary layer which separates the light fluid originating at the surface from the denser fluid which abuts the eastern boundary.

This solution, which is of the similarity type, illustrates the applicability of solutions of the ideal fluid thermocline problem with discontinuities. It is these discontinuities which enable ideal fluid solutions to satisfy eastern boundary conditions. Thus, contrary to statements in the literature, there is no a priori need for an eastern boundary layer which exchanges mass with an ideal interior.

This concept of a weak solution is implicit in recent theories of the large-scale oceanic circulation. For example, in the continuously stratified, quasigeostrophic model developed by Rhines and Young, the solution is singular at the boundary between the moving pool of homogenized potential vorticity and the motionless shadow region. Analogous surfaces of discontinuity enable the models discussed in previous studies to satisfy eastern boundary conditions. The present study makes this assumption more explicit and shows how one particular dissipative mechanism (vertical density diffusion) heals the singularity.

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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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