Abstract View

Volume 27, Issue 6 (June 1997)

Journal of Physical Oceanography
Article: pp. 941–962 | Full Text | PDF (1.50M)

Primitive Equation Instability of Wide Oceanic Rings. Part I: Linear Theory

Peter D. Killworth and Jeffrey R. Blundell

James Rennell Division for Ocean Circulation, Southampton Oceanography Centre, Southampton, United Kingdom

William K. Dewar

Department of Oceanography, Supercomputer Computations Research Institute and Geophysical Fluid Dynamics Institute, The Florida State University, Tallahassee, Florida

(Manuscript received February 1, 1996, in final form September 30, 1996)

DOI: 10.1175/1520-0485(1997)027<0941:PEIOWO>2.0.CO;2

ABSTRACT

The linear stability of two-layer primitive equation ocean rings is considered in the case when the rings are wide compared with a deformation radius, as is usually observed. Asymptotic theory is developed to show the existence of solutions for arbitrarily wide rings, and these solutions can be followed as the rings are made successively narrower. An exponential cubic radial dependence is used for the mean flow, rather than the more usual Gaussian structure. There are two reasons: a Gaussian shape was fully discussed in a previous paper, and a Gaussian has exceptional properties, unlike other power laws. The specific cases of warm and cold Gulf Stream rings are considered in detail. The theory provides an accurate prediction of phase velocity and growth rate for cold rings and a reasonable prediction for warm rings. Solutions in the asymptotic regime have a larger growth rate than other (nonasymptotic) solutions for cold rings, but not for warm rings. Attention is given to the role of the mean barotropic circulation, which had been found in earlier work to have a strong effect on ring stability. There is still evidence for stabilization when the mean flow in the lower layer vanishes, but other features are also involved. In particular, the linear stability of a ring appears to be as sensitive to subtle shape details as it is to the sense of the deep flow. The authors generally find warm co-rotating rings with a cubic exponential form to be unstable, although somewhat less so than counterrotating rings.

top

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
Allen Press, Inc. assists in the online publication of *AMS* journals.