Abstract View

Volume 14, Issue 1 (January 1984)

Journal of Physical Oceanography
Article: pp. 47–58 | Abstract | PDF (824K)

Rossby Wave Radiation from a Strongly Nonlinear Warm Eddy

Glenn R. Flierl

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

(Manuscript received December 31, 1982, in final form August 15, 1983)

DOI: 10.1175/1520-0485(1984)014<0047:RWRFAS>2.0.CO;2

Options:
- Create Reference
- Email this Article
- Add to MyArchive
- Search AMS Glossary

Search CrossRef for:
- Articles Citing This Article

Search Google Scholar for:
- Glenn R. Flierl

ABSTRACT

One of the serious flaws in the standard quasi-geostrophic equations, commonly used for understanding the evolution of mesoscale eddies, is the requirement that the change in thickness between density surfaces must be small compared to the mean thickness. In the case of warm core rings, the thickness of the thermostadt layer may range from 500 m at the center to zero at the edge. Yet the prediction of the evolution of such features should be vastly simplified by noting that there is a dominant equilibrium balance of forces in the fluid, with the beta effect and the time derivatives being relatively small.

In this paper, the author presents the nonquasi-geostrophic model for the evolution of a warm core ring using a two-layer fluid in which the upper layer has a finite volume so that the interface surfaces on a basically circular boundary. The lowest order flow in the warm pool is much faster than the Rossby wave speeds βL^2 and is not geostrophic but rather is assumed to be in a state of cyclostrophic balance. The time changes then occur on a time scale set by $(\beta L)^{-1}$ and can be calculated by balancing the net Coriolis forces due to the translation of the warm pool with the southward forces caused by the β effect and the form drag of the lower fluid caused by Rossby wave generation. The lower layer is assumed to be deep so that the lower layer dynamics are quasi-geostrophic, being forced by the motion of the warm pool.

For very deep lower layers, the generated waves can be calculated explicitly and the form drags can be shown to induce a southward motion of the upper pool and decay of its energy. This wave drag vanishes for very special choices of the size of the upper pool and the lower layer motions are then nonzero only in the region under the warm pool and have a net counterclockwise circulation with angular momentum equal and opposite to that of the upper layer. This is not expected to occur for most oceanic cases.

The calculation of the first-order structure in the warm pool shows a dipole character resembling a modon pair. The self-induced tendency of the pair is for westward motion. Although dynamically analogous to a modon with a strong rider, there are important differences due to the surfacing of the interface, the order-one Rossby number and the loss of energy owing to wave generation in the lower layer.

top