Abstract View

Volume 17, Issue 10 (October 1987)

Journal of Physical Oceanography
Article: pp. 1688–1695 | Abstract | PDF (584K)

Horizontal Entrainment and Detrainment in Large-Scale Eddies

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(Manuscript received October 3, 1986, in final form April 28, 1987)

DOI: 10.1175/1520-0485(1987)017<1688:HEADIL>2.0.CO;2

ABSTRACT

We compute the evolution of disturbances on a circularly symmetric eddy having uniform vorticity in a central core, in a surrounding annulus, and in the irrotational exterior water mass. This vortex is known to be (Kelvin-Helmholtz) unstable when its annular width is less than the core radius. Our calculations for the nonlinear regime show that amplification of azimuthal wavenumber $n = 2$ causes the vortex to split into two dipoles, in agreement with previous numerical calculations for a smoothed version of our vorticity field. This paper concentrates on the evolution of large-amplitude disturbances on the outer edge of a stable and robust eddy. We show that lateral wave breaking of vorticity isopleths causes intrusions of the (irrotational) exterior water mass into the central core of the vortex, a physical process which is relevant to lateral diffusion and isopycnal mixing in baroclinic ocean eddies. Similar intrusive features occur for an $n = 1$ disturbance, which also causes a "self-propagation" of the entire eddy. The large-amplitude disturbances on the eddy can be initiated by the action of external eddies or currents. A simple model for this case exhibits filaments detraining from the eddy, as well as intrusive features.