Abstract View

Volume 17, Issue 6 (June 1987)

Journal of Physical Oceanography
Article: pp. 735–740 | Abstract | PDF (473K)

Energetics of Linear Geostrophic Adjustment

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(Manuscript received August 26, 1986, in final form October 30, 1986)

DOI: 10.1175/1520-0485(1987)017<0735:EOLGA>2.0.CO;2

ABSTRACT

The potential and kinetic energy spectra following geostrophic adjustment of a barotropic fluid are determined as functions of the spectrum of arbitrary initial sea level or velocity. Remarkably, the functional dependences between initial and final spectra, and the general conclusions reached are independent of whether spatial variation in the initial field is permitted in either one or both horizontal directions. For initial sea level displacements, the potential and kinetic energy spectra obtained for the adjusted state are respectively shown to be low- and band-pass filtered versions of the initial potential energy spectrum. The maximum kinetic energy, ΔE, is obtained for initial displacements of wavelength k_0^{-1} equal to the deformation radius, a, and is equal to 1/3 of the change in potential energy, ΔP, from initial to adjusted state. The value of $\frac{1}{3}$ for $\Delta E/\Delta P$ is also found for steplike initial displacements for which no horizontal scale is defined. However, in general $\Delta E/\Delta P$ is shown to be dependent on the horizontal scale of initial displacements and bounded above by ½. The values, $\Delta E/\Delta P \leq \frac{1}{3}$, found by van Heijst and Smeed for a variety of nonlinear multiphase fluid adjustment problem are also suggested to be products of the assumed steplike initial conditions and length scales imposed by the presence of walls. The energetics of linear adjustment for initial velocity fields are also discussed and a time scale of adjustment for narrow band initial fields is estimated to be of order $(1 + k_0^2a^2)^{½}/k_0^2a^2$ inertial periods.

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