Abstract View

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Meanders and Detached Eddies of a Strong Eastward-Flowing Jet Using a Two-Layer Quasi-Geostrophic Model

Motoyoshi Ikeda

Pacific Marine Environmental Laboratory, Environmental Research Laboratories, NOAA, Seattle, WA 98105

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ABSTRACT

The process of meander growth on and eddy detachment from an eastward flowing oceanic jet, which is modeled after the Gulf Stream east of Cape Hatteras, is studied using numerical solutions of nonlinear equations. The equations express potential-vorticity conservation in a two-layer quasi-geostrophic model with a weak planetary β effect. Solutions are restricted to a spatially periodic, temporally growing case. Initially, small-amplitude meanders are given, being superimposed on the jet. The solutions describe a process in which the meanders grow increasingly larger, the larger meanders are cut off, and cyclonic and anticyclonic eddies are detached southward and northward, respectively. Concurrent with the eddy detachment, an eastward flow is restored in the upper layer, and the lower layer develops an eastward flow under the restored jet and two westward flows north and south of it. A baroclinic instability is very effective in meander growth, while a weak β effect is necessary for eddy detachment; i.e., the meander grows large enough for the detachment by taking potential energy from the basic flow, and the β effect then cuts off the large-amplitude meander.

This two-layer weak planetary β case is contrasted with a one-layer case when meander amplitude is much smaller, as well as a two-layer zero β case when no eddy is detached in spite of large-amplitude meanders. A topographic β effect is examined, when southward increase of depth is introduced instead of latitudinal gradient of the Coriolis parameter. In a weak topographic β case, flow patterns are very similar to those of a weak planetary, β case. In a strong topographic β case, no eddy is detached. The results are compared with Gulf Stream meanders and detached eddies.

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