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On the Interaction between Thin Isolated Eddies and Longshore Currents

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ABSTRACT

A simplified two-layer analytical model describing the interaction between a longshore current and a thin lenslike eddy is considered. The eddy is situated near a vertical wall and is embedded in a frictional boundary current which is flowing from one latitude to another. Attention is focused on the conditions under which the boundary current compensates for the tendency of the eddy is drift due to β so that the eddy is stationary. The model incorporates movements resulting from the circulation within the eddy, the longshore flow and β. Both the upper and lower layer are taken to be active; diffusion is neglected but bottom friction is included. Although our model is simplified, the movements within the eddy are not constrained to be quasi-geostrophic, in the sense that the Rossby number can be relatively large and the interface surfaces at a finite distance from the center. The desired solutions are constructed analytically.

It is found that a thin lenslike eddy adjacent to a western boundary can remain in a fixed position if the current in which it is embedded is *flowing from low to high latitudes* at a (“critical”) speed which depends on β, the inclination of the coastline, the frictional coefficient along the bottom of the ocean and the eddy's size, intensity and volume. Presumably, a northward flowing current whose speed is ten than “critical” will allow the eddy to drift *upstream* (southward), whereas a current whose speed is stronger than the *critical* will sweep the current *downstream* (northward).

In contrast to western boundaries, thin eddies embedded in eastern longshore flows can never be stationary regardless of the current's characteristics. This difference between western and eastern boundaries exists because as the current flows, it exert two forces on the eddy. One is parallel to the coastline (and can compensate for the eddy's β-induced force) and the other is perpendicular to the wall. In the western boundary case, the cross-stream force pushes the eddy toward the boundary causing it to lean against the wall. In the eastern boundary case, on the other hand, the force pushes the eddy away from the wall causing it to accelerate toward the open ocean.

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