Abstract View

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Joint Vortices, Eastward Propagating Eddies and Migratory Taylor Columns

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ABSTRACT

The behavior of an isolated pair of vortices consisting of two eddies situated on top of each other in a three-layer ocean is examined analytically. The amplitudes of both eddies are high and, consequently, the two eddies behave as one unit and migrate together in the ocean. For this reason, it is proposed to call the system *joint vortices*. The eddies are of equal or opposite sign; each vortex is situated in a different layer so that there are two active layers and one passive layer.

Attention is focused on the behavior of joint vortices on a sloping bottom in the deep ocean and on a β plane in the upper ocean. That is, we consider deep joint eddies situated on an inclined floor in the lowest two layers of a three-layer ocean and upper joint eddies in the upper two layers. Special attention is given to the cases where one of the vortices is a lens-like eddy. Approximate solutions for slope (or β) induced drifts in the east-west direction are obtained.

It is found that because of the high amplitudes and the resulting nonlinear coupling, the joint eddies have a mutual drift which is very different from the drift that each individual vortex would have. For example, *while each individual vortex translates to the west in the absence of a conjugate vortex, the combined vortices may drift steadily to the east*. This bizarre behavior stems from the presence of a “planetary lift” which is the oceanic equivalent of the side pressure force associated with the so-called *Magnus effect*. It is directed at 90° to the *left* of the drifting eddies.

Other results of interest are: (i) Under some conditions, the *westward drift* of joint eddies consisting of two cyclonic vortices it much faster than the long-wave speed. Such fag drift contradict previously held contentions that the speed of cyclonic eddies cannot exceed the long wave speed. (ii) As it translates westward, an anticyclonic lens-like eddy can carry a Taylor column on top of it.

Possible application of this theory to various eddies in the ocean is discussed.

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