Abstract View

Volume 8, Issue 5 (September 1978)

Journal of Physical Oceanography
Article: pp. 861–872 | Abstract | PDF (1.06M)

On Geostrophic Adjustment in Sea Straits and Wide Estuaries: Theory and Laboratory Experiments. Part II—Two-Layer System

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(Manuscript received May 17, 1977, in final form April 11, 1978)

DOI: 10.1175/1520-0485(1978)008<0861:OGAISS>2.0.CO;2

ABSTRACT

A frictionless nonlinear model with allowance for motions which are far from a state of geostrophic balance is considered in order to describe the dynamics of outflows consisting of two layers of fluids. The governing equations are solved by means of perturbation expansions, conformal mapping and Fourier series. The theory is compared with laboratory experiments.

The model predicts that an outflow from a channel with uniform velocity distribution deflects to the right in the Northern Hemisphere. The parameters of the problem are combined in such a way as to show that rotational effects are important whenever the ratio between the internal Froude number to the Rossby number is not negligible; the inverse of this ratio has a “critical” value, below which the flow separates from the left basin bank. The mathematical analysis shows that an outflow from a channel with initial negative relative vorticity approximately equal to the Coriolis parameter deflects to the left. As in the uniform flow case the flow separates from one of the banks under certain “critical” conditions.

Two experimental systems which included an abrupt cross-sectional variation in a rotating channel consisting of two layers were used. The experimental results compare favorably with the direction of deflection predicted by the mathematical model. Possible application of this study to the Straits of Gibraltar and other outflows are discussed.

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