Abstract View

Volume 16, Issue 12 (December 1986)

Journal of Physical Oceanography
Article: pp. 2137–2149 | Abstract | PDF (1011K)

Onset of Estuarine Plumes

Shenn-Yu Chao and William C. Boicourt

Center for Environmental and Estuarine Studies, University of Maryland, Cambridge, MD 21613

(Manuscript received February 11, 1986, in final form July 10, 1986)

DOI: 10.1175/1520-0485(1986)016<2137:OOEP>2.0.CO;2

ABSTRACT

The onset of estuarine plumes is numerically studied here, using a three-dimensional, primitive-equation model. The model ocean consists of a narrow estuary that is connected to an otherwise enclosed ocean basin. The basin is initially filled with saline water. Subsequently, freshwater is pumped in near the surface and the saline water is withdrawn from below at the head of the estuary. To maximize the chance of development for a baroclinic flow field, a rigid-lid and a flat bottom are assumed, and the inflow–outflow profile has no barotropic component.

The plume expands in the direction of propagation of the coastally trapped waves after the freshwater release. The intrusion speed inside the estuary is consistently higher than that along the shelf. Energy is therefore accumulated near the estuary mouth, forming a bulge of anticyclonic surface flow. The far-field flow consists of a bore intrusion along the shelf. The transitional zone between the near-field and far-field flows is characterized by strong cyclonic surface flow and also strong downwelling. For reasonable amounts of vertical mixing and bottom drag, two-layer opposite flows are confined inside the bulge and the far-field bore intrusion is unidirectional. In the limit of small vertical mixing and vanishing bottom drag, the difference in intrusion speeds in and out of the estuary is reduced. The seaward expansion of the bulge decreases, and the undercurrent leaks out of the bulge and propagates behind the nose of the bore. The three-dimensional structures of the density-driven estuarine circulation and also of the bore intrusion along the shelf have been identified.