Abstract

Coastal currents are important agents for the transport of heat, salt and other properties in the ocean. Generation and dynamics of coastal currents are investigated, including the role of coastally trapped waves, with focus on four specific problems.

In the presence of a sloping bottom it was found that a buoyant coastal current that gradually loses its buoyancy along the coast can be described completely with geostrophic dynamics. The along-coast density gradient drives a geostrophic flow towards the coast, generating a barotropic current along the coast, parallel to the depth contours. Thus a coastal current can retain its transport along the coast without deepening. The theoretical predictions were compared with numerical experiments mimicking the Nordic Seas using simplified forcing and topography. A sloping bottom is essential since geostrophic dynamics are not enough to describe a similar current along a vertical wall.

The propagation and structure of perturbations on a buoyant coastal current along a vertical wall was investigated. Using a 1 1/2-layer model, analytical solutions were derived in two cases; a current with no horizontal shear in the buoyant layer and a current with constant potential vorticity.

A theory for the transient establishment of barotropic coastal currents along closed depth contours was derived. With local forcing, the response can be described as a sum of topographic waves, the mean along-contour acceleration and a stationary recirculating part.

The difference between the response to cyclonic and anticyclonic forcing in a closed basin was investigated using a numerical model. It was found that although the cyclonic response remained undisturbed, the anticyclonic response was severely reduced by along-coast variations in the bottom slope. The cyclonic response was stationary and well described by linear theory, while the anticyclonic response deviated substantially from linear theory and never reached a steady state.

Key words: Coastal currents, trapped waves, JEBAR, ocean circulation stability.