Abstract

The coastal ocean is a complex and important system that is used for various human purposes. This thesis analyses some features of the dynamics of the coastal ocean and presents some conceptual models suitable for their simulation.

There are several ways to estimate the statistical properties of a current field, for instance from long time-series of current observations. Another approach is to use a combination of long-term observations of the forcing of the current and a model tuned against shorter records of current observations. A forced statistical model is presented and shown to be useful to estimate the probability of extreme current events.

The flow through straits is forced by along-strait pressure gradients. It is resisted by wall friction and topographic form-drag, both quadratic in speed, and can be restricted by geostrophic controls. Öresund has previously been shown from observations to have a linear flow-resistance term of the same magnitude as predicted by the theory of geostrophic control. However, it is shown here that the linear resistance term is an instrument-induced artefact caused by erroneously calibrated current meters.

The freshwater-influenced surface layer in a fjord is a dynamic and important part of the physical and biogeochemical systems. Simulations of the surface layer dynamics can be simplified if there is a hydraulic control section at the mouth of the fjord, as this provides a dynamic boundary condition. It is shown from hydrographic observations that the Holandsfjord responds to an increased freshwater discharge by setting up a hydraulic control section at a contraction in the inner part of the fjord. The power supplied by the wind to mix buoyancy in the surface layer is estimated to be 6–7 $\mathrm{mW\,m^{-2}}$.

Vertical motions of the pycnocline and sea surface and the establishment of narrow coastal currents are integrated parts of the response of the stratified coastal ocean to fluctuating winds. A sloping bottom enhances the vertical motions of the density surfaces, which are important for the water exchange with inshore areas. A model of the coastal density variability for a two-layered ocean with horizontal bottom is presented. An empirical extension accounting for the effects of sloping bottoms is also derived using observations of the variability of the density for various bottom slopes. The extended model predicts the density variability in the Baltic Sea reasonably well.

Key words: coastal ocean, models, surface layer dynamics, upwelling, water exchange, statistical models, strait flows, current measurements