Abstract

Intensive experimental studies in the Baltic and in the Gullmar Fjord are presented in this thesis. High spatial and temporal resolution in observations of stratification and velocity fields has been obtained using rather recently developed oceanographic instrumentation, in particular Acoustic Doppler Current Profilers (ADCP).

It has earlier been hypothesized that the integrated thermal wind equation may be used to estimate the inflow of deepwater to the Baltic using only one density profile in the Arkona deepwater pool. The hypothesis assumes a quasi-steady bottom pool with a boundary current along its northern rim. To test the hypothesis a ship-mounted ADCP was used for an almost synoptic survey in early February 1993 in the Arkona Basin, at that time well filled due to a major Baltic inflow. The measurements verified both the pool structure and the applicability of the suggested equation.

A survey in the Irbe Strait showed that quasi-geostrophic flow along the sides of the strait is responsible for the exchange of water between the Baltic proper and the Bay of Riga. The diurnal and two-day periods, dominants in the velocity measurements, only modulated the flow but did not contribute to the exchange.

In a joint ongoing international project, DIAMIX, three extensive field surveys have been carried out in the Baltic. They revealed that the response, with inertial oscillations, of the upper layer to wind forcing is very sensitive to the seasonal stratification. Also the deepwater show frequent near-inertial baroclinic waves and occasional cyclonic and anti-cyclonic eddies. An estimate of the long-term mean vertical energy fluxes by near-inertial internal waves from the surface layer gave the surprising result that this energy path to the deepwater may support only 15% of the energy needed to sustain the known levels of deepwater turbulence.

The 'fjord part' of this thesis is based on data from three periods with moorings deployed in and outside the Gullmar Fjord. It was found that the vertical movements (diel migration) of a rather large krill population could be followed using backscatter data from the ADCPs. The timing of the vertical migration coincided with sunrise and sunset throughout the observational periods. The residence depth (during daytime) of the krill was limited by oxygen deficit in the basin water. After a renewal of the basin water, the migration covered the full depth and the vertical speed was observed to increase during descent.

The dynamics of the Gullmar fjord involve, besides internal tides and direct wind-forcing, also natural modes of oscillations i.e. seiches. These are forced by local wind and rapid changes in the coastal sea level and stratification. Two internal seiche modes are coupled through the sill and the period and structure of the modes are determined by the stratification and topography of the fjord. These features are well described by a simple analytical model. A fraction of the energy in the internal seiches as well as the contribution from the fundamental surface seiche, and the tides, contribute to diffusive mixing of the basin water. The efficiency of this process agrees with common values from other fjords.

Key words: The Baltic, inflow, bottom pools, near-inertial waves, fjord dynamics, mixing, seiches, krill, DVM.

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