Abstract

The transport and spreading of nutrients, pollutants, genes and other substances are important for e.g. the marine ecosystem and water quality. Processes leading to transport and dispersion in the surface layer are investigated in order to better understand the apparently very efficient dispersion of juvenile freshwater found by Eilola & Stigebrandt (1998) in the surface layer of the Baltic proper.

Historical data from the Baltic proper were used in this thesis. Current data revealed the frequent occurence of inertial oscillations, even during weak wind forcing. One data set showed that inertial oscillations were non-coherent on scales above 10 km, and a tentative horizontal wavenumber spectrum for the Baltic proper was constructed. Non-coherence in inertial currents may be a source of horizontal current shear giving a dispersive effect. Long-periodic motion in the spectra was not well-resolved, which implies that mesoscale eddies are transient and not periodic.

Using data from the north-western Baltic proper it was found that buoyancy forcing influences the wind drift in the surface mixed layer. Positive buoyancy fluxes gave a deflection of the transport only 30° to the right of the wind, negative buoyancy fluxes gave a 60° deflection. The magnitude of the transport was smaller than the theoretical Ekman transport for positive buoyancy fluxes and thin surface layers, and larger for negative buoyancy fluxes. Drag at the bottom of the surface layer may explain the retardation of the current, and a wind-parallel component.

Recurrent changes in the wind drift due to wind and buoyancy forcing was found to give rise to a dispersion mechanism not previously decribed. In the shallow mode, the upper part of the tracer cloud moves with the wind drift, leading to a larger horizontal area covered by the tracer. In the deep mode, vertical mixing increases the tracer's volume. The area of the tracer cloud grows as elapsed time squared, t^2, and depends on the wind drift velocity in the shallow mode. The relation was demonstrated by a numerical experiment and is in accordance with the spreading of juvenile freshwater in the Baltic proper, and other published experimental results.

Experimens and various proposed dispersion mechanisms indicate that in the surface layer, shear and wave interaction explain dispersion on 10-1000 m scales. Mesoscale eddies are efficient from km scales, and experiments show that this effect declines above scales of 50 km. The proposed wind drift mechanism has no such cutoff. In order to make the best choices of dispersion models, a better assessment of the energy levels and length scales in the eddy field, and from the wind forcing, are necessary.

Key words: Dispersion, wind drift, mixed layer, buoyancy flux