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Baroclinic internal wave energy distribution in the Baltic Sea derived from 45 years of circulation simulations

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Internal waves and internal tides are an essential component of the functioning of stratified shelf seas. They carry substantial amounts of energy through the water masses, drive key hydrophysical processes such as mixing and overturning and support the functioning of marine ecosystem in many ways. Their particular impact becomes evident near and at the bottom where they often create substantial loads to engineering structures and exert a wide range of impacts on the bottom sediments and evolution of the seabed.

We analyse several properties of spatio-temporal distributions of energy of relatively long-period large-scale internal wave motions in the Baltic Sea. The analysis is based on numerically simulated pycnocline variations that are extracted from the hydrographic data calculated by the Rossby Centre Ocean circulation model (RCO) for the entire Baltic Sea for 1961–2005. This model has a horizontal resolution of 2 nautical miles and uses 41 vertical layers with a thickness between 3 m close to the surface and 12 m in 250 m depth. The model is forced with atmospheric data derived from the ERA-40 re-analysis using a regional atmosphere model with a horizontal resolution of 25 km. It also accounts for river inflow and water exchange through the Danish Straits. See (Meier, H.E.M., Höglund, A., 2013. Studying the Baltic Sea circulation with Eulerian tracers, in Soomere, T., Quak, E., eds., Preventive Methods for Coastal Protection, Springer, Cham, Heidelberg, 101–130) for a detailed description of the model and its forcing.

The resolution of the model output used in this study (once in 6 hours) is sufficient for estimates of spectral amplitudes of the displacements of isopycnal surfaces with a typical period of 2–12 days. We provide the analysis of kinetic and potential energy of motions with these periods. The resulting maps of the maxima of energy and spatial distributions of near-bottom velocities have been evaluated for the entire simulation interval of 45 years and for single 5-yr intervals.

The maxima of energy of such motions are concentrated in an approximately 50 km wide domain along the nearshore of Latvia and the Western Estonian archipelago. Several narrower regions of relatively high concentrations of energy are located around the southern tip of Sweden, along the coasts of Poland and the island of Gotland, and at the northern and north-eastern coasts of the Sea of Bothnia. The performed analysis sheds new light on the potential impact areas of long-period internal wave motions in the Baltic Sea and associated regions of intense mixing and large wave-driven near-bottom velocities.