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Variations in the wave climate of the Baltic Sea in the last 25 years from satellite altimetry

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Due to the complex geometry and relatively small size of the Baltic Sea, the global studies of wave climatology do not cover the interior of the Baltic Sea. The existing studies have revealed highly variable patterns (in both space and time) of wave properties and equally complicated patterns of long-term changes in the wave climate. Moreover, different sources of information such as buoy measurements, visual observations or numerical simulations often lead to the extensive mismatch of the descriptions of the wave climate and its changes.

A feasible way forward is to employ satellite altimetry data sets. Even though there are several problems with their use in small water bodies, they can provide homogeneous data over large sea areas with an appreciable spatial and temporal resolution. The temporal coverage of such data sets is already more than 20 years. We present, for the first time, an analysis of the basic properties of wave climate for the Baltic Sea over 25 years derived from a multi-mission satellite altimetry data. The data are from 1990 till 2015 and count about 700 000 individual measurements. The data were cross-validated with available buoy measurements and corrected (or doubtful measurements removed) for (1) ice cover, (2) distance from the land and (3) biases between different missions (see Kudryavtseva, Soomere & Giudici, this issue).

The analysis of the resulting dataset shows that no significant trend exists in the basin-wide average wave heights. This feature is consistent with the model results for the whole Baltic Sea that indicate several patterns of local changes but virtually no long-term changes in the overall wave intensity. Different quantiles of the wave heights exhibit different kinds of temporal variations. The 99th and 90th quantiles (that correspond to strong storms) exhibit no significant trend but are oscillating on a timescale of about three years. The 75th, 50th, and 25th percentiles (that characterise the most frequent wave conditions) show very different behaviour. Their most evident feature is a cyclic variation with a period of about 15 years. This time scale roughly corresponds to similar time interval revealed in several numerical simulations. The wave fields generated by winter and spring storms show very good correspondence with the North Atlantic Oscillation (NAO) index. The best correlation is with the 99th percentile for the spring season (99% significance level). The strong correlation indicates almost one to one correspondence between the storms in the Baltic Sea and the NAO index for this season. We also discuss the similarities of observed timescales with other climate indices.