

Geodetic observation of sea-level change and crustal deformation in the Baltic Sea region

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Fennoscandia and the Baltic Sea represent one of the key regions for glacial isostatic adjustment (GIA) investigations. An exceptional density of long tide gauge records and permanent GPS stations provides a unique observational basis for the determination of recent rates of relative sea-level change and vertical crustal deformation.

Relative sea-level changes reflect both GIA and eustatic sea-level changes. Based on original historic documents we compiled tide gauge records for eight stations at the southern Baltic coast of 126 up to 197 years of length. Homogeneous time series of the relative sea level were derived from these data. Our regionally concentrated data was complemented by long-term sea-level records retrieved from the PSMSL data base thus covering the entire Baltic Sea and adjacent coasts of the North Sea. From these records relative sea-level change rates were derived for approximately 60 tide-gauge stations.

Recent deformations of the earth surface, which are dominated by GIA in the region under investigation, can be determined from GPS observations. The extraction of geophysical signals from GPS-derived time series requires a stable realisation of the terrestrial reference system and a homogeneous observation data processing. In this context we benefit from the results of a reprocessed global GPS network. A regional densification of this global network allowed to infer consistent crustal deformation rates for 44 stations.

The GPS derived height change rates can be applied to reduce the relative sea-level changes observed by tide gauges yielding an estimate for the eustatic sea-level change. For sites where both observation techniques are collocated the eustatic sea-level trend over the last 100 years was derived. Its comparison with global eustatic rates provides a rigorous consistency check.

Our tide gauge records from the southern Baltic coast allow to infer not only changes in the mean sea level but also extreme sea-level events. The tide gauge readings of maximum sea levels were complemented by water level information from historic storm surge marks preserved along the German Baltic coast. Based on these data extreme high-water levels, their incidence and spatial variation were investigated. In the tideless Baltic Sea extreme sea levels are triggered essentially by atmospheric forcing in conjunction with resonant basin oscillations. Due to its peripheral location the southern Baltic coast is especially affected by such short-term events. Their contribution has to be taken into account in addition to eustatic sea-level rise and GIA related crustal deformation when assessing future hazard risks.