

Is the Baltic sea-level change accelerating?

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1. Background

As a consequence of increasing concentrations of greenhouse gases in the atmosphere, the global rate of sea-level rise is expected to accelerate in the future. Some studies indicate that this acceleration has already been detected in the 20th century record of global sea-level rise (Merrifield and Merrifield, 2009) while others do not detect a significant change (Holgate, 2007). For regional planning agencies more important than the global number is, however, the change in the rate at regional scales.

The Baltic Sea is a region strongly influenced by isostatic rebound from the last deglaciation, with the Earth crust in the Northern Baltic rising at roughly 10 mm/year and in parts of the Southern Baltic sinking at about 1 mm/year (Ekman, 1996; Rosentau et al. 2007). Time series of sea-level measured by coastal gauges thus display strong linear trends due to isostasy. The values of these trends form the basis for sea-level rise projections related to coastal protection, with a rough estimate of possible sea-level rise caused by climate change added to the isostatic trends.

In this contribution we analyse long Baltic sea-level time series with the aim to identify accelerations indicative of a climatic contribution to Baltic Sea-level rise and thus help refine the estimations of Baltic Sea level rise in the future.

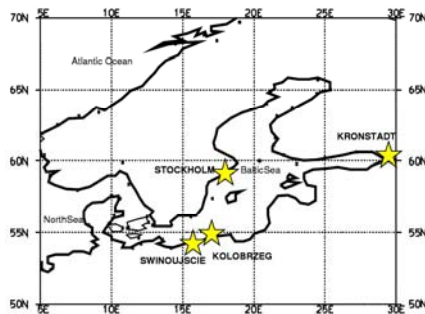


Figure 1. Sketch of the Baltic Sea, showing the location of the sea-level gauges used in this study.

2. Data

Following Hünicke et al. (2008) winter means of four of the longest time series of sea level records (up to 200 years long) from stations situated in the central, eastern and southern Baltic Coast have been examined: Swinoujscie (Permanent Service for Mean Sea level [PSMSL]¹), Kolobrzeg (PSMSL; before 1951 provided by TU Dresden), Stockholm (Ekman, 2003) and Kronstadt (Bogdanov et al., 2000).

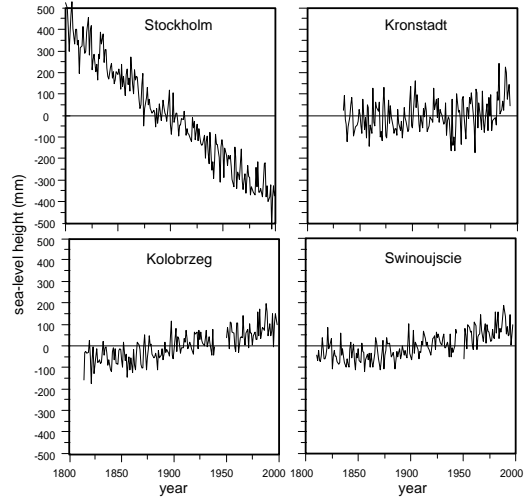


Figure 2. Sea level time-series.

In addition, satellite data from the Topex-Poseidon and Jason missions covering about the last three decades have been also included in the analysis. As these records have a monthly resolution, possible differences in the seasonal rates of sea-level change have been also considered.

3. Methods

Different statistical methods have been applied to identify changes in the rate of change. One method is based on the estimation of multidecadal linear trends, followed by the estimation of temporal changes in these trends. Another method attempts to fit the sea-level records to a linear and a quadratic, instead of only linear, trend over the whole observed period. As the possible acceleration signal is small, and the overall linear trend is heavily contaminated by the influence of isostatic adjustment, great care has to be put on the estimation of uncertainty ranges.

Furthermore, spatial discrepancies in the estimated accelerations should be explained by the presence of additional climate factors, such as the North Atlantic Oscillation in the winter season, which is spatially heterogeneous.

4. Preliminary Results

Preliminary results indicate that, although the present rates of sea-level rise are not unprecedented and the maximum rates were observed at the turn of the 19th century, the 200-year long records are best explained if a small acceleration of the rate is allowed for.

¹ <http://www.pol.ac.uk/psmsl/>

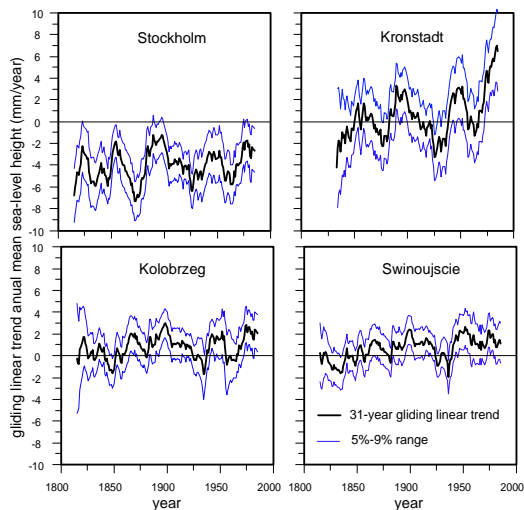


Figure 3. Gliding linear trends of selected sea-level records, estimated by linear fit in moving 31-year windows, together with the 5% and 9% uncertainty range. The abscissa of each data point indicates the centre of the 31-year window.

5. Summary and Conclusions

Several studies have attempted to identify a possible acceleration of the global sea-level rise in the 20th century. The impacts of sea-level rise on the coast in the future will, however, occur at regional scales. Coastal engineers and planning authorities require projections of future sea-level rise at these local and regional scales (Hünicke and Storch, 2009).

In this study we analyse long mean Baltic sea-level records with the aim of identifying changes in the rate of sea-level change. The analysis is based on the estimation of gliding linear trends through the records and its comparison with simultaneous trends derived from reconstructions of global sea-level (Holgate, 2007; Jevrejeva et al., 2006) for the 19th and 20th century and with satellite data for the last few decades.

Future sea-level rise in the Baltic will be determined by several factors, some of them still poorly known, such as the dynamics of polar ice sheets. Many planning agencies assume a continuation of the present broadly linear trends, allowing for an additional 'climate contribution'. The estimation of an acceleration rate can contribute to improve these pragmatic estimations.

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