Poster D04

Mean Baltic Sea Level in a changing climate

- a review of the observational period

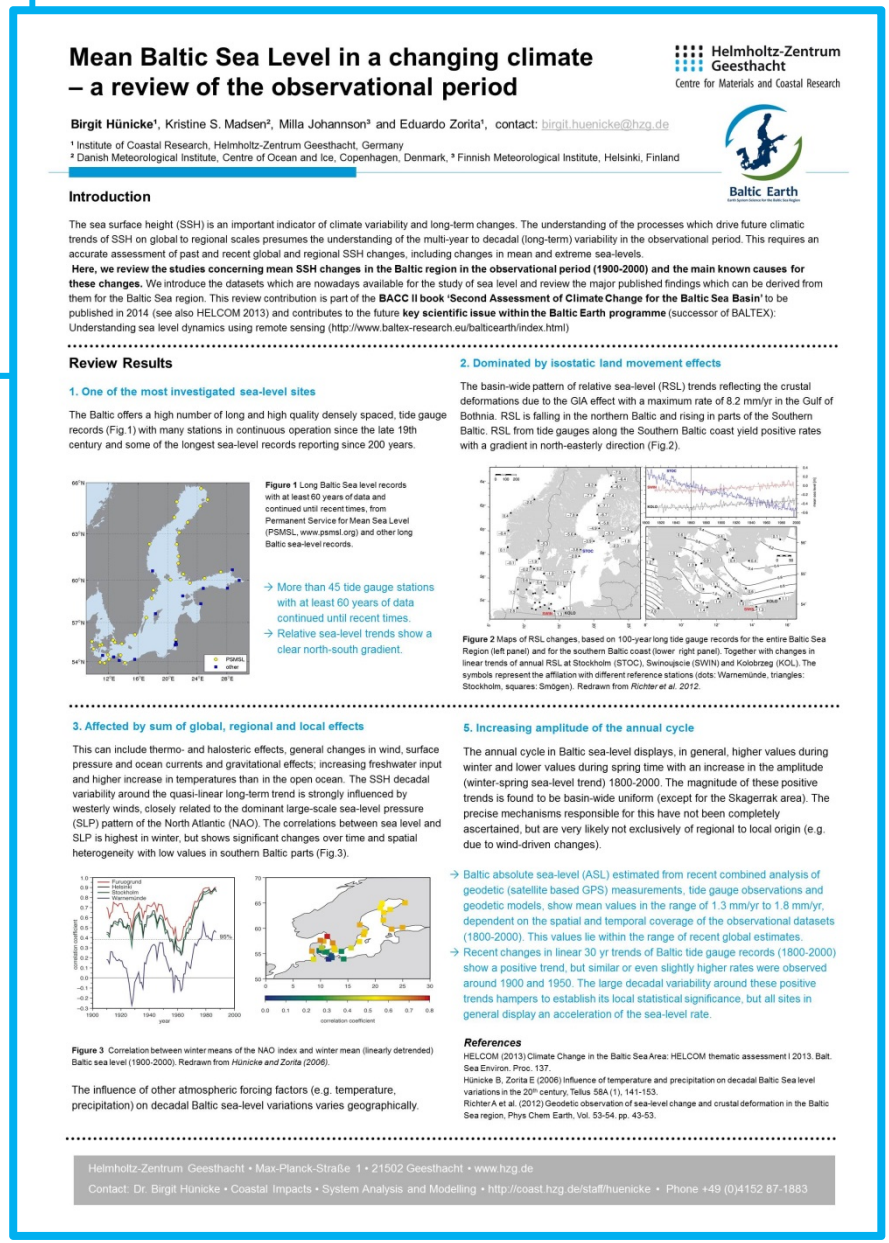
Birgit Hünicke,
Madsen K.S., Johannson M., Zorita E.

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

- review of major published findings concerning mean SSH changes in the Baltic region and the main known causes for changes
- introduction of available datasets

- part of the BACC II book 'Second Assessment of Climate Change for the Baltic Sea Basin' to be published in 2014

- contributes to the future key scientific issue within the Baltic Earth programme (successor of BALTEX): Understanding sea level dynamics using remote sensing



Mean Baltic Sea Level in a changing climate – a review of the observational period

Helmholtz-Zentrum Geesthacht
Centre for Materials and Coastal Research

Birgit Hünicke[1], Kristine S. Madsen[2], Milla Johannson[3] and Eduardo Zorita[1], contact: birgit.huenicke@hzg.de
[1] Institute of Coastal Research, Helmholtz-Zentrum Geesthacht, Germany
[2] Danish Meteorological Institute, Centre of Ocean and Ice, Copenhagen, Denmark, [3] Finnish Meteorological Institute, Helsinki, Finland

Baltic Earth

Introduction

The sea surface height (SSH) is an important indicator of climate variability and long-term changes. The understanding of the processes which drive future climatic trends of SSH on global to regional scales presumes the understanding of the multi-year to decadal (long-term) variability in the observational period. This requires an accurate assessment of past and recent global and regional SSH changes, including changes in mean and extreme sea-levels.

Here, we review the studies concerning mean SSH changes in the Baltic region in the observational period (1900-2000) and the main known causes for these changes. We introduce the datasets which are nowadays available for the study of sea level and review the major published findings which can be derived from them for the Baltic Sea region. This review contribution is part of the **BACC II book 'Second Assessment of Climate Change for the Baltic Sea Basin'** to be published in 2014 (see also HELCOM 2013) and contributes to the future **key scientific issue within the Baltic Earth programme** (successor of BALTEX): Understanding sea level dynamics using remote sensing (http://www.baltex-research.eu/balticearth/index.html)

Review Results

1. One of the most investigated sea-level sites

The Baltic offers a high number of long and high quality densely spaced, tide gauge records (Fig.1) with many stations in continuous operation since the late 19th century and some of the longest sea-level records reporting since 200 years.

Figure 1 Long Baltic Sea level records with at least 60 years of data and continued until recent times, from Permanent Service for Mean Sea Level (PSMSL, www.psmsl.org) and other long Baltic sea-level records.

→ More than 45 tide gauge stations with at least 60 years of data continued until recent times.
→ Relative sea-level trends show a clear north-south gradient.

2. Dominated by isostatic land movement effects

The basin-wide pattern of relative sea-level (RSL) trends reflecting the crustal deformations due to the GIA effect with a maximum rate of 8.2 mm/yr in the Gulf of Bothnia. RSL is falling in the northern Baltic and rising in parts of the Southern Baltic. RSL from tide gauges along the Southern Baltic coast yield positive rates with a gradient in north-easterly direction (Fig.2).

Figure 2 Maps of RSL changes, based on 100-year long tide gauge records for the entire Baltic Sea Region (left panel) and for the southern Baltic coast (lower right panel). Together with changes in linear trends of annual RSL at Stockholm (STOC), Swinoujscie (SWIN) and Kolobrzeg (KOL). The symbols represent the affiliation with different reference stations (dots: Warnemünde, triangles: Stockholm, squares: Smögen). Redrawn from *Richter et al. 2012.*

3. Affected by sum of global, regional and local effects

This can include thermo- and halosteric effects, general changes in wind, surface pressure and ocean currents and gravitational effects; increasing freshwater input and higher increase in temperatures than in the open ocean. The SSH decadal variability around the quasi-linear long-term trend is strongly influenced by westerly winds, closely related to the dominant large-scale sea-level pressure (SLP) pattern of the North Atlantic (NAO). The correlations between sea level and SLP is highest in winter, but shows significant changes over time and spatial heterogeneity with low values in southern Baltic parts (Fig.3).

Figure 3 Correlation between winter means of the NAO index and winter mean (linearly detrended) Baltic sea level (1900-2000). Redrawn from *Hünicke and Zorita (2006).*

The influence of other atmospheric forcing factors (e.g. temperature, precipitation) on decadal Baltic sea-level variations varies geographically.

5. Increasing amplitude of the annual cycle

The annual cycle in Baltic sea-level displays, in general, higher values during winter and lower values during spring time with an increase in the amplitude (winter-spring sea-level trend) 1800-2000. The magnitude of these positive trends is found to be basin-wide uniform (except for the Skagerrak area). The precise mechanisms responsible for this have not been completely ascertained, but are very likely not exclusively of regional to local origin (e.g. due to wind-driven changes).

→ Baltic absolute sea-level (ASL) estimated from recent combined analysis of geodetic (satellite based GPS) measurements, tide gauge observations and geodetic models, show mean values in the range of 1.3 mm/yr to 1.8 mm/yr, dependent on the spatial and temporal coverage of the observational datasets (1800-2000). This values lie within the range of recent global estimates.
→ Recent changes in linear 30 yr trends of Baltic tide gauge records (1800-2000) show a positive trend, but similar or even slightly higher rates were observed around 1900 and 1950. The large decadal variability around these positive trends hampers to establish its local statistical significance, but all sites in general display an acceleration of the sea-level rate.

References

HELCOM (2013) Climate Change in the Baltic Sea Area: HELCOM thematic assessment I 2013. Balt. Sea Environ. Proc. 137.
Hünicke B, Zorita E (2006) Influence of temperature and precipitation on decadal Baltic Sea level variations in the 20th century, Tellus 58A (1), 141-153.
Richter A et al. (2012) Geodetic observation of sea-level change and crustal deformation in the Baltic Sea region, Phys Chem Earth, Vol. 53-54, pp. 43-53.

Helmholtz-Zentrum Geesthacht • Max-Planck-Straße 1 • 21502 Geesthacht • www.hzg.de
Contact: Dr. Birgit Hünicke • Coastal Impacts • System Analysis and Modelling • http://coast.hzg.de/staff/huenicke • Phone +49 (0)4152 87-1883