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Climate of the Past Discussions

Interactive comment on "The climate in the Baltic Sea region during the last millennium" *by* S. Schimanke et al.

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First of all, we would like to thank the reviewer for his/her comments. We followed all recommendations to improve our manuscript.

Specific comments: p. 1372, l. 14: The Baltic Sea is not an estuary. I suggest some phrases as "estuarinelike circulation", or something similar.

The sentence will be changed accordingly. "The Baltic Sea is one of the largest inland brackish seas with an estaurinelike circulation and sensitive to changes in the environmental conditions."

p. 1375, l. 8: I miss a few remarks about the biogeochemical model which obviously has been used in this study.

The reviewer is absolutely right that some remarks as well as a reference are missing. We will add the references Eilola et al. (2009, 2011) and adapt the paragraph. Moreover, we will change the abbreviation RCO to RCO-SCOBI when we refer to the ocean model to emphasize that the used model is an ocean model with biogeochemistry. The paragraph will be changed to:

2.1.2 The Rossby Centre ocean model with interactive biogeochemistry We use the Rossby Centre Ocean model (RCO) coupled with the Swedish Coastal and Ocean Biogeochemical model (SCOBI, e.g. Eilola et al., 2009) abbreviated as RCO-SCOBI. The domain covers the entire Baltic Sea (Fig. 1). ....

after page 1375, line 4 we include:

The coupled biogeochemical model SCOBI simulates the dynamics of nitrate, ammonium, phosphate, phytoplankton, zooplankton, detritus, and oxygen. RCO-SCOBI is able to simulate the climate of the recent past in agreement with observations and is in the range of other state-of-the-art biogeochemical models (Eilola et al., 2011). For more details, the reader is referred to Eilola et al (2009, 2011) and Meier et al. (2012). RCO-SCOBI is forced with 10m wind,.....

p. 1380, l. 2-4: I do not understand the message of this sentence and its relation to discussion on the NAO before. Could it be re-formulated?

The sentence will be re-written to: "Thereby, we note that the imposed external forcing (mainly GHG concentrations and solar variability) has large scale effects albeit with large local differences. For the relatively small Baltic Sea region the temperature climate appears to be controlled by a combination of the direct effect of the forcing itself and by internal variability. The latter may be purely a result of internal dynamical processes or a result of effects of the changing forcing on, for instance, the NAO."

p. 1380, l. 6: Use NAOI (or index) when referring to positive or negative conditions. This will be changed in the revised version.

p. 1382, l. 1: I propose to refer to Fig. 3 at this place.

We do not see why to refer to Fig. 3 here. The paragraph is only about precipitation and runoff whereas Fig. 3 illustrates the temporal evolution of the temperature. We include a reference to Fig. 6 (precipitation and runoff). Perhaps, this was the intention of the reviewer.

p. 1384, l. 3-4: This statement seems a bit vague to me. Heat budget is not only controlled by air temperature. Moreover, wind speed, humidity, cloudiness, solar radiation etc. contribute as well.

Our statement was not well formulated and the reviewer is right that the reasons are more diverse. As it is not within the scope of this study to examine which effects are most important (e.g. air temperature, wind speed, humidity, solar radiation, albedo, etc.) we remove the sentence.

p. 1384, l. 24: A further effect of increased wind may be a deeper mixing which is another driver for decreasing salinity.

Absolutely. A corresponding sentence will be included: “The increase of wind speed deepens the mixing layer which leads to a dilution of inflowing salt water, too.”

p. 1386, l. 10: Again I doubt this statement. Freezing and melting of ice should compensate in terms of the heat budget. More important seems to me the albedo of snow covered sea ice.

The sentence will be removed in the new manuscript. See also reply to your point p.1384, l. 24.

p. 1389: I would like to see some remarks on the reliability of the biogeochemical model, especially under low nutrient loads conditions.

The parametrizations in SCOBI are based on measurements and observations which we believe are valid in a wide range of conditions. Herewith, SCOBI produces present

day climatologies in agreement with observations for the Baltic Sea. Nevertheless, it seems that biogeochemical models have still problems/shortcomings when it comes to the simulation of oxygen conditions under nutrient poor conditions (Gustafsson et al.,2012, AMBIO, Meier et al., 2012, ERL, or Kabel et al, 2012, Nature Clim. Change). Therefore, much effort is made in this field in the moment. However, the used biogeochemical model (SCOBI) is up-to-date as shown in many recently published studies, e.g. Eilola et al. (2011, JMS), Meier et al. (2011, GRL), Meier et al. (2012, Climate Dynamics), Meier et al (2012, AMBIO), and Meier et al (ERL).

We will additionally refer to Meier et al. (2012) to point out that this is an ongoing issue. Moreover, we will include the following sentence: “Up to now, the uncertainty is rather high for oxygen concentrations under oligotrophic conditions in state-of-the-art biogeochemical models.”

Table 2: Please specify to which temperature you are referring to (air, SST, region) and to what reference the anomalies are considered.

The table addresses 2m-air temperature anomalies over the Baltic Sea area w.r.t. the pre-industrial mean (950-1900 AD). The table caption will be updated to: “Overview over simulated 2m-air temperature anomalies during the MCA and the LIA w.r.t. the pre-industrial mean (950-1900 AD). The values reflect differences in the Baltic Sea area as indicated in Fig. 1. Anomalies are shown for winter (DJF), summer (JJA), and the annual mean (ann). The rows show values for the entire century, the second half of the century, and the absolute maximum (minimum) for a 50 yr period within the MCA (LIA).”

Fig. 7: Labels are too small.

The label size will be increased in the revised version. Moreover, the left part of the figure was slightly changed to be more similar with the rest of the figure. According to comments from reviewer 3 the temperature pattern of the global model will be included, too.

References:

Eilola et al. (2009): On the dynamics of oxygen, phosphorus and cyanobacteria in the Baltic Sea; A model study

Eilola et al. (2011): Evaluation of biogeochemical cycles in an ensemble of three state-of-the-art numerical models of the Baltic Sea

Gustafsson et al. (2012, AMBIO): Reconstructing the development of the Baltic Sea eutrophication 1850-2006

Kabel et al. (2012, Nature Clim. Change): Impact of climate change on the Baltic Sea ecosystem over the past 1,000 years

Meier et al. (2011, GRL): Hypoxia in future climates: A model ensemble study for the Baltic Sea

Meier et al. (2012, Climate Dynamics): Modeling the combined impact of changing climate and changing socio-economic development on the Baltic Sea environment in an ensemble of transient simulations for 1961-2099

Meier et al. (2012, AMBIO): Impact of climate change on ecological quality indicators and biogeochemical fluxes in the Baltic Sea – a multi-model ensemble study

Meier et al. (2012, ERL): Comparing reconstructed past variations and future projections of the Baltic Sea ecosystem – first results from multi-model ensemble simulations

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Interactive comment on Clim. Past Discuss., 8, 1369, 2012.

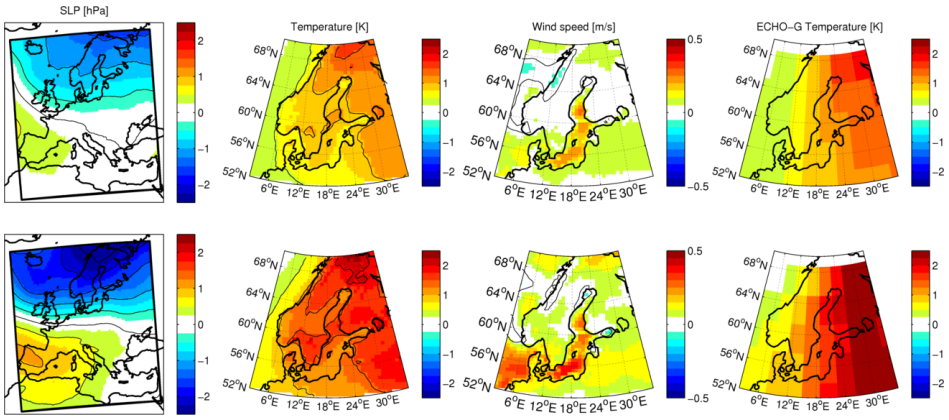

Fig. 1. Adapted Fig.7 out of the manuscript. The right column shows difference patterns for the global ECHO-G simulation.