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Interactive comment on "Mechanisms of variability of decadal sea-level trends in the Baltic Sea over the 20th century" *by* Sitar Karabil et al.

Anonymous Referee #1

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Recommendation

Major revisions.

Synopsis

The paper analyses the sea level (SL) variability in the Baltic Sea and its drivers. Sea level observations from 29 tide gauges, some of them going back to the eighteenth century, from around the Baltic Sea are used together with a satellite-based reconstruction of sea level for the whole Baltic that goes back to 1950. Observation-based data sets of SLP, precip, and temperature are used to investigate their relation to SL variations. The

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Discussion paper

paper focuses on longer time scales by considering the relation between decadal-scale trends of the variables, rather than the variables themselves.

SL variations on longer time scales are found to be highly connected to NAO (North Atlantic Oscillation) variations, with larger correlations in the northern than in the southern Baltic. Precipitation in the Baltic catchment also plays an important role for SL variability.

Discussion

The paper seems to be technically sound, but I miss an explanation of the relevance of the results. What are possible implications?

Furthermore, the presentation is often unclear. The list below gives some hints as to where the presentation of the work can be improved.

Together, I think that a major re-writing of the paper is necessary before it can be accepted.

Major remarks

p 7, eq. (2) Regarding the robustness of your method: you calculate the residual of the SLP *trend*. What happens if you exchange the order of operations, i.e., calculate the trend of SLP *residuals* (remove the first five SLP PCs from the SL fields and than look at the trends)?

p 8, 1st para so only 10-20% of the decadal SL trends are not directly related to SLP. How much is that in cm - I mean, what are we talking about?

p 8, l 21/22 It is not clear from the caption (nor from the text!) what you are doing. As far as I understand the top row is correlation between full decadal SLP trend and full SL trend. In the bottom row the SLP signal is removed from the tide gauges, but what about SLP? Do you correlate the decadal SLP trend with the tide gauge residuals, or do you also subtract the first five PCs from the SLP trends? - Note that this remark not only applies to this figure, but to the whole paper.

p 9, Tab. 1 What do you mean by "previous season"? You show four correlations. Take for instance "winter". You correlate it with winter - which winter? The same, or the following? You also correlate it with summer, but winter is not previous to summer. I guess that what you are doing is a lag-correlation with lag of 0, 1, 2, and 3 seasons, but I am not sure. Please clarify.

p 8, l 27/28 Why would you expect a relation between air temp and SL in winter? I could imagine a relation between summer T and autumn (or winter) SL because of evaporation, but why winter? Which brings me to another question: Why do you consider precip in the following, but not evaporation?

p 9, Fig. 8/9 precip is probably not independent of SLP. So if you remove the effect of SLP from your analysis, you probably also remove a lot of the precip effect. I guess that the purpose of these two figures is to somehow disentangle the two effects, but I do not understand what the result is. Does precip have an effect beyond SLP?

p 10, l 3-11 Are you saying that for some (but not all) seasons precip affects SL in the following season, and that it depends on data set (reanalysis *vs.* CRU) for which seasons you find an effect? OK, so what, what are the implications?

Detailed comments

p 1, l 23/24 Sounds odd - “decadal trend” depending on previous season precip. What you mean is that previous season precip also ha a decadal trend.

p 3, l 8/9 To my knowledge the physical connection between the North Sea and the Baltic is through the Danish Straits, which are more or less exactly north-south (i.e., meridionally) oriented.

p 3, l 13 Of course is the impact of NAO higher in winter than in summer. NAO is mainly a winter phenomenon. The explained variance of a NAO-like pattern is highest in winter, and small in summer.

p 4, l 6 remove GIA effect → remove the GIA effect

p 4, l 6 I would start a new paragraph after “time series”

p 4, l13-15 too long a sentence and not to follow.

p 4, l 18 of Atlantic Multidecadal Oscillation → of the Atlantic Multidecadal Oscillation

p 6, l 3 continues → continuing

p 7, l 1 the β coefficients in this equations are different from those in eq. (1). Please use different symbols to prevent confusion.

p 7, l 2 SLP principal component - I think yo mean the PC of SLP-*trend*, don’t you?

p 7, l 19 NAO is major factor → NAO is the major factor

p 7, l 21 as it stands, this sentence implies that Stockholm is representative for the southern Baltic and Warnemünde for the Baltic proper.

p 8, l 21/22 & l 29/30 The lower row is not explained.

p 9, l 11 tide gauge residuals → tide gauge trend residuals ????

p 9, l 28 delete second appearance of *between*

Figures (i) Please add an indication of significance to all correlation maps. (ii) Consider removing panels from the figures. Having correlations for different seasons or for the two stations does not add significant information.