We thank the reviewer very much for reviewing our manuscript, for providing constructive criticism and useful suggestions. We respond to all comments below.

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 #3

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The paper is devoted to decadal trends of sea-level in the Baltic Sea over the twentieth century. Due to global climate change the question of sea level trends and their reasons is vital also for the Baltic Sea. Former studies about the inter-annual to decadal variations of the sea-level of the Baltic Sea have shown that an important part of variability in these time scales results from atmospheric forcing, that could be described through NAO index, mostly in winter. But it has been shown also that in summer the influence of precipitation and temperature has a strong effect on sea-level variations. In this article, a statistical model is used to capture the simultaneous link between atmospheric circulation and sea-level for seasonal means, and later residuals of statistical model are researched to reveal other reasons of sea-level variability. The paper is in many places unclear and I think that several points should be better addressed before considering it for a final publication.

1) The novelty of the paper is not clearly stated.

Previous studies have shown that the sea-level records display relatively large variations of decadal trends in the Baltic Sea. This indicates that natural factors can cause substantial deviations from the expected spatially homogeneous centennial sea-level trend due to large-scale factors like rising ocean temperatures in the North Atlantic, melting of polar ice caps. These regional natural factors should be understood and taken into account, especially for shorter term (multidecadal) future sea-level projections. Whereas the factors that drive the interannual variations of Baltic sea level have been more profusely investigated, it is still not known whether the mechanisms that have been claimed to account for the interannual variations of sea-level are also responsible for the variability of decadal sea-level trends in the Baltic Sea.

In this study, we analyse long-term sea-level and climate records with the aim of explaining the observed variability of the decadal and multidecadal sea-level trends in the Baltic Sea. We mainly investigate whether the same mechanisms that have been found to explain the interannual variations of Baltic sea-level are also responsible for the variability of the decadal sea-level trends.

We will clarify the novelty of the study in the manuscript.

2) It is not clearly written out what is the consideration of using 11-year gliding trends. Why to correlate the speeds of change of various climatic variables?

The increasing external climate forcing impacts the global mean temperature, so that in increasing forcing results in higher temperatures. In contrast to temperature, the effect of the increasing radiative forcing is, to first approximation, related to the sea-level rate. The sea-level itself, in contrast to the sea-level rate, reflects the cumulative impact of past external climate forcing. This is why the studies focused on the detection and attribution of climate change deal with sea-level rates and their variability. There is therefore a need to characterise the mechanisms that may affect the variations of the sea-level rate. In the Baltic Sea, previous studies have investigated the link between climate or atmospheric forcing and sea-level. However, so far very few studies have focused on the sea-level rates and on the question of whether the mechanism that affect sea-level variability are also as important for the decadal sea-level rates or whether other mechanisms come into play.

3) There is no discussion part and the conclusions are very general.

We will expand the conclusion and focus more on implications of the results.

We will include a discussion section addressing several points: the magnitude of atmosphere-driven decadal trends versus the residuals trends, the differences between the mechanism that we have identified as driving factors for decadal sea-level variability and the factors that are responsible for the interannual variations, and in particular the possible role of precipitation.

The conclusion section will be shortened and tightened up summarizing the most import points that can be derived from the results: the variability of the decadal trends in the Baltic is spatially more homogeneous than the interannual variations; the factors that are responsible are regional and not clearly connected to the North Atlantic; trends in wind forcing can only explain about 50% of the trend variability; precipitation may play a relevant role.

4) The overall presentation is well structured, but in the section 2, there are too many subtitles, not every dataset needs a subtitle.

We will only use these subtitles *2.1 Sea level data* and *2.2 Climatic data sets*

5) The methodology section needs improvements. It is not clearly written what is the period under consideration, various data sets have various periods of availability. NAO indices are available from different sites. There is no reference to dataset used. Were the gridded data

used in the original grid, or were computed into a common grid? What is the study area? Page 7 line 3 "Y is time series of gliding trend anomaly". Anomaly against what? It is not explained.

We will clarify the methodology section based on the reviewer's suggestions.

Specific comments:

1) Typing errors in references

We will double check and correct them.

2) The quality of the figures should be improved to add readability to this work. In Fig 1 the numbers of stations are partly covered by the colour point. Would be better to present the names of the stations in Fig 2, then is seen easily how long are the time series in separate stations.

We will add the names of the stations in Figure 2.

Knowing of names of stations in Fig 1 is not crucial. In figure caption of Fig 10 the blue and red line are not explained

We will add legend to Figure 10.

What are units of trend?

We will write the units of trends for each variable in the corresponding caption.