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Title: The acceleration of sea-level rise along the coast of the Netherlands started in the 1960s
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Point by point reply to reviewer #2

We thank the reviewer for their careful reading and beneficial comments on the manuscript and address their points below. Since we added a table to the revised manuscript (Table 2), Table 2 of the old version is Table 3 in the revised version. Also, two appendix sections are added (Appendix A and Appendix B), making Appendix A of the old version Appendix C of the revised version. Some major changes have been made to the manuscript. We obtained the most recent available tide gauge records and atmospheric data. Therefore, the time series are extended to 2021 and, respectively, 2022. We checked whether using more predictive variables in our models including wind as a predictive variable improved the results. We found that adding the meridional wind to the model that only included the zonal wind improved the results. Therefore, we now include a local wind model that includes both the zonal and meridional wind. We included results on the nodal tide influence in the appendix as well as the sea-level rates for the individual tide gauge stations.

Summary

The paper estimates the sea-level rise (SLR) using the average of six tide gauges along the coast of the Netherlands, from 1890 to 2020. For this purpose, the authors used four Generalized Additive Models – GAMs, to estimate the sea-level trend, as well as the influence of the lunar nodal cycle and zonal wind on sea level, the latter using two different approaches. Results indicate an acceleration of SLR starting in the 1960's, which protrudes once the tidal and wind effects on sea level are removed. Besides, they show that wind effects force a long-term SLR, as well as a low- frequency variability modulating sea level by about 1 cm, which is related to Sea Surface Temperature variations in the North Atlantic. I find the aim of the paper very relevant, as the assessment of coastal rates of SLR and its acceleration due to anthropogenic forcing, is essential to obtain adequate projections of future sea levels, necessary to perform effective coastal adaptation strategies. Besides, I find the paper scientifically relevant, especially for the use of GAMs to estimate the sea-level trends, allowing them to isolate the influence of particular variables. The paper is well written and has an excellent presentation quality. However, there are few comments I would like the authors to consider before submitting this preprint for publication in a scientific journal.

Main Comments

- *L103. Through the entire paper, the assessment of the sea-level along the coast of the Netherlands uses the average of the six tide gauges. I suggest to include a comment about the reasons of using this average instead of using the individual time series (or both). Furthermore, I think it would be interesting to assess if the SLR trends and acceleration observed in the averaged time series stand, if the same method is applied to the individual tide gauge time series. In particular, the wind effect on sea level could be very different from one station to the other, depending not only in spatial differences in the wind forcing, but also due to coastline configuration, bathymetric differences, among others.*

Thank you for this useful comment. In the paper, we will expand on our reasoning to use the average of the six tide gauges. The aim of this paper is to study the sea-level rate for the Netherlands to better understand sea-level projections and improve adaptation choices. The sea-level rates are useful for policymakers, and our results are already used for sand suppletion. Indeed, the rates could be different for the individual stations, but it does not fit the scope of the current study to study those differences. We aim to keep the paper concise and looking at the sea-level rates of the individual stations adds complexity because of vertical land motion and small-scale ocean processes. Using the average of the six stations is sufficient to study the acceleration of the sea-level rates. Moreover, since CMIP6 climate models don't have a resolution on the local scale there is no use to study the individual stations to relate the sea-level rates studied in our work to the projections. We will, however, also include the rates of sea level for the individual stations in the appendix.

- *L112. Two sinusoidal waves in opposition of phase with the 18.6 year period were used to assess the nodal effect on sea-level. Although in L120 the authors recognize this approach might remove some additional variability around the nodal period, I suggest the authors to include in the results section, at least one paragraph describing the amplitude and phase lag of the nodal cycle clearly seen in the TrNc GAM. This result should be compared to what is known about this cycle in literature.* (l.114) Thank you for this useful comment. We will include a section in the appendix on our results for the nodal cycle amplitude and phase lag and a comparison to the equilibrium tide, as suggested. We will add a figure showing the statistical estimation of the nodal tide resulting from our models TrNcZw and TrNcPd and the equilibrium tide to the section in the appendix.

- *Appendix A. In L321 authors indicate they assess the low-frequency relation between wind influence on sea level and low-frequency SST. At this point I think authors should guide the reader, indicating the physical relation between these two variables they are trying to expose. Later in L345, authors offer a physical explanation for the relation found between SST in the north box and zonal wind. In my view, the hypothesis that changes in the meridional temperature gradient strength the jet stream, is not strongly presented. Due to air-sea interaction, SST has an inverse relationship with atmospheric pressure at sea level. As used in the paper (TrNcPd), changes in the meridional atmospheric pressure gradient modulate zonal wind in the region. Therefore, the relation found between wind influence on sea level and SST is probably possible due to variations in the atmospheric pressure gradient, what in the region is measured by NAO. This reasoning also supports the stronger correlations found in TrNcPd when compared to TrNcZw. I suggest authors to review literature about the relation between NAO and SST (air-sea coupling) in the North Sea (e.g. doi/10.1029/2022JD037270), to present a stronger case in the Appendix. Changes in the Appendix might force some changes in the main paper.*

  We agree that this appendix needs some clarifications and we will rewrite it to elaborate on the NAO-SST-wind relationship and its bearing on the multidecadal wind-influence-on-sea-level signal that we show in Fig. 3d. We will explain the two relevant, well-established modes of variability, NAO and AMV, in more detail and explain our analysis results better. The pressure difference component of our GAM *TrNcPd* is closely related to the NAO which also varies at multidecadal time scales. Therefore, we will add some more discussion on the low-frequency behaviour of the NAO (e.g. doi:10.1007/s00382-014-2237-y). As for the SST influence on the wind, we will sketch how changing North Atlantic SST (pattern)s can influence the Dutch sea level via winds as you suggest. This section is currently not finished, but we will supply a new draft within a week.

Specific Comments

- *L4. ... covering the period 1890-2020.*

  Thanks, we will change this.

- *L13. Verify a typing error.*

  Thanks, we will change this.

- *L134. Authors assess sea level from 1890 to 2020. Suddenly in this line, they mention that wind effects on sea level are assessed from 1836 to 2020. I suggest authors to include a comment about the reasons of extending in time the assessment of the wind forcing.*

  Thanks, we will clarify that once the regression coefficients are obtained, we can obtain the wind influence on sea level over the entire time series of the wind data, which covers 1836 - 2021. However, in the method section, we only focus on the fact that both atmospheric reanalysis datasets are combined using a linear bias correction method. In the paragraph 'analysis of model output', we will clarify how we obtain the wind influence on sea level.

- *L189. In this line authors assess the wind-driven trend in sea level for the 1928-2020 period. However, Figure 3b show trends for two periods. I suggest authors to include a comment about the wind-driven sea-level trends observed during the first period. I think this is important especially due to the large difference in the trends observed in TrNcPd.*

  Indeed, we will include a comment on the trends for the first period.

- *L232. The authors speculate about the reasons behind the SLR decreasing rate observed from 1900 to 1960. Please consider to move this explanation to the discussion section.*

  We will move this paragraph to the discussion section.

- *Table 2 legend. The probability in the third line is 0.23.*

  Thanks, we will change this.

- *L246. Verify the referencing.*

  We corrected this in the text.

- *L274. 2000 onwards, ...*

  We will rephrase the sentence for clarity.

- *Figure A1 legend. Define the AMV acronym, indicating that the area is shown with the black limits. Try to use colors that can be easily distinguished in panels' b and d.*

  Thanks. We will clarify the appendix by adding the AMV acronym description, the area indication, and we will improve the colours in the figure.