

## **Response to Reviewer #2 of “Characteristics of joint heavy precipitation and high sea level events on the Finnish coast in 1961–2020”**

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We thank the reviewer for constructive comments of our submitted manuscript. The point-by-point reply to the comments of the reviewer are below. Your comments are marked in black and our responses in blue.

This work presents a joint analysis between sea level and precipitation observations around the coastlines of Finland to investigate the occurrence of compound events that are relevant for coastal flooding episodes. The results are generally well described and presented, although the analyses are sometimes superficial. I am giving some suggestions below, followed by a list of minor issues that I have found in the manuscript. I believe that this work has the potential to be published, after the points below have been addressed.

Section 4.2: why is the timing of the compound events different between tide gauges in the end of the gulfs and those closer to the Baltic? what are the mechanisms explaining this difference? is it because extreme sea levels are caused by different processes in the two areas?

We speculate that the slightly different timing of the compound events is related to the earlier freeze-up of the sea in the end of the Gulf of Finland and the Bothnian Bay, which restrains the occurrence of the most extreme sea level heights later in the winter. We discussed this finding in the first paragraph of Section 5.1.

Section 4.3: The idea of the composite maps to investigate the patterns that lead to compound and non-compound events is interesting. But the robustness of the results shown in the maps in figures 6 and 7 should be discussed. Only 27 and 28 situations are used to produce these maps and there is a lack of information about their similarities. I think deviations from the mean fields are needed to improve the interpretation of these results. In addition, to increase the size of the sample I suggest redoing these maps using various nearby tide gauges, instead of only one. This limitation is noted later in section 5.1, but without further development.

Thank you for this comment. For the revised manuscript, we have developed further figures 6 and 7, and the related discussion on them as follows:

- We added stippling to the figures to indicate where the difference of the non-compound mean field to the compound mean field is statistically significant. For this reason, we added sea level pressure to a separate row.

Thus, the figures 7 & 8 now have three rows (sea level pressure, total column water and 10-meter wind speed).

- We now also use nearby stations in the composites. Thus, for Kemi composite, we also use events from the Oulu tide gauge (Fig. 7 in the revised manuscript). For Hamina composite, we also use events from the Helsinki tide gauge (Fig. 8). Duplicate events were naturally neglected.
- We use only the months from September to March when compound events predominantly take place
- Deviations from the mean fields (i.e. anomaly charts) are added to the appendix.

We hope that the information given by figures 7 and 8 makes more sense now.

There is no information on the predominant month when these situations take place. I guess, from the seasonal cycles in figure 4, that precipitation extremes will dominate in summer and sea level in winter. I wonder if the synoptic patterns of precipitation-only and sea level-only extremes during the fall/winter season are different from those shown in figures 6 and 7, when all seasons are included. I think it would be more interesting to select the season when coincidences are possible; otherwise, what we are seeing is only the dominant pattern in different seasons.

As stated already in the previous response, we now use the September-March period in the composite figures. Thus, this issue is no longer present.

67: please, rewrite the sentence “that have been investigated on the Finnish coast not until the recent decade” as it is hardly understandable.

We rewrote the sentence to “that have been investigated on the Finnish coast in the recent decade”.

100: on the use of the maximum daily sea levels, is there any difference due to different samplings before and after 1971?

We acknowledge that observations before 1971 are likely biased towards lower values due to coarser samplings. This issue is added to the revised manuscript to line 126: “Due to coarser sampling before 1971, the daily maximum values in the pre-1971 period may be slightly biased towards lower values.”

111: 21tg to 21st

We chose to remove this sentence due to a confusion raised by another reviewer.

142: the term “orthogonal” can be misleading in this context. If calculated with rotational EOFs over monthly data, NAO, SCA and other patterns are by construction orthogonal to each other (on a monthly basis, not on a seasonal or yearly basis). The meaning of orthogonal here seems to refer to the spatial structure of the MSLP right?

Indeed, this is what was meant to communicate to the readers. We rephrased the sentence to “The spatial structure of MSLP in SCA pattern is orthogonal to NAO (i.e. the NAO pattern is zonal and the SCA pattern is meridional).”

170: change were to was

Thank you for pointing this out.

214: change are to is

Thank you for pointing this out.

Figures 6, 7: units are missing from the legends. Also in the caption, what does “average sea level height” means? Is it the average for the particular tide gauge during the selected episodes?

We decided to remove the legends regarding average sea level height and precipitation, because in the revised versions of the figures we also use the nearby tide gauges. Thus, it is not unambiguous how to define the average sea level or precipitation from events occurring in more than one tide gauges.

Section 5.3: this section seems to me more part of the introduction. Just a suggestion...

The section 5.3 was moved to Introduction with some small modifications to the text.