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## Review for Weiss et al.

Anonymous Referee #3

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Referee comment on "Co-evolution of the terrestrial and aquatic ecosystem in the Holocene Baltic Sea" by Gabriella M. Weiss et al., Clim. Past Discuss.,  
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This is a review for the manuscript "Co-evolution of terrestrial and aquatic ecosystem structure with hydrological change in the Holocene Baltic Sea" by Weiss et al. The authors use a large suite of organic biomarker proxies to analyze environmental change in the Arkona Basin for the Holocene. As expected, large changes in the different proxies indicate large changes in hydrology and possibly climate in the region fitting with the well-known different phases of marine conditions in the Baltic. However, I do have some problems with the current structure and missing discussion. The resolution of the records is very low, in several cases there is only two or three datapoints for a phase. Along with the absence of any information on the age model, this makes a discussion on trends in phases and at their transition and the presence or absence of events like 8.2 or 9.2 kind of useless. The discussion basically reads as a long list, i.e. "this proxy changed in this direction meaning that" without hardly including anything on the many studies in the area itself; I think the ms is missing a big opportunity to make this a much better story (see also the comments below).

I am not an organic biomarker specialist so I cannot judge on the suitability of the methods, although the description of the analyses and their background in the introduction is very elaborately done.

I'm missing a discussion that is involving the enormous amount of studies that have been performed in the Baltic already. Most references are only related to biomarker records, some of them from non-Baltic locations. Because the resolution and age control are low and you are focusing on different phases, my suggestion would be to restructure the ms by starting to identify your different phases and what they are based on (i.e. existing literature) and then pool the samples you have for those phases into a specific signal for that phase so that you are basically creating snapshots of those phases. In a next step these can then be compared with studies that are especially concentrated around the southern Baltic like the Arkona/Bornholm area (IODP expedition 347 – Site M0065;

Heinrich et al., 2018; Anjar et al., 2012; Jensen et al., 2016); Belt seas and Kattegat (e.g. Kotthoff et al., 2017, Ni et al., 2020; Hyttinen et al., 2020), or lake/terrestrial records from northern Germany and southern Sweden (e.g. Dräger et al., 2017; Hannon et al., 2018). If such studies can be linked with the biomarker results it would make the study much more valuable in identifying the processes behind the signals.

Line 31: The Baltic Basin existed long before the deglaciation

Intro: A very detailed background on organic proxies, but nothing about other salinity proxies in the Baltic. Many studies have attempted to reconstruct salinity changes in the Baltic, e.g. Gustafsson and Westman, 2002; Emeis et al., 2003; Mertens et al., 2012; Ning et al., 2017, Ni et al., 2020 and others.

First paragraph of the intro could use more referencing, it's very well studied!

Terrestrial vs marine....how does that work in the Baltic? How do you define the brackish environments with this regard?

Age model: Just a short reference to previous papers explaining the age model is not enough. Sedimentation rates and variations can be extreme in the Baltic especially when changing between the different settings. It is essential that this is explained and shown in the ms. The Arkona Basin is located at an interesting point just after where the saline inflows enter the present Baltic. Timing in this area does not necessarily have to be the same as in the Baltic Proper or the Straits/Kattegat. Simply assuming that this is the case is unlikely to be true. Same goes for comparison with the lake records in Finland.

I would not call the first 9.30 meters the top of the core when the whole core is 12 m. A 100 cm resolution is very low; is there any particular reason why this is so slow when downcore records were going to be reconstructed?

Sediments in the Baltic are notorious for transport of material. How does this affect the different proxies? Radiocarbon studies in the central Baltic have shown that organic matter is continuously re-deposited and can result in large temporal differences. Could this be the reason some of your changes are not aligning with commonly accepted events?

Line 241: With continental uplift I assume you mean isostatic rebound?

Lines 246-248: "The SIS was retreating at this time (Muschitiello et al., 2015; Cuzzone et

al., 2016), thus it is plausible that a meltwater pulse transported a higher concentration of n-alkanes from the north into the basin just after 10.2 ka.” This reads like kind of a loose statement. This would require things like age control, and are there signs of a meltwater pulse (e.g. sedimentological)? Has this been shown before, then cite it, and if not you need to bring more explanation.

Section 4.2.1: First you conclude that the low concentration of alkanes indicates less continental runoff, but then following the other proxies you conclude that more continental runoff occurred. What does the literature say about this? Which pathways, e.g. rivers, were in the area, maybe climate was actually changing becoming drier or wetter.

Lines 293-295: “While our record is of insufficient resolution to capture this rapid event, the increase of  $\delta^2\text{H}$  alkane values noted at 9.2 ka is presumably also influenced by the environmental conditions present at that time. Another rapid cold event occurred at 8.2 ka, which is not observed in our record, but may be elucidated with higher resolution sampling at this time interval.” Indeed, as the age control is lacking and the resolution low your 9.2 event may well be the 8.2 one.

Several of the curves in the figures have no error bars on them. It would be good to add them. Add other relevant study sites to the map and include them into the discussion, e.g. Bornholm, northern Germany, southern Swedish lakes, Little Belt.

The Pangaea link is still missing.

To conclude, I think this dataset definitely has the potential to make an interesting manuscript after re-structuring and expanding the discussion. So currently I recommend major revisions.