

Clim. Past Discuss., author comment AC1
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Authors' Response to RC1

Paul D. Zander et al.

Author comment on "Seasonal climate signals preserved in biochemical varves: insights from novel high-resolution sediment scanning techniques" by Paul D. Zander et al., Clim. Past Discuss., <https://doi.org/10.5194/cp-2021-56-AC1>, 2021

Authors' Response to RC1

Thank you for your comments and review of our manuscript. We feel the comments can be addressed in a revised version of the manuscript. Our responses are provided in italics.

General comments

The manuscript by Zander et al. presents high-resolution geochemical records from biochemical varve sequence of Lake Zabinskie. The topic is very interesting and timely. The use of biogenic content as climatic proxy is underrepresented among varve studies, nearly missing, due to their more complex nature compared to for example clastic varves or minerogenic content of mixed varves. Exploring biochemical content of varved sediments provide new insights to climate studies and new opportunities for high-resolution climate reconstructions, not only for new locations but also for different seasons. Zander et al. use state-of-the-art methods and present high quality data with comprehensive statistical analyses. The manuscript is well written and the figures and tables are of high quality. The interpretations are logical and justified by data. I have only few minor comments to improve the manuscript and one technical issue related to manuscript structure.

Specific comments

Line 98 How many researchers calculated varves

Three researchers identified the varves in ZAB-20-1. These were then compared with previous varve counts from ZAB-12-1 (also done by three researchers, published in Zarczyński et al. (2018)).

Line 190 How about cultural S? If excluded in Lake Zabinskie, shortly comment. In addition, it seems from supplementary Figure 2 that varve characteristics change at 1965 where the analyses of this paper begins. It is out of the topic to discuss older sediments, but could you very briefly mention the reason for the change (anthropogenic?), so that reader would understand where the record starts, from what conditions related to anthropogenic activities. If known. With this background information, reader would have a better perspective on local

conditions and hence easier to evaluate the data related to the elements sensitive to anthropogenic activities.

We believe sulfur is primarily of natural origin at this site, though to some degree it may be affected by human activities. There are no nearby industrial sources of S, though long-distance atmospheric transport from anthropogenic sources, soil erosion, and fertilizers could contribute some amount of sulfur to the lake. However, we think the deposition and preservation of S in the sediments is mainly controlled by redox and microbial processes.

Your observation is correct that there is a slight shift in varve characteristics around the time our study period begins. Generally, the varves in the years preceding 1966 feature more Fe and Mn, and less Ca. The varve preservation is also slightly worse. Although this is outside the scope of our investigation for this study, we interpret these changes to indicate that lake mixing was more intensive during these years. This may be due to a combination of climatic factors as well as changing vegetation. There has been reforestation around the lake since around 1950 (Wacnik et al., 2016), meaning the lake was more wind exposed in this time (1950-1965) compared to our study period. We can add a short discussion of these changes to provide more context to the record.

Line 214 "High values of Ti denote the ice-covered period, when mainly fine lithogenic detrital material is deposited." Could you please briefly specify the process? Usually ice cover reduces sedimentation by reducing clastic material transport from the catchment and also protecting littoral sediments from waver activity and resuspension.

We will clarify that this is due to slow suspension settling of very fine (fine silt/clay-size) detritus. Additionally, biogenic production essentially stops under ice cover, which means the relative amount of clastic material settling is higher. This process is also well documented by comparisons of sediment trap monitoring and recent sediments in Bonk et al. (2015).

Line 252 Could you please specify how? This is less carefully explained compared to other three varve types.

We will expand on this VT-4 paragraph. VT-4 is generally similar to VT-2, with the most important difference being higher S throughout the varve year. We interpret this as an indication of strongly reducing conditions because oxidation would release sulfate into the overlying waters.

Line 316 ITRAX beam width 20mm?

We think this comment probably refers to line 416. For ITRAX it is 20-mm wide (across a core, parallel to strata). This was stated here as a contrast to the imaging technique we used. We will clarify that this was to highlight an advantage of the XRF imaging technique used in this study compared to conventional linescan core-scanning (ITRAX). The advantage is that we use a 2-mm wide window, which results in less mixing of layers (mixed pixels) in varves with boundaries that are tilted relative to the ITRAX window, or varves with otherwise complex geometry.

Figure 3 B: It would be nice to have years represented by each varve in addition to the information of the sediment depth. Can you add calendar years of each varve like you show them in fig 3A?

Yes, we will make this addition to the figure.

Technical corrections

There is two discussion chapters in the manuscript: chapter 3 "results and discussion" and chapter 4 "discussion". This should be revised and structure clarified, by either having results and discussion at the same chapter or remove discussive parts from current "results and discussion" section and present them in chapter 4 in discussion. In my opinion both ways would work here.

Thank you for pointing out this error. Section 3 should be labeled "Results and interpretation"

References

Bonk, A., Tylmann, W., Amann, B., Enters, D., and Grosjean, M.: Modern limnology and varve-formation processes in lake Żabińskie, northeastern Poland: Comprehensive process studies as a key to understand the sediment record, *J. Limnol.*, 74, 358–370, <https://doi.org/10.4081/jlimnol.2014.1117>, 2015.

Wacnik, A., Tylmann, W., Bonk, A., Goslar, T., Enters, D., Meyer-Jacob, C., and Grosjean, M.: Determining the responses of vegetation to natural processes and human impacts in north-eastern Poland during the last millennium: combined pollen, geochemical and historical data, *Veg. Hist. Archaeobot.*, 25, 479–498, <https://doi.org/10.1007/s00334-016-0565-z>, 2016.

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