Climate of the Past Discussions

Clim. Past Discuss., author comment AC2
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Authors' Response to RC2

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-AC2, 2021

Authors' Response to RC2

Thank you for your review and helpful comments. Our responses are in italics.

This paper reports a detailed, sophisticated and careful assessment of biochemical varves as an archive of past climate variability. In my view, the manuscript is a timely and important contribution to the varve palaeoclimate literature because it demonstrates convincingly that high-resolution geochemistry (XRF) measurements and hyperspectral imaging can extract robust climatic signals at the seasonal scale from biochemical varves. I believe the research will be of great interest to the readership of Climate of thePast journal. The manuscript is well written and clear throughout and the statistical evaluation and analysis is convincing. I really commend the authors on this work. There are a handful of areas where clarification would be useful prior to publication but these are generally minor comments. Overall, the manuscript is, in my view, very suitable for publication.

Comment #1: Given the broad audience of the target journal (Climate of the Past), I suggest the authors incorporate a deeper overview of biochemical varves in the introduction. The use of clastic varves for similar purposes is mentioned on lines 38-40 so perhaps the next segment of text could say more on the key characteristics of biochemical varves.

We agree with reviewer's suggestion, and we will add more background information on biochemical varves in the introduction.

Comment #2: It would be worth stipulating somewhere – and ideally early on – the basis for the calibration time window (1966 - 2019). Presumably this was guided by how far back in time meteorological data are available? Perhaps this could be explained at first use on Line 65.

The time window was mainly defined by the interval where we have the most confidence in the varve count (there is uncertainty in the count prior to 1965). Minimal (zero) chronological uncertainty is fundamental for the calibration of the varve-climate comparison. We will clarify this in the introduction.

Comment #3: The varve types are reported on Figures 2 and 3A prior to being explained in the text, which does not happen until Section 3.3. As a result, the coloured horizontal strips and legend rather lack context. I'm not sure what the best solution is; I agree it seems logical to present and interpret the long record first, as the authors have done, but the reader is left pondering the varve types. I suggest the authors give some thought to improving the sequencing here. Perhaps it would be most straightforward and sufficient to simply mention in the caption of the figures "see main text Section 3.3 for an explanation of the Varve Types"?

Yes, thank you, your suggested addition to the caption seems suitable and helpful.

Comment #4: The decadal variability in the dominant varve type is striking and intriguing. For example, the authors draw attention to the notable shift away from VT3 after the late-1980s (e.g. Line 238). I would welcome some commentary from the authors on the following aspects: what are the potential implications of decadal variability on centennial or millennial-scale varve-based climate reconstructions? Similarly, how different would the regressions and calibrations be if, say, the instrumental data used in the calibration only extended back to the late 1980s, thereby missing the period when VT3 is the dominant signal? How different would the GAM outputs be if only the VT-3 data were used?

We interpret the decadal variability in VT to be significantly driven by climate, though other factors can of course play a role. Therefore, we think our data shows a strong potential for varve-based climate reconstructions to capture decadal variability, though longer datasets are required to conclude this with confidence.

To some extent, the split-period validation touches upon the second part of this comment. We found that the GAM outputs for the temperature model were generally similar for the periods 1966-1992 and 1993-2019. The wind model, however, changed substantially when fit to data from 1966-1991 versus data from 1992 and 1995-2019 (1993-1994 missing data). We will do further testing on VT-3 only data to see the effect on the GAM output and report this in the final revision report.

Comment #5: The data and statistical output are convincing but the presentational format of the correlation coefficients is a bit odd and inconsistent. Figure 6 (monthly correlations) works nicely in terms of aesthetics and reporting a great deal of data in a simple and effective way. I was left wondering about seasonal correlations, which I then find in Table 1. The table is fine but it is more difficult to trace the positive and negative correlations across sedimentary variables and seasons – not least because significant positive and significant negative correlations are in bold font. Did the authors have a specific reason for using one figure and one table? I suggest they consider plotting both as figures using the same formatting style.

We will include a plot of seasonal correlations in the same format as Fig. 6 in the revised manuscript.

Technical comments:

Figure 1A: It may just be my screen but the light and dark green colours were difficult to distinguish.

We will look into improving the contrast.

Comment: Superscript formatting is missing in a handful of instances, for example MAR units on Figure 2 and 137Cs in the figure caption.

Thank you for pointing out these formatting errors.

Line 416: Is the XRF beam 20-mm wide?

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 imagining 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.