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Resubmission of revised manuscript cp-2023-73

Dear Prof. Dr. Piotrowska,
dear Reviewers,

Thank you for the opportunity to revise our paper on “North Atlantic Oscillation polarity during the past 3000 years derived from sediments of large lowland lake Schweriner See, NE-Germany” by Adolph et al. again. We appreciate the reviewers’ comments and suggestions which were very helpful again.

We completely revised and restructured the manuscript according to your suggestions. The most relevant change made in the manuscript is a restructuring into a Results and a combined Interpretation and Discussion section. Please find below a detailed reply to all reviewer comments. The revised versions of the manuscript were uploaded as PDF file with track changes and as PDF file with all changes accepted. Thank you for considering our manuscript for publication.

Sincerely,

Marie-Luise Adolph

Responses to Reviewer 1

General comments:

Dear Authors,

Thank you for implementing most of the proposed changes. I can see that the manuscript has improved significantly. However, I still have some minor to major concerns. For example, there is a mix of tenses throughout the manuscript, which is especially evident in the Interpretation chapter. This needs to be corrected.

The entire manuscript should be checked and corrected for language and text flow, as some sentences are challenging to follow (e.g., the sentence in lines 348-355).

While the scientific merit of the manuscript is good, my biggest concern is its extensive length and numerous repetitions. Some information appears first in the introduction, then in the interpretation section, and again in the discussion. I am unsure if this division enhances clarity. It might be beneficial to reorder the manuscript, such as by merging results and interpretation or interpretation and discussion. Additionally, many sentences are overly long, which makes reading difficult.

During the review we checked the manuscript and corrected for language and text flow, addressed the issue of overly long sentences and removed repetitions. As suggested by Reviewer 2, we restructured the manuscript into a Results (Chapter 4) and Interpretation and Discussion (Chapter 5) section. The overly long sentence mentioned by Reviewer 1 was changed to:

“Distinct variations in winter temperatures, moisture source region and/or evaporative lake water enrichment (Fig. 5) are mainly modulated by the North Atlantic Oscillation (NAO) in the North Atlantic region (Hurrell and Deser, 2009). We observe four distinct time slices at Schweriner See: i) From 3030⁺¹⁷⁰/₋₂₁₀-2820⁺¹⁸⁰/₋₁₈₀ cal BP (unit A-B, Fig. 4) and 2110⁺¹⁶⁰/₋₁₃₀-830⁺¹⁰⁰/₋₉₀ cal BP (unit D, Fig. 4), milder winter temperatures, a southern moisture source region in the southern/central North Atlantic and/or a higher evaporative lake water enrichment indicate NAO+ conditions. Contrary, ii) from 2820⁺¹⁸⁰/₋₁₈₀-2110⁺¹⁶⁰/₋₁₃₀ cal BP (unit C, Fig. 4) and 830⁺¹⁰⁰/₋₉₀-105⁺⁹⁵/₋₇₅ cal BP (unit E, Fig. 4) colder winter temperatures, a northern moisture source in the northern North Atlantic and/or Arctic regions and/or lower evaporative lake water enrichment correspond to NAO- conditions.” (line 340-347)

It would also be valuable if the authors provided R scripts for age-depth modeling along with the publicly available age-depth model. This would help to verify the model and parameters used, support open data principles, and ensure result repeatability. This is a suggestion only and does not affect the overall rating of the manuscript.

Thank you so much for this recommendation. We uploaded the rBacon output files in a zip-compressed folder. If something else is needed, please let us know. The ¹⁴C and ²¹⁰Pb/¹³⁷Cs results are additionally uploaded in the pdf supplement file.

Below, I list several **technical issues**:

Line 18: Change "CE" to "calBP."
Changed to 105⁺⁹⁵/₋₇₅ cal BP (~1850 CE)

Line 22: Rewrite "moisture source region sources" for clarity.
Changed to "moisture source region"

Line 23: Clarify the meaning of "i.a."
Changed to "among others"

Lines 71 vs 73: Decide between "large lake" and "rather large lake" for consistency.

Changed to "large lake"

Line 95: Clarify the missing 7.9% of land cover.

Added "grassland (7.6 %) and others (0.3 %)"

Line 175: Define TOC as "Total Organic Carbon (TOC)."

Added the definition

Lines 234-235: Move references out of the results section.

We removed the references in the results section

Line 244: Ensure consistency in describing depth intervals (44-45 cm instead of 45-44 cm).

Changed

Lines 278-280: Divide the long sentence into two for clarity. The second one can start with TOC/N ratio. Additionally, please either add "is" after TOC/N ratio or delete "which" after.

We divided this sentence into two sentences: "Organic matter parameters agree visually well with in-situ chloropigments (Area₆₀₀₋₇₆₀, Fehler! Verweisquelle konnte nicht gefunden werden.), which are indicative of past primary productivity (van Exem et al., 2022). Additionally, TOC/TN is mostly <12, which suggests a dominance of nonvascular aquatic plants with only a small contribution of vascular plants (Meyers and Ishiwatari, 1993)." (lines 269-272)

Line 305: Address the discrepancy between the temporal resolutions mentioned. Here, the authors write that the one-centimeter sample in diatom analysis covered 1-6 years, but in the methods section the temporal resolution is equivalent to a 16-85 years. Something is wrong here.

We addressed this issue in the methods section: "For diatom analysis, 91 samples with a one-centimetre thickness and 1-2 cm³ volume were taken in the same sampling resolution (equivalent to a 16-85 year temporal sampling resolution between samples, with 1 cm samples covering 1-6 years) as the pollen analyses."

Lines 314-315: Rewrite the sentence for clarity and accuracy. I suggest: Lacustrine sediments generally contain a mixed signal from terrestrial and aquatic sources, which can be distinguished by chain-length distribution of n-alkanes.

We rewrote the sentence to "Lacustrine sediments generally contain a mixed signal from terrestrial and aquatic sources, which can be distinguished by the n-alkanes chain-length distribution (e.g. Strobel et al., 2021; Ficken et al., 2000)."

Lines 355-364: Remove the repetition of information from the introduction.

We removed many information in this section and moved them to the introduction.

Line 375: Add the missing reference.

Added

Thank you for considering these suggestions.

Responses to Reviewer 2

General comments:

The revised manuscript by Adolph et al. titled 'North Atlantic Oscillation polarity during the past 3000 years derived from sediments of large lowland lake Schweriner See, NE Germany' developed a lot and I support publication of the work in *Climate of the Past*. Still, the manuscript would benefit from some reorganizations and few improvements.

Main point:

The sub-division of the commonly used discussion section in an interpretation (section 5) and discussion (section 6) part leads to repetitions and the reader needs to skip back and forth through the manuscript. Proxy interpretations from the archive itself and comparisons with other paleoclimate archives interact and support each other. Therefore, I suggest to merge sections 5 and 6 and have only one discussion chapter about organic matter/ $\delta^{2}\text{H}$ variations and NAO variability and one discussion chapter about minerogenic input and lake level fluctuations.

We addressed this issue by combining the Interpretation and Discussion section (Chapter 5), which is discussing NAO variability first and afterwards the lake-level variability.

Specific comments:

(1) Study Area. This chapter can be streamlined, check for repetitions.

We revised the study area chapter and removed repetitions

(2) Lines 153-154 (Methods): The interpretation of Area600-700 as proxy for in-situ productivity is presented in the interpretation chapter. Delete it in the methods.

Deleted

(3) Line 161-162 (Methods): This interpretation of Cu, Ni, Zn as anthropogenic impact proxy XRF data presented in the interpretation chapter. Please delete it here.

Deleted

(4) Lines 170-172. Please quantify the amount of diatoms adding uncertainty to the estimation of siliciclastic matter content. Is this bias relevant for your interpretations?

We only investigated this qualitatively. We added this information in the methods section. "Subtracting carbonate content and LOI550 from the total sample weight, the percentage of siliciclastics, which includes a share of silicious algae as revealed by qualitative microscopic analyses on the LOI ash residues, was calculated." (Lines 160-161)

(5) Results chapter 4.2. (Sediment composition): Check for missing references to figures.

We added missing references

Detailed comments:

Abstract:

Line 23: Replace 'eventually' with 'thereby'?

We replace it with "thereby"

Line 26: Use 1850 CE, like in line 18, to be consistent?

Changed to "105⁺⁹⁵/₋₇₅ cal BP (~1850 CE)"

Main text:

Line 48: Add a point after 'conditions' and start a new sentence for NAO-.

Line 48: Add 'more' before 'meridional'.

Added

Line 122: Delete 'and' before 'photographed'.

Deleted

Line 145: 'Clean' instead of 'cling'?

As we, indeed, used cling wrap, we want to refrain from changing it to "clean wrap".

Line 150-152: Rephrase: 'Measurements were performed on U-channels...'

Changed to "Hyperspectral imaging was carried out at the Université Rouen Normandie on U-channels previously extracted from the cores in Greifswald."

Line 241: Replace 'gravity' by 'short', to be consistent with the methods.

Replaced

Line 254: Add 'respectively' after the numbers.

Line 341-343: Add a reference for these sentences.

Added