Response to review from Referee 1

On behalf of all authors, I would like to thank Referee 1 for the helpful comments and the review of our manuscript. The responses and planned changes are provided in italics and green.

General comments:
The manuscript by Adolph et al. provides a reconstruction of North Atlantic Oscillation (NAO) polarity during the past 3,000 years, derived from lake sediment profiles from Schweriner See, located in NE Germany. The authors employ a multi-proxy approach to interpret past climatic signals. The manuscript presents data of good quality, with clear and organized figures. The supplementary data is well-structured and easy to navigate. In general, the manuscript aligns with the scope of the journal.
However, I have several concerns that should be addressed before publication. Firstly, the authors employ an impressive number of methods (over 10), but many of them lack proper descriptions in the results section, and some are not even mentioned (e.g., grain size analysis). The discussion requires revision since, in its current form, it covers various aspects, such as NAO, climatic events, lake level fluctuations, and minerogenic delivery. However, most of these aspects remain speculative at this point, as the discussion rarely relates to the results. I strongly recommend focusing on the obtained results first, and then comparing them with findings from other sites. The lack of a comprehensive discussion of the results creates the impression that many of the analyses conducted were unnecessary, as their usefulness in the current form of the manuscript is unclear.
As this was also noted by Reviewer 2, we will restructure the results and discussion section by combining "Results and Interpretation" to better explain the involved processes and improve the Discussion in a revised version of the manuscript.

Specific comments:
The introduction should clearly state the knowledge gap, specific study goals, and hypotheses.
We agree with the reviewer's suggestion, and we will revise the introduction to adress knowledge gaps, study goals and hypotheses more clearly.

The term "dominating mode of the NAO" needs a better explanation for clarity.
We will change the "dominating mode of the NAO" to "respective mode of the NAO"

Explain the uneven uncertainty of the age-depth model.
The age-depth model was calculated using the r-package "rbacon". We used the mean and the respective error is based on the 95% confidence interval, in which the probability function is included.

Rewrite the results section. Currently, it combines results with their interpretation and references to the literature. In this section, only the authors' results should be described. Additionally, the authors have provided over 10 analyses in the methods, some of which are poorly described or not mentioned, such as grain size analysis.
During the revision, the results section will be rewritten to address this issue and to include all used methods.

Extending the profile to 1000 cm without time control may not provide a broader perspective. If the extension is relevant, it should be mentioned in the methods section and discussed.
In a revised version of the manuscript, we will only focus on the upper 9 m.

Address the discrepancy in the age designation (with changed uncertainty sign) in the introduction part of the discussion.
To avoid confusion with the changed uncertainty sign and based on the suggestion later in the review, we will remove CE ages.

Clarify the resolution of distinct analyses and the number of years covered by each sample.
As shown in Fig. 2, the sedimentation rate changes from 2 to 10 mm a^{-1}, which changes also the resolution covered by each analysis. Based on the reviewer's suggestion, we will add the range of years covered by each analysis in a revised version of the paper.

Discuss whether the diatom signal related to long-lasting ice covers could have been captured for a single, extreme winter event.
To address this, we will add in the methods section that "For the analysis, one-centimeter-thick samples were used." In the discussion, we will add that "Based on the sample thickness of one centimetre, which covers 1-5 years depending on the sedimentation rate, it is not possible to distinguish between individual years. However, the regularity in the occurrence of S. chantaicus suggests that single events are likely not responsible but rather long-lasting changes in environmental conditions."

Explain the link between inc/coh and milder winter temperatures, as this ratio was previously associated with lake productivity.
To account for this suggestion, we will explain the link between inc/coh, productivity and milder winter temperatures in a revised version of the paper in more detail.

Technical corrections:
Add "years" to the title: "...during the past 3 ka years..."
Based on the suggestion from reviewer 2, we will change the title to "North Atlantic Oscillation polarity during the past 3000 years derived from sediments of large lowland lake Schweriner See, NE-Germany".

Use a consistent age unit (CE, cal BP, centuries) for clarity.
In a revised version, we will use cal BP as a consistent age unit.

Correct the syntax error in lines 34-37.
Will be corrected to "Some areas in Central Europe, such as NE-Germany, have already been affected by lowering lake and groundwater levels (Germer et al., 2010)."

Provide the lengths of cores SAS21-11 and SAS21-12 (line 121).
We will add the respective lengths of 13.56 and 15.51 m.

Color is also is one of the sedimentological properties (line 126).
We will remove the additional mention of sediment colour here.

Correct the sentence in line 237: "…variations in organic matter variations…".
Will be changed to "variations in organic matter content"

Ensure that depth ranges are consistently provided, with the shallower depth mentioned first.
As the sediment core is described from the bottom to the top, we would like to keep the deeper depth first.

Line 250 is an interpretation, not a result.
This will be addressed in a revised version of the manuscript when we revise the results and interpretation section.

Use consistent language (British English vs. American English) throughout the manuscript.
BE will be used consistently in a revised version of the manuscript.

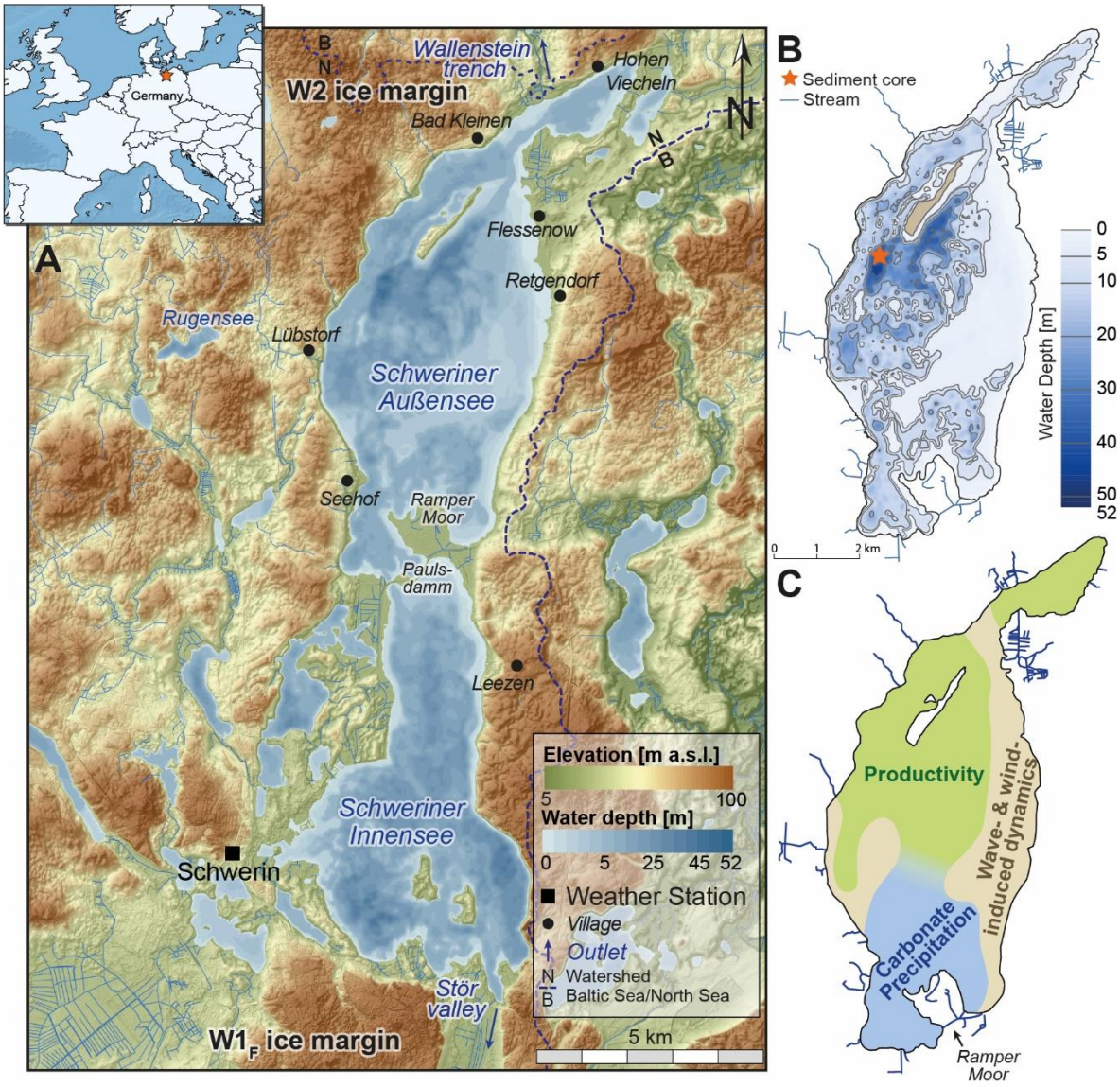
Add a period at the end of the sentence in line 359.
We will add the period at the end of the sentence.

Include information on the location of Dosenmoore (line 402).

We will add "ca. 105 km northwest of Schweriner See" and refer to Fig. 5, where Dosenmoor is shown on a map.

Add a space between "spread" and the citation (line 438).
The space will be added.

It would be good to include map of Europe in Figure 1 for clarity and changing the brackets in the depth scale from () to [] for consistency.
We will change the Germany inset to a small overview map of Europe as well as the brackets as suggested.



Ensure consistent terminology in Figure 2 (yellow "remains" vs. "residue").
This will be changed in a revised version of the manuscript to residues.

Label the panels in Figure 3 for clarity (e.g., A and B or upper and lower).
As suggested, A and B will be added to the figure.

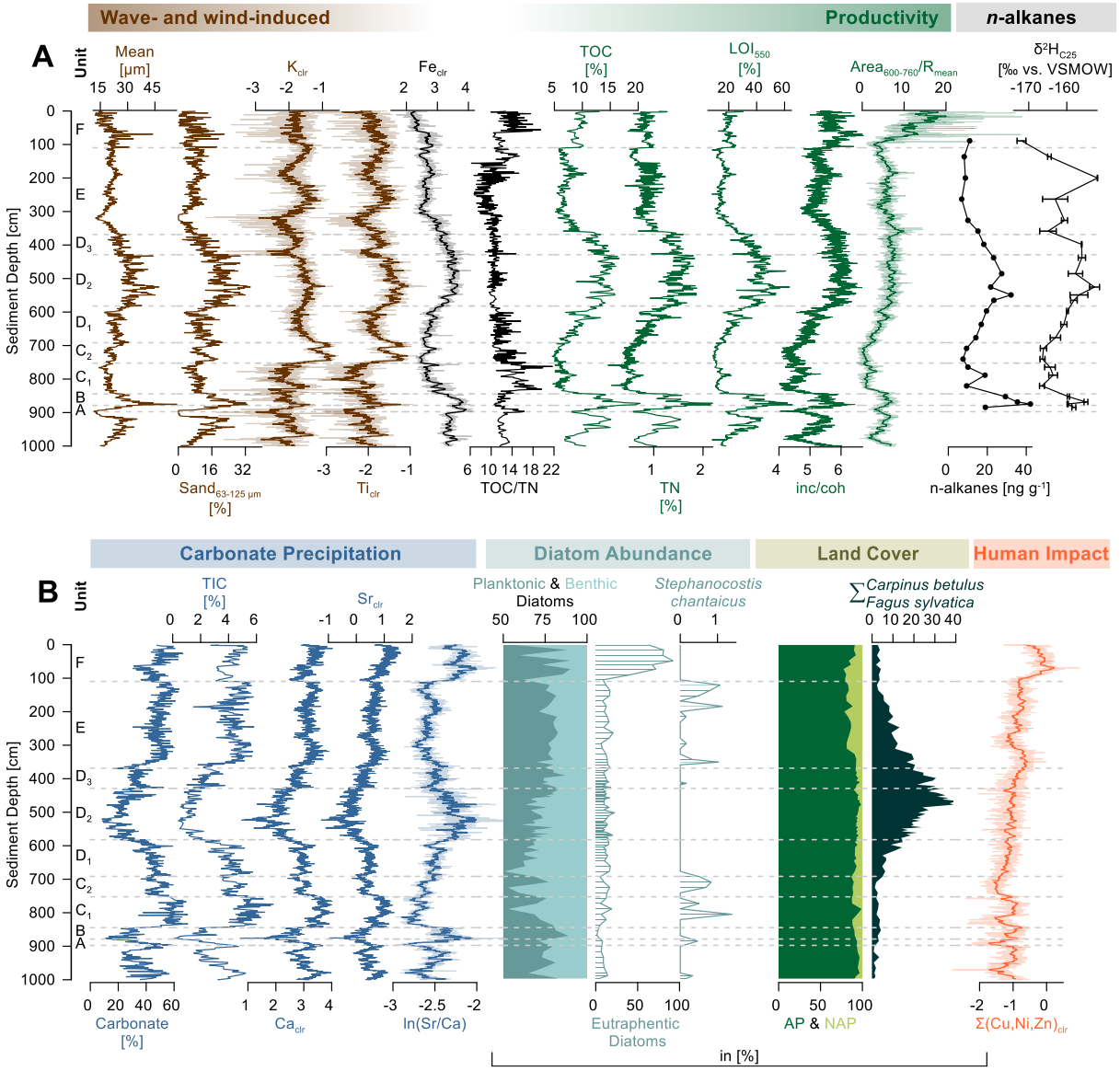


Fig. 1: Sedimentological, geochemical, spectral and micropaleontological characteristics of sediment core SAS21. A) Wave- and wind-induced processes (brown lines) are represented by grain size mean, sand$_{63\text{-}125\mu m}$, potassium (K_{clr}) and titanium (Ti_{clr}). Iron (Fe_{clr}) cannot be assigned to wave- and wind-induced processes or productivity. Productivity (green lines) is shown by total organic carbon (TOC), total nitrogen (TN), loss on ignition 550 °C (LOI_{550}), inc/coh ratio, as well as chlorophyll-a and its derivates ($Area_{600\text{-}760}/R_{mean}$, 101pt running average). The n-alkanes and their isotopic signatures are exemplary (δ^2H of nC_{25}). B) Carbonate precipitation (blue lines) is represented by the carbonate content, total inorganic carbon (TIC), calcium (Ca_{clr}), strontium (Sr_{clr}) and the Sr/Ca ratio. Diatom abundance is represented by the percentage of planktonic (teal area) and benthic (light blue area) diatoms, the abundance of eutraphentic diatoms indicating eutrophication and the under-ice blooming diatom Stephanocostis chantaicus. Land cover changes are indicated by palynological investigations and represented by the AP/NAP (dark green vs. lime green area) ratio and summed up Carpinus betulus and Fagus sylvatica (very dark green area). Human impact is represented by ∑(Cu, Ni, Zn) (orange line). XRF data (Ti, K, inc/coh, Ca, Sr, ln(Sr/Ca) and ∑(Cu, Ni, Zn) are shown in 2 mm resolution and as 9pt running average.

Revise Figure 6 to have consistent numbering for regions (e.g., A, B, and C for Poland, Eastern Central Europe, and Mid Europe). Clarify the difference between "Mid" and "Central."

We used both terms “Mid Europe” and “Central Europe” as these were the terms used in the original publications. To differentiate and clarify the difference we changed “Mid Europe” to “Jura mountains”. Based on the suggestion, we changed the numbering of the regions to A, B and C.

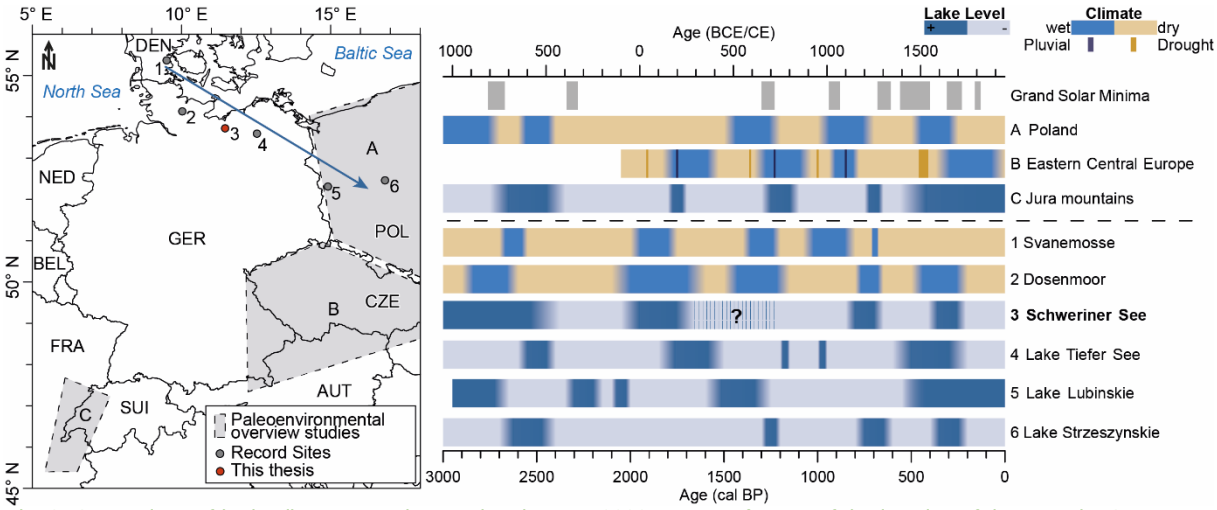


Fig. 2: Comparison of hydroclimate records covering the past 3000 years. Left: Map of the location of the records. Grey areas indicate the spatial extent of paleoenvironmental overview studies. The blue arrow indicates the NW-SE direction where compared records are arranged. DEN: Denmark, POL: Poland, CZE: Czechia, AUT: Austria, SUI: Switzerland, FRA: France, BEL: Belgium, NED: Netherlands, GER: Germany. Right: Grouped hydroclimatic records and individual records below the dashed line are shown above. Summarized records are from A) Poland (Starkel et al., 2013), B) Eastern Central Europe (Büntgen et al., 2021) and C) the Jura mountains (Magny, 2004). Hydroclimate reconstructions, which show wetter (blue bar) and drier (beige bar) conditions, are compared to lake-level variations and bog surface wetness reflecting hydroclimatic conditions differentiating between lower (light blue bars) and higher (dark blue bars) lake levels from 1) Svanemosse (Barber et al., 2004), 2) Dosenmoor (Daley and Barber, 2012; Barber et al., 2004), 3) Schweriner See (this study), 4) Tiefer See (Theuerkauf et al., 2022), 5) Lake Lubińskie (Bonk et al., 2023) and 6) Lake Strzeszyńskie (Pleskot et al., 2018). Grand solar minima are shown as suggested by Usoskin et al. (2007). The question marks and shaded area in the Schweriner See lake-level variations mark the period, masked by increased storminess. The lake level during the period was most likely higher.