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Title: The climate in Poland (Central Europe) in the first half of the last millennium, revisited

Dear Professor Natalia Piotrowska

Editor, Climate of the Past

We would like to thank you and the anonymous reviewers for providing positive feedback and constructive comments on our manuscript. All comments were carefully considered, and we believe they helped us improve the description of our work. The detailed corrections/modifications are listed below, point by point.

(Note: The changes in the text and the answers to the reviewer's questions/suggestions are marked in red font. We revised the text taking into account all comments and suggestions proposed by the reviewers. All changes have been carefully applied to the text.)

Response to Reviewer No. 1

Dear authors of the manuscript "The climate in Poland (Central Europe) in the first half of the last millennium, revisited", This study significantly furthers our understanding of climate variability in Poland during the first half of the last millennium. The new documentary records and the three tree-ring chronologies are noteworthy contributions to the paleoclimate research community. Archiving these records in a public database would substantially enhance the impact of this manuscript. However, the manuscript lacks a clear scientific question and a discussion of the related climate mechanisms. Here are my revised comments:

ANS: Thank you.

Main Comments:

The manuscript could be improved by introducing a clear scientific question or objective that it seeks to answer.

ANS: Done

It would also benefit from a detailed discussion on climate mechanisms related to the extreme events and warm periods. Please clarify how your current reconstructions differ from and contribute uniquely to the existing body of work. While reconstructions are valuable, it is essential to interpret and provide insights from these reconstructions, such as information about extreme events, rather than merely listing them.

ANS: All these suggestions were taken into account. Please see the text.

A detailed comparison, highlighting the similarities and differences between the tree-ring records and documentary records, could reinforce the benefits of using multiple proxies.

ANS: Such a comparison is already presented in detail in the *Summary and discussion* section. See text.

Specific Comments:

Lines 18-19: Clearly define the motivation and scientific question of your study.

ANS: Done.

Line 19: Consider incorporating all available quantitative climate reconstructions into your study, such as the gridded reconstructions (Neukom et al., 2019) and the reanalysis reconstruction (Tardif et al., 2019).

ANS: Thank you for this suggestion. Both items were included in the discussion part.

Line 50: The claim "Only a few papers also deal with a pre-1500 period" seems unsupported. Perhaps you could mention that there are significantly fewer studies dealing with the pre-1500 period compared to the post-1500 period.

ANS: You are right. We changed the text according to your suggestion. It should now should be clear.

Line 96: Please translate the information in Table S3 into English to facilitate the review process.

ANS: Done.

Line 183: Could you explain the reason for separating the sections before and after 1360 CE?

ANS: For pre-1361 we have significantly fewer sources, not enough to present the frequency of extreme categories of weather (3, 2, -2, -3), such as are presented in Figs 3 and 4. The following sentence was added for clarity: *It should be emphasized that there was a significant increase in the number of available historical written references from the 1360s onwards, and therefore 1360 was chosen as the threshold year for delimiting the two subperiods.*

Lines 209-210: If this sentence does not contribute significant information, consider removing it.

ANS: Done.

Lines 257-259: Please clarify the logic in this sentence.

ANS. Done. The sentence was corrected to: *The time distribution exhibits a few MRs coinciding across a larger territory simultaneously. These events are limited to the 15th century, when they were found in southern Poland (Wrocław, Kraków) in the 1440s and 1450s, and in Wrocław and Kutno in the early 1480s and 1490s.*

Lines 275-283: Please explain why tree-ring records respond to winter temperature in Poland, given that most tree-ring chronologies mainly respond to growing-season temperature, which directly impacts photosynthesis and the formation of growth rings (Fritts, 1976).

ANS: Please note that most dendrochronologies available for the world come from mountains or subpolar areas (see PAGES 2k Consortium: A global multiproxy database for temperature reconstructions of the Common Era, Sci. Data, 4, 170088, https://doi.org/10.1038/sdata.2017.88, 2017). For these areas, summer temperature influences the rate of tree growth, but our

dendrochronologies come from lowlands or uplands and, here, late winter and early spring temperature is critical (see Table 1, and more examples in Zielski et al. 2010, their Table 7.1).

The following passage was added to the text for clarity: *We confirmed (Table 1) the results presented earlier by Zielski (1997), who reveals statistically significant correlations between annual tree-ring widths (Kuyavia-Pomerania dendrochronology, 1891–1991) and the monthly mean air temperatures from the region, particularly from February and March, but also from January and April. Their values were equal to 0.47, 0.55, 0.26 and 0.18, respectively. This means that, in Poland, the low temperature occurring at the end of winter and at the beginning of spring has a strong negative influence on the width of tree-rings. On the other hand, precipitation has a weaker influence than temperature, though only in June and July is this statistically significant. More information about climate signal in selected trees in Poland is provide in Table 7.1 in Zielski et al. (2010).* Zielski A., Krąpiec M. Koprowski M., 2010, Dendrochronological Data, in Przybylak R, Majorowicz J, Brázdil R, Kejna M (eds). The Polish Climate in the European Context: An Historical Overview, Springer, Berlin Heidelberg New York, 191-217.

Lines 279-281: Please clarify what you mean by "the record today." Is it the instrumental record?

ANS: Thank you for this suggestion. Today means here period 1951-2000. We added this information to the text.

Lines 301-302: Consider including the instrumental temperature variability from 1951-2000 in Figure 10 A, B, C for a clearer comparison.

ANS: The series finishes at 1500 in Fig. 10, so we cannot add the period 1951–2000. This period was used by us to calculate temperature anomalies for the study period 1001–1500.

Lines 359-362: Comparing tree-ring chronologies directly could provide more insightful results.

ANS: Thank you for this suggestion. However, tree-ring reconstructions for Poland allow reconstruction of late-winter/early-spring temperatures (see Zielski 1997, Krąpiec 1998, Zielski and Krąpiec 2004, Przybylak et al. 2005 and Szychowska-Krąpiec 2010), while reconstructions available for other parts of Europe and the world most often reconstruct the summer temperature. Therefore, in our opinion, such comparison is not appropriate, because seasons often respond differently to climate change. See also Luterbacher et al.'s findings (lines 383-386 in the preprint) or Goose et al. (2006).

Lines 391-392: Please explain why the reconstruction matches the simulation.

ANS: Thank you for this suggestion. We have rethought this passage of the text and decided to delete this sentence. See the text.

Lines 438-439: This information does not seem to fit in the results section. Consider moving it to a more appropriate section.

ANS: Lines 438-439 are in the *Conclusion and final remarks' subsection* and not in the result section as the reviewer writes. Therefore we did not introduce any change.

Lines 440-430: There appears to be a logical inconsistency in this section. The relationship between seasonal temperatures does not seem to justify a replacement.

ANS: The lines mentioned by the Reviewer appear not to agree with the article as it is displayed to us, and we think that the reviewer is perhaps remarking on lines 440-443. If so, we do not share the Reviewer's opinion, and we still strongly maintain our view that the mean winter temperature in Poland significantly better represents the annual mean temperature than does the mean summer temperature. This is well understood by Polish climatologists. However, such relations are seen not

only in Poland but in all areas at polar and moderate latitudes, because the variability of winter temperature is significantly greater here than that of summer temperature.

Lines 462-463: This does not seem to be a conclusion.

ANS: Thank you for this suggestion. We changed little the sentence slightly to: *Good agreement was found between the reconstructions of Poland's climate from 1001–1500 and many reconstructions available for Europe, which is in line with findings presented by Luterbacher et al. (2010) for the period 1500–2000*. We hope that this sentence can now be treated as a conclusion.

The correlation coefficients in Table 1 for the tree-ring reconstructions are rather small, indicating that the explained variance in two out of three chronologies is less than 25%.

ANS: Please note that we used RE, CE and RMSE values for verification periods. In this case, CE and RE reach positive values and RMSE is below 1. The interpretation of these results was based upon previous research in life sciences.

McCarroll, D. Simple Statistical Tests for Geography; Chapman and Hall/CRC: Boca Raton, FL, USA, 2016; ISBN 9781498758819.

Cook, R.D. Using dimension-reduction subspaces to identify important inputs in models of physical systems. Proc. Sect. Phys. Eng. Sci. 1994, 9, 18–25.

Wilson, R.; Tudhope, A.; Brohan, P.; Briffa, K.; Osborn, T.; Tett, S. Two-hundred-fifty years of reconstructed and modeled tropical temperatures. J. Geophys. Res. Oceans 2006, 111, 1–13.

I hope these suggestions help enhance the clarity and impact of your manuscript.

ANS: Thank you. We also think that the text is now clearer.

References

Fritts, H., 1976. Tree rings and climate. The Blackburn Press, New Jersey.

Neukom, R., Steiger, N., Gómez-Navarro, J.J., Wang, J., Werner, J.P., 2019. No evidence for globally coherent warm and cold periods over the preindustrial Common Era. Nature 571, 550-554.

Tardif, R., Hakim, G.J., Perkins, W.A., Horlick, K.A., Erb, M.P., Emile-Geay, J., Anderson, D.M., Steig, E.J., Noone, D., 2019. Last millennium reanalysis with an expanded proxy database and seasonal proxy modeling. Clim. Past 15, 12