Clim. Past Discuss.,
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Climate of the Past Discussions
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# *Interactive comment on* "Differing pre-industrial cooling trends between tree-rings and lower-resolution temperature proxies" *by* Lara Klippel et al.

**Lara Klippel et al.**

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(1) comments from Referees, (2) author's response, (3) author's changes in manuscript

Comment 1: (1) Although the different tests applied by Klippel et al. are meaningful and reasonable, I would like to suggest one other experiment that might explain some of the offset in trends. The data preparation in this study follows the steps outlined in the PAGES2k network study. However, the last step described in the PAGES study, a scaling to temperature, is not applied (for some unknown reason, data were also not scaled in the corresponding PAGES figure). For the significance of long term trends, the scale is irrelevant and I'm not suggesting a scaling to temperature. (2) We did



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not scale the data to temperature, to produce Figure 2 (this publication) because in Figure 8 of the original publication (Pages 2k 2017) the data were also not scaled to temperature. See the original caption: “Figure 8. 50-year binned composites stratified by archive type, for all types comprising 5 or more series. Composites with fewer than 10 available series are shown by a dotted curve, while solid lines indicate more than 10 series. Shading indicates 95% bootstrap confidence intervals with 500 replicates. Gray bars indicate the number of records per bin. The composites are expressed in standard deviation units, not scaled to temperature”. (3) No changes made.

Comment 2: (1) More importantly, I want to point out that binning (or any other sort of low-pass filtering) needs to be followed by a scaling to either standard normal deviates or temperature, if the frequency spectra of the original data are very different. The latter is to be expected according to the title of this manuscript. The signal of low resolution records will be inflated compared to the low frequency tree-ring signal if scaling precedes binning. I expect the weak negative trend in the tree-ring compilation over the 1 1800CE period to become less weak compared to trends in other archives (Fig. 2) if scaling to a common target follows binning (or low-pass filtering). This is a common procedure in multiproxy studies (e.g. Ljungqvist et al. 2016). These considerations should not alter the significance of trends. However, even binned tree-ring records might still have a less negative slope in the frequency space compared to records with an originally low temporal resolution. (2) This was tested by switching the procedure (Fig 1x): First binning, the scaling (blue = glacier ice, orange = marine sediment, red = lake sediment, green = tree-ring records). Here we show both a reproduction of Figure 2 (upper panel) and the result of the suggested, reversed processes of binning followed by scaling (lower panel).

Fig. 1x: Reversing the binning/scaling procedure increases multi-decadal to centennial scale variability. However, this is the case for all proxies, i.e. not only for the tree-ring data. The reduced pre-industrial cooling in the tree-ring data remains the same. (3) No changes added to the manuscript.

Comment 3:

(1) Marine sediment records with 200 year time steps, which fulfil the PAGES selection criteria, should have no (non-random) loading at frequencies around 50 years and therefore a steeper negative slope. Having a higher proportion of variability at multidecadal scale (compared to millennial scale) might penalize tree-ring records when assessing the significance of linear trends over almost 2 millennia. Whether this effect is relevant or not, could be tested, e.g., by binning with 200 years intervals. This might decrease the difference between tree-rings and other archives in Fig. 5. (2) The test slightly changes the differences, however, the major discrepancies remain the same (see Fig. 2x).

Fig. 2x after using 200-year bins. (3) No changes added to the manuscript.

Comment 4: (1) The significance of trends might be even more affected by the variable length of tree-ring records. Is there a relationship between the length of the records and the significance of trends? It is reported that trends were calculated over the 1-1800CE period, but it is not clear how the authors dealt with records terminating before 1CE. Even if only records of >800 years are selected, the vast majority of them will not cover the entire 1-1800CE period. I assume the trends were then calculated over the remaining period, e.g. from 1000-1800CE. The authors need to specify in which way they considered that a shorter record (i.e. less degrees of freedom) likely reveals less significant millennial scale trends. (2) We are aware of the problem, thus analysis was constraint to records longer than 800 years. (3) Further information and explanation was added to the manuscript (Fig. S.3).

Comment 5: (1) The authors are a bit ambiguous in their terminology when it comes to the appropriateness of detrending methods. Although they acknowledge that RCS detrending is best applied to datasets with certain characteristics (L52-54), they term individual detrending methods as inappropriate (L64+102). I agree that individual detrending methods are often inappropriate to preserve low frequency trends. However,





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depending on the age structure and the replication of the dataset, RCS can be likewise inappropriate. Some authors of tree-ring based climate reconstructions consider such shortcomings by stating that their record cannot capture millennial scale trends, an information that is usually ignored when incorporating data in larger scale compilations. Multiproxy data collectors are not necessarily dendrochronologists. Thus, it is vital to be more specific when discussing these aspects to keep dendroclimatology credible. (3) This is very correct, we adopted the text accordingly and by including Signal Free Regional Curve Standardization. Minor comments

Comment 6: (1) P3 L61-65 Differences between TRW and MXD data are not discussed in this manuscript. Without testing the hypothesis that MXD is better able to preserve millennial scale trends, I suggest to remove these sentences in order to prevent wrong expectations among readers. (2) Even though it is not tested in the publication, we consider this a very important finding which needs to be considered in the introduction. (3) No Changes.

Comment 7: (1) P3 L74 Inhomogeneous spatial distributions and mixed climate signals are not only problems for the tree-ring component! In fact, I would guess that the average climate signal is much stronger among tree-ring records compared to other archives. (2) Yes this is likely true. However, we have no expertise in assessing the limitations and strength of other archives. Thus we focus only on tree-ring records to perform this analysis. (3) No changes made.

Comment 8: (1) P7 L14 Please define Arctic. (3) Explanation was added.

Comment 9: (1) P8 L41-42 But the trend is not only significant in the global (or NH) mean. Fig. 5 shows that about half of the records exhibit a significant trend at local scale. (3) Changed to “multiple” tree-ring datasets.

Comment 10: (1) P9 L70-72 Instead of presenting the number of overlapping tree-ring chronologies it would be more helpful to report a percentage (although this might be more difficult under a constantly changing number of records). (2) “Although this





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might be more difficult under a constantly changing number of records". We agree and therefore we don't consider to report a percentage to be a useful information here. (3) No change.

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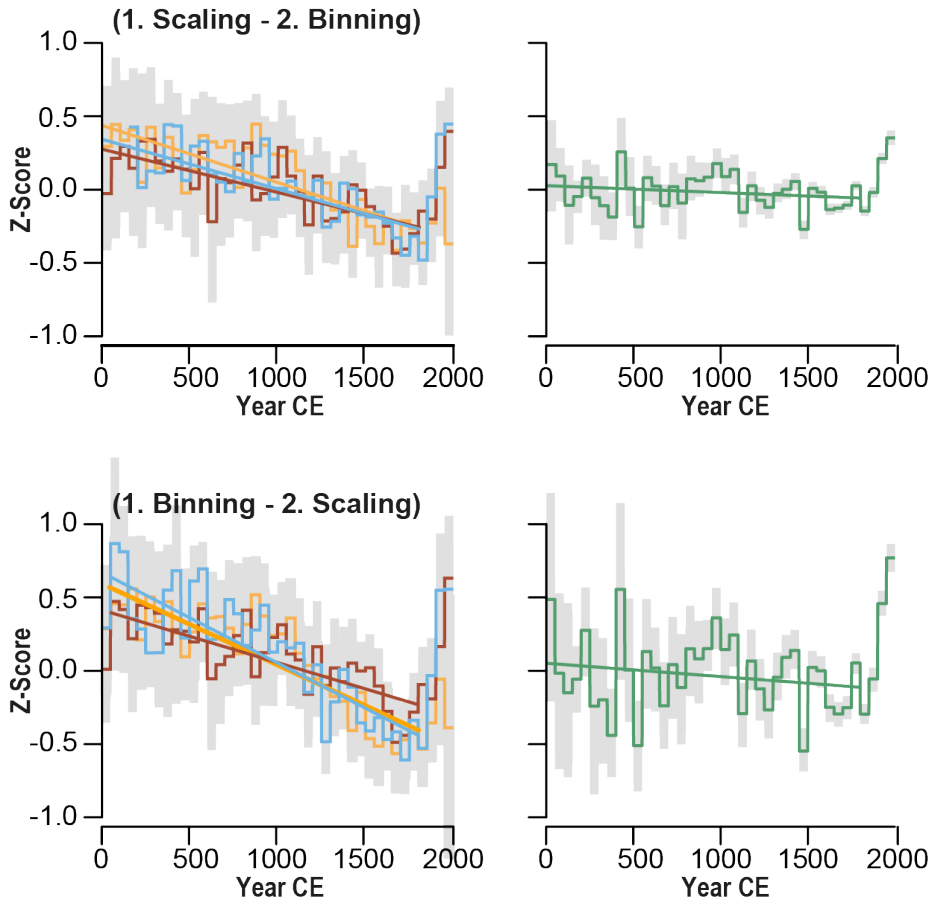


**Fig. 1.** Fig. 1x: Reversing the binning/scaling procedure.

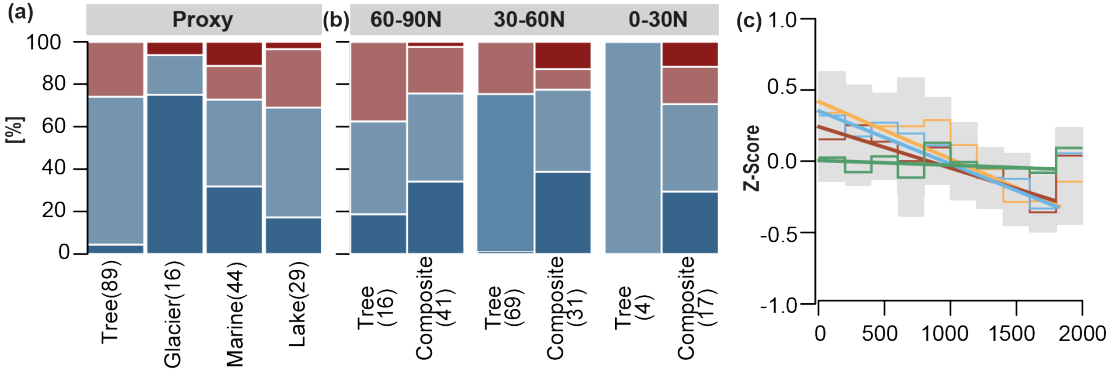


**Fig. 2.** Fig. 2x using 200-year bins.



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