

# ***Interactive comment on “Differing pre-industrial cooling trends between tree-rings and lower-resolution temperature proxies” by Lara Klippel et al.***

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The manuscript "Differing pre-industrial cooling trends between tree-rings and lower-resolution temperature proxies" is a worthwhile contribution to the paleoclimate literature. It investigates a notable lack of millennial scale trend in a compilation of tree-ring chronologies from the recently published PAGES2k database (PAGES2k Consortium 2017). The lack of cooling trend – hypothesized to be a result of orbital forcing – contrasts information from other archives such as marine and lake sediments as well as glacial ice. The authors analyze three potential reasons for the absence of this trend in many of the tree-ring data: (1) a latitudinal or seasonal bias in the tree-ring network,

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(2) an inappropriate detrending applied to many of the tree-ring chronologies and (3) the climate signal strength. The PAGES2k database is the most extensive collection of temperature sensitive proxy records up to date. As such, it is of high relevance for large scale paleoclimate studies, although the selection criteria applied by the PAGES community are somewhat controversial. Quality assessments of this product, beyond the tests reported by the consortium in the Scientific Data study, are topical and of high relevance for all secondary users. If the authors can address the comments listed below, this will be a manuscript suitable for publication in *Climate of the Past*.

The message of the paper is somewhat discouraging: The largest collection of temperature sensitive tree-ring records is unable to preserve millennial scale trends. However, I'm not sure if the main reason is the proxy type (TRW vs. MXD) as suggested early on (P3 L63-64). Much more relevant seems the selection strategy for proxy records in large scale compilations. This study shows that the PAGES approach (i.e. basically maximizing the number of records) is unable to account for limitations of single records and I fully agree that, therefore, this compilation should be used very carefully.

Major comments 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. 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

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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. Marine sediment records with 200 years 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 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. 3) 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, 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.

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Multiproxy data collectors are not necessarily dendrochronologists. Thus, it is vital to be more specific when discussing these aspects to keep dendroclimatology credible.

Minor comments 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. 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. P7 L14 Please define Arctic. 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. 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).

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