Climate of the Past Discussions

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Comment on cp-2021-190

Anonymous Referee #1

Referee comment on "Prospects for dendroanatomy in paleoclimatology – a case study on *Picea engelmannii* from the Canadian Rockies" by Kristina Seftigen et al., Clim. Past Discuss., https://doi.org/10.5194/cp-2021-190-RC1, 2022

Comments on "Prospects for dendroanatomy in paleoclimatology – a case study on *Picea engelmannii* from the Canadian Rockies"

General comments:

This manuscript investigates the potential of dendroanatomical features of high-elevation Engelmann spruce from the Canadian Rockies as paleoclimate proxies. In doing so, the authors develop the longest dendroanatomical dataset for North America. I feel this study very interesting as it not only provides a comprehensive assessment of a relatively new tree-ring proxy type, dendroanatomy, but also attempts to compare dendroanatomical parameters with those obtained using the existing techniques - X-ray densitometry and blue intensity. I also appreciate that the authors test for the resolution related biases in BI and X-ray density and use two climate datasets to avoid biased results. This study finds that maximum radial cell wall thickness and anatomical MXD are the two most robust proxies of summer temperature and may be superior to MXBI and even X-ray MXD, where the latter has long been recognized as the most temperature-sensitive tree-ring proxy. These promising results will encourage dendroclimatologists to use anatomical parameters to better understand regional and large-scale climate history spanning centuries to millennia.

Overall, this study is valuable, although there are a couple of weak parts, that are outlined below.

Major comments:

My primary comments are about the long-term trend analysis in section 3.3. In dendroclimatology, it is widely accepted that many tree-ring parameters, even including dendroanatomical ones (see fig. S7 of Björklund et al., 2020), exhibit age effects which may mask true low-frequency climate variability embedded in tree-ring data. Thus, detrending is fundamental to remove these non-climatic, long-term trends, while it may also be challenged in specific cases. Indeed, it may be difficult to disentangle the long-term climate and age signals in even-aged samples as is the case of this study. Here, the authors try to interpret long-term trends of different parameters based on non-detrended series. Though "a robust picture of long-term trends needs RCS-type detrending" is acknowledged on Lines 578–579, I still wonder whether the analysis of the long-term trend based on the non-detrended data (mixed with both age-related and climatic trends) is appropriate. Moreover, the use of instrumental temperatures here to compare with non-detrended tree-ring data is confusing as non-detrended tree-ring data contain more information than climate.

While the authors' analysis on the "high-pass" time series is good enough (not necessary to change), I would suggest using the detrended dataset for discussing the long-term trends (Lines 578–600), unless reasons and meanings of not using detrending could be sufficiently justified in the manuscript. The signal-free approach (Melvin and Briffa 2008) may be efficient to preserve more low-frequency climate signals. If the signal-free regional curve standardization does not lead to success due to low replication, signal-free approach plus age-dependent spline would likely be useful (see Wilson et al., 2019, Heeter et al., 2020, Wang et al., 2020). I also think even if these detrending methods may result in problematic long-term trends, it is still useful to present/discuss these chronologies rather than the non-detrended series. At least this will show that some tree-ring parameters are likely facing issues of retaining low-frequency signals, and further studies are thus needed. It might be useful to plot the age-related trend of each tree series for each parameter similar to (if necessary, replace) Figure 9, when discussing the success or failure of using these detrending methods. In addition, the reconstruction of Luckman and Wilson (2004) might be used as a reference to assess the long-term trends of detrended chronologies.

Additional comments:

Line 32: Long-term secular trends, please refer to the major comments.

Line 49: It is better to specify what are the “important climate periods”.

Lines 70–71: Perhaps also add Björklund et al., 2020 (see the recommended references in the end).

Line 80: should use “has become”...

Lines 97–102: Try to merge the two sentences. The second sentence is quite similar to the latter half of the first sentence.

Lines 104–105: Avoid saying that 15 trees are well-replicated. A well-replicated dataset may refer to a collection of hundreds of trees.

Line 109: X-ray radiography is not a new technique and Dendro2003 is a system designed about 20 years ago. There are now many advancing techniques providing higher-resolution density data, such as computed tomography (see Van den Bulcke et al., 2019). “the state-of-art” here should be removed.

Line 114: Be careful, *en dash* (–) should be used to represent the range in all cases, rather hyphen (-). Please check throughout the manuscript.

Line 115: What is the meaning of “pivotal locations” here? I think every location lacking a good proxy record can be pivotal for paleoclimatology. Consider removing “pivotal”.

Line 133: Try to move the arrow a little to indicate the correct location. A bit misleading here.

Line 136: Athabasca Glaciers is not indicated in Figure 1A). Please try to indicate it on the map, or remove the “Athabasca Glaciers” in the figure caption.

Line 145: It is better to use “immersed” instead of “washed”.

Line 158: The averaged cell wall thickness is not discussed in the manuscript. It is not necessary to keep it here. CWT should be moved to Line 157.

Lines 159–161: What is the tangential width of the measurement window? The 75th percentile of what values? Are only the 75th percentile values used or 0–75 percentile used? Please specify. In addition, by delimiting the 20 um bands some tracheids would be separated into different bands, I wonder how the CWT was obtained? It seems hard to measure “two radial and two tangential cell walls per tracheid cell” if tracheids are separated. Perhaps more details are needed so that the experiment could be repeated.

Line 179: Should indicate the version of CooRecorder.

Line 197: Figure S3 is not mentioned anywhere in the manuscript. Perhaps need to refer to Figure S3 here and re-order the supplementary figures.

Lines 204–205: The justification for not using RCS is not convincing enough. In my view, RCS works efficiently in cases where dead trees are also included, as it could avoid the “segment-length-curse”. If RCS does not work for the 15 living trees, the low sample replication and un-uniform growth patterns are more likely the reason. So, consider clarifying here that low replication hampers the use of RCS. I also suggest giving some supplementary graphics of RCS chronologies to explain why RCS is not suitable. In line with my major comments, it is worth trying signal-free RCS and signal-free age-dependent spline smoothing as well.

Lines 213–215: Is there a particular reason why the robust mean is not used here? Specify if possible. However, it is not a big problem. It is better to use “detrended data” (or “Spline smoothed data”, if a second detrending method is used; see major comments) in the manuscript because some medium-frequency signals may still be retained by using the 35-yr spline smoothing. “High-pass filtered data” sounds like all low frequencies are filtered out.

Lines 220–221: Please avoid writing “sufficient sample depth” here. The minimum sample depth is only 9, which even doesn’t lead to an EPS>0.85 for many parameters according to Table 1.

Line 229: Caution, the term “cross-correlation” is wrongly used in this manuscript. Generally, in statistics, the term “cross-correlation” represents the lagged correlations between time series, rather than correlations across time series. “Pairwise correlation” should be used in the entire manuscript.

Line 241: The correct citation should be “St. George and Luckman (2001)”. Change it also in the reference list.

Line 245: Citation or URL of Meteorological Service of Canada should be added. In addition, I couldn’t find the gridded data spanning 1895–present from the Meteorological Service of Canada. Where the data could be accessed?

Line 264: What is the time period used to calculate the r bar and EPS? The period 1585–2014 here is not consistent with Line 219 which describes 1700-1994 is used for the subsequent analysis. Please be consistent.

Line 266: If there is only one study cited here, the sentence should be: “with a previous study...”

Line 272 and Table 1: How the n for EPS = 0.85 (the last column of Table 1) is estimated? Some n is even greater than the actual number of samples. I guess "n for EPS = 0.85" is calculated based on the rbar and the equation of EPS. Please clarify this somewhere perhaps with an equation, e.g., at the bottom of Table 1.

Lines 301 and 414: See the comment for Line 229.

Lines 336–337: Should use "The first two components together represent 68.1% of the total variation". Should also clarify what correlation is used, Pearson's r?

Lines 339, 390, and 418: see the comment for Lines 213–215.

Lines 364–366: Perhaps also useful to compare the seasonal responsive window with *Picea* species in the North American continent. For example, black spruce in the eastern North American boreal forest, in similar latitudes.

Line 391: "Monthly or seasonally averaged temperature".

Lines 411–413. Besides the low measurement resolution, the color sensitivity of the BI method may also affect the signal strength of MXBI to some extent. It is hard to ensure that all the measured wood cores are completely free of color biases. It is thus highly appreciated to use a few sentences somewhere to illustrate that weaker signal strength may also result from the color sensitivity of MXBI even for unstained living trees, see Wang et al., 2020. This is a fair discussion about the BI method.

Line 430: consider referring to Figure S3 after “in the widest rings”.

Line 439: r^2 should be used instead of r2. Sometimes R^2 is also used in the manuscript. Please keep the expression consistent.

Lines 485–487: Consider simplifying the sentence: “were further assessed by a split-period calibration procedure (1901–1948 and 1949–1994)”.

Lines 488–489: Refer to the major comments.

Lines 513: Since the r^2 distribution consists of 1000 values, it is better and more logical to perform some statistical test (e.g., two-sided student’s t) to show whether correlations of different parameters are similar or not.

Line 516: Figures 7–9 were mentioned only once each in the main manuscript. Maybe should consider moving them to the supplementary material. In addition, “correlated width” should be changed to “correlated with”.

Line 530, figure 6: the top-left annotations appear not complete. Only Max. radial CWT in A) and only aMXD in B)? Since aMXD and X-ray MXD are more directly comparable, why they are plotted in two separate plots? Perhaps show chronologies using either signal-free RCS or signal-free age-dependent spline here, after the major comments are taken into account.

Lines 550–611: please refer to the major comments.

Line 560: Should use “lower frequencies”.

Line 625, Figure 9: Why JJA temperature is used here? Ring width contains JJ signal and density parameters contain JA signal.

Line 655: Please remove “the state-of-art”.

The reference list: check the format on Lines 729–731; Line 745: “IAWA J”; Line 755: “Science”; Line 795: remove “Verona”; check Lines 804–806; Are Lines 829, 832, and 870 necessary? Line 864: volume and page numbers should be added.

References cited in this review:

Björklund et al., 2020. Dendroclimatic potential of dendroanatomy in temperature-sensitive Pinus sylvestris.

Heeter et al., 2020. Late summer temperature variability for the Southern Rocky Mountains (USA) since 1735 CE: applying blue light intensity to low-latitude Picea engelmannii Parry ex Engelm

Luckman and Wilson, 2004. Summer temperatures in the Canadian Rockies during the last millennium: a revised record.

Melvin and Briffa, 2008. A “signal-free” approach to dendroclimatic standardization.

Van den Bulcke et al., 2019. Advanced X-ray CT scanning can boost tree ring research for earth system sciences.

Wang et al., 2020. Temperature sensitivity of blue intensity, maximum latewood density, and ring width data of living black spruce trees in the eastern Canadian taiga.

Wilson et al., 2019. Improved dendroclimatic calibration using blue intensity in the southern Yukon.