

## ***Interactive comment on “Sampling density and date influence spatial representation of tree ring reconstructions” by Justin T. Maxwell et al.***

### **Anonymous Referee #2**

Received and published: 4 June 2020

The work by Maxwell et al. explores whether an improvement of the tree-ring based Living Blended Drought Atlas (Cook et al., 2010) can be achieved over the Ohio River Valley, US, by increasing the density of the proxy network, as well as incorporating a broader range of tree species. The work also briefly assess whether including the last decades in the calibration/validation exercise might change the performance of the reconstruction models.

Overall I find the ideas of this work compelling, and thus I regard the results being of general and international interest. The data is treated with more or less standard methods within the field of dendrochronology and the analyses appear to be sound. Moreover, I find the idea of combining multiple species to obtain a more robust reconstruction compelling. Although the study has a sound rationale and execution, the

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value gained by the authors' approach appear to have had marginal benefits. In light of this, I miss a discussion on quality versus quantity of predictors in state-of-the-art field reconstructions. Listed below, are a few more specific comments which I hope will help the authors improve the final manuscript.

Specific comments:

P1/L32: "By sampling tree in 2010 [. . .]" reword to "By extending the calibration period to 2010 [. . .]" (suggestion)

P2/L50: Oliver et al., 2019 is missing in the reference list. Also, tree-ring based drought reconstruction are not restricted to the mid-latitudes and certainly not only to US (which is somehow implied by the references the authors cite)

P2/L54: "[. . .] creating a 2.5° x 2.5° reconstruction" was it not a 2° x 3° PDSI grid that was used in Cook et al., 1999?

P2/L55: "The NADA produced multiple centuries of both spatial and temporal data of drought variability" remove either "multiple centuries" or "temporal" – its redundant to have both

P3/L81: "Yet, developing a reconstruction assumes that this climate-tree-growth relationship is stationary over time. This assumption was generally true in the early development of the field of dendrochronology (ca. 1920s–1950s; Fritts, 1976). However, as human activities drive the Earth's climate system into historically unprecedented, and potentially non-stationary and non-analogous conditions (Milly et al., 2008), exceptions to this assumption have emerged." Please rephrase, it's unclear and contradictory. By pointing out that the system is stationary between 1920s-1950s the authors also admit that the relationship is non-stationary.

P3/L86: "Changes in the drought signal recorded by tree rings have been established only recently [. . .]" Do the authors refer to the midwestern US? If so, please be more specific.

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P4/L97: "... if the year when trees are sampled influences the climate reconstruction" This sentence is awkward, please rephrase. It is not the year when the trees are sampled, but rather the period that is covered by the calibration period that might influence the reconstruction skill.

P4/L98: "We calibrate the reconstruction with recent (post-1980) radial growth and climate data..." Please rephrase. It is not the reconstruction that is calibrated, but the tree-ring data that is calibrated with climate data to obtain the reconstruction.

P5/L126 "We used the list method to visually crossdate all samples, and then the program COFECHA to statistically verify the crossdating" (suggestion)

P5/L147: indicate the period for the correlation analysis, and also the significance level applied in this screening

P6/149: what is the rationale behind using a 250-km search radius? Was it selected based on the spatial characteristics of regional drought climatology observed in the instrumental data?

P6/L150: it should be mentioned that a dynamic search radius was used to produce LDBA, with the requirement that at least five chronologies had to be located around each grid point. By eyeballing the very sparse tree-ring network in fig 1A I would assume that the search radius might even have been larger than 450 km across the ORV region. Please check if this is the case, and clarify in the text.

P6/L151: did the authors also consider lagged associations between tree-ring and drought data? This has been done in LDBA (i.e. tree-ring data year  $t + 1$  were considered in the reconstruction of drought in year  $t$ ), meaning that there were actually potentially twice as many predictors of drought at each grid point compared to the number of tree-ring chronologies located around each grid. Also, were there any requirements about the minimum number of chronologies to be included in the predictor pool for the new ORV reconstruction?

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P6/L161 and P9/L239, L295: The spectral properties of the resulting hydroclimate reconstructions will be affected by the way the short-lag autocorrelation structure in the tree-ring data is treated. If I am not mistaken, for the LDBA reconstruction a low-order AR model was fitted to both the instrumental and tree-ring series to correct for the mismatch in the short-term autocorrelation. The prewhitened time series were then used to test the association between drought and tree-growth and to build the regression models. The autocorrelation of instrumental data was then added back to the final tree-ring reconstructions of drought. It should be mentioned if a similar approach was adopted also in this study.

P8/L220: “The ORV reconstructions were shorter in length (maximum of 343 years) compared to the LBDA reconstructions (maximum of 2,006 years) due to each grid reconstruction having a smaller search radius (250 km vs 450 km) for chronology inclusion.” This sentence needs to be rephrased. The ORV reconstruction is not shorter because of a smaller search radius, but because the temporal extension of the tree-ring network was more limited than in the LDBA.

P9/L248: Not sure I understand how the beta-weight values for the different species were obtained. Are these the loadings from the PCA?

P11/L280 “compared to”

P11/L283: “multiple gridded reconstructions” perhaps “multiple grid points” would be better suited here

P14/361: “[. . .] calibrating our models “ do the authors mean validating?

Conclusions: I am missing a sentence or two about future prospects/possibilities of extending the newly sampled data in the ORV region back in time.

Figure 1: please add a scale ruler for reference. Also, it might not be clear what the rectangle in the figure represents.

Figure 4: the spatial patterns in the ORV and LBDA reconstructions look pretty similar

to me. I would therefore be careful to conclude, based only on this plot (as well as figs 1-3 in the supplement), that the ORV reconstruction better match the distribution of soil moisture values and the spatial patterns of the instrumental data compared to the LBDA reconstruction” (L233). The authors need to perform some additional analysis to support this conclusion. For instance, the authors could compute point-by-point correlations between all possible pair of grid points in the instrumental data, ORV and LBDA, respectively, and then plot the correlation as a function of distance between grid points (correlation decay distance). If the spatial characteristics of droughts in the ORV reconstruction is indeed more accurate than in the LBDA, then the CDD of the ORV would be more similar to instrumental data. The slope of the correlation vs distance curve would be much less steep for the LBDA reconstruction, because of higher spatial autocorrelation

Figure 5: the information in this figure loses some of its value if not compared /validated against the spectral properties of the instrumental data. This could be done by restricting the analysis to the modern period when also instrumental data is available

Figure 6: please indicate in the different figures whether the flips refers to wet, dry or total flips.

Figure 8: add the periods for calibration and verification either in the figure or in the caption. Also, the figures is not easily interpreted. I suggest the authors add a third column where the differences/residuals between ORV and LBDA calibration and verification statistics are shown.

P7/L200 mentions that the 1941-1980 period was used for validation, while in fig 9 caption it says that calibration period ended 2010. Please clarify.

Not all the text is visible in the supplemental Table 1. The timespan of the chronologies should be included. Also, the state abbreviations would probably be meaningless for most of the international readership (at least they should be defined in the caption if the authors decide to keep them)

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There are two figure 3 in the supplement

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