**Climate
of the Past**

Discussions

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

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We would like to thank the Referee for the constructive review. The feedback provided will help us to improve the manuscript. Written below are our point by point responses to the Referee's comments. Our responses are below each comment and are the changes we propose to the manuscript based on the Referee's comments. The revised version of the manuscript will be prepared based on the decision of the Editor.

Anonymous Referee #2

COMMENT: 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 in-

corporating 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 re-construction compelling. Although the study has a sound rationale and execution, 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.

RESPONSE: Thank you for the general positive response. We would argue that while the patterns are generally the same, the difference in extremes make a big difference in our understanding of past extremes in hydroclimate. We will make this point clearer to ensure readers will understand the importance of our findings. Part of this expansion will consist of broadening our discussion about quantity and quality of gridded reconstructions.

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

RESPONSE: We will make this change.

COMMENT: 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)

RESPONSE: Thank you for catching this, we will add Oliver et al. 2019 to the reference list and ensure we cite a better representation of articles that are beyond the US.

COMMENT: P2/L54: "[...] creating a 2.5âŮęx 2.5âŮęreconstruction" was it not a 2âŮęx

3âŮęPDSI grid that was used in Cook et al., 1999?

RESPONSE: Yes, you are correct. Thank you for catching this, we will make the change.

COMMENT: 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

RESPONSE: We will remove "temporal"

COMMENT: 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.

RESPONSE: Thank you, our intention was to highlight when this work was generally being done but we see the confusion now and will reword to improve clarity.

COMMENT: 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.

RESPONSE: We were referring to a changing signal in drought in general. While there has been a lot of research on changing temperature signals, that is not the case for hydroclimate variability. But yes, the documentation has been recently in the midwestern and eastern US. We will reword to improve clarity.

COMMENT: 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

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trees are sampled, but rather the period that is covered by the calibration period that might influences the reconstruction skill.

RESPONSE: Great point, we will make the change.

COMMENT: 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.

RESPONSE: We will reword.

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

RESPONSE: We will make the suggested change.

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

RESPONSE: We will make the suggested change.

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

RESPONSE: We tried a few different radii, but 250-km worked well with the density of our tree-ring network. Basically, the density determined how small the radius could be. If we had an even denser network, we could do a smaller search radius. Similarly, a less dense network would require a higher search radius. We will justify this decision in the resubmission.

COMMENT: 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

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would assume that the search radius might even had been larger than 450 km across the ORV region. Please check if this is the case, and clarify in the text.

RESPONSE: This is an excellent point and thank you for catching our mistake. We will look into the actual radius of the LBDA for the study region.

COMMENT: 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 no of chronologies to be included in the predictor pool for the new ORV reconstruction?

RESPONSE: Yes, we did use the t +1 in addition to year t. We will make sure to add the needed text in the resubmission. We did not have a requirement of minimum no of chronologies but used the EPS of 0.85 to determine how far back the reconstructions could go. All gridded recons had more than 5 chronologies in the calibration period. We will add text about this and add a supplemental figure showing the number of chronologies used in the common period for each gridded reconstruction.

COMMENT: 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.

RESPONSE: Thank you for this important point. Yes, we followed the exact methods

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for the LDBA reconstruction. We will be sure to add this information into the text during the revision.

COMMENT: 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 LBDA.

RESPONSE: We understand your confusion based on how the sentence was written. We were trying to say that a very old chronology can be used in multiple grids that are quite far away with a larger search radius. The baldcypress in Missouri, for example, allowed many of the gridded reconstructions to go back much further in time for the LBDA. But yes, your point is also true. We will make sure to rephrase to increase clarity.

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

RESPONSE: Yes, thank you for pointing out this confusion. These are indeed the loadings from the PCA. We will edit this text in the resubmission. However, in thinking about this, we will add a 2nd panel that also shows the correlation between each chronology and the instrumental PMDI.

COMMENT: P11/L280 "compared to"

RESPONSE: We will make this change

COMMENT: P11/L283: "multiple gridded reconstructions" perhaps "multiple grid points" would be better suited here

RESPONSE: We will make this change.

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COMMENT: 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.

RESPONSE: We do mean calibrating because we are not including years up to 2010. But it is the validation statistics that change. We will rephrase to increase clarity.

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

RESPONSE: We will make these changes.

COMMENT: 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 figs1-3 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 gridpoints (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

RESPONSE: It is more of the differences in extreme values rather than the spatial pattern. However, we like your suggestion of the correlation decay distance and will explore it in the resubmission.

COMMENT: 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

RESPONSE: Thank you for this point. We will either change the period of analysis or add a panel showing the data between all three during the period of instrumental data.

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

RESPONE: We will make this change.

COMMENT: 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.

RESPONSE: We will make these changes.

COMMENT: 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)

RESPONSE: This is a comparison of the validation statistics between reconstruction models that ended in 1980 and in 2010 to see how the statistics changed. We will ensure the text in line 200 is clear in the resubmission. Thank you for the suggestions for supplemental table 1. We will make those changes.

COMMENT: There are two figure 3 in the supplement

RESPONSE: Thank you, we will correct the mistake.

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