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Interactive comment on "Bottomland hardwood forest growth and stress response to hydroclimatic variation: Evidence from dendrochronology and tree-ring δ^{13}C values" *by* Ajinkya G. Deshpande et al.

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The outstanding request I make, that will require more substantial work, is that your calculation (and associated analyses) be switched to using a conventional big delta D13C carbon isotope discrimination rather than reporting small delta d13C values that were corrected with a pseudo-discrimination value.

Authors' Response: We agree that switching our carbon isotope results from δ13C to discrimination (Δ13C) is a more robust approach than the pseudo-correction method

that we had used earlier. Consequently, we have now switched all our calculations and analyses to Δ13C notation. Since the effect of declining atmospheric δ13C signature is relatively small over the study period, the conversion of our isotope measurements to Δ13C did not change the strength of relationships between tree-ring C isotope values and climate or ring-width index. However, we are now replacing the plots and related text with Δ13C.

Lines 173-174: ARSTAN produced three detrended chronologies (Standardized, Residual and ARSTAN). To be clear, please state that you used the ARSTAN chronology, correct?

Authors' Response: Edited to "The final standardized ARSTAN (A) chronology (ring-width index (RWI)) was generated for each site using the ARSTAN program."

Line 181: Analyses, here and elsewhere unless referring to a single measurement or test.

Authors' Response: Changed to "analyses" at all relevant mentions.

Lines 203-208: It would help readers in biogeosciences to use the most common or conventional definition for big delta (D13C) and employed this in their analyses where D13C = (13Cair - 13Cplant)/(1+13Cplant). The original citation for carbon isotope discrimination is Farquhar 1983 (Aust J Plant Phys Mol Biol), but most often cited as the review paper by Farquhar, Ehleringer and Hubick 1989. Either one would be appropriate, in my view.

Authors' Response: Please refer to our first response. This paragraph now reads as: "Atmospheric δ13C depletion trend over the study period was removed from the tree-ring carbon isotopic record by converting carbon isotope ratios (δ13C) to carbon isotope discrimination values (Δ13C) (Farquhar, 1983): Δ13C=(δ13Catm-δ13Cplant)/(1+δ13Cplant) Average annual atmospheric δ13C values from La Jolla Pier, CA, USA (Keeling and Keeling, 2017) were obtained to calculate Δ13C (Table 2)."

Lines 215-216: Obtained from where? Provide source.

Authors' Response: Source added (NOAA NESDIS, 2018) here and in section 2.4.

Lines 245-246: These series intercorrelation values are quite high. What is reported here is not incorrect but it would help readers get a truer sense of the shared variation among trees if you calculated the series intercorrelation after averaging ring-width values within each tree. You can report both values if you wish. Without doing so, calculating intercorrelation values across all series represents variation within and between trees with no viable means for readers to know which was more important.

Authors' Response: A new table with the suggested intercorrelation values has been added.

Line 323: What dry-wet transition? Be more specific.

Authors' Response: The first paragraph of the discussion section has been shortened and edited as follows: "Bottomland hardwood forests in the southeastern United States have been reduced to a small proportion of their original expanse. The hydrology of these wetland forests has been altered due to land use change and river regulation (Wear and Greis, 2002; Blann et al., 2009; Dahl, 2011) and the alteration is exacerbated by hydroclimatic anomalies such as droughts and floods (Ferrati et al., 2005; Erwin, 2008). These disturbances coupled with topographic heterogeneity cause some portions of these riverine wetland forests tend to be drier than others." The term dry-wet transition has been deleted.

Lines 327-329: I did not see evidence that fully tested this hypothesis. The detrending methods used are not incorrect for comparing climate responses, however, there may be very different raw tree growth rates among stands that could help shed light on the sufficiency of moisture availability for growth. This can be assessed using "RCS" type methods that detrends each site by the age-specific ring-width growth or age-specific basal area increment growth across all trees and stands. Controlling for cambial age

is especially important when investigating growth rates of relatively young trees like those in this study. I am not saying to your or the editor that you should get rid of your current detrending methods – I am saying that you should employ another set of analyses noting whether or not the raw growth rates among stands corresponds with the differences in climate sensitivity and carbon isotope results you show.

Authors' Response: Thank you for this very useful suggestion. After considering your suggestion about adding an age-specific ring-width index, we employed RCS detrending as given by Briffa et al. (1992) using the method specified by Biondi and Qeadan (2008), which controls for cambial age. We have now analyzed our growth-climate and growth-Δ13C relationships using the new ring-width index generated by RCS detrending in addition to ARSTAN. We will add these methods and results to the revised version. However, it needs to be noted that our ring-width indices generated using both the methods were highly correlated.

Line 343: Water-logged soils also can impose physiological stress that is not well measured by stable isotopes, so this statement may be too broad. I think it would be more correct to say that the trees from the wetter sites had lower stomatal constraints on leaf gas exchange.

Authors' Response: Sentence rephrased as suggested.

Line 343: The use of resilience here (and in most papers) is not supported by any sort of physiological definition. It would be more accurate to simply omit this statement.

Authors' Response: We agree with your and the other referees' comments about the use of the term "resilience" in this study and we acknowledge that defining resilience in this ecosystem would require a more detailed approach. Consequently, we are omitting the resilience narrative from this study and will explain our findings as a function of differences in physical/hydrological conditions between sites.

Lines 352-356: This part of the Discussion could be improved by framing these findings within that previous shown for tree growth and carbon isotopes in another riparian oak trees across a continental gradient in aridity (see Voelker et al. 2014 Plant Cell & Environ 37: 766-779). In that paper we demonstrated that the relationship between growth and carbon isotopes changes greatly and potentially switches in directionality depending on site aridity.

Authors' Response: Thank you for pointing us towards this study. It is very interesting to see how the relationship between RWI and Δ13C varies over a large geographical area encompassing a wide distribution range of a species. The manner in which the relationship switches from positive to negative with wetter and cooler conditions is very intriguing. In case of our study, we can see the trend of this relationship change from positive to a flatter slope within the same landscape. We will cite Voelker et al. (2014) to improve this part of the discussion.

Line 358: I am not sure what this means. Are you saying these trees are morphologically different and/or genetically different?

Authors' Response: We have omitted "physiological resistance" from this sentence as the absence of drought-related stress signals at the wet site can be attributed to hydrological differences and higher soil moisture availability.

Line 359: It seems you are referring to drought stress here, correct? Please be specific.

Authors' Response: Please see our response below.

Line 362: Again, do you mean drought stress?

Authors' Response: Please see our response below.

Line 363: Although, if you read Voelker et al. 2014, we found the same trend for trees growing under cool and wet conditions as compared to those trees at warmer and/or drier locations irrespective of waterlogging.

Authors' Response: Lines 352-370 edited to: "Our third hypothesis that tree-ring Δ13C

would have a positive relationship with radial growth holds true under dry edaphic conditions, where drought stress restricts plant growth. Whereas in trees growing in wetter soils, tree-ring Δ13C and radial growth were largely decoupled. Similar differences in the relationship between tree-ring Δ13C and radial growth of the ring-porous bur oak (Quercus macrocarpa M.) have been observed across continental gradients where tree-ring Δ13C correlates positively with radial growth at drier sites, while the relationship is negative under wetter conditions (Voelker et al., 2014). These differences have been attributed to indicators of site aridity (VPD, precipitation:evapotranspiration). A similar relationship has also been observed in pond cypress trees in the southeastern Everglades, Florida, USA (Anderson et al., 2005). While we did not observe a negative relationship between tree-ring Δ13C and radial growth at the wet site, no correlation between the two highlights the beneficial effect of wetter hydrological conditions on vegetation at the flooded site. Consequently, the absence of drought-related stress signals at the wet site is possibly due to supplemental soil moisture availability from flooding. At the drier sites, drought-related lower tree-ring Δ13C values are correlated with slower radial growth, which indicates that moisture deficit causes physiological stress in these trees, reducing stomatal conductance and eventually inhibits growth. Additionally, tree-ring Δ13C and radial growth at the wet site was highly uncorrelated especially during years when growing-season precipitation was more erratic (dry spring followed by a wet summer and vice versa). The drought effect of drier hydroclimatic conditions is ephemeral and less intense at the wet site due to slower depletion of soil water reserves. Therefore, seasonal dry spells slightly reduce tree-ring Δ13C but do not always result in growth inhibition in wetter parts of this landscape due to sufficient moisture availability. We had expected to observe lower tree-ring Δ13C values during extremely wet growing seasons due to flooding stress, but the absence of these signals indicates adaptation to excessive wetness. It has been suggested that wetland species that experience frequent flooding develop adaptive traits that enable rapid reopening of stomata with the recession of flood waters as oxygen availability in the root zone increases (Crawford, 1982; Kozlowski and Pallardy, 1984; Kozlowski, 2002). Consistent with this, our observations signify that trees growing in drier conditions do have a more distinct tree-ring ∆13C-growth relationship as compared to those growing in wet conditions.”

Lines 395-396: This should be more specific than just "tree-ring d13C". The 13C signature of initial radial growth in each year will not reflect spring conditions, but spring conditions could affect the 13C of wood that forms later.

Authors’ Response: Please see our response below.

Lines 397-399: Yes, but it would help to be clear that these results are not evidence of an absence of a signal from the previous year, it just means that the signal from the previous year was likely relatively small compared to that of the current year. This would be expected because the earlywood portion of ring-porous oaks like those of Q, nigra have very low wood density compared to the latewood. Therefore, even if all early wood vessels had a 13C signature purely from the previous year, by compositing with the latewood (from young trees where latewood is a large proportion of the ring), the signal of the previous year would be too small to detect.

Lines 399-401: See previous comment.

Authors’ Response: We completely agree with your point. Rephrased lines 394-401 to: “It is apparent that if wood at the very beginning of the growing season is formed using assimilates from the previous growing season, earlywood tree-ring ∆13C does not have a correlation with early-growing season precipitation from the current year (Helle and Schleser, 2004; Porter et al., 2009; Schollaen et al., 2013). In our study, tree-ring ∆13C is well-correlated with early-growing season precipitation from the current growing season. Although this indicates that majority of annual wood is formed using assimilates from the current growing season, it needs to be noted that earlywood portions of ring-porous oaks like those of Q. nigra have lower wood density (Gasson, 1987; Lei et al., 1996; Rao, 1997). Therefore, by using entire annual ring composites, the relatively small signal from the previous year could be present but not distinctly

detected. Hence, comparing our RWI and tree-ring ∆13C values with previous years’ climate yields no correlation ($p>0.05$) indicating its relatively weak effect.”

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