Biogeosciences Discuss., 12, C3413–C3417, 2015
www.biogeosciences-discuss.net/12/C3413/2015/

Biogeosciences
Discussions
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Interactive comment on "Ideas and perspectives: use of tree-ring width as an indicator of tree growth" *by* R. A. Hember et al.

Anonymous Referee #1

Received and published: 8 July 2015

This paper presents an alternative method for assessing tree-growth sensitivity to extrinsic forcing factors, indicating that current methods are inadequate and are underrepresenting the relationship between tree-growth and changing environmental conditions. The authors propose using a derived biomass number as opposed to ring-width indices to measure growth sensitivity to climate. However, as the manuscript currently stands, the argument for why the absolute-growth rate should be used over tree-ring width is not satisfactory, nor is the methodology clear. The examples used are not straight forward, nor is there a direct comparison between typical dendrochronological time-series analysis and the alternative method. I do not feel that the subject matter addressed in this paper fits the scope of Biogeosciences, as it does not specifically address interactions between different terrestrial spheres. Instead, this paper addresses a methodology used in interpreting the growth response of trees, specifically those methods used

by dendrochronologists. As the authors focus on this fundamental practice of dendrochronology perhaps this paper would be better suited to a different journal, such as Dendrochronologia.

General Comments: The proposed standardization approach uses the mass of carbon gained over time as the metric of growth, whereas traditional dendrochronological practices use annual ring-width measurements. However, the authors rely upon allometric equations and assumptions of wood density to transform the diameter measurements into estimates of aboveground stem biomass. Even locally calibrated equations contain moderate amounts of uncertainty. Within the Jenksins et al. (2004)* database of allometries the R2 values can range from 0.12-1.0, indicating that the relationship between diameter and biomass might not be as straightforward as the authors suggest.

* Jenkins, J.C., Chojnacky, D.C., Heath, L.S., Birdsey, R.A., 2004. Comprehensive database of diameter-based biomass regressions for North American tree species.

This paper challenges a core principle of the dendrochronology methodology, and to fully convince the reader that this new method trumps the traditional methodologies proper comparisons must be made. I would suggest expanding the literature review to include the many works that have addressed this issue, especially those of E.R. Cook. Standardization of tree-ring chronologies has been a contentious issue within the discipline and has been thoroughly addressed in the literature. The author's cite a need to compare environmental sensitivities across studies of tree growth as the motivation for this new standardization technique, but the current methods of standardization already allow for comparison across sites and timer periods. The tree-ring community has largely come to a consensus on standardization practices, and to supplant the current practices this paper would need to be expanded to include and rebut the pertinent literature from which the detrending methods are derived. The authors should consider some of the following articles when expanding their literature search:

Cook, Edward R., and Kenneth Peters. "The smoothing spline: a new approach to

standardizing forest interior tree-ring width series for dendroclimatic studies." Tree-ring bulletin (1981).

Cook, Edward Roger. "A Time Series Analysis Approach to Tree Ring Standardization." Ph.D. Dissertation. The University of Arizona(1985).

Cook, Edward R. "The decomposition of tree-ring series for environmental studies." Tree-Ring Bulletin (1987).

Cook, E. R. Kairiukstis, L. Methods of Dendrochronology in Applications in the Environmental Sciences (Kluwer, Dordrecht, 394 pp.104-123, 1990)

Cook, Edward R., et al. "The'segment length curse'in long tree-ring chronology development for palaeoclimatic studies." The Holocene 5.2 (1995): 229-237.

Cook, Edward R., and Kenneth Peters. "Calculating unbiased tree-ring indices for the study of climatic and environmental change." The Holocene 7.3 (1997): 361-370.

Esper, Jan, Edward R. Cook, and Fritz H. Schweingruber. "Low-frequency signals in long tree-ring chronologies for reconstructing past temperature variability." science 295.5563 (2002): 2250-2253.

Helama, S., et al. "Detection of climate signal in dendrochronological data analysis: a comparison of tree-ring standardization methods." Theoretical and Applied Climatology 79.3-4 (2004): 239-254.

Biondi, Franco, and Fares Qeadan. "A theory-driven approach to tree-ring standardization: defining the biological trend from expected basal area increment." Tree-Ring Research 64.2 (2008): 81-96.

The practice of using tree-ring widths to reconstruct biomass is relatively new. However, the practice of using tree rings to reconstruct climate variability is not. A more thorough inspection of the literature and more clear and concise explanation of the methods used are needed to properly evaluate this technique.

Specific Comments: P. 8345 L. 2: Loptin et al., 2008 did use the cohort comparison approach, but they did a full time-series analysis on the discs and cores that were collected. It does not appear that this analysis was performed in this study, rather the ring widths were later derived.

P. 8345 L. 9: Briffa and Melvin, 2011 and Brienen et al., 2012 are not listed in the bibliography. P. 8345 L. 12-13: “Lastly, the relative sensitivity of standardized w to extrinsic factors may vary with age or size in ways that are not consistent across dimensions.” The standardization process is carried out to specifically account the effects that changing geometry or tree age might have on the underlying signal. P. 8345 eqtn. 1: It is not clear how sensitivity (λ) is derived from equation 1.

P. 8345 L. 18: Possible typo mm sd-1.

P. 8345 L. 25: It would be helpful if the vulnerability and stress-functions were presented in a figure for the reader.

P. 8346 L. 1: I am confused how AGR is independent of biomass and when kg C is used in both instances.

P. 8346 L. 2: What statistical tests were used to determine this and what criteria were used for evaluation?

P. 8346 L. 8: The test used to compare the sensitivities needs to be explicitly stated and reasoning for the very strict p-value, and the p-value itself need to be given.

P. 8346 L. 10: It seems that the data management is rather circular. Ring width (w) was calculated by inverting the allometric equation used to generate the AGR assuming an allometric relationship. These datasets need to be independent of one another if they are to be compared. It would greatly improve the argument if cores were taken and ring-widths explicitly measured for comparison with the AGR. I was expecting a time-series derived from tree rings, but it does not appear as though this analysis was done.

P. 8346 L. 11: Many of the processes used in dendrochronological studies are quite

standard, however the detrending techniques are not. Detrending methods are quite diverse and selected depending upon the question to be answered. To say that equation 2 is a standard equation for all of dendroecology is a bit misleading. However an assessment of multiple detrending methods (e.g. neg. exponential, various cubic smoothing splines, and basic mean) and their respective sensitivities would be useful in this case. However, a similar analysis already exists: Helama, S., et al. "Detection of climate signal in dendrochronological data analysis: a comparison of tree-ring standardization methods." Theoretical and Applied Climatology 79.3-4 (2004): 239-254.

P. 8346 L. 15: A figure showing the data and the age-response function would be useful for the reader. As of now we are taking the author's word that the ring-width estimate is unbiased. If a statistical test or metric was used to determine this, it should be stated.

P. 8347 L. 21: The authors claim that the uncertainty contributed by allometric equations is minimal. A quantification of the uncertainty and it's effect on the growth sensitivity is needed.

Figure 1: Colors should be consistently used to indicate a single variable. Panel (d) does not fit the color scheme used in the previous three panels. Also, it is not clear how ring age was determined.

Interactive comment on Biogeosciences Discuss., 12, 8341, 2015.