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Discussions

Interactive comment on "When trees don't act their age: size-deterministic tree-ring standardization for long-tern trend estimation in shade-tolerant trees" *by* Rachel Dietrich and Madhur Anand

Anonymous Referee #2

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GENERAL COMMENTS

Dietrich and Anand present a detrending method that accommodates tree size and age information to remove ontogenetic trends from tree-ring width series on a Generalised Additive Modelling (GAM) framework. They argue that their framework is especially suited to recover medium frequency climate signals from shade-tolerant species where age is not a good predictor of ring width and demonstrate its skill in recovering a synthetic sigmoid growth signal imposed on ring-width data simulated by the SORTIE gap model for sugar maple and white pine stands. The imposed medium frequency

signal mimics a period of climate fertilization and acclimation during the last century. Using the synthetic data for different thresholds of minimum tree size for sampling, they show that their framework performs similar or better than other established detrending methods such as Regional Curve Standardization (RCS), Basal Area Increment (BAI) and conservative curve fitting. Then they apply their methods to real data and compare them with the RCS. With these two exercises and metrics of model parsimony the authors conclude that their detrending framework based only on tree size or tree size plus age overperforms the traditional methods in removing the ontogenetic trend and recovering the underlying mid-frequency common signal in ring-width series, especially for shade-tolerant species.

The proposed framework contains a sufficient degree of originality and has potential value to study long-term forest growth changes, but the analysis needs to be improved to convincingly demonstrate that the framework works under a range of circumstances (e.g., shapes of the mid-frequency signals, varied proportions of aged/unaged trees, number of sampled trees) both with the synthetic and real-world ring-width datasets. The authors make the comparison with other methods only for the synthetic case and not for the real-world data. The same comparison should be done for the latter too. The use of SORTIE's size-based growth for size-based standardization in the synthetic case sounds circular, as pointed out in the discussion. For this reason, the comparison of the same methods in the real-world dataset is important. The authors should also better discuss what are the potential problems and biases or in which way they improve over methods that perform as well as their framework (RCS and BAI). I recommend major revisions in order to improve (i) application and reproducibility of the method, and (ii) the presentation and discussion of the results.

SPECIFIC COMMENTS

1) Introduction

In the current manuscript it is not clear how the proposed methods solve the problem

presented in Figure 1. Probably, the size-based solution should also be illustrated in Figure 1.

The C-method is mentioned but not referenced in the discussion. It should be mentioned in the introduction and cite the paper that describes it - Biondi and Qeadan 2008.

The use of similar mixed-effect modelling approaches for tree-ring standardization should also be mentioned in the introduction. It is mentioned only in the discussion in Lines 358 and 399.

2) Methods

It is not clear if the standardization using the proposed models is applied based on individual series or based on a model fitted to the cloud of all data and then subtracted from each series (as in Fig 4). Please explain it more clearly.

For the sake of reproducibility, I recommend the authors to present a worked example with the corresponding R code as supplementary material.

It should be explained in the main text how SORTIE simulates tree-ring widths, what is the underlying formulation and the environmental drivers. As a sensitivity test, the authors should repeat the analysis of Figure 2 for an imposed growth decline and vary the shape of the growth increase to linear and present it as supplementary material. It seems that in Figure 3 the standardization models get a more linear-like increase in growth instead of the sigmoid saturating trend imposed on the synthetic data. To clarify this apparent issue it would help if the mean chronologies of each method are shown as an inset for the last 100 years along with the imposed signal. This would make easier to evaluate if the fitted models suffer from end effects.

Compare the same methods for real world data and not just RCS as currently done.

3) Results

I miss a summary table with the main statistics of performance and parsimony when comparing the methods.

Isn't it more logical to start with Figure 3 instead of Figure 2? In this way the reader sees first how the chronologies look like and on what the comparison is based.

In Figure 4 it is clear that the GAM fitting is very noisy at large sizes or ages when there are fewer data points. How much does this noise affect the overall fit? What is the frequency response of the underlying spline in the GAM if any? Melvin et al. 2007 solved this problem by using a time-varying-response smoothing spline, which gets stiffer with age as the data availability declines. Can a similar solution work for this case in the GAM?

What are the different curves in Figure 4 and what are the gray points? It is not stated in the caption. Why the resulting chronologies are not shown in the current results? I recommend adding a figure with the resulting mean chronologies for each method.

Lines 311-314. What is COMBred? This comes out of the blue.

It is not clear what Figure 5 tells. What does the Rsq mean?

4) Discussion

The finding that BAI works for recovering mid-frequency growth signals when only large dominant trees are sampled is interesting because it suggests that this method should be less sensitive to the typical big-tree sampling bias of traditional dendrochronological collections.

The discussion should touch on the potential advantages and shared shortcomings of the proposed methods with RCS and BAI in terms of data requirements and biases. How sensitive are the proposed methods to the proportion of aged/unaged trees in the sample and the number of trees in a site?

REFERENCES Biondi, F., & Qeadan, F. (2008). A theory-driven approach to tree-

ring standardization: defining the biological trend from expected basal area increment. Tree-Ring Research, 64(2), 81-97.

Melvin, T. M., Briffa, K. R., Nicolussi, K., & Grabner, M. (2007). Time-varying-response smoothing. Dendrochronologia, 25(1), 65-69.

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