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Climate of the Past
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Interactive Comment

Interactive comment on "A likelihood perspective on tree-ring standardization: eliminating modern sample bias" *by* J. Cecile et al.

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General comments:

The title of this paper claims to eliminate "modern sample bias". Modern sample bias arises from sampling trees at one point in time (e.g. cores are taken from living trees) in a situation where the mean growth rates of trees vary independently of climate forcing. The elimination of "modern sample bias" from RCS chronologies would be extremely useful.

To be of value to dendroclimatology this elimination has to be achieved while generating a chronology that includes the long-timescale variance preserved by RCS (contained in the changing index series means over time). The authors do not demonstrate that

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this basic requirement is met by their “fixed effects standardization”. This omission needs to be corrected before the paper is suitable for publication. The paper will be much improved if the authors demonstrate the value of their approach using practical examples preferably based on published chronologies (e.g. Torneträsk or Yamal).

Curve-fitting standardization methods generate series of tree indices for each tree with the same mean value (usually 1.0). This rescaling removes the effects of “differing contemporaneous growth rates” from each tree and removes the mean growth rate of trees over time from the chronology. This effectively high-pass filters the chronology and is a serious problem where the preservation of long-timescale tree growth information is required. Curve-fitting methods eliminate any differences in mean-tree growth rates and thus do not suffer from “modern sample bias”.

The RCS method was introduced to try to overcome the high-pass filtering problem inherent in curve-fitting methods. RCS retains the relative growth rates of individual trees in series of tree indices. The presumption is that the variation in tree growth rates referred to as “differing contemporaneous growth rates” is random and that having sufficient samples in each year ensures that the means for each year (chronology values) provide an unbiased estimation of variation in the effects of climate forcing on tree growth over time at all timescales.

The ability of the proposed methods to evaluate the difference between additive and multiplicative models is useful. The evaluation of the signal-free method as accounting for an “unbalanced experimental design” again seems to be useful. The proposed methods appear to be flexible and as such may have considerable potential to improve dendroclimatic methods. The value of these methods to dendroclimatology needs to be evaluated in the context of creating chronologies representing tree-growth rates over time. This manuscript needs to demonstrate that the proposed new method can produce chronologies representing tree growth over time.

Detailed Comments:

Abstract: L10 “Including a term for the productivity of each tree accounts for the underlying cause of modern sample bias, allowing for more reliable reconstruction of low-frequency variability in tree growth” - but the mean productivity of all trees in each year is vital to the reconstruction of low-frequency variability (see 4th paragraph above).

L20 “regional curve standardisation is improved” – to make this claim you need to show an improvement to chronologies not an improvement to the model fitting. Also you need to do this using an appropriate data set for which RCS was designed (e.g. containing some sub-fossil material). This conclusion is not demonstrably supported by the results shown in this manuscript.

L22 “modern sample bias produced a significant negative bias” the authors have not shown the slope difference is caused by modern sample bias so the validity of this conclusion is not demonstrated.

P4501 L12 – The “slow-grower survivorship bias” affects the shape of the RCS curve but this shape change is not directly relevant to “modern sample bias”. (Multiple growth-rate based RCS curves can resolve the shape of the growth curves for different growth rates and will enable estimation of the magnitude of this effect). One effect of “slow-grower survivorship bias” is to produce a forest of living trees which, although it represents the mean growth rates of trees at the current time, is missing samples (specifically the fast growing trees from earlier time which became large and died) such that rings which grew in earlier periods taken from these living trees do not represent the mean growth rate of trees in the years when those rings grew. Thus sampling living trees produces systematic bias in the earliest years represented.

L17 – The “differing-contemporaneous-growth-rate” problem generally applies to all trees and sites over all time, manifest by trees having differing growth rates in the same climate and caused by micro-site variation (e.g. some seeds fall on stony ground). In RCS there is a presumption that this is random with respect to calendar year and ring age and can be removed simply by having sufficient and well distibuted sample replication over time. Care needs to be taken to ensure sample homogeneity over time (e.g. with respect to changing aspect, altitude or soil type) and the presumption is that this avoids any systematic bias. If diameter (or size) based sample selection procedures, as typically used in dendroclimatology, are used to sample a group of living trees in the presence of “differing-contemporaneous-growth-rates” a systematic chronology bias can occur in the living-tree section of a chronology.

“Modern sample bias” is thus the result of sampling living trees in the presence of either “slow-grower survivorship bias” or “differing-contemporaneous-growth-rates” (and usually both) and produces a systematic bias whose magnitude does not reduce with increasing replication.

L25 – “only limited correction” not a useful description for a considerable improvement over previously published standardization methods. It is not wise to discard the use of multiple RCS curves so lightly (at least until fixed effects standardization is shown to solve the problem). The type of models described in this paper could be developed to evaluate the use of multiple RCS curves.

P4504 L18 “dendrochronological practice of log-transforming series before analysis” this is rarely used for chronology production. Log transformation tends to overcompensate for the positive skew and cannot handle zero values and does not work well in practice.

L20+ The “persistent differences in growth rates between trees” after age adjustment and over a common period are the “differing-contemporaneous-growth-rates”. The average of the growth rates of trees over any period of time is the low-frequency chronology signal being sought for that period. The “inherent productivity of each tree” could be defined as an absolute value or as a fraction relative to the mean growth rate of all trees (the chronology signal) over the common period for that tree. “T” could be defined so as to contain the long-timescale chronology variance although in this paper it appears not to.

P4505 L7-23 “From this perspective, it is clear that differing-contemporaneous-growth-rate bias (and thus modern sample bias) is an omitted variable bias!” The absolute values of growth rates are an important contribution to the chronology mean and not a systematic bias. The growth-rate differences between trees in any year are part of the noise to be removed by the averaging of sufficient samples. The systematic bias created by sampling living trees is the problem (modern sample bias) to be reduced or removed.

L25 - The additive model is generally only used with power transformation in RCS (see Cook and Peters 1997) or with MXD data (e.g. Grudd 2008).

P4508 “Competitive dominance” - The natural “self thinning” has little effect in the dendroclimatic context – only relatively older trees that have successfully passed through the early stages of competition are sampled. The evidence is that slow-growing trees tend to survive longer than fast-growing trees in dendroclimatic samples - although this effect is relatively small.

P4511 “Big-tree selection bias ...” – building an RCS curve requires that growth rings of the same age are distributed over time and RCS cannot be used on an “even-aged stand”. Sampling trees that died at random dates (e.g. typical sub-fossil collections) overcomes the sampling bias but cannot be applied to the living-tree portion of the chronology.

P4512 Explaining the error in modelling “Gita” is not the primary objective because the variable of interest is a “Tt” which contains long-timescale variance. The standardisation objective is to find the mean growth rate of trees in each year and not to explain the variance of tree rings. This paper needs a clear statement of the criteria for measuring the success of removing the effects of “modern sample bias” whilst retaining mean tree-growth rates.

P4514 L5 Flat detrending is rarely used as it does not correct for the change of ring width with tree age.

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P4514 A comparison between sample chronologies created using SF RCS and equivalent fixed effects standardisation model would be useful – results should be the same if RCS curve smoothing is excluded.

P4515 L22 - RCS smoothing "in part this was for convenience". If you have sufficient trees (2000+) the RCS curve can be smooth enough not to need any smoothing. With fewer trees there is noise originating mainly from the climate signal. Tree growth in an unchanging climate without noise is expected to be smooth so we can undoubtedly justify smoothing to correct for lack of trees (although negative exponential is not usually suitable - see Melvin and Briffa 2007 Dendrochronologia, 26 (2) for suggestions as to what is required of smoothing).

P4517 "Exploring published ring-width data" - Classic RCS (e.g. Briffa 1992) requires a chronology much longer than the age of individual trees (more specifically a chronology containing data from sub-fossil trees). Using RCS methods on chronologies composed solely of living trees sampled at one point in time, where the climate signal distorts the RCS curve is problematic. The signal-free method can reduce this problem provided there is a sufficiently wide variation in tree ages.

It may be that many of your selected sites are not well suited to RCS processing. You would be better using far fewer and more appropriate sites. Including a couple of well replicated sites containing sub-fossil trees and well replicated living-tree only sites would be sufficient. If you are correcting "modern sample bias" then your method will not change the sub-fossil portions of the chronologies. Demonstrations should include comparison of chronologies with old and new methods. Torneträsk and Yamal TRW would be suitable sub-fossil data sets (available from http://www.cru.uea.ac.uk/publications/papers) .

P4519 L19 - Choosing a model on the basis of explaining "G" does not measure the quality of the chronology – the "correction" needs to produce a more accurate assessment of the long-timescale chronology variance in order to be useful.

P4520 L12 - The ratio comparison detects the change in chronology represented by explaining “I” in the modelling and this may not be change related solely to “modern sample bias”. If you have sufficient sub-fossil samples in a chronology the shape of the RCS curve will not change due to the presence of “modern samples”. The period of changing living-tree counts can be used to isolate the effects of “modern sample bias” on the chronologies.

Again, some sample chronologies need to be shown. The difference created by explaining “I” in the modelling needs to be clearly demonstrated (e.g. low-pass filtered for clarity) in chronologies.

P4521 l2 “Contrary to prevailing opinion” - It has not been shown that the change created by the correction is solely related to “modern sample bias” and it remains (until demonstrated) possible that something else is responsible.

L8 – “D’Arrigo et al. (2008) suggest that ...” does not seem to be right as modern sample bias is associated solely with RCS and divergence is generally associated with curve-fitting chronology construction methods.

L10 – “The generally negative trend” is worrying – no examples are shown and no suggestion as to why other methods produce observations with opposite sign.

L15 – “Regional curve standardization is a biased implementation of signal-free standardization, ..” only if you do not have a set of trees with a wide enough time range. There is a need to distinguish in your discussion between “systematic bias” and “random noise”.

L20–L5 next page “The estimates of I are ..”. This is very speculative and not shown in the paper.

P4532 L21 “signal-free standardization results in an unbiased least-squares estimate” not least-squares since the convergence criterion we use is based on minimizing least absolute differences.

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P4540 Melvin 2012a and 2012b are same paper.

Thomas Melvin 30/08/2013

Interactive comment on Clim. Past Discuss., 9, 4499, 2013.