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Interactive comment on "How large are temporal representativeness errors in paleoclimatology?" *by* Daniel E. Amrhein

Anonymous Referee #2

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The paper by Armhein addresses an important topic in palaeoclimatology, namely that of time representativeness of proxy data and the subsequent use of that data to compare between models and other data sets. I found the paper very hard to read and very technical, especially for COTP, though I would consider myself at the more technical end of the audience for this type of paper. I wonder if this work might be served better by publishing the mathematics in a more theoretical journal and subsequently interpretation and case studies in COTP. I found the figures well-presented but hard to interpret, and I found the table of notation (Table 1) particularly unhelpful; it looks like it was put together in 5 minutes.

The key concept seems to revolve around the idea that there is a target measurement x which is desired to be averaged over temporal period tau_x, but the scientist only

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Discussion paper

has access to an observation y which is averaged over an interval of tau_y. The origin of both the target and the observation is the ‘true’ time series r(t). The paper’s goal seems to be to estimate the error in using y to estimate x. I found this slightly strange, for two reasons. The first is that x and y are assumed to be centred at different time points. It’s not clear to me why the centring needs to be (that) different. The second is that, if I were doing this, I would try to estimate r(t) as well as I possibly could, and then create smooths from this to allow me to compare with other time series. Perhaps this isn’t possible, but I couldn’t see why.

I wonder if some of these problems might be solved by having a maximally simple running example at the start that makes clear the novelties of the approach using the bare minimum of maths/notation. That seems to be what has been attempted in Figure 1, though this just raises further questions. The light grey line appears to be r(t) (this isn’t mentioned?) which is unobserved. Labelling the vertical axis as r(t) is slightly confusing since y and x are not values from r(t) but averages from it. We would like to get x from y where y is centred on t minus Delta over period tau_y and x is centred on t over period tau_x. The key quantity theta is defined as the different between x and y, and most of the maths proceeds with the assumption that r(t) is weakly stationary. At this point I find myself a bit stuck as to the appropriateness of how this works. I don’t think I’ve ever seen a situation similar to this. Aside from the stationarity assumption (which might hold locally?) in all the cases I’ve worked we have multiple y observations covering the spanned period. (I suppose it might be more realistic if tau_x < tau_y as often we’re interested in estimating a climate value at a more precise time point than the observations).

I’m further confused by the lower panel of Fig 1 which I initially assumed was the distribution of the error described by tau_x (they nearly match in magnitude) but is actually a completely different measurement uncertainty. I don’t think that panel is helpful here. However, the legend points out that the uncertainty in theta is characterised by: sampling procedures, variability of r, archive smoothing, and chronological uncertainty. I totally agree with these fantastically important points. It's a strangely important sentence to appear in a figure caption. Having the lower panel display just one of these is confusing.

In Section 2 the paper dives into a lot of technical detail which I followed mathematically but quickly lost all the interpretation. I was hoping to pick things up again in Figure 2 which shows the frequency representation of the boxcar function at the top and the power transfer function at the bottom for assumed values of Delta, tau_x, and tau_y. This seems to show which frequencies are contributing most to the TR error. However I've read the bullet points in Section 2.3 about 5 times now and I can't follow them. They talk about certain summary statistics which aren't shown in the Figure (226 and 1325 years?).

Figure 3 rescues things a little bit by being a bit clearer but even then it doesn't introduce the 4 panels or the colours so I can only make good guesses as to what some these plots are showing. The top two panels are particularly helpful. Unfortunately without any further interpretation of Figures 2 and 3 I was completely lost beyond Section 3.1, which is a big shame. I really wanted to follow this.

Some minor points: * I got very confused about the role of tau_a. I thought the archive smoothing was represented by tau_y as that is what we are observing? * Section 2 I thought was mis-named. It's not really a statistical model in a generative sense. It's more a collection of useful summary statistics that can indicate problems in temporal representativeness. * The glossary in Table 1 needs at least a sentence of interpretation for the more complicated quantities. Saying e.g. H(v) represents the power transfer function is fine, but what would be more useful is to say that high values of this for frequencies v indicate a large contribution to the variance of theta * P6L11 "archives". Also this sentence is quite unclear and where my confusion about tau_a stems from * Eq 18 starts to get very confusing when the double square brackets are used to indicate expectations over different random variables. Perhaps use a subscript?

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