Climate
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Discussions

# Interactive comment on "Does a proxy measure up?: A framework to assess and convey proxy reliability" *by* F. Garrett Boudinot and Joseph Wilson

**Anonymous Referee #1**

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General Comments

The manuscript provides an epistemological discussion about paleotemperature proxies used by earth system scientists. The paper suggests that for proxies geared toward reconstructing past temperature, there should be a more coherent and consistent way to acknowledge the confounding causal factors (CCFs) that potentially complicate all available proxies, such as $\delta$18O calcite, TEX86, and mercury thermometers.

The points are good reminders for paleoclimatologists, and the paper is technically sound and clearly written. Still, I don't find that the manuscript offers any truly novel ideas or any tangible way of tackling the uncertainties in proxy systems. Nor do I see a

clear and unified suggestion for how proxy uncertainties should be discussed in future papers. Most paleoclimatologists are well aware of the shortcomings of the proxies, and researchers are working to incorporate CCFs into Proxy System Models. The paper might be difficult for non-experts to find useful.

Specific Comments

I consider there to be a distinction between "proxy" and "indicator", where proxies offer a quantitative estimate of past environmental condition, whereas indicators give a non-quantitative description of past changes. I think this dichotomy also deserves a place in this discussion. At line 478, I think that by definition, proxies are quantitative because they are substituting for a variable of interest.

Given that the paper discusses the importance of word choice in describing proxies, I'm surprised they used the word "paleothermometer" so freely. In my view, this word and its relatives are sometimes used inappropriately. Its use in this manuscript detracts from the discussion on the understanding of the proxy interpretations. I recommend using "paleotemperature proxy" rather than "paleothermometer" for the very reason they discuss – that there are confounding factors and the proxies are proxies, not old thermometers.

It seems like this paper revisits the utility of transfer functions which has received considerable discussion, in, for example, Journal of Paleolimnology. Consider the numerous transfer functions derived for diatom assemblages – can a single diatom record really be used to estimate salinity, DOC, temperature, phosphorus, etc., or, does this example approach the case where many CCFS are addressed for a single proxy system? I was surprised that the term "transfer function" was never used in this manuscript, given that this is the standard method by how we translate any proxy measurement into paleotemperature estimates.

Along those lines, there are numerous papers evaluating how different assumptions, different statistical methods, independence of datasets, autocorrelation, etc. all impact

reported uncertainties in transfer functions. I suggest the authors incorporate discussion or references to these earlier works. For example:

Telford, R. J., & Birks, H. J. B. (2005). The secret assumption of transfer functions: problems with spatial autocorrelation in evaluating model performance. Quaternary Science Reviews, 24(20-21), 2173-2179.

Telford, R. J., Andersson, C., Birks, H. J. B., & Juggins, S. (2004). Biases in the estimation of transfer function prediction errors. Paleoceanography, 19(4).

Telford, R. J., Li, C., & Kucera, M. (2013). Mismatch between the depth habitat of planktonic foraminifera and the calibration depth of SST transfer functions may bias reconstructions. Climate of the Past, 9(2), 859.

Guiot, J., & De Vernal, A. (2011). Is spatial autocorrelation introducing biases in the apparent accuracy of paleoclimatic reconstructions?. Quaternary Science Reviews, 30(15-16), 1965-1972.

Of particular note is the recent work done by Bronwen Konecky, Sylvia Dee, and many others to develop Proxy System Models (PSM). With a push to incorporate proxy measurements into climate models, it seems timely to discuss how understanding and modeling the CCFs is particularly important for PSM development.

Why is there so much focus given to mercury thermometers, but none given to digital thermometers? While mercury thermometers are described as proxy-like, do the authors suggest there is some way of measuring temperature that is not a proxy? What is the true end member there or does it not exist?

Line 190: I would like to see another example of an inference-constrained proxy to make sure that concept is clear, because it is still not obvious to me after this one example how it differs from the observation-constrained proxy.

Line 342: Measurements do not require external calibration equations. The translation of measurements into temperature estimates do.

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Line 409: "This allowed users to apply d18Ocalcite..." needs to clarify that the use is no longer to estimate past temperatures but to estimate past seawater d18O. They should specify what opportunities and confidence grew from the combining of Mg/Ca and d18O?

In Figure 3b, since the data come from reported uncertainties in the literature, it seems like it would be possible to include values on the y-axis. I would like to see those values and how they compare between these systems.

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