

## ***Interactive comment on “A few prospective ideas on climate reconstruction: from a statistical single proxy approach towards a multi-proxy and dynamical approach” by J. Guiot et al.***

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### **1 General comments**

I am grateful for the opportunity to review this paper since, in doing so, I have (re)read several papers by the same authors that I would not otherwise have read all at the same time. This kind of overview was necessary because the current paper draws on about a decade of work by this group. Therein lies both the potential strengths, but also the grave weaknesses of this particular paper.

These authors are amongst the most ambitious researchers working on quantita-

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tive palaeoclimate reconstruction. They are seeking to combine what can be learnt from mechanistic models (such as vegetation models) with what can be learnt from proxy-based palaeoclimate evidence (such as pollen data from lake cores). Their preferred framework for doing this is the fully-probabilistic modelling framework known as Bayesian inference. In order to use such methods for an enormous problem like the one in the case study developed here, the authors are working right at the cutting edge of what can reasonably be undertaken with modern inference tools and computing power. For this reason, in statistical terms, they are more than a decade ahead of other palaeoclimate researchers, most of whom are using more conventional statistical methods such as regression analysis and are undertaking post hoc comparison and combination of pre-existing reconstructions derived from different proxy data sources or climate models. Consequently, I cannot fault the ambition and far-sightedness of these authors.

My concerns lie in the fact that the authors do not provide enough clarity or enough detail to allow others to be sure what they have done and to reach informed judgements about the pros and cons of the various modelling and data handling choices that they have made. In some cases, we are encouraged to look at their earlier work, suggesting that further details will be found there, but in no case did I find the details on model structure, specific implementation and/or parameterisation choices that I was looking for. This is a real weakness since, if I cannot be sure what the authors did, I cannot be sure whether I am happy or not with anything more than the general approach.

In the present paper, the authors provide reasonable motivation for use of a fully probabilistic framework and outline how the Bayesian framework can be used to update from prior to posterior. In a method paper, however this is inadequate; we really need the detailed nitty gritty of exactly how things were done and why.

All that said, it is pretty clear that these authors have been working on something ambitious and potentially important and I would like to see the material make it to print some how. The authors need to decide whether this is purely a “concepts” paper (as

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the title suggests) or whether it is a “method” paper too. If the former, then the present technical level may well suffice, provided that the examples are carefully selected to explore one idea at a time and that it was made clear that the examples are offered as “proofs of concept” only. If the authors want to provide a methods paper, however, then considerably more technical detail must be offered in a manner and place that is readily accessible. Whichever approach the authors take, I offer below some specific suggestions for improvements.

## 2 Specific suggestions

- The combination of poor English, in places, and the high level of reliance on citing previous work means that we cannot be sure about any of the details of the modelling or implementation. Exploring such issues in the main body of the paper may have been considered off-putting for the majority of CPD readers, but we do need to have them somewhere so that those readers who are interested in the details can implement the ideas themselves if they wish. Thus I suggest that, if this is to remain a method paper, the authors consider using two complementary approaches to documenting the details.
  1. Prepare a technical appendix, written using formal statistical notation, and use it to document every detail of the current modelling setup. This will involve documenting some material that was developed for previous papers as well as the new ideas developed for this one. We need to see a clear development of all of the models used and learn precisely how and why they were parameterised as they were. This will inevitably be long and very technical, but, once it is written, it can be cited and added to each time developments are made.
  2. Release the code used to produce the results reported in the paper. Open-

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source licenses, like GPL, allow the authors full recognition, while also permitting others to see what has been done, to rerun analyses if need be and to add to code if they wish to make developments.

- There is no discussion of chronological uncertainty in this paper. Where does the chronological information come from? Radiocarbon dating, I guess; in which case, how are these data utilised. There must be some interpolation, was this done inside or outside the formal Bayesian analysis? See discussion of Haslett et al (2006) and in Parnell et al (2008) for more on this.
- Throughout the paper, the figures are very hard to interpret due to the poor English in the captions.
- The abstract and the first paragraph of the introduction are very general, but, from the second paragraph of the introduction, focus is on pollen data only with no explanation as to why. For a “concepts” paper this move to the specific should, be left until quite a lot later.
- Why is the general explanation of Bayesian inference provided in a sub-section headed “Europe at the last Glacial Maximum”?
- Lines 1 to 14 on page 105 seem pivotal to our understanding of the methods used, but the English is poor and they are very hard to follow.
- On page 105, in line 16, what is “bijective”?
- Section 2.2 implies that the reconstruction in 2.1 uses BIOME3, but this is not clear. Page 107, line 16, implies that 2.1 uses only pollen data.
- Figs 1 and 2 show relationships between temperature and precipitation and between precipitation and latitude. What is the importance of the linear fits shown on these plots?

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- On page 108, in Equation 1, limits are shown for rejection sampling without any explanation as to how they were selected.
- On page 110, line 21, what is the meaning of the phrase “precipitation and temperature chronologies” It seems to be that precipitation, temperature and chronology were interpolated from New et al (2001). If so, this is a clear example of a place where, in order to assess the method, we need to be told a great deal more. How was the interpolation undertaken? Was it fully integrated into the MCMC or done as a separate step? If the former what shortcomings might this lead to in the posterior reconstructions reported?

### 3 References

J. Haslett, M. Whiley, S. Bhattacharya, M. Salter-Townshend, S.P. Wilson, J.R.M. Allen, B. Huntley, F Mitchell (2006) Bayesian palaeoclimate reconstruction, *Journal of the Royal Statistical Society, Series A*, 169, 3, 395–438.

A.C. Parnell, J. Haslett, J.R.M. Allen, C.E. Buck and B. Huntley (2008). A flexible approach to assessing synchronicity of past events using Bayesian reconstructions of sedimentation history. *Quaternary Science Reviews*, 27, 1872–1885.

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