**Climate
of the Past
Discussions**

Interactive comment on "Bayesian parameter estimation and interpretation for an intermediate model of tree-ring width" *by* S. E. Tolwinski-Ward et al.

Anonymous Referee #1

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1 General comments

It is a pleasure to be given the chance to comment on this paper which is well written and, for those of us interested in using proxy data to make inference about past environments, is a good follow on piece to "An Efficient Forward Model of the Climate Controls on Inter-annual Variation in Tree-Ring Width" (Tolwinski-Ward et al, 2010) in which the VS-Lite model (which is at the core of the work described here) was initially suggested and implemented. The present paper suggests a successful Bayesian framework for estimating the parameters of the VS-Lite model using both simulated (synthetic) and observed tree-ring widths.

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VS-Lite is a simple, mechanistic forward model, chosen for the current work because it can be run quickly enough to allow simulation-based estimates of its parameters. One of the things that is missing from the present paper, however, is a clear statement of the nature and structure of the likelihood implied by VS-Lite. In particular, given that climate is a spatial-temporal phenomenon, we really need an explicit statement early on, eg in Section 2, about how spatial and temporal correlations are represented in VS-Lite. It seems from what is said at the end of Section 4 that spatial correlation is not accounted for in the model, but there is no explicit mention of temporal correlation. Explicit descriptions of this sort, early in the paper, are especially important since the priors used are all independent and so any correlation between parameters can only come from the likelihood (i.e. from VS-Lite).

2 Section-by-section comments

In Section 2.2, we are told in some detail about the ways in which the prior distributions were parameterised. In general this section is very nice, however, the authors should make it explicit that these priors are species dependent and state clearly what species of trees they are likely to hold for. There also seem to be some important typographical errors in this section i.e. the upper limits on the beta priors for T_2 and M_2 are not consistent with the intervals stated in the main text.

Also in Section 2.2, the statement of the 90% probability interval for the prior on T_1 is a really helpful addition. It would be good if similar intervals were offered for the priors on the other main parameters too.

Towards the end of Section 2.2, the authors offer details about the runs they made to provide the results in the later sections. It was a surprise to learn that their parameter estimates were based on an effective MCMC sample size of just 240 samples per parameter per site. For those of us who have used MCMC sampling for Bayesian in-

ference in other contexts, this seems very small indeed. It is not inconceivable that the authors would get reproducible results with such a small sample size, but they should say something about what checks for reproducibility were made and what level of reproducibility was obtained (e.g. the number of decimal places to which the median and variance estimates used to obtain the figures were reproducible). It would also be helpful if the the authors could add a sentence about the nature of the smoothing techniques that they used to obtain their estimated posterior distributions from the samples (i.e. those in Fig 1).

Linked to the point above is the issue of computational expense. The authors should provide some quantitative measure of the computational resource required to obtain the results in the paper (particularly those in the figures) and should say something about the relative resource required to run, say, VS and VS-Lite without the Bayesian parameter estimation described here. This is important since, as the authors make clear, further model components will be needed in future, for example to add spatial correlation, and these will have associated extra computational expense.

Section 2.3 also needs some more work since, at present, the experimental set-up is rather impenetrable. A considerable improvement could be obtained by explaining, in the first paragraph, the intellectual and practical framework in which the experiments are being conducted and defining the terms PPE and OPE. Once that is established Sections 2.3.1 and 2.3.2 would also benefit from restructuring to divide the material into generalities relating to the experimental approach and specifics relating to the implementation of the experiment in this case. At the moment the two are mixed together, requiring multiple reads to disentangle them.

Section 3 provides a thorough catalogue of observations about the results but, with insufficient comments on their interpretation, they are not as valuable as they could be. If the authors omitted interpretations due to lack of space, then it would be better to move some of them to an appendix and focus in the main text just on key results, offering clear statements about what can be inferred from them. An example of a really

helpful interpretation offered in the current version is that provided between lines 15 and 19 of page 16, where we learn that the model fit to data was sensitive to the upper soil moisture threshold, yet not sensitive to the lower soil moisture threshold and that the sensitivity to temperature thresholds was site location dependent. More interpretations of this sort earlier on in the paper would really help readers appreciate the strengths of the proposed approach.

In Section 4 (page 17) the authors indicate that, when the data contain little information, the posterior inference is determined by the prior model. They indicate that this situation arises when the data are noisy, when the model is insensitive to the parameter in question or when the length of the data series is limited and cannot inform the parameter values. What the authors do not provide is any quantification of these statements. It would be really helpful to future users if they could say, for example, what length of data series they found to be necessary and/or what level of noise in the data causes problems.

Currently there is no separate section on planned future work. Some is discussed at the end of Section 4 and it might be sensible to separate this out and include a little more. For example it would be good to know how spatial correlation might be included (not just that it should be) and to learn about any plans the authors may have for further work on inverting the model, for example to allow inference about $\mathbf{M}$ and $\mathbf{T}$ from observed proxy data at locations or time periods for which observations on them are not available.

3   Minor typographical errors

- Several section headings have full-stops which need removing.

- The authors should check the typography of the sentence that starts on line 22 of page 7, in which the word choices is misspelled and "$0°$C" should probably be

in brackets.

- Equation 5 should finish with a comma and equations 3, 4 and 6 with full-stops.

- Towards the end of line 21 on page 12 the word "than" should be "that".

Interactive comment on Clim. Past Discuss., 9, 615, 2013.