

Interactive comment on “Evaluating climate model performance with various parameter sets using observations over the last centuries” by M. F. Loutre et al.

Anonymous Referee #2

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(throughout I use a convention of p[page number]:[line number] to refer to specific parts of the text)

Overall

The manuscript assesses the performance of the LOVECLIM intermediate complexity Earth System Model when different sets of parameter values are used for a number of key parameterisations. Simulations of the climate of the pre-industrial, the last century and the last millennium are carried out with these different parameter sets, comparisons with observational datasets made and differences between the simulations are noted. The general topic addressed, that of improving knowledge of model uncertainty,

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is important and the paper is basically well written.

In its current format, however, I feel it suffers somewhat from both a lack of detail in the analysis, and a lack of scientific conclusions. There are two key phrases in the introduction that I think sum up the problem:

p712:22-23 "Policymakers are facing a wide range of possible scenarios [...] without knowing precisely why they differ and how reliable they are"

p713:22-23 "more specifically, the overall goal of this study is to identify a number of parameter sets in LOVECLIM [...] that yield past and present climate simulations coherent with observations."

The authors demonstrate very well that they have achieved their overall goal (although I might take issue with the description of /how/ these sets have been identified), but they do little towards answering questions relevant to the wider issues outlined in the first quote. Plans to address such questions in "forthcoming studies" are clearly in place (p713:28), but that doesn't necessarily justify the current lack of general conclusions in this paper.

Taken at face value, the second quote as to the overall goal of the study suggests that the majority of the paper, in its current form, might be a better fit to another EGU journal, Geoscientific Model Development (www.geosci-model-dev.net). This, I feel, would be an appropriate place to document the existence and evaluation of the different-parameter-set versions of LOVECLIM without more extensive analysis and discussion. With such a target, the paper would need little revision.

For publication in Climate of the Past, I would agree with the already-published comments of referee#1 that section 6 is currently by far the strongest, and that the overly descriptive sections 4 and 5 in their current form could be safely moved to an appendix. This then would free up space into which the analysis of the last century runs could expand, with an eye to drawing some more conclusions that reach beyond the validation

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of a particular model and its parameter sets.

Content Comments

2 Model Description

p715:26 The prescribed nature of the cloud forcing in ECBilt is passed over lightly here, and not mentioned again. Given that cloud feedbacks in models are one of the primary sources of uncertainty in determining climate sensitivity, if general conclusions are to be drawn from a parameter-uncertainty study with LOVECLIM then I think this limitation of the model deserves a more considered discussion.

3 The parameter sets

p716:16,20 Frustratingly little detail is given as to why these parameters were chosen, what ranges of uncertainty were considered for each and how the particular sets considered were, prior to the study, "chosen to produce reasonable simulations of present-day climate [...]". Were all other potential combinations tried and rejected under a metric as outlined in section 7?

p717:2 It is noted that Goosse et al. (2007) has considered a number of the climate parameter sets previously, yet the results of this paper aren't mentioned again - it would seem that a useful comparison of the model response in that study could probably be made with the present results.

The descriptions of how each parameter is used in the model very useful though.

4 Preliminary experiments

As alluded to in the overall comments, this whole section feels rather vague and purely descriptive, without drawing anything in the way of conclusions. p720:12-14 suggests that this is deliberate, but I'm not sure I buy it. The section does demonstrate that they have achieved a "reasonable" range of "reasonable" climate models, but just leaves me asking "why?" (not to mention "what is reasonable?". Why do the different parameter

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sets end up with different climate sensitivities? What parameter variations are responsible for the different responses to MOC hosing? The carbon cycle sensitivity is at least subdivided into land and marine parameters, but more explanation of the land parameter effects would be interesting. This kind of analysis would be really interesting, and is the sort of thing I think should be done in order to get the most out of this work.

A multi-panel figure that simply shows parameter value against climate sensitivity for each parameter might be a useful place to start, although one would of course expect a degree of non-linear interaction between the different parameter variations in the sets.

Is there a particular reason carbon-parameter set 2 is used for 4.1, 4.2 and 4.3 rather than the others? This information should also be in the text, not just in table 3. Which climate-parameter set is used for 4.4?

I'm afraid I don't find the experiment acronyms (first digit for climate sensitivity, second for MOC sensitivity third for CO2 sensitivity) very clear. The third digit seems to only be used in passing in section 7 anyway.

5 Last Millennium

This whole, rather brief section is pretty vague and, as with section 4, could easily be moved to an appendix, or much more briefly described as a preliminary experiment.

6 Last century

This section has a bit of welcome detail, although I would still like to see some analysis that explains how the climate differences come about from the different parameter sets.

p730:19-20 CO2 sensitivity is clearly affecting the ocean heat content more than the MOC, but I think it's going too far to say on this evidence alone that CO2 sensitivity is dominating "ocean behaviour" as a whole.

7 Performance of the parameter sets

In general a good section, but it would be nice to see some conclusions drawn. Would

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the authors recommend their metric for application to other model ensembles? Could the metric score be used to usefully weight the results of individual members of a perturbed parameter ensemble, retaining information from all their parameter sets?

p733 implies a significant issue with the heat uptake of the ocean in LOVECLIM. I would echo reviewer#1's comment in wondering whether a parameter-variation study such as this one might at least speculate on a parameter tuning that might alleviate the problem.

8 Conclusions

This isn't so much a conclusions section, as a summary and short discussion - at least I'm still not clear on what the author's actual conclusions from this study are, past that sensitivity to CO₂ concentration dominates their model spread - although they do not say clearly how this sensitivity comes about from their parameter sets. For a science paper, rather than a pure model description paper, I'd like to see quite a bit more in here. For instance, a discussion of how, given LOVECLIM's inherent drawbacks in terms of cloud feedbacks and ocean heat uptake, results from a model uncertainty study such as this could be robustly applied to the real world would be welcome.

Additional typographical comments

p712:16 "much slightly" is wrong - 'much less', perhaps?

p722:18 "remind" is transitive - you need to be 'reminding the reader', or maybe just 'remembering'?

p727:9 "mean" is unclear - you need to say what dimension(s) you're averaging over. Global means, time means...?

p731:3 "the adequacy between" isn't grammatically correct - something like '... a measure of how well the simulated trends fit the observationally-based estimates of several ...' would work

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p731:7 "is depending" should be 'depends'

p732:27 "prevent to simulate" should be something like 'prevent simulation of'

p733:10 "to acceptable range" - 'to acceptable ranges' or 'to an acceptable range'

p733:17 "is performing" should really be just 'performs'

p734:24 I find the convention of denoting the opposite sense of a relationship in brackets like this unpleasant to read and almost always unnecessary.

Interactive comment on Clim. Past Discuss., 6, 711, 2010.

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