

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 #1

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The manuscript presents a method how uncertainties in the choice of climate model parameters can be constrained by measuring differences between transient simulations and past climate observations using the LOVECLIM model. This paper is well within the scope of Climate of the Past, scientifically of high quality and addresses the important topic of improving the model sensitivity to provide more trustful transient simulations and future climate predictions.

The manuscript contains a wide range of experiments for various time periods and using various parameter sets and forcings. Although I see the structure outlined in the introduction, it is difficult to read, to follow and to clearly see the message or aim of

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the study. Many sections such as the simulations of the last millennium remain purely descriptive. I suggest a restructuring or a severe shortening of the “Preliminary Experiments” and “Last Millennium” sections. I would even favor moving them to the “Supplementary Material” for people who are really interested in details of this specific model. Then the main focus should be on the model performance assessment over the past century which is clearly the strongest section containing a good discussion. Especially the abstract and the conclusions are weak and need to be rewritten. Therefore I suggest major revisions to be made.

General comments:

Abstract:

- The aim of the paper is not clear after reading the abstract. It needs to be explained that the correct model parameters should be assessed, model uncertainties in recent future predictions, etc. It also does not read fluently because thoughts/sentences are not connected.

1. Introduction:

- Line 6ff: It remains vague how model uncertainties have been assessed in previous studies and if the measure by Gleckler et al. (2008) is different from the measure used here.

- Last paragraph of the Introduction could be shortened by including the references already in the preceding paragraphs.

3. The parameter sets:

- Here is is not clear who the experts are and how they have chosen the parameters. Can this choice cover the whole range of uncertainties and does the choice that is made to produce “contrasted responses” (line 22, page 716) influence the results?

4.4 Sensitivity of the carbon cycle:

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- The entire overview over the huge amount of experiments is confusing. One big table with all experiments and all codes/names of the experiments could help.

5. Last Millennium:

- Do not use abbreviations for words that are used only a few times like Conc or Efor. This makes it just complicated for the reader to search for the place it was used first.

- As NO conclusions for the model performance assessment are drawn from this and the previous experiments/sections, I suggest to move them to the Supplementary Material or to shorten them severely.

6. Last century:

- Now again new ensembles of simulation with new forcings are introduced. I would suggest to have a section and comprehensive table about all experiments. Otherwise it is far to complicated. The last paragraph of 6.1 rather belongs to the introduction. It makes the impression as if a new paper starts here and actually it would be a good choice to have the paper starting directly with the last century as all conclusions are drawn from discussions done in that second half of the manuscript.

- Section 6.2 to 6.4 are mainly descriptive results while in sections 6.5 a discussion of the results is added at the end. Here a consistent split into results and discussion would be better or the sections 6.2 to 6.4 should also include some interpretations.

- What does the variability of MOC strength depending on the parameter set tell us? Are model comparisons useless because each model itself already has large uncertainty related to its tuning? What is the message of this paper, to find a best parameter configuration or to show the possible range and thus model uncertainty?

7. Performance of the parameter sets:

- What metric did other studies use before, e.g. Gleckler et al. 2008? It remains unclear why the metric is degraded to indexes, especially if the threshold is a critical value as

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discussed on page 735, line 6ff.

- Does the result of not finding a “perfect” parameter set indicate that there is none for this model or just that it was not found by the small amount of sets that could be tested?
- A major conclusion is that the ocean heat uptake of the LOVECLIM is too large. First that could also be mentioned in the final conclusions. But second the reader would like to know if there is a parameter or another option to correct the model for the bias which was found here.

8. Conclusions:

Most of the conclusions sections reads like an introduction or description. Hardly any real conclusions are made in this section. There are many interesting results which have been discussed in the paper which the authors need to use in this section to make much stronger conclusions, e.g. what did we learn from the experiments, especially about model and parameter uncertainty or the LOVECLIM model specifically, should model parameters in the future always be tuned in a way that transient simulations fit past observations, etc.

Figures:

There should be a legend in each figure. It is not practical to always search for a color code in a different figure on another page.

Detailed comments:

Abstract:

Page 712, Line 6: parameters seem to be rather “selected” than “identified”

Page 712, Line 11: the sentence “Climate simulations ...” is not connected to the text before and after

Page 712, Line 17: wording: “set of parameter sets”

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Page 712, Line 18ff: not clear, why are parameters useful that are not able to reproduce past climate?

1. Introduction:

Page 713, Line 21: vague, how large is “quite large”?

Page 713, Line 21ff: sentence too long and unclear.

Page 713, Line 28: ideas for forthcoming studies would better fit in an outlook

Page 714, Line 21: full stop missing

Page 715, Line 3: here it is said that parameters are “selected” and not “identified”. Make consistent

Page 715, Line 27: there are a lot of simplifications in the model, why is especially the cloudiness mentioned to be a limitation?

4.1 The pre-industrial climate:

Page 721, Line 8: observations for 1979-2000 are compared with pre-industrial model simulation as if they should be the same

4.3 Sensitivity to water hosing:

Page 722, Line 4: “anomalous”? Is there usually a normal amount for freshwater added? Where is the freshwater taken from/compensated?

4.4 Sensitivity of the carbon cycle:

Page 723, Line 17: not surprising that the model follows the GHG concentrations if it is constrained by them.

Page 724, Line 13: also say which sensitivity Frank et al. (2010) found

Page 724, Line 14: which third digit? The reader is only confronted with 2 digits for most of the paper. The entire overview over the huge amount of experiments is confusing.

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One big table with all experiments and all codes/names of the experiments might help.

5. Last Millennium:

Page 725, Line 4: There is a reconstruction of land cover changes during the last millennium which might have been better than assuming a simple linear evolution (J. Pongratz, C. Reick, T. Raddatz and M. Claussen: A reconstruction of global agricultural areas and land cover for the last millennium. GLOBAL BIOGEOCHEMICAL CYCLES, VOL. 22, GB3018, doi:10.1029/2007GB003153, 2008) Is there a reason why it was not used?

7. Performance of the parameter sets:

Page 731, Line 3: what does “configuration” mean here?

Page 733, Line 14: confusing, now the 3-digit experiment names are used for the first time

Page 733, Line 17: Its major ... → Its only major ...

Page 734, Line 16ff: correct this sentence

Page 734, Line 24: A weaker CO₂ (what ???) generates...

Page 734, Line 26ff: Meaning of last sentences is unclear

Figure 13:

- Codes on the x-axis are not explained and different from the 2/3-digit code used in the text.

- This figure should also not be split over two pages because the legend has to be visible

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