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Climate of the Past Discussions

Interactive comment on "Strength and limits of transient mid to late Holocene simulations with dynamical vegetation" *by* Pascale Braconnot et al.

Anonymous Referee #1

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In their manuscript, the authors not only present the first transient Holocene simulation with the IPSL Earth System Model, but also a set of different time-slice experiments that has been used to initialize and evaluate the transient simulation and to test the stability of the simulated vegetation distributions. The transient simulation captures the main Holocene long term vegetation trends reasonably well and show regionally different timings of major vegetation changes. It indicates large scale vegetation degradation. The integration of several different tree PFT types enables the model to also reveal strong changes in the Eurasian forest composition. The sensitivity experiments show that the calculated vegetation, temperature and precipitation distribution depend on the chosen model setup. Initializing the model with totally different vegetation states (bare soil everywhere vs. simulated vegetation map) leads only to slight differences

for mid-Holocene boundary conditions, but to multiple states under pre-industrial conditions. The author raise the question, whether the vegetation-climate system is more sensitive in pre-industrial times. The large number of experiments around the actual transient simulation indicates that the authors have designed this study very carefully and thoughtfully. They raise a couple of interesting questions and show what should be considered when setting up and evaluating transient simulations. The single results are presented clearly and accurately and are accompanied by many well-designed figures. The study is interesting and well suited to be published in Climate of the Past, though I suggest few fundamental revisions.

My main point is that the main objectives of the study remain unclear. The authors analyze the effects of a variety of changes in the model and setup of the simulations compared to the CMIP5 model-version, but it is not necessarily clear why these changes are chosen and why they are relevant for the transient simulation. Furthermore, the results (also those considering the transient simulation) are usually only mentioned because a detailed analysis of the effects would go beyond the scope of a single study and requires even more simulations. This gives you the feeling that everything is addressed, but without a clear outline and without a clear (final) message. There are several points that reinforce this impression:

- The single chapters are not really linked and there is no separate method chapter, instead methods and results are merged in the individual sections.

- you somehow get lost in the different simulations and don't always know which simulation is being talked about or what are the characteristics of this simulations (unless you look it up again).

- The title is 'strength and limits of transient...Holocene simulations' and also the abstract promises a focus on the transient simulation, but then, 9 pages follow discussing other simulations. At page 10; the Holocene simulation is introduced followed by only 3 pages presenting the results of this transient simulation. I think this ratio of results

from the transient simulation to the results from the other simulations is not balanced, particularly because a clear connection to the results of the other simulations may not always be seen.

- I furthermore think that the conclusions do not represent the title. What are the strength and limits of the transient simulation? From reading the conclusions I do not know this...

I recommend to restructure the manuscript. The time-slice experiments must be embedded more strongly in the results of the transient simulation and a clear link must be established between the simulations. To reduce the number of experiments and figures, the simulations dealing with finding an appropriate initial state or discussing the differences to the PMIP3-CMIP5 model could be shifted to the Appendix. These are technically interesting but seem not to follow any scientific question. The result section of the transient simulations should be extended and more specified. In addition, research questions and aims of the study should be worked out to give the results a clear framework.

Minor revisions and technical corrections:

- The abstract should focus more on the highlights of the results.

- L36: write: reduction in North African monsoon intensity. . .

- L38: separate 'variabilityor' in 'variability or'

- L56: Do you mean 'mid-Holocene boundary conditions' ?

- L94-95: The sentence 'before. . .' needs a verb.

- L111: It is '30min'

- L130: what do you mean with 'transient late Holocene simulation'

- L145: it is 'trace gases', please correct it in the entire manuscript

- L160: Again, what is meant by 'transient late Holocene simulation'

- L178: delete the first 'close'

- L185: Do you mean 'land surface cooling is due to? . . . ('is' instead of 'as')

- L185: 'first L11 version' why first?

- L202: simulations of global warming

- L202: There is no 'Fig. 2e'

- L203-205: I did not get these sentences, please specify.

- L243: Please explain the metrics in more detail (e.g. in the Appendix) because the metric package may be unknown to the readers.

- L257-258: To me it is not clear which simulations ran with dynamic vegetation and which not.

- L263: it is '1901-1910'

- L314: The heading of chapter 3 is: 'mid-Holocene simulations. . .' so why is there a section dealing with pre-industrial climate?

-L319-320: I do not understand what is meant by 'vegetation biases' in this context. When vegetation is interactive, the calculated vegetation distribution can be biased, but how does this bias impact the representation of the simulated vegetation? Please clarify.

-L337: What do you mean by this? that the differences in PI simulations are of similar magnitude as the differences between PI and MH ?

-L347: delete the blank after NH.

-L353: 'no' instead of 'not'

-L383: '. . . follow the long term insolation changes in each hemisphere. . .' What about

SH Winter? Please be more precise.

-L:385: Do you mean 'MH insolation forcing' ?

-L389: this 'plateau' trend in temperature during SH summer is not a feature of the insolation forcing, showing still an increase in insolation during this period. For the NH winter temperature change, variability is very strong, but the main trend is still increasing and not 'plateau' shaped.

-L409: It seems as if the tree fraction follows the summer insolation change. Please specify and explain. What about the annual mean changes in temperature, precipitation and insolation?

-L435-436: Where does this variability come from?

-L437-438: Something is wrong in this sentence, I guess the first 'and'.

-L456: What do you mean by 'rapid changes' and if these 'deserve attention' why don't you investigate them in this study?

-L459: 'several' instead of 'sever'

-L462: 'Is it the case. . .' instead of 'It is the case. . .'

-L476-477: Is there a possibility to figure out the reasons for having different PI climate-vegetation changes?

-L493: 'including instead of 'to include'

-L496: I suggest adding: 'large scale features in climate and vegetation change expected from . . .'

-L499: 'annual mean' of what?

-L502: 'Why should the trend be linear?

-L514: 'It might. . .' instead of 'I might'

-L528-530: This needs to be further specified.

-L535: Maybe it is 'other' instead of 'over'

-L544: Is it really 'reference period' or just 'reference simulation' ?

-L581: Why is 'BIOMES' written in capital letters?

-L581: Isn't it originally the method of Prentice et al.2011? What is different to the method of Zhu et al. 2018?

-L589: it is: high northern latitudes

-L590: It is not obvious why the GDD limit of 500°C is being tested, are these values realistic? I guess ORCHIDEE also uses a GDD limit of > 350°C for the existence of boreal trees vs. tundra (GDD5<350°C). A biomisation using a GDD limit of 500°C thus may not represent the vegetation simulated by the model, because it suggest tundra in regions that are suited for forests.

-L595: Something is wrong in this sentence. . .

-L598-599: Should we now reconsider the choice of bioclimatic limits in the DGVMs?

- What about data availability?

-Fig 2: The units in the caption do not agree to the units in the headings of the figures

-Fig.3: The pressure levels do not match, please also explain the metrics in more detail.

-Fig.4: Why are MH_Vnone and MH_Vmap so different?

-Fig.5: In the headings for a) d) and g) you use m instead of minus, please change

-Fig.7: It should be explained, why there is Savanna in the northern latitudes. In my print, the pink and orange color is not really distinguishable. Please state, why there is no grassland in North Africa in your simulation

-Fig.9: Maybe this figure could be moved to the Appendix.

-Fig.10: I think it is very interesting, that the winter precipitation on the NH does not (or only very slightly) changed during the Holocene.

-Fig.10: L1116: NH summer, b) Northern hemisphere winter .... you could also write NH winter, furthermore, winter and summer season should be defined in the caption (i.e. months that are taken)

-Fig.10: When looking into palaeo-seasons, one always faces the problem of different calendars. The months NDJF or JJA differ in length between mid-Holocene and PI. It should at least be mentioned in the text and in the caption, that this 'problem' exist and is not considered, neither by the model nor in the analysis. But this problem may change the trends discussed here!

-Fig.11: it is 'Northern Hemisphere'. It would also be interesting, how the simulated tree cover and bare-soil fractions at the end of the simulation compare to modern estimates on (natural) tree cover. How large is the underestimation of forest in the high northern latitudes by the model?

Fig.12: What causes the strong peak around 4.8ka ?

Fig.12: L1128: 'tree' instead of 'Tre'

Fig.14: 'm' vs 'minus' or '-', and sometimes bare soil is written in two words sometimes not.

-L1164 delete one '.'

Fig.A2: citation for the BIOME6000 records is needed

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