Comment on cp-2021-119

Anonymous Referee #3

Referee comment on "Influence of the choice of insolation forcing on the results of a conceptual glacial cycle model" by Gaëlle Leloup and Didier Paillard, Clim. Past Discuss., https://doi.org/10.5194/cp-2021-119-RC4, 2021

Review of „Influence of the choice of insolation forcing on the results of a conceptual glacial cycle model"

The manuscript is based on a simplified version of the conceptual model of Parrenin and Paillard (2003). While there are 5 tunable parameters in the model, the authors consider 4 of them as fixed and adjust the value of the fifth one (V0) in order to maximise the fit to paleo records, according to a criterion counting the failed or successful reproduction of deglaciations. The authors evaluate the different values that the parameter takes in order to optimise the fitting to the paleo data when using 4 different insolation forcings and considering different periods of time in the last 2500 kyr.

The main conclusions are that:

- Independently of which of the 4 insolation forcings is used, it is possible to find values of V0 (changing in time) in order to provide a reasonable fit of the model output to the paleo records.
- For all the forcings, to increase the accuracy of the fit to paleo data, the value of V0 increases after MPT.

I think the manuscript is interesting and well written. However, I have some questions and suggestions of some extra analysis to include.

General comments

- I think that it should be clearly stated in the abstract, introduction and conclusions that the paper will focus on the deglaciation threshold V0, while keeping all the other 4 model parameters constant. In particular, I find the sentence "to be able to reproduce the frequency shift over the Mid Pleistocene Transition, the deglaciation threshold needs to increase over time, independently of the summer insolation used as input" misleading if it is not pointed out that all the other parameters are fixed. If temporal changes in the other parameters were also allowed, then the frequency shift over the MPT could potentially also be reproduced via other changes.
- How do the results change if you consider the insolation at 50°N, as in Caulder's model, instead of 65°N?
- What happens if you decompose the summer solstice insolation into its precession and obliquity components and use each of them as forcing in your model? By the results shown in the manuscript, the ISI above 300W/m2 forcing (which contains almost no precessional signal) still produces what the authors deem a "good fit to data". Therefore, I think that a clean separation into the precessional and obliquity components of, let's say, summer solstice insolation could be a clean experiment to compare with.
- Will the results be the same with a different fitting criterion? For example, if instead of the defined c, the criterion for the optimisation is to maximise the correlation between time-series of normalized paleo and modelled ice volume, how do the results change? It is obvious that the correlation measure will penalise the ISI above 300W/m2 forcing, as it clearly cannot reproduce the variability at the 100 kyr frequency.
- I am interested in knowing more about the optimisation procedure. For each period and insolation forcing, did you any optimisation algorithm or trial and error?
- How do you define the "Best fit over the Quaternary"? (Section 3.2) This is not explained. I assume the authors use a V0 that changes with time (5 different values, in the 5 different periods considered), is that correct? Please, make explicit.
- For the "Best fit over the Quaternary" the authors use a V0 that changes with time. As a benchmark, I think the authors should also show how the performance with a changing V0 compare with the one of a constant V0. Please, repeat the optimisation procedure using the whole 0-2500 kyr BP period and provide the optimised constant V0 and corresponding model output. Please add these curves for each forcing in Figure 4. Also add in Figs. 1 and 2 the corresponding optimal constant-over-time V0 and accuracy when considering the entire 0-2500 kyr period.

Specific comments

L 25-26: "…due to reduced summer insolation, at latitudes typical of Northern Hemisphere ice sheets, 65° N." I suggest to change for "…due to reduced summer insolation, at latitudes of the Northern Hemisphere critical for ice sheet growth (65°N)."

L 38: independent --> independent

L 49: the more insolation --> the highest insolation

L 53: more adapted --> better

L 71: explicitely --> explicitly

L 77-77: In Equation (1) the labels (g) and (d) are misplaced

L 80: "…a typical latitude for Northern Hemisphere ice sheets." This part of the sentence has already been used in the introduction, no need to repeat it.

L 93-93: "The importance of orbital forcing alone seems able to start a glaciation" This sentence does not make sentence, please reformulate.

L 169: "In order to study the evolution of the optimal model parameters over the Quaternary…" Please correct to indicate that only V0 is being optimised.

L 170: periods --> period

L 173: "…the best fit parameters…" please modify to indicate only V0 is being fit

L 183-184: "The model state was compared to the middle of the deglaciation." I don't understand this sentence

L 233: varying --> varying

L 242: varies --> varies

L 273-274: "To model future natural evolutions of the climate system, one would need to take into account for possible evolutions of the V0 threshold." Please acknowledge that, possibly, the other parameters might as well change.

L 283: Also add here Talento and Ganopolski, 2021 as reference.

L 287: "…very few tunable parameters… " in fact, you should clarify that you tune only 1 parameter.

Section 2.4: I think a plot of the d18O record used with indications of the start and end of deglaciations, according to your criterion, is due here. Or at least refer the reader to this information in figure 3.

Figure 1: Normalized to what? by standard deviation? Please clarify. The ylabel in blue line must be corrected.

Why show only until 1000 kyr BP when the totality of the Quaternary (0-2500 kyr BP) is the focus on the rest of the paper? Please show the plot considering 0-2500 kyr BP.

In all the text: The acronym ISI was introduced in line 5, but frequently not used afterwards.

When starting a new paragraph, sometimes there is an indent, sometime there is not.