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Climate of the Past Discussions



# *Interactive comment on* "Simulations of the last interglacial and the subsequent glacial inception with the Planet Simulator" *by* M. Donat and F. Kaspar

**Anonymous Referee #2**

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## General comment

This paper explores the importance of climate components (sea surface temperature and vegetation changes) and of processes (temperature and moisture transport changes) in the transition from the last interglacial to glacial states using a numerical model. This time period has been studied by many other researchers with different models, and is known as one of the tricky climate events to capture by comprehensive models. The authors chose to use a coarse resolution GCM with reduced complexity but conducted as many as 12 equilibrium experiments in addition to a transient simulation. The experimental design is well-organized, and the nonlinearity of the system

found is interesting. However, I do not find that the presentation is thorough, and thus it requires a major revision.

**Major points**

1. Section 3: Since the glacial inception is a threshold-type problem (ice starts to melt at 0 degC), it is very important to describe the model bias in regions of interest under the present-day condition. In particular, REF run in the AOV configuration shows a cold bias on a global average (Figure 1a). More importantly, the explanation is needed for 2-3 degrees globally colder climate in the REF control run of the AOV configuration compared to REF control runs of other configurations. This is a serious problem because the signal (the difference between 115 kyBP and REF) is much smaller than the bias introduced by coupling the model components (Figure 1a). The feedback involving SST and vegetation is likely exaggerated in the AOV configuration, and it should be discussed.

2. Section 4: While the results suggest that changes in vegetation are critical to capture the glacial inception, there is no detailed description about vegetation changes. This point should be thoroughly discussed. In addition, description of the vegetation model component should be added.

3. Section 4: While a relatively large number of experiments was conducted, the authors did not address much on experiments other than the AOV configurations. The comparison with other experiments including spatial temperature changes should be described. Even if there are no significant changes in those runs on regional scales, that fact should be noted. The statistical testing such as t-test for the differences may also be useful to distinguish responses from internal variability.

4. Section 5: Could the threshold crossing at 123 kyBP be artificially influenced by the use of acceleration of the boundary condition? The response time is relatively slow in the AOV configuration ( 300 years), and the model is integrated only for 200 years at this point. How does this acceleration introduce uncertainties to the timing of the



CPD
2, S758–S761, 2007





EGU

simulated threshold-crossing?

**Minor points**

1. Section 1: It is probably helpful to add a figure which shows insolation changes between 125 kyBP and REF, and between 115kyBP and REF (e.g., insolation vs. month at 65°N and 65°S).

2. Section 2: What is the climate sensitivity of the model? It is written on page 1349 that "It is therefore of interest to compare the behaviour of diverse models". For that, it is useful to provide some measure to distinguish this model from others.

3. Section 2: The vegetation model component should be described to some extent as it plays a critical role in the results. It also helps to understand what exactly vegetation change leads to the change in model parameters (e.g., surface albedo, snow-masking depth, and/or soil depth).

4. Section 2: Even though the magnitudes of other forcings ($CH_4$, $N_2O$, dust, solar, volcano) are unknown or known to be small, it would be nice to mention them.

5. p.1354: Please elaborate what "annual minimum sea ice/snow cover" really means. Is this a minimum snow cover at all model time steps throughout the simulations?

6. p.1354: bottom line: As stated, the simulated perennial snow cover could be seen as qualitatively consistent with reconstructions. It would be helpful for the purpose of comparisons with other models, to add how many grid points over land are actually covered by perennial snow and how large the area is?

7. p.1355 lines 8-10: How do you determine that the longwave flux, rather than latent or sensible heat fluxes, is responsible for the warming?

8. It is stated that the unrealistic perennial snow cover over northeast Asia is due to the model bias of too much precipitation in that region. How about North America? Could the simulated perennial snow cover in North America also be influenced by a model



CPD
2, S758–S761, 2007





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bias?

9. Figure 1b: Since the authors claimed that the simulated perennial snow cover over northeast Asia is probably not realistic, the temperature change may be more of interest if averaged over North America, rather than an entire 50-80°N latitudinal band. Could we still see the nonlinear response of the system that the authors claimed?

10. Figure 6: How does this snow volume evolution fit to the sea level reconstruction? Is it possible to compare? It may be more useful if the unit is converted to the water-equivalence. The comparison with sea level records should also be done excluding the overestimated snow cover in northeast Asia, if possible.

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