

## ***Interactive comment on “Holocene biome changes in Asia – an analysis of different transient Earth system model simulations” by Anne Dallmeyer et al.***

### **Anonymous Referee #1**

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The manuscript of Dallmeyer et al. applied BIOME4 model, driven with different transient Earth system model simulations, to get the general potential vegetation changes from Holocene to 0K in Asia. Model experiments are well organized, including the modern validation, sensitivity test, anomaly approach for climate model bias treatment, general pattern analysis, and comparison for the key region using pollen-reconstructed vegetation transient changes. The paper is well written, with clear thoughts and solid results. Thus, I rate it a good manuscript, and I have the following issues, hope the author could address them.

1 Model tuning/validation are using inconsistent information for 0K reference run, e.g. period for climate data, CO<sub>2</sub> concentration, and biome. Author chose the averaged

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climatology of 1960-2000 from CRU TS3.1 dataset, and drove BIOME4 model with preindustrial 280 ppm CO<sub>2</sub>-concentration, rather than the mean CO<sub>2</sub> concentration of 1960-2000. However, the reference observed biomes for comparison is from modern data. To be simplify, author is using Modern climate + PI CO<sub>2</sub> to simulate Modern biomes. I understand that author hope to show model's performance in lower CO<sub>2</sub> environment. However, in BIOME4 model, CO<sub>2</sub> has been treated as a very important factors for biome distribution. Thus you cannot ignore the effect of change CO<sub>2</sub> concentration from 280ppm to 345ppm or the mean level during 1960-2000.

It would be helpful and more convinced if the author could add the following information:

- a) A detailed logic about using preindustrial CO<sub>2</sub> concentration (280 ppm) and modern climate, but comparing with modern biome data;
- b) Quantify the CO<sub>2</sub> effects on modern biome distribution by comparing simulation using mean CO<sub>2</sub> concentration during 1960-2000 with simulation using prescribed 280ppm. The similarity of the two simulations would support the choice of using 280 ppm CO<sub>2</sub> concentration.
- c) If using modern CO<sub>2</sub> concentration did generate some difference, would it affect the adjustment of BIOME4 model, e.g. LAI, NPP and soil moisture limits, and other bioclimate limits?

I think this is very important. Because here the model is highly tuned with today's observation. The choice of modern climate and CO<sub>2</sub> data would affect this tuning. The change of those modified climate (and other) limits would have impact on the transient MH simulation.

2 Author mentioned that BIOME4 is an equilibrium vegetation model, and also attributed the failure of simulating modern Arctic tundra with deciduous taiga and boreal woodlands by this equilibrium issue. This also caused the inconsistent short-term variability between simulation and pollen-reconstructed biomes. Does this mean the

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climate change during each 500 years are either too big variation or too short period to be treated as equilibrium? And how big the influence is for the transition zone simulation?

3 One of the main targets of this paper is “to test the robustness of the simulated vegetation changes and quantify the differences among the models”. As pollen-reconstructed biomes can be used another way for climate model-data comparison, it would be much more interesting if some more analysis/discussion about the evaluation/quantification about effects from uncertainties and bias of climate models in terms of model components, forcing setting. And this would also be more relative to this paper’s subtitle “an analysis of different transient Earth system model simulations”.

Other questions and technical issues:

1 in Figure2, it is clear that there is discrepancy for desert, shrubland, and grassland between observation and simulation for desert-stepper-forest transition zone (Region 1 in Figure1). Would it have effects on the 6k simulation?

2 When the GCM output is interpolated into 0.5, whether elevation is considered? Would elevation have impacts on BIOME4 simulations using different GCM model outputs. Because different models have different spatial resolutions, which would deliver different elevation to the same 0.5 grid cells.

3 500-year window length was applied for time slice analysis, and 120-year long-term mean was used to represent the climate status for each time slice. However, it is still not very clear, whether the 120 years are starting from the first year of each window or these 120 years are evenly distributed around the starting year of the window.

4 In Figure6b, how can the precipitation be negative value?

5 And please also check the data for Figure 6. The ensemble mean precipitation of 30mm/day for a desert-stepper-forest transition zone should be too big.

6 line 472, could the author explain the meaning of temporal “linear”, and why should

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we expect it should be linear or non-linear?

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