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Interactive comment on “Biogeophysical feedbacks trigger shifts in the modelled climate system at multiple scales” by S. C. Dekker et al.

Anonymous Referee #2

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This paper tried to contribute to the ongoing debate of whether the positive feedback between vegetation and climate may lead to multiple equilibria and regime shifts in the climate system. The methods of giving perturbations to the initial biomass are valid, and most conclusions are reasonable. However, there are several important issues that the authors need to address. I think whether this paper can be accepted depends on whether these concerns can be properly addressed.

1. The method of this study is close to that in Brovkin et al. (2009), but the ocean is fixed in this study. Therefore, it is not valid to compare results in this study with those of Brovkin et al. (2009) and some others that considers the ocean processes. The multiple equilibria found in this study are for the vegetation-atmosphere system and not the whole climate system. This should be emphasized in the title and paper.

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2. Section 3.1, last paragraph. The negative correlation between biomass and temperature does not necessarily indicate a cooling effect of biomass on atmosphere. The correlation itself can not indicate any causal relationship. Actually, the correlation should have regional differences. In Sahel, the biomass is largely controlled by rainfall, which is negatively correlated with temperature. In Amazon forest, the biomass strongly relies on the amount of solar radiation, which has a positive correlation with temperature (Nemani, et al. 2003).

3. Section 3.3. It is not clear how the S index is calculated for the Fig. 6 (a) and (b). Are perturbations from Deq to Geq and from Geq to Deq? I know this can not be right, because it will lead to the same result for (a) and (b). I also agree with another reviewer's comment to use percentage biomass perturbations instead of absolute biomass values. It may lead to very different results.

4. According to this study, the African Sahel is a region with high resilience and there is no sign of multiple equilibria. However, some previous studies have shown the possible existence of multiple equilibria over this region (e.g., Wang and Eltahir 2000a, b). Studies also show that climate variability or noise may force the climate to an intermediate state between two equilibrium states (Zeng and Neelin 2000; D'Odorico et al. 2005). The authors need to consider these previous results in their introduction and discussion.

5. Page 10994, lines 6-7. "lower land temperatures directly increase the gradient between ocean and land and subsequently increase the strength and length of the monsoon". This statement is not right. Summer monsoon is caused by warmer land and cooler ocean.

Minor comments:

1. The paper of Foley et al. (2003) is referred but not listed. 2. The writing of this paper needs some improvement and some typos need to be corrected.

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