Anonymous Referee #1

We would like to thank the referee for valuable comments. Below the refrees comments are shown in *italics*, the replies are shown in normal type.

General:

The present paper investigates the importance of climate change patterns from 4 GCMs and CO2 emission scenarios on the global terrestrial ecosystem carbon balance, especially on net primary production and net biome production using the DGVM LPJ-GUESS and a statistical emulator of that. The study uses a powerful method for analysing the characteristics of GCM specific climate patterns with regard to the global terrestrial ecosystem carbon balance.

Comment 1:

Methods:

The method of the SVD analysis should be translated into language the more casual reader would understand. It was not easy to understand the different modes of this. Page 6 line 15 to 25 should be revised.

Reply:

The text describing the SVD analysis is now rewritten. We now describe clearly that SVD is a standard algorithm that can be used to calculate EOFs or PCA. Further we have added text and explicitly clarified the concept of modes.

Comment 2:

How is the replacement model [eq. 2-4] validated? For cross validation, the validation data should be not included for deriving the parameter. Of course not many data are available but may be 1 emission scenario or different runs could be used.

Reply:

We performed a validation analysis and now present the validation results in supplementary material. We made an additional calibration of the emulator, excluding one scenario per GCM, thus excluding one third of the simulations. The results show that the emulator is not sensitive to the exclusion of data, and that it would not change the conclusions drawn in the paper if a smaller subset of the data were used instead of all the data.

We have also added a section in the main paper explaining the method and the results of the validation study.

Comment 3:

Is the initial pool of eq. 4 the values of the LPJ-GUESS model with CRU-climate? It is not explained clearly, which values are assumed for the first iteration?

Reply:

The total terrestrial carbon pool of year 1901, the first year after spin-up, was used. We have clarified this in the revised paper.

Comment 4:

The differentiation of the statistical analyse of the GCMs, LPJ-GUESS simulations

driven by these GCMs and results from the replacement model should be more structured. The authors need to pull out the inferences more fully.

Reply:

We have added a new section, section 2.1, giving an overview of the approach. Together with clarifications throughout the text this clarifies what is done when and why in the revised manuscript.

Comment 5:

Page 3 first sentence the reference should be Table S1 **Reply:** Changed.

Comment 6:

Page 13 line 9 Fig.5 shows "that the discrepancy between the global and land temperatures are becoming smaller" - I can't see that

Reply:

The land warming amplification diverges from the value found for the 21st century at the end of the simulation. It starts approaching the global temperatures. We now describe this clearly in the text.

Comment 7:

Page 14 line 14 if that influences the α -value the CRU-data of the first at least 30 years should be not included for analysing the data. It is known that this occurs mainly at the beginning of the 20th century in the CRU-climatology.

Reply:

Yes you are right. The presence of multi-year episodes with constant climatology, mainly in the early part of the 20th century, is a limitation of the CRU dataset. Despite this shortcoming, the CRU data are one of the best datasets available of historic climate. Removing the first period would shorten our historical simulation. It would also mean that we need to initialize the model using data from a later period in time, possibly containing a larger trend. We have clarified that we have not investigated the possible influence of including these periods in the analysis, but we doubt that they influence the α -value to a degree that would change the conclusions of the paper.

Comment 8:

Figure 2 The difference of SST-TS1 and SST-TS2 (TS?) is not explained and figure 2e has no label on the y-axis.

Reply:

TS1 and TS2 are acronyms for time series, it is now explained in the caption. Also, we have added y-axis ticks and labels to the 2e plots.

Comment 9:

It would be nice if the figures of the supplementary material would be revised. Many plots are redundant, I suggest to join figures S1 and S2. **Reply:**

Figures S1 and S2 are now merged and has become figure S3.