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Interactive comment on "Vegetation modulates the impact of climate extremes on gross primary production" *by* Milan Flach et al.

Anonymous Referee #1

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The study deals with the role of vegetation for the effects of climate extremes on gross primary production (GPP). This is by analysing a selection of different observational data sets for the last 15 years or so. Although I find the subject of the study interesting and highly relevant, I don't find its presentation in the manuscript meets the quality standard, making it suitable for publication in its current form. Therefore, in my opinion, the manuscript should undergo a major revision before being published in Biogeoscienes. I will further explain my reservations in the following:

General comments:

1. In the study, forests are combined over the whole globe, providing estimates of the impacts of droughts and/or heatwaves on GPP at a global scale. I wonder, whether it would add value to the study, if also different categories of trees or different climate

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ranges (which typically also have a dominating type of trees) were distinguished. Different types of trees in a different background climate might be affected by the extreme events in different ways.

2. I find that the presentation of the results (Section 3) only makes up a relatively small part of the paper, certainly as compared to the introduction and the section on the methodology. I think this section needs to be extended to have a more balanced paper.

3. I find that the conclusions (Section 5) of the paper a bit weak. I think they could be extended in several ways, e.g. what the findings of the study mean for the terrestrial carbon budget and carbon dioxide concentrations under climate change.

4. I am a bit confused that some of the dots in Fig. 1 seem to be assigned to different types of ecosystems. Unless this is related to the way of presentation, it needs to be explained that grid points can comprehend different types of ecosystems and that in the analysis all (my assumption) types of ecosystems are included rather than the dominating type. I also wonder, whether, if in fact different types are considered, there should be a lower limit on the extent/fraction of the area covered by each type in a grid point.

5. I miss information on the types of ecosystem that are considered in the study in various places. Actually, it seems the only place, where this information can be obtained, is in Fig 4b. The information could easily be provided in a table in Section 2, where the ecosystems could also be grouped in the three main categories: forest, agriculture and others.

6. I miss a discussion of the limitations and potential biases of the data used in the study. This is only done for the FLUXNET data in the discussion (Section 4).

Specific comments:

Abstract

7. Page 1, lines 10-11: “On the other hand... droughts and heatwaves.” – That would

actually mean a limitation of the data, which to my understanding hasn't been discussed in the paper.

Introduction

8. General: I would find a short paragraph on the structure of the paper at the end of the introduction really helpful.

9. Page 2, line 27: "the crucial role of timing" – I assume this refers to the timing of the extreme events. Please clarify.

10. Page 2 line 31: "the least understood aspect" – I wonder whether there is a review paper on this or another suitable reference to support this statement.

11. Page 2, line 39: "in some meteorological... in ecological processes" – I am not sure, what this statement means. Please clarify.

12. Page 2, lines 95-96: "extreme relative to their expected value" – I am not sure that I understand this. In any case, considering a global absolute threshold would not make much sense, while it would make sense to use locally varying thresholds based on the same percentile, e.g. the 95th percentile, would.

Method

13. General: I think it would be nice to properly introduce the acronyms of the various datasets.

14. Page 3, line 55: "ERA5" – I think it need to be mentioned that in ERA5 vegetation doesn't vary but is prescribed via some climatological value. That has an effect on the turbulent energy fluxes at the land surface and, thus, might also affect the near-surface temperature.

15. Page 3, line 57: "GLEAM model-data integration framework" – It would be interesting to know how and to which extent these data are constrained by observations.

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16. Page 3: line 62: “2003-2018 period” – The choice of this particular time period for the study is not motivated at all.

17. Page 3, line 71: “for more details see the B” – It is not clear, what this means and what it refers to. Appendix B, maybe (see also my comment below)?

Results

18. Page 6, line 115: “non-forested land-cover types” – This is one of the (many) places, where information on the types of ecosystems is missing. See also my comment above.

19. Page 8, lines 136-137: “the most important. . . model” – I find it interesting to note that according to this statistical model soil moisture doesn’t seem to play a role. This is, however, in contrast to the results presented in Fig. 4b, where soil moisture receives a rather large weight. I wonder, how these – at first sight – contrasting results can be reconciled.

20. Page 8, lines 148-149: “but enhanced productivity. . . contrasting anomalies)” – I am not sure what this statement means. Please clarify.

Discussion

21. General: I think it would be important to also discuss the potential implications of the effects of extremes on net ecosystem productivity (NEP), given the effects on GPP, to the extent possible.

Conclusions

22. General: I think the conclusions need to fill more than the one short paragraph (see my comment above). I also wonder, whether it would be helpful with a short summary of the main results of the study.

Appendix

23. General: I find the appendix unnecessary. This is because, in my view, Fig. A1 should be part of the section on the results (it is discussed quite a bit and is needed to give a complete picture) and Fig. B1 doesn't provide much relevant information (and is not really referred to).

Figures

24. Figure 1: One of the prominent extreme events ("Russia 2010") is not linked to a dot in the figure. Is this a mistake or doesn't exist a particular grid point that can be assigned to this event? Also, I think this figure should be extended with the panel representing "other ecosystems", now Fig. A1 in the appendix.

Supplementary material

25. General: An introduction into the structure of the figures, i.e. what the different panels show and how they relate to each other. Also, I think it would be helpful to give the "identification" of the extreme period and the type of extreme (drought, heat wave or a compound even) in a headline. I understand the rational for presenting mean values for temperature and soil moisture, but presenting anomalies instead might highlight some of the regional details and would indicate the soil moisture/temperature coupling. Also, an indication of the colours/numbers of the different ecosystem types shown in the figures would be helpful. That could also be part of the introduction to the supplementary material. See also my comment above.

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