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Interactive comment on "Species composition and forest structure explain the temperature sensitivity patterns of productivity in temperate forests" *by* Friedrich J. Bohn et al.

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Comments of reviewer 2 in blue, reply in black. Note, there is an online supplement including Appendix R.

The authors use an individual-based forest modelling approach to isolate the effect of five forest structure (LAI, maximum stand height, and canopy stratification) and composition (functional diversity and its optimal distribution) parameters on the overall sensitivity of simulated wood production to increasing mean annual temperature and seasonal amplitude in a European temperate setting. The model is integrated hundred of times over a single year and forest stand using synthetic climate scenarios with per-

turbed temperature to simulate an ensemble of productivities for thousands of stands with a range of initial conditions of structure and composition, representative of different stand development stages. This synthetic dataset, broadly consistent with ecological rules observed in the real world, is then analysed using a statistical regression method in order to quantify the relative effect of the five structural and compositional parameters on the simulated temperature sensitivity of forest productivity. Their results indicate that an index of optimal species distribution of the trees in a forest stand – the ratio of actual productivity of a forest stand to the maximum productivity achieved by changing only the species of the trees whilst keeping the same stand structure – explains ? 88Among the remaining four parameters, forest height (a proxy of stand development stage) is the most important variable in explaining the rest of the fractional variance of temperature sensitivities. Thus the authors conclude that the sensitivity of plant productivity in temperate forests to changes in temperature is driven by forest structure and species diversity. I believe that the main scientific finding is of interest for the wider biogeosciences com- munities. The overall modelling experiment seems appropriated to disentangle the relative importance of forest structure and composition properties on patterns of temperature sensitivity of temperate forest productivity in the model world. However, the manuscript is very difficult to follow at times and the discussion of the main findings is simply too thin. I recommend major revisions in order to improve (i) the readability and English of the manuscript and (ii) to better discuss the underlying mechanisms and implications of the findings for the wider ecological theory.

Thank you very much for your review. We will revise our manuscript carefully including your recommendations.

We will enhance the readability and we will send the revised manuscript to native speakers to improve the English and the grammar.

We further will add two new sections discussing the implications of our results for forest management and global vegetation modelling (see appendix R1 and R2) and enlarge the conclusion (see appendix R3). Finally, we will carefully revise the Discussion in-

cluding more details of the underlying mechanisms.

SPECIFIC COMMENTS

Regarding the first point above, I have the following comments:

-Introduction

It is informative but the English and grammar need revision.

As explained above, we will revise the manuscript regarding English and grammar using the help of a native speaker.

This section tends to be redundant with the opening paragraph and appendices. I recommend reorganizing it and make it more concise. It is not clear how the stands at different stages of development were initialised. Were the structure, composition and development stage randomly generated or did you apply some spin-up? This has implications for the realised productivity when computing the Ω_{AWP} index. Why exactly 370,170 stands?

We did not perform any spin-off. Trees are "planted" with a certain size derived from the stem size distribution considering that each tree of a forest has a positive productivity and enough space for its crown. The forest factory creates forests, which are based on 15 different stem size distributions and 256 species mixtures. 100 forest patches with a size of 400m^2 of each combination were built (in total 384,000). To generate these 100 forests of each combination, we randomly selected a tree from a stem size distribution, assigned a species and checked if the tree has enough space and a positive productivity. In a few cases not all species of the mixture could be placed within a forest by the algorithm, so we rejected such forests. We end up with 370,170 forest stands. We will reformulate the text in 2.2 of the Methods section.

In Line 28 of page 4 it is said "We end up with five climate scenario sets of one-year

length that differ in precipitation and radiation." But since these scenarios are derived from five different real years, they should also differ in absolute temperature values? As I understand it, within each synthetic scenario, radiation and precipitation are the same and only temperature changes at the specified steps. Among the five scenarios, the absolute values of all variables should be different. Please explain better this part to the reader.

Thanks for mentioning this point. The absolute temperature values differ between the 5 time series. We will explain this point in more detail.

In Fig. 2, what does the shading in the middle panels mean? The meaning of H_{forest} is not explained in the caption.

Thanks for mentioning this point. The shading represents the standard deviation obtained from the analysis of five different time series (with the same modification of MAT and Q95). We will rewrite the text and explain H_{forest}.

-Results and Discussion I found many passages in these sections very difficult to follow. There are result statements with no reference to the figures or tables that leave the reader guessing the corresponding figures. The results section is rather short and most of the discussion is still results.

We will move figure 5 und 6 (and the corresponding text) from the Discussion into the Result section. We further will expand the Discussion by two new sections, which will discuss the implications for forest management and vegetation modelling (see also Appendix R2 and R3). Finally we will carefully revise the results and discussion to improve the text and link the statements with the corresponding figures.

Figure B1 shows a long negative tail in the distribution of the obtained sensitivities. The authors focus exclusively on the positive sensitivities and neglect negative values, despite declaring in the introduction that responses can be both positive and negative. Why the simulated sensitivities are so asymmetrical and the negative values are not

discussed?

We will explain the large negative values and the long negative tail of the sensitivity values in more detail. However, we don't know the reason for the asymmetric distribution. In addition, we will modify figure 5 and replace forest C by an old-growth forest with negative SI-values.

In the discussion I miss a more complete explanation of the underlying ecophysiological and metabolic mechanisms (e.g. Figs 5 and 6). Also, there is no discussion of the potential limitations of the model and the modelling experiments performed here. For instance, autotrophic respiration seems to be a critical factor affecting the response of net productivity to changes in temperature in the model. How well is this process represented in the model version used? Would you get the same result if you account for uncertainties in parameterisation of this process?

Thanks for mentioning these points. The forest factory is based on the well-established and often applied forest gap model FORMIND. The parametrization was used and discussed in several previous studies (Bohn et al 2014, Bohn et al 2017, Rödig et al. 2017). We will make this clearer in the Method section. We further will enlarge the section "4.1. The study-design" and enlarge the explanations in the Appendix discussing photosynthesis and respiration rates of single trees (Figure B7). In general, the parameters with the highest uncertainty within the FORMIND-model are establishment and mortality, which are not used in this study.

Finally, what are the implications of the main finding for the wider ecosystem and climate modelling communities that usually rely on global models that have no explicit forest structure? Any recommendation?

This is a good point. Thank you. We will add a new section, which discusses the implication of our analysis on global vegetation modelling (see Appendix R2).

-Conclusion Rather brief. Here the authors could wrap-up the wider implications of

their main findings.

We will extend the conclusions to include implications of our study for future forest modelling and forest management. (See also Appendix R3 : new conclusion).

-Figures

The figures are excellent but the captions are not sufficiently informative. Please improve the captions.

We will revise the captions.

Fig 3 could be merged with Fig B2. The latter is important to understand the overall result.

We will do this.

Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2017-335/bg-2017-335-AC2-supplement.pdf

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