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Biogeosciences Discussions

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

Anonymous Referee #2

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GENERAL COMMENTS

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 hundreds of times over a single year and forest stand using synthetic climate scenarios with perturbed 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 ∼88% of the temperature sensitivity of forest productivity simulated by the model. Among 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 communities. 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.

SPECIFIC COMMENTS

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

-Introduction It is informative but the English and grammar need revision.

-Method This section tends to be redundant with the opening paragraph and appendices. I recommend reorganising it and make it more concise. It is not clear how the stands at different stages of development were initialised. Were the structure, com-

position 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?

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.

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

-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.

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?

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?

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?

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

-Figures The figures are excellent but the captions are not sufficiently informative. Please improve the captions. Fig 3 could be merged with Fig B2. The latter is important to understand the overall result.

-English and grammar There are many grammar errors and typos through the text. Please revise English and correct typos.

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