Interactive comment on "Uncertainty sources in simulated ecosystem indicators of the 21st century climate change" *by* Jarmo Mäkelä et al.

Martin Thurner (Referee)

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Mäkelä et al. disentangle different sources of uncertainty regarding the projected changes in a set of carbon and water cycle indicators during the 21st century. They apply the land ecosystem model JSBACH and the forest growth model PREBAS, which allows them to study not only the effects of prescribed climates and representative concentration pathways (RCPs), but also of parameter uncertainties and forest management practices.

This comprehensive analysis sheds light into the impact of uncertainties in projected climate, RCPs, model parameters and, which I find most interesting and novel, harvesting practices on a selection of important ecosystem indicators at two boreal forest

sites in Finland. Although the authors have already put huge efforts into this work, I can see a few issues regarding the applied methods and presentation of results that should be addressed before this work can be published in Biogeosciences. I recommend the authors to address especially the major comments below.

Martin Thurner

Major comments

What are the conclusion and implications of this work? This should be highlighted also at the end of the abstract.

Please describe the parameter selection and sampling in more detail in the methods and/or Appendix A, even if this has been presented in earlier studies. This would make it easier for the reader to understand your work. I am not sure what it means to use 100 parameter vectors (Line 105)? Only 100 combinations in total (this seems insufficient to cover the uncertainty in ca. 20 parameters)? Or do you mean 100 values sampled for each parameter? It is also not clear to me why largely different sets of parameters have been selected for the 2 models (Appendix A)?

Since canonical correlation analysis allows identifying linear relationships between two sets of variables, I wonder if this is the most appropriate approach here, given the non-linearities in the processes determining the investigated indicators? I see that this point is mentioned in the discussion section, but wonder if there is no other, better suited approach that could be applied?

It is unclear to me why some of the indicators are calculated for both models and others either for JSBACH or PREBAS (Table 1)? I understand that some indicators may not be simulated by both models, but for instance biomass and soil carbon should also be available from JSBACH simulations.

The potential impact of uncertainty arising from different process implementations (or missing processes) in the models could be at least discussed.

Minor comments

I am not sure if the term "ecosystem indicators of climate change" is very descriptive for the selected indicators. These are a collection of carbon fluxes / stocks and vegetation and water cycle properties and maybe you could find a more suitable name.

Title: You should mention that this study focuses on boreal forest sites (in Finland)

Line 41: The impact of what?

Line 42: Do you mean future forest productivity in Finland or in general?

Lines 61-73: It would be interesting to get to know the distribution in tree diameter at both sites. This would make it easier to understand the differences in the effect of the forest management scenarios at both sites.

Line 83: Maybe describe the harmonized FMI meteorological data in a bit more detail.

Line 100: Which version of JSBACH do you use? Not sure if Kaminski et al. 2013 is the most appropriate reference for the JSBACH land surface model.

Line 102: Please state here that the parameter distributions are shown in the Appendix.

Line 102: How would the results be affected by coupled model runs?

Line 104: You mean only 1 PFT is present in the study regions?

Line 108: Wouldn't the "model uncertainty" also comprise uncertainty due to model structure (i.e. implementation of processes, missing processes)

Line 123: Do you mean mortality due to competition for resources?

Line 136: These are not only biophysical, but also biogeochemical indicators.

Line 138: Please list in detail how many scenarios have been investigated for each uncertainty component. Maybe a table would help to present this.

Table 1: Why is "gross growth" grouped into the "Biomass" group and how does it differ

from GPP?

Lines 158-164: Please state the values of the redundancy index for the different scenarios (at least in the bar plot in Figure 1) and explain what these values actually mean (what is a typical value range of Rd?)! What does it mean if Rd values for all factors are low (cf. Fig. 2)?

Figure 1: I suppose the colour scheme for the JSBACH simulations is not correct (management scenarios are displayed, although they have not been implemented in JSBACH).

Figure 2: Please use the same colour scheme as in Fig. 1.

Line 179: Please always state if you refer to ecosystem, autotrophic or heterotrophic respiration.

Lines 187-188: Isn't this statement in conflict with your previous finding that the impact of parameter uncertainty on overall uncertainty would be small?

Line 197: Which processes are (not) considered in the models that could lead to an impact of management on the seasonality indicators?

Line 222-223: Why are the model parameterisations responsible for the differences in soil moisture distributions and not rather the climate models?

Figures 7 and 8: A legend could explain which colour refers to which climate model.

Figure 8: Why are cumulative drought days displayed and not the trend in drought days over time? This might make it easier to spot changes in drought days.

Line 254: I suggest using a more informative heading than "Impact to ecosystems".

Line 341: I cannot find the supplementary material?!