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Interactive comment on "Sensitivity of simulated historical burned area to environmental andanthropogenic controls: A comparison of seven fire models" *by* Lina Teckentrup et al.

Anonymous Referee #1

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The manuscript "Sensitivity of simulated historical burned area to environmental and anthropogenic controls: A comparison of seven fire models" by Teckentrup et al compares several global fire schemes implemented in different global land surface models in a controlled setup (based on FireMIP), to analyze which processes and parameterizations cause differences between models. To this end, the authors perform a sensitivity analysis, where five different factors (CO2, population density, land use, lightning and climate) are individually modified. The authors identify land use as the most important factor for differences between models and discuss several potential routes to improve global fire models.

The manuscript represents a significant contribution to attempts to improve the parameterizations of Earth system models. It is well written and relatively easy to understand. I have, however, one major concern regarding the setup of the sensitivity analysis, which also effects a part of the findings presented in the manuscript (see comments below). This point should be accounted for before submitting a revised version.

General comments:

In my opinion, the design of the sensitivity analysis is not sufficient to support all conclusions made in the manuscript. The setup is suitable to analyze differences between models with respect to one factor (e.g. CO2). This is the case, because the modification of the factor (e.g. keep at constant value) is the same for all models, so differences between models have to result from the shape of the relation between this factor and the examined variable, burned area, which is implemented in the model. This is nicely explored in the manuscript by additional analyses of how the respective factors affect processes in the model.

However, the setup is not suitable to compare the relative effects, meaning the relative importance, of different factors, e.g. population dynamics and climate. The reason is that the factors show trends of different strength over the examined period (1900-2013). It is not clear to me how the authors separate the effect of the trend from the effect of the relation between factor and the simulated burned area (see specific comments below).

For example, let us assume that both CO2 and climate have a similar effect on burned area in the models. However, CO2 shows a strong trend in the period 1900-2013, while climate does not. This is enhanced in the setup of the sensitivity analysis by choosing a low value for CO2 for the experiment, but average values of climate variables. Consequently, the slope of the relative difference in burned area (e.g. Fig. 2) will be larger for CO2 than for climate, although both factors are (hypothetically) equally important in the model. This also affects the relative differences between models: If the general effect

of CO2 is amplified compared to climate in our hypothetical case, also the differences between models will be larger for CO2 than for climate. The authors need to clarify this, both in the methods and discussion section of the manuscript.

Specific comments:

P 2 L 7 Please replace 'regularly' by a more detailed description, such as 'at least once in 100 years' or similar. Does that mean that at least 60% of the land surface are never affected by fire?

P 2 L 12 Please put the 5.6 ppm CO2 into context: Which percentage of the total feedback per degree of warming does this correspond to?

P 2 L 26 Please explain the term 'woody thickening' shortly. How does vegetation composition change?

P 2 L 28 Why does reduced stomata conductance lead to increased fuel moisture? Is it assumed that plants take up water from the litter layer? Please explain this shortly.

P 3 L 6 It is quite difficult to understand this sentence. Please start with the end (nr of fires times size) and may be split into two sentences.

P 4 L 21 Does the around 150 year shorter spin-up for two of the models have effects on the fuel amount? Or is the turnover of the fuel fast enough to exclude that the models with shorter spin-up have less fuel?

P 5 Tab1 Why are only low values of CO2, population density and land use(?) included in the sensitivity analysis? Would it not make more sense to either use intermediate values, similar to climate and lightning, or, alternatively, test high values in addition to the low ones?

P 6 L 11 Please add a short description of how these data sets differ, beyond the retrieval algorithms, since this is important to understand the results (e.g. agricultural fires in GFED4s).

P 6 L 16 In which direction is the distribution skewed? Does the model resolution have an effect on the shape of the distribution?

P 6 L 21 The values 0.01 and 0.2 refer to the GFED4 and FireCCI50 data sets, I assume? Please make this clear.

P 8 L 9 - P9L2 I think this part should be shifted to the discussion.

P 9 L 4ff I do not understand the line of argument: In the first three experiments (CO2,population,land use), relatively strong trends and large model differences throughout the 20th century are reported. In the other two experiments, the trends are weaker. However, this result may be influenced from the setup of the sensitivity analysis, since there are trends in CO2, land use and population density over the 20th century. Population density, for instance, is kept at the low value of 1900 in the experiment, so it is logical that the rel. diff. BA increases over the 20th century for models, which assume a positive effect of population density on BA (e.g. LPJ-GUESS-SPITFIRE), due to the trend in population density. For models which assume a negative effect of population density on BA (e.g. LPJ-GUESS-SIMFIRE-BLAZE), the opposite is the case. However, it is not described how the effect of the trends (e.g. increase in population density) is separated from the effect of the factor in the model (e.g. effect of population density on fire). Figure 2 and Table 4 are only suitable to compare the relative effect of one factor between models, but not the relative importance of different factors. Maybe the relations between rel.diff. BA and lightning, and also rel.diff. BA and climate, are weak because the trends over the 20th century are not as pronounced as for the other factors, and also average values (1901-1920) are used for the experiments. In this case, the mean values of baseline scenario and the experiments would be very similar to each other, and variations would be randomly distributed over the 20th century, which is partly consistent with Fig. 2. Therefore, I am not convinced that the slope of the rel. diff. BA over the 20th century (Tab 4, Fig 2) is a good measure of the strength or importance of a certain factor in the model, compared to other factors.

P 12 L 11 Please add 'concentrations,' after 'CO2'.

P 16 L 3 Please explain shortly why the presence of lightning always leads to a net suppression of fire by humans.

P 18 L 15ff From the listed parameters, only the first two (precipitation and temperature) are climate variables. The others are dependent variables, which are also influenced by other factors (e.g. CO2). Please explain why you include them in the test. Moreover, I would like to see an analysis of the effects of wind speed. Is there a trend in wind speed from 1900 to 2013 ?

P 18 L 30 The word 'is' occurs one time too often.

P 19 L 10-12 I am not sure that this statement is valid, given my concerns on the setup of the sensitivity analysis above.

P 19 L 32 The word 'Table' is missing in the brackets.

P 21 L 14 How strong is the trend in changing climate compared to other trends, e.g. population density and CO2?

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