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Atmospheric Chemistry and Physics Discussions

Interactive comment on "The changing radiative forcing of fires: global model estimates for past, present and future" *by* D. S. Ward et al.

Anonymous Referee #1

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Review of "The changing radiative forcing of fires: global model estimates for past, present and future," by Ward et al., submitted to ACPD.

In this paper, Ward and coauthors examine the radiative forcing for a suite of changes resulting from fires under preindustrial, present-day, and future (2100) conditions. They find that the cooling from fires is largest (-1.2 Wm-2) under preindustrial conditions, diminishes to -0.5 Wm-2 for the present-day, and then increases to about -0.8 Wm-2 in the 2100 atmosphere. The study has some interest since fires perturb a wide range of variables (e.g., albedo, CO2 concentrations, cloud cover) and knowing the sum of the forcing of these variables advances knowledge of the radiative effects of fires. The sensitivity of these forcings to changing conditions is also useful information.

Main points.

1. The paper reads like a first draft. It is difficult to understand the set-up of the model experiment, what assumptions were made, and what the important points are. It is not clear about what conditions were applied to each scenario. Methods of calculating the forcing are scattered between the methods and results sections and the appendix. Background material is also scattered. Much textbook pedagogy is inserted in the paper. Most paragraphs contain 3 or more awkward or overly wordy sentences. There is an overreliance on obscure acronyms. Many results are not quantified in the text. Figures are often not fully described. For those variables which generate small forcings, the text could be condensed to 1 or at most 2 paragraphs. The paper could be half the length it is now.

2. Tables, figures, and captions also require extensive revision, with the exception of Table 3. The browsing reader should be able to discern most of the story of the paper from just these sections. The returning reader should be able to pull out important points from these sections without having to burrow into the text to retrieve details. Again obscure acronyms make understanding the tables and figures challenging to understand. Table footnotes would be helpful, and better captions and labels.

3. The paper apparently builds on Kloster et al. (2012), "The impacts of climate, land use, and demography on fires during the 21st century simulated by CLM-CN." This is not made clear. A summary of the results of this paper should be presented in the introduction, as well as a summary of the trend in fires from the preindustrial to the present-day. A description of the radiative effects of the trends in fires calculated by Kloster et al. (2012) would then proceed more smoothly and succinctly.

4. The section on "aerosol indirect effects on biogeochemistry" is unclear and should be cut. In this section, the authors first describe several potential biogeochemical effects and then dismiss them as unimportant. They then introduce a biogeochemical feedback that apparently affects the carbon cycle, but is incompletely described. What the authors call the climate-BGC feedback should not be included as a forcing unless the authors can convince the reader of the mechanisms that contribute to this forcing.

5. The authors need to do more work to convince the reader what is new. For example on page 10551, the authors state, “Since fires are a relatively novel addition to current global models it is important to stress that many models could be missing this large forcing if they do not prescribe CO2 concentrations.” Are the authors saying that carbon cycle models have historically not included wildfires? My understanding is that in fact they have. Wouldn’t the effect of fires be already folded into the calculated forcings of such models? This discussion of novelty should be in the introduction and the conclusion sections.

Specific points.

1. All forcings should be identified as a forcing of one condition relative to another. It is often not clear if a stated forcing was calculated relative to the preindustrial atmosphere or to the no-fires case.

2. It is not clear what the authors mean by fires. Wildfires? Fires set to clear land? What is the definition of “deforestation fires”? Both the no-fires and fires cases include land use change, but it isn’t clear if the no-fires case included forcings from the fires used to clear land for agriculture. There should be a separate paragraph near the beginning of the paper explaining these points.

Abstract. The abstract is too long. All forcings referred to should be quantified. What is the “negative change” in RF in lines 15-16? What does “small” forcing mean? (I.e., less that what?)

Methods. The authors should begin this section with an overview of the model set-up, the basic assumptions, the models used, etc. As is, the methods section is confusing. There are disconnects in the set-up that are not well explained. For example, it appears that future climate drives fire emissions but not the “atmosphere simulations” (page 10540). What are atmosphere simulations and why do they use year 2000 climate? The authors state that land and ice albedos remain constant, but elsewhere calculate the albedo difference between fires and no-fires.

Methods. A paragraph explaining what triggers fire in the land model is needed. Have the model fires been validated, and if so, what was the result? Also, how are GFED emissions derived?

Page 10541. What does atmospheric forcing mean? Why is population density needed for the calculations?

Page 10542. The acronym FIRE_CLOSS is unnecessary. Replace this and other obscure acronyms with plain English.

Page 10543. What are the important points of Figure 3b? Just that GFED is different?

Page 10544. What quantity was found to be 45% in the van der Werf (2006) paper?

Page 10545. “All fire emissions were released into the lowest model level.” What model?

Page 10546. Acronyms for simulation names are challenging to understand.

Page 10547. It’s not clear what changes in the different chemistry simulations. The same climate from year 2000 was used in all cases. Did anthropogenic or biogenic emissions change? If so, what emissions were applied?

Page 10548. While the global temperature effect of fire aerosols was small (0.05 oC), regional effects could be large.

Page 10548. “We assume that deforestation proceeds similarly whether fire is available as a vegetation-clearing tool or not.” Please clarify and explain earlier in the paper. This sounds like an important assumption.

Page 10550. “The American Meteorological Society defines. . .” An example of textbook pedagogy. The authors should strive to make their paper more succinct, about half the length that it is now.

Results. This section needs to be shortened. All background information should have

already been presented by now in the paper. If some of these results have appeared in Kloster et al. (2012), they can be briefly summarized here. For those variables which generate small forcings, the text could be shrunk to 1 or at most 2 paragraphs, with references to other papers. All forcings should be specified relative to a base state (no fires or preindustrial). Most of the changes described should be quantified. For example, in the sentence, "While the C storage . . . increases rapidly toward the year 2100," how rapid is "rapidly"? Also, the outstanding features of each Figure should be described in the text.

Page 10552. "In the RCP 4.5 future scenario. . ." Paragraph is unclear and not sufficiently quantitative.

Page 10552. "the RF from fire CO2 is . . . compared to the preindustrial RF. Radiative forcing is not typically calculated relative to another RF.

Page 10552. What is the significance of the shaded area in Figure 4b? What accounts for the jumps in both the fires and no-fires scenarios in Figure 4c?

Page 10555. What is the message of Figure 5?

Page 10556. What accounts for the decreases in AOD in Figure 6?

Page 10559. Figure 8 should be more thoroughly explained.

Conclusions. The authors should do more to convince the readers of what is new in their paper. They should also restate the simplifying assumptions made, and discuss the consequences of these assumptions for their results.

Appendices. I recommend that the descriptions of the forcing calculations be significantly reduced and included elsewhere in the paper. As is, there is much repetition.

Tables. Tables should be stand-alone – that is, the reader should fully understand the different items in the table without referring to the text. Footnotes should help explain the tables. For example, in Table 1, what is "Data ocean model" and what does "Year

2000 climate" mean? All acronyms need to be spelled out in footnotes.

Table 1. The entire set-up should be made clear in this table. What changes in the transient simulations? What is meant by emissions? Use footnotes.

Table 2. Percentages and concentrations should not be mixed in a column.

Table A2. Region names should be spelled out. What are the scaling factors used for?

Figure 1. What does the person icon represent?

Figure 2. Bar plots should always start at zero so that the relative lengths of the bars have some meaning. Just use symbols, not bars. Acronyms are not explained and are inconsistent with simulation names.

Figure 3. Acronyms need to be spelled out for this and all Figures.

Figure 4. Labels and legends are needed.

Figures 6 and 7. Panel labels are needed.

Figure 8. This figure should be two panels instead of one with an inset. Both figures need axis labels, not just one. What do grey lines represent?

Figure 9. Unnecessary, since forcings are minor.

Figure 10. Again, make two panels instead of one with an inset. Inset plot is hard to see.

Figure 11. Are these global forcings for each biome?

Figure 12. Can some uncertainty be placed on the indirect aerosol forcing? Also are these forcings relative to the no-fires scenario in the preindustrial?

Figure 13. Authors should make clear that these forcings are calculated relative to the preindustrial simulation with fires (if that is indeed the case).