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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Historical (1700–2012) Global Multi-model Estimates of the Fire Emissions from the Fire Modeling Intercomparison Project (FireMIP)" *by* Fang Li et al.

Anonymous Referee #3

Received and published: 12 May 2019

The Authors provide a new dataset of nine fire model estimates of carbon and 33 other gas and aerosol emissions. They provide a present day analysis of the data and show that LULCC is the largest source of uncertainty when simulating historical fire emissions. The collection of this dataset is a useful step forward in synthesizing fire modelling and one which should be of great use to the climate and Earth system science community. The Authors are to be commended on such a large effort and the manuscript will be suitable for Atmospheric Chemistry and Physics once some improvements are made to the manuscript.

Major comments:

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Firstly, while the content is of great interest I find myself agreeing with the previous reviewer that the grammar is not yet at a level suitable for final publication. Unfortunately, many parts of the manuscript (mainly in the first half) were hard to follow due to this. I therefore also propose an extensive review of the text. I have included some suggestions below, but it is not an extensive list.

Secondly, while the methodology and presentation of results is suitable for publication the manuscript will benefit from further analysis in three ways. The manuscript's main objective is in presenting a dataset for use by the community, and these additions are all ways to make the manuscript more useful for that potential user.

1) Extending the multi-model SD/zonal average plot in Figure 3 for other time slices across the dataset. A small discussion on which models are outliers for different regions/times would be insightful too.

2) As the Authors do not know what regions will be of interest to the potential user in their studies I feel that Figure 9 should be for all regions, not just the three with the most variance, even if trends are small. Furthermore, as it is likely that the potential user will first want to compare to CMIP6 the GFED regions in Fig 8 should follow the CMIP6 version in van Marle (i.e., further segregate the Americas). Similar plots for other emissions species would also be useful and can be place in the SI.

3) The present-day evaluation is of a suitable level for publication as is; however, further historical evaluation can be undertaken. In particular, the contribution of crop burning and how the fire models compare against historical fire proxies (not just the CMIP5/6 reconstructions). As crop fires are only accounted for in CLM, please discuss what this means in terms of missing estimates of historical emissions across FireMIP, a figure of % contribution to total emissions over time for example would be insightful. Included should be a discussion of current knowledge of crop fires in the present day, their uncertainties in emissions back in time, and what this means for CMIP/FireMIP as LULCC has been shown to be the largest uncertainty here. This then links to an

overall evaluation of historical emissions with proxies. The inclusion of an updated Figure similar to the one from van der Werf's 2013 paper for example? I leave it to the Authors to decide on how best to do this, but it should be included to once again help guide the potential user; perhaps in section 4.3.

Other/Minor comments:

Lines 61-62. The statement 'consistent with multi source merged historical reconstructions' is in reference to CMIP5/6; however, a multi-source merged historical reconstruction of the proxy data (ice cores, charcoal, tree scars etc.) would not result in the same conclusion. Please either rephrase in terms of CMIP, add that this disagrees with proxies, or remove.

Line 77: Species emitted from fires

Lines 81-89: I think this sentence needs to be clearer, both in grammar and content. Are all the items in the list symptoms of the atmospheric composition changing in response to fires? For example, changes to the 'terrestrial nutrient and carbon cycles' are more a symptom of changes to the magnitude of deposition and alteration to the land vegetation itself and the human health impacts are linked to the air quality changes (as R1 has also mentioned). Perhaps writing as a numbered list would help?

Line 90: There have been observation campaigns, such as SAMMBA, which have attempted to observe aerosol from fires at the regional scale using a combination of ground based and aircraft measurements. While they are only snap shots, due to the inherent time limitations of campaigns (as compared to say satellites), for completeness I would ask the Authors to list some of these as attempts to bridge that gap.

Line 99: Define 'present day period', i.e. list years data available.

Line 100: Suggest altering to say something like 'gases such as...' as they way it is currently presented appears to be a definitive list but is not. For example, vanillic acid has also been used as a unique tracer of fires. Please also make it clear that is the

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methane carbon isotope which is the tracer, as this species has many sources.

Line 104: Can the authors add a few words to describe aerosol indices, it is perhaps not as common as the others and would aid in reader comprehension.

Lines 104-109: Suggest that the Authors add something positive here about proxies for balance. While it is true that no proxy can accurately define the past, it currently reads a bit as if you are suggesting all this work is not of any worth.

Lines 117:119: Suggest: 'Fire emissions of trace gases and aerosols are derived from the product of the simulated DGVM carbon emission and a species emission factor (Li et al., 2012; Knorr et al., 2016).'

Line 185: 'their estimates of' rather than 'the simulations of'?

Line 186: remove comma

Line 190-195: Much of this is not grammatically correct, please rephrase.

Lines 227-235: The information in this paragraph could come before the protocol in the paragraph before. Such that when reading the protocol, it is clear where the data is from already.

Line 255: See Andrea (2019) for details; as this paper is only in prep I would suggest not explicitly directing the reader to it for more details.

Line 255-256: Suggest: 'All FireMIP model simulations used the same EFs from Table 2.'

Line 261: Incorrect placing of semi-colon (should be a comma), it could however be placed before 'similar' if wanted. Also suggest adding 'are classified as' for each of the three PFT instances not just the first.

Line 287: please define 'them'

Line 316: The definition of discrepancy is 'a difference between two figures, results,

etc. that are expected to be the same'. I do not think these results should be expected to be the same as the underlying factors have uncertainties in their representations, as the Authors mention?

Line 317: Emissions are 'from' the land, not 'over' them which is the concentration. Suggest to double check for occurrences elsewhere.

Lines 347-350: More details here please.... Why? Which models are driving this variability? Do satellites suggest this is a variable region too? etc.

Lines 402-403: But in disagreement with the ice-core/tree scar/charcoal proxies? These show variability in emissions from 1700-1900, with a peak $\sim$1850?

Lines 531-535 and 547-550: If most models do not capture these trends does it not therefore suggests that historical emissions are likely underestimated in most fire models (and hence also CMIP6)?

Line 551: The conclusions appears to stop a bit abruptly, could the authors finish the conclusions on an outlook or implication etc. to tie it all together a bit more. One example, global CMIP6 emissions are basically flat w.r.t. time, and so using model emissions which are much more variable will result in a different simulated climate/Earth system response.

Figure 2: The lat/lon co-ordinates are too small to read. Remove as they are not actually necessary.

Figure 7: suggest moving d and e to the a and b positions then decreasing the axis limits for the other three so the differences can be seen.

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