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**Interactive comment**

# *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 #1**

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General comments:

Li et al. compared global fire emissions simulated from state-of-the-art models with satellite observations during the present day, and with measurement-based reconstructions during the past ∼300 years. The authors found the population density change and land-use and land-cover change (LULCC) as two major factors contributing to the inter-model variability. They claimed that the multi-model based fire emission reconstruction may provide an important dataset with multiple potential applications. The topic of this study is important and suitable for Atmospheric Chemistry and Physics. I find the design and results of this experiment are mostly well described in the paper. But there

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Discussion paper

are several shortcomings in this manuscript that prevent me from recommending it for publication in the current form. First, the manuscript should undergo extensive language editing. Although I am not a native speaker of English, I can notice that a lot of sentences in this manuscript, mostly in the Introduction section, are composed of too many clauses and are often hard to understand. Second, section '4 Historical changes' can be improved, in both contents and structure (see below for detail). Third, the use of CMIP6 data in comparing with FireMIP model simulations sounds like a lit of circular argument to me, since results from 6 FireMIP models were used in the creation of CMIP6 reconstruction. I believe this paper will be an important contribution to the fire community once these issues are adequately addressed.

Specific comments:

1. Complex or ambiguous sentences in the 'Introduction' (an incomplete list):

L66-69: This sentence seems too complex. The four 'and' and one 'as well as' used in this single sentence make it hard to be understood.

L81-89: Similarly, this sentence is way too long. The last clause (regarding the 'air quality') should belong to a separate sentence.

L93-94: The authors are too assertive in some claims and statements, in my opinion. For instance, in both cases of 'fire emissions are estimated based on. . .' and 'Satellite-based fire emission estimates are derived from. . .', it may be better to use more modest expressions such as 'are often estimated. . .', or 'are primarily derived from. . .'.

L98-99: 'Data are available globally, but only cover the present-day period'. What 'Data' are you exactly talking about, (general) fire emission data, or satellite-based fire emission data? Please be more specific.

L100-101: 'and CO concentration trapped in. . .'. It is the CO who gets trapped, not the 'concentration'.

L104-108: Again, I have a problem in understanding this 'complex' sentence, partly

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due to the 6 'and'/'or' appearances in the final clause.

2. Section 4: Historical changes

Sections 4.1 and 4.2 are not well separated (even their titles are similar). The drivers of historical changes are discussed at the end of 4.1 and also in 4.2. Is it better to move all contents of drivers to section 4.2, and switch the section titles of 4 (Historical changes) and 4.1 (Historical changes and drivers)?

L359-360: Any theoretical explanation on the lower amplitude of seasonality from JSBACH-SPITFIRE model?

L440-441: Can you expand the explanation a little bit? i.e., how did 'assuming no fires over croplands and setting high fuel bulk density for pastures' lead to the sign change in LULCC response in JSBACH model?

Section 4.3: I like the discussions of drivers of global changes in section 4.2. But I would also like to see how these drivers play different roles on a regional scale.

3. Possible circular reasoning

According to the text in L303-308, CMIP6 estimates were calculated using different data sources (including 6 FireMIP model results). But the details of the reconstruction process were not given in the manuscript. How large do the FireMIP model results contribute to global emissions in CMIP6? Regardless of the amount of this fraction, some agreements between FireMIP and CMIP6 shown in Figures 6 and 9 are likely due to the use of the same data source. If you plot similar figures using data in North America + Europe + Equatorial Asia + central Amazon (where no FireMIP information is used in CMIP6) only, the comparisons will be independent and maybe more convincing.

4. Other specific comments

L330: It will be interesting to see the combustion completeness ranges in FireMIP models other than LPJ-GUESS-GlobFIRM.

L492: 'fire and Earth science research communities'. Is fire science not a part of the Earth science?

Figure 1: 'CRUNCEP atm.' shown in this figure is not easy for readers who are not familiar with reanalysis data. This can be changed to 'atmospheric forcing' as being consistent with that in the main text.

Figure 3. The pattern shown in this figure is highly dependent on the spatial distribution of BC emissions. It will be good to see a map of inter-model std normalized with mean emissions.

Figure 7: The population density is shown in the figure as 'control run - sensitivity run', which may cause a lot of confusion. In fact, I had a hard time understanding the meaning of 'increasing population density' (in L416) and 'rising population density' (in L421) at first, until I realized the use of this reverse scale in Figure 7. It there any particular reason that you did not use 'sensitivity run - control run' instead?

Technical corrections:

L59: 'most of the models' to 'most models'

L116: Is it better to change 'are applied to global change research' to 'have been widely used in global change research'?

L142: In order to make it more specific, 'Our study' may be replaced with 'This study', or 'The present study', or 'The study presented in this paper', etc.

L144: 'the nine DGVMs' to 'nine DGVMs'

L145: 'The dataset provides the basis for' to 'This dataset provides a basis for'?

L280: Why not spell out 'CE' for easier reading?

L325-326: 'whereas they are 1.5-4.2...for satellite-based products'. To be consistent with the previous clause, the range value should be in the singular form.