Dear reviewer,

We greatly appreciate the comments of the reviewer, please find below our response to the issues raised.

Kind regards,

Margreet van Marle

Interactive comment on "Historic global biomass burning emissions based on merging satellite observations with proxies and fire models (1750–2015)" by Margreet J. E. van Marle et al.
Anonymous Referee #2

Received and published: 13 March 2017

This paper presents the methods and results from the development of a global fire emissions inventory representing 1750-2015. The results are to be used as consistent inputs to climate model simulations. The authors integrate the results of fire models, satellite-based fire inventories, fire proxies (i.e., charcoal records), and visibility observations to provide emission estimates. The description of the methods is very complete. Further, this type of effort is incredibly challenging, and the authors provide an good discussion about the uncertainties in the assumptions they made in their approach. Despite shortcomings in the data and models, this is a very good effort and will provide improvements to future model simulations. I only have minor suggestions and some editorial comments for the authors.

General Comments: I may have missed this, but I would assume that fire models that are described need to be forced with atmospheric inputs. It is unclear to me what forcing were applied in the simulations that produced the emission results. This should be made more clear somewhere in the paper. I am assuming that they were all driven by the same climatic drivers?
The FireMIP models were all driven with the same climatic drivers as explained in the FireMIP protocol (http://www.imk-ifu.kit.edu/downloads/pai/FIREmip_protocol_web0.3.pdf). We have now rephrased this in the main text (P12 L01): "FireMIP used identical forcing datasets with prescribed meteorological forcing (1901-2013), global atmospheric CO_2 concentrations (1750-2013), lightning (1871-2010), land use change (1700-2013), and population density (1700-2013) (Rabin et al., 2016)."

El Niño is obviously an important driver of fire activity and emissions, particularly in EQAS. This is not captured in the emission estimates before the 1970's. Is this a problem? Can the authors comment on this further?
The title of the paper where this reconstruction is based on is "Human amplification of drought-induced biomass burning in Indonesia since 1960" (Field et al., 2009). The key message there is that it takes both humans and drought to get big fire events and the relation between ENSO and fire emissions becomes weaker when going back in time because there were

fewer humans aiming to convert the landscape. The reviewer is right that before the 1970's we will not capture those fires but the data indicates that emissions were low then anyway.

Editorial Comments:
Page 3, line 16: Should it be "directly" and "indirectly"
We changed this to directly and indirectly.

Page 3, line 24: What other land surfaces? The previous sentence talks about deforestation fires. So, is this land surfaces other than forests?
Yes, we changed this to: "For fires not associated with deforestation."

Page 5, line 7: Change to "All of these" - *Done*
Page 5, line 14: Change "which" to "that" – *Done*

Page 6, lines 7-11: This is a very long sentence and could be broken up to read more clearly.
We changed this to: "Based on CH_4 concentrations and its isotopic ratio, Ferretti et al. (2005) have hypothesized that this decrease of human-driven fires in the South American tropics was related to the arrival of Europeans and the introduction of diseases in the tropics. This would have decimated the population and lowered the number of human ignitions. However, decreased burning is evident in both the Americas and globally (Power et al., 2013), and thus is better explained by widespread cooling during the LIA."

Page 6, line 18: The differences "over the past decade"? What is meant by this?
We actually meant the past decades but have rephrased that part of the text (P6L17) to: "Although biomass burning reconstruction based on isotopic ratios of CO and those of CH_4 as well as those derived from charcoal records show similar features there are key differences. These are most pronounced for the past 50-100 years and could be the result of different lifetimes of CO (two months, providing more regional information) and CH_4 (about a decade, providing information on a global scale), but also because of the distribution of the charcoal datasets, which is denser in temperate regions than in the tropics."

Page 7, lines 9 and 10: "data" are plural. Change to "provide" – *Done*

Figure 1: Shouldn't the satellite observations circle expand downward to local scales? *Yes, we have extended the Satellite observations circle more towards local scale and towards decadal scale (GFED4s is now available for 2 decades).*

Page 9, line 6: The reference for GFED4s should be provided. *We added the reference to GFED4s (van der Werf et al., 2017).*

Page 10, line 11: A comma should be used before the word "which" (here and throughout the paper). – *We have the checked the paper for "which" and added a comma if necessary.*

Page 11: The emission factors used in this are from Akagi et al. 2011. Did you include the emission factors from the updates to this dataset (from 2015).
Most of the emission factors are indeed from Akagi et al. (2011) but updates and other sources were used as well. This is detailed in van der Werf et al. (2017)and in the text we now refer to that paper (P11,L08): "As a final step, these carbon emission estimates are converted to trace gas and aerosol emissions using emission factors based mostly on the compilation of Akagi et al. (2011) but updates and other sources were used as well (van der Werf et al., 2017). An overview of the emission factors used in this study is given in Appendix C."

Page 14, line 17: Change "which" to "that" – *Done*

Page 14, line 25: change the tense to be consistent ("are" should be "were") – *Done*

Page 16, line 3: How can you compare the visibility outputs to 1750 – 2000 when those data don't go back that far? This is unclear. – *The 1750-2015 reconstruction was based on GFED4s (1997-2015), visibility observations (1950-1996 for EQAS and 1973-1996 for ARCD), and the lowest decadal average from that time series for the pre-visibility time period. This time series was compared to HYDE population density. We changed this sentence to: "and extended visibility-based fire emissions using the lowest decadal average for the period before visibility observations became available"*

Page 17, line 7: all "of" our – *Done*

Page 18, line 22: Define IAV when first used. – *We defined IAV at P03L06.*

Page 18, line 24: Change "which" to "that" – *Done*

Page 28, line 2: Change to "there are very little data" – *Done*

Page 34, line 18-19: Current emissions? Does this mean the current emissions (2000? 2010?) in the CMIP5 estimates? – *Changed this sentence to: 'which was lower than their emission estimates in 2000'*

Page 34, line 21: Should "in" be "is"? – *No, in our opinion this sentence is grammatically correct.*

Page 36, line 14: This sentence is worded poorly and should be rewritten.
Page 39, line 8: Should there be an ; or : after "emissions" – *We rephrased this to: 'We have assumed that fire emissions did happen at a much lower rate, either man-made or naturally. However, the relation between climate, humans and fires is complicated (Archibald, 2016).'*

References:

Akagi, S. K., Yokelson, R. J., Wiedinmyer, C., Alvarado, M. J., Reid, J. S., Karl, T., Crounse, J. D. and Wennberg, P. O.: Emission factors for open and domestic biomass burning for use in atmospheric models, Atmos. Chem. Phys., 11, 4039–4072, doi:10.5194/acp-11-4039-2011, 2011.

Archibald, S.: Managing the human component of fire regimes: lessons from Africa, Philos. Trans. R. Soc. B Biol. Sci., 371, 20150346, doi:10.1098/rstb.2015.0346, 2016.

Field, R. D., van der Werf, G. R. and Shen, S. S. P.: Human amplification of drought-induced biomass burning in Indonesia since 1960, Nat. Geosci., 2, 185–188, doi:10.1038/ngeo443, 2009.

Rabin, S. S., Melton, J. R., Lasslop, G., Bachelet, D., Forrest, M., Hantson, S., Li, F., Mangeon, S., Yue, C., Arora, V. K., Hickler, T., Kloster, S., Knorr, W., Nieradzik, L., Spessa, A., Folberth, G. A., Sheehan, T., Voulgarakis, A., Prentice, I. C., Sitch, S., Kaplan, J. O., Harrison, S. and Arneth, A.: The Fire Modeling Intercomparison Project (FireMIP), phase 1: Experimental and analytical protocols, Geosci. Model Dev. Discuss., 1–31, doi:10.5194/gmd-2016-237, 2016.

van der Werf, G. R., Randerson, J. T., Giglio, L., van Leeuwen, T. T., Chen, Y., Rogers, B. M., Mu, M., van Marle, M. J. E., Morton, D. C., Collatz, G. J., Yokelson, R. J. and Kasibhatla, P. S.: Global fire emissions estimates during 1997-2015, Earth Syst. Sci. Data Discuss., 1–43, doi:10.5194/essd-2016-62, 2017.