

## ***Interactive comment on “The biomass burning contribution to climate-carbon cycle feedback” by Sandy P. Harrison et al.***

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Response to Referee #3

Thanks Sam for this positive review, the helpful suggestions and spotting the typos.

1) Although the methodology is not complex, we agree that it might seem so given that we are including analyses of satellite-era and palaeo-data that have to be carried out somewhat differently. We think it will be worthwhile to include a paragraph at the beginning of the Methods section to spell out the underlying logic and to illustrate this with a flowchart, as you suggest. This paragraph will also clarify the logic of including the methane and methane-isotope versus charcoal comparison in this paper. We agree that establishing the good relationship between the methane record and the charcoal

C1

record is an important part of this paper since it demonstrates conclusively, and for the first time, that the assumption that charcoal can be interpreted as a record of biomass burning on palaeo-timescales is valid. We propose to emphasise this point further in the revision.

2) We agree that the description of the GFED data sets in the Readme file and in the various publications is not exactly clear. In van der Werf et al. (2017), which is the most comprehensive description of what was done to obtain the GFED4 and GFED4s data sets, it is clearly stated that the MODIS-era data starts in August 2000. The derivation of pre-MODIS era burnt area from the VIRS and ASTER active fire data is via optimization against the post-2001 MODIS data. Our decision to include 2000 was because the record included five months of MODIS data, corresponding to the southern hemisphere fire season, and increased the number of data points available in a time series that was already limited in length. However, we did test whether inclusion of these data made a difference to our results. What emerges from these tests, documented in the Supplementary, is that the year 2000 is not anomalous and if there is an overly-influential observation it is 2003. Thus, we feel comfortable with using the 2000-2014 period in our analyses. However, we will note that the records for 2000 are a mixture of pre- and post-MODIS in the methods section and justify our inclusion of this year in the analyses.

3) This is a very good suggestion. The flowchart that we propose to add at the start of the Methods section will make it clear how we go from a relationship with mean land temperature to a feedback strength related to mean global temperature.

4) Our focus in the SI was weighted towards explaining the derivation and testing of relationships in the palaeodata, because we assumed that this was less well known. However, we will expand the SI further to include parallel information about the modern data to that provided for the palaeodata.

5) The important point here is not that our central estimate of  $\delta m$  is low. The point

C2

is that it is highly uncertain (with confidence intervals wide enough to include all published values), so our analysis does not allow us to place any further constraint on the appropriate value of  $\delta m$ . Our calculations do not assume any particular value.

6) We agree that we do not explicitly state that the relationship between temperature and fire is positive, although we cite a number of references that explicitly show that it is, but we will clarify this in the text.

7) We do not claim that peatland only burns as a result of human intervention. Palaeo-data show that peatlands have burnt through natural fires (see e.g. Grant et al., 2014 *Journal of Quaternary Science*; New et al., 2016, *Mires and Peat*, Volume 18, Article 26, 1–11, <http://www.mires-and-peat.net/>, ISSN 1819-754X). However, it is true that the major tropical peatland fires in recent years have been associated with substantial modification of the natural environment by humans, particularly through drainage for agricultural use. Nevertheless, in the case of both peatlands (see e.g. Page et al., 2009 DOI 10.1007/978-3-540-77381-8\_9) and deforestation fires (see e.g. van der Werf et al., 2008, *PNAS*), there is also a strong climate driver with major fire years associated with ENSO variability. Thus, in making our analyses, we initially exclude agricultural fires – on the assumption that these are solely human controlled – and subsequently exclude peatland and deforestation fires because of the likelihood that they show a substantial imprint of human activities. We agree that other landscapes may be heavily human-modified, but that does not necessarily detract from the fact that climate plays a major role in the year-to-year incidence of fires.

8) We have provided a high level of detail in the Supplementary Information so that others can reproduce our analyses. And it is clear that this is useful because you are asking for further expansion of the SI. However, we agree that it would be useful to provide a reader with more guidance about which sections of the SI to refer to in the main text, and we will pay attention to enhancing its readability.

9) We have changed this to “N<sub>2</sub>O, and ozone precursors”.

C3

10) We will change this to read: Changes in biomass burning therefore need to be taken into account in estimating the ‘climate-carbon cycle feedback’, i.e. the longer-term positive feedback by which global warming leads to a reduction in land carbon storage, a consequent reduction in the net uptake of CO<sub>2</sub> so that more CO<sub>2</sub> remains in the atmosphere, and thus an amplification of the initial warming (Arora et al., 2013; Cox et al., 2013; Wenzel et al., 2014)’.

11) The use of a semi-colon here is grammatically correct.

12) We can add a comma here to increase readability.

13) We can remove the comma here to increase readability.

14) We will indicate that this is the GHCNMv2 dataset. This was created from more than >7000 stations worldwide and provides a historical records since 1901. The construction of the data set is described by Peterson and Vose (1997) and we will add this reference to the text.

15) We have corrected this typo.

16) Thanks. This should be  $c_t^*$ .

17) We will provide the information about the sections in the Supplementary Information where R code and/or relationships are documented. We will also add references to the appropriate sections in the SI for other material cited in the text.

18) Figure 2a shows the relationship between emission and land temperature anomalies, and we will make that clear in the text.

19) We will add a definition of climate sensitivity at the first use of this term in the text in Section 2.7 (i.e. ‘the global mean surface temperature change for a doubling of CO<sub>2</sub> concentration’).

20) We will correct this typo. Thanks for spotting it.

C4

21) We assume that this refers to Figure 4c, which parallels Figure 2a but for the palaeodata. And again, yes, this shows the regression between anomalies. We will clarify this in the text.

22) Fig. 4: We will provide a new version of this figure with Y-axis labels on all three panels.

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