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Earth System Dynamics
Discussions

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 #4

The relationship between temperature and charcoal has been established in previous studies, but we agree that establishing the quantitative relationship between charcoal and the ice-core methane and methane-isotope record is an important additional piece of information. As a result of comments by Reviewer #1, we will expand the discussion of previous studies on the charcoal-temperature relationship in the Introduction, and we will also stress the importance of the quantitative relationship between charcoal and methane in the discussion.

We were at pains to point out the relationship between temperature and emissions over

the satellite era is not robust, and that it becomes non-significant if deforestation and peatland fires are not taken into consideration. It is clear that other factors, including the impact of human fire suppression, have had an overwhelming impact on fire during recent decades. Our goal here however is not to investigate the regional controls on fire (the subject of a number of recent papers), whereas our emphasis on testing for a temperature-fire relationship is necessary in order to estimate the global feedback strength. We have included the satellite-era analysis here for completeness, but we hope that it is clear from the discussion in the paper that the more robust estimate of the feedback is based on the palaeodata.

It is true that including pre-2000 data in the regression produces a negative slope. We omitted these data, however, because the pre-MODIS era data are thought to be much less reliable since they are derived from VIRS and ASTR active fire counts via optimization against the post-2001 MODIS data (see response to Sam Rabin, Referee #3). As we stress in the paper, even after eliminating these early (anomalous and less reliable) data points, the relationship we find is barely significant and becomes non-significant if peatland and deforestation fires are omitted.

We agree that an examination of the relationship between palaeodata and temperature at a regional scale could provide additional corroboration for the global relationship. Such analyses have already been done e.g. by Marlon et al (2013) for the data-rich regions of North America, Europe and southeast Asia. In all cases they showed a positive relationship between temperature and charcoal abundance. We have now performed separate analyses for broad latitudinal bands (see our response to Referee #1) and propose to add these in section 3.4 of the paper.

This referee's comments highlight a key point that should be clarified in our revised manuscript. We are not claiming that fire responds only to temperature. We are well aware that this is not the case (see e.g. Bistinas et al., 2014, which is cited in the text along with other analyses of the multivariate controls on fire). However, we argue that if other factors are properly taken into account, the relationship between fire (and

fire emissions) and temperature is positive. We did not say, nor do we mean to imply, that the relationship between fire emissions and temperature was positive in the pre-industrial epoch, became negative in recent decades and will become positive in the future. The lack of a significant relationship between fire emissions and temperature during the post-2000 interval, and the observed decrease in fire over recent decades (e.g. Andela et al., 2017) while climate has been warming, point to the increased influence of other controls on the fire regime.

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