**Reply to Meinrat O. Andreae comments**

I have some concern regarding the emission factors used in section 2.3.1b, page 12f. The authors base their values for the emission factors of CO and $CO_2$ on GFED4.1s, which in turn are based on a blend of Andreae and Merlet (2001) and Akagi et al. (2011). Newer estimates for these emission factors are available in Andreae (2019). These newer estimates, which are based on a much more comprehensive data base than the previous estimates, differ from the ones used here by as much as 30% in some cases. I wonder how much difference it would make if the updated emission factors would be used in the authors' calculations.

We thank Meinrat O. Andreae for the comments and remarks posted.

First, we would like to mention that all estimates (CMS-GFED3, GFED3, GFED4.1s and FIREMo) are based on the emission factors based on Andreae and Merlet (2001) and Akagi et al (2011). The CMS-GFED3 $CO_2$ emissions are based on this calculation, we consequently thought more judicious and correct to have all $CO_2$ emissions with the similar emissions factors for better comparison. In order to be more specific on that, we added the sentence page 12 line 304 : "For better comparison and as the CMS-GFED3 product (we will introduce later) used the emission factor of Andreae and Merlet (2001) and Akagi et al. (2011), we applied the same emission factors and consequently did not use the new estimate established by Andreae (2019)".

However, to answer the question if the use of a different emission factor would have give different conclusions, we calculated the FIREMo product with the emission factor of Andreae (2019) and compared it with the one used in our paper (FIREMo calculated with Akagi et al., 2011).

The figure below show the difference for the OCO-2 MIP regions between the two FIREMo estimates. We also added the NEE and net fluxes estimates based on the respective FIRE emissions. We can observe that for all regions over the globe, the difference between the two fires estimates are negligible (in the order of 15 TgC/yr) with higher estimates using Akagi et al., (2011) than with Andreae (2019). In our study, since the respiration are calculated using the fires estimates and re-balancing to match the global NOAA growth rate, the differences between both estimates in the net fluxes are completely negligible.

The small differences could have been also assumed, when looking at the Fig. 2 of Andreae (2019) paper, we can see that the ratio of MCE (Mole Combustion Efficiency calculated using CO and $CO_2$ emission factor) between this study and Akagi et al., (2011) has a ratio very close to 1. Additionally, the ratio of emission factor for $CO_2$ between both studies is also very close to 1. There is then no large differences between the two estimates for all vegetation types.

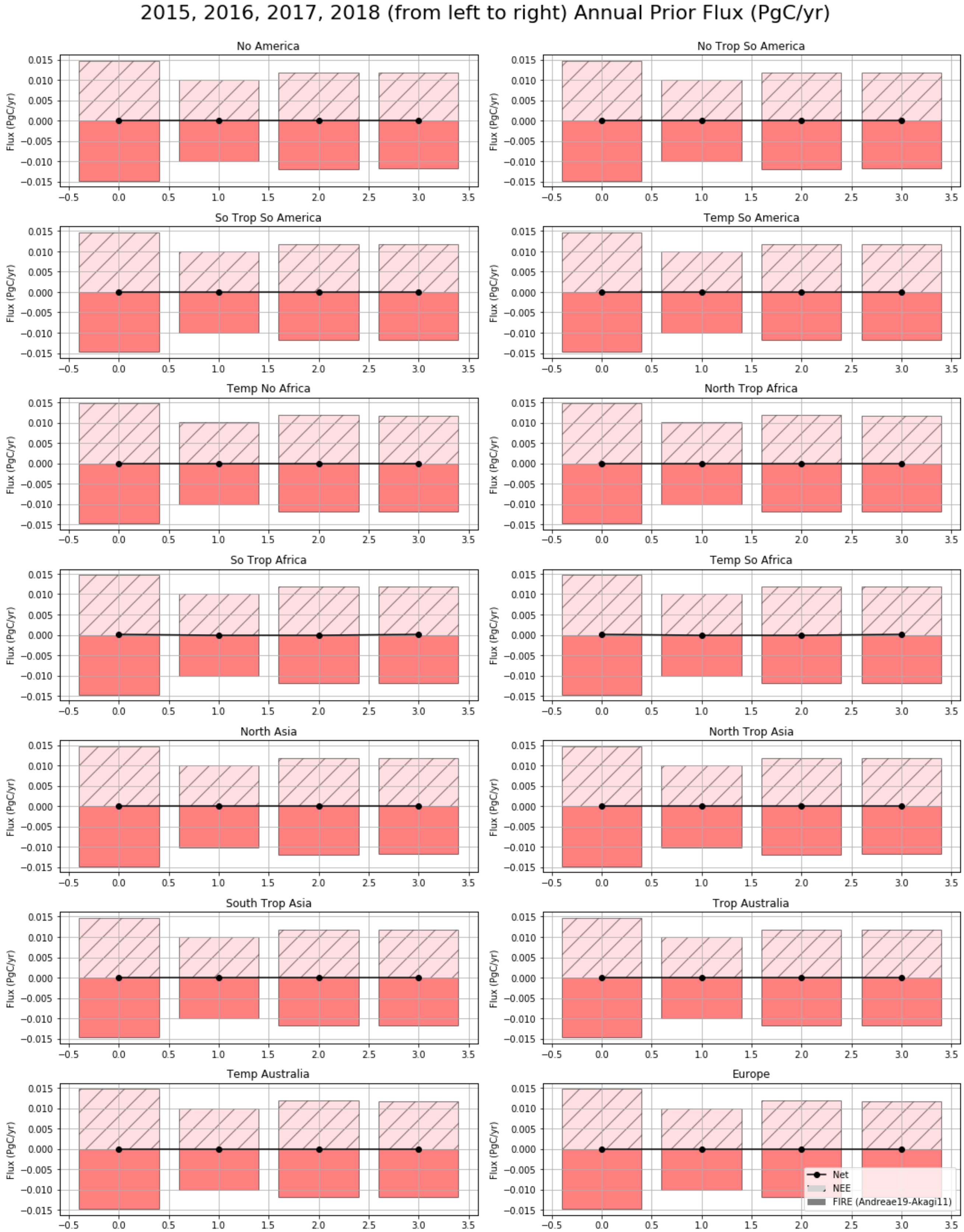


*Figure 1. Differences between the prior emissions calculated with CO posterior fire emissions using Andreae (2019) versus Akagi et al., (2011) for the OCO-2 MIP regions. Fire emissions are in dark red bar, NEE emissions are in hatched bar and net flux are the dot/lines. Flux are in PgC/yr.*

One should also keep in mind, that in particular the EF for $CO_2$ and consequently the emission ratio $CO/CO_2$ are quite difficult to determine accurately in the field for a number of reasons. These include the difficulty of distinguishing the often relatively small fire inputs of $CO_2$ from large biospheric variability, the issue of variable background concentrations, and the problem of accounting for residual smoldering emissions that do not get lofted into the smoke plumes (Guyon et al., 2005; Burling et al., 2011; Yokelson et al., 2013). This introduces systematic errors in the EF($CO_2$) values that may well exceed 10%. While this problem obviously cannot be mitigated here, it should be at least pointed out to the reader as a significant source of uncertainty and possibly explored by a sensitivity study.

This is a good point that we acknowledge and indeed need to be mention in the paper. As one of the reviewer mentioned that the paper was too long in length ("*The lengthy descriptions in each section distracts from the main points of this original work. Perhaps some of detailed descriptions, figures and comparisons can be moved to a supplementary document.*"), we did not add a sensitivity study in the paper (we will consider that for future work), but we have added this sentence page 36 line 714: "However, the estimation of EF and consequently the emission ratio $CO/CO_2$ cannot be determined accurately in the field and can introduce systematic errors in the EF($CO_2$) values that may well exceed 10%. One challenge is separation of the information between small fire inputs of $CO_2$ (and hence their detection) from large biospheric variability. Other difficulties come from the issue of variable background concentrations and from smoldering emissions that are not projected into the smoke plumes (Guyon et al., 2005; Burling et al., 2011; Yokelson et al., 2013).".

Two minor issues:

In the caption of Table 2, van der Werf et al. (2017) should be cited explicitly (if the authors prefer to keep these emission factors).

We added the reference in the caption of Table 2.

I don't understand what is meant by the sentence: "Finally, the emission ratio for each vegetation type was divided to the posterior CO fire partitioned as used in Christian et al. (2003) and Basu et al. (2014)." (line 307f).

In this section, we explained how we calculated our FIREMo ($CO_2$ fire prior estimates based on CO posterior emissions from MOPITT). We break down our CO emission estimates within the 3x2 regions according to vegetation type using the GFED4.1s partitioning to get CO emission from each vegetation type for each grid box. Then we used the emission ratios measured by Van der Werf et al., (2017) to convert those into $CO_2$ emission per vegetation per grid box. For this conversion, the posterior CO fire partitioned are divided by the corresponding emission ratio of each vegetation type, such as the equation:

$CO_{2i} = \frac{CO_i}{ER_{(CO/CO2)_i}}$ with *i* corresponding to the vegetation type (sava, borf, temf, peat, agri, defo).

To make sure this sentence is understood by the reader, we added page 13, line 308: "Finally, the emission ratio for each vegetation type was divided into the posterior CO fire partitioned for each vegetation type (annotated i in the equation) as used in Basu et al., (2014) following the equation :

$$CO_{2i} = \frac{CO_i}{ER_{(CO/CO2)_i}}$$ .”

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