# Response of the authors to comments by reviewer #2 – bg-2020-86-RC1, 2020 – "Seasonality of greenhouse gas emission factors from biomass burning in the Brazilian Cerrado"

Roland Vernooij (corresponding author) on behalf of the authors:

We thank Reviewer #2 for the time and effort in assessing our manuscript, and the detailed and constructive comments. Please find below our point-to-point response to the review. The revised text and updated figures are included in the updated manuscript.

| **Reviewer # 2 detailed comments** | **Author's response, reasoning and comments** |
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| Fuel amount estimated from quantifying recovery time since last fire which was derived from Landsat data. Here, the study lacks to inform the reader how this data on fuel type and fuel amount is integrated into the emission factor quantification in equ. 1 and 2, respectively. | In this study we do not use fuel amounts, and they are not included in Eq. (1) and Eq. (2). As they calculate the emission factor, they primarily depend on the ratio of the emitted carbonaceous species. Through the carbon content of the fuel (which does differ for different fuel types based on literature), this is then calculated back to a g kg-1 dry fuel unit. We do not attempt an estimation of the total emissions. |
| The authors need to add respective information and they need to describe how the upscaling is done in order to analyse the spatio-temporal variation. | We have added the following clarification to section 2.5:<br><br>"The weighted average ($\overline{\mathrm{EF}}$) for combined cerrado vegetation types in the EESGT was calculated through Eq. (3) in which n is the number of vegetation types, $BA_i$ is the burned area over the years 2013 to 2018 and $BA_{tot}$ is the burned area over the same period. Since we lack detailed fuel load and combustion completeness data, the $\overline{\mathrm{EF}}$ for EESGT is based on BA.<br><br>$\overline{\mathrm{EF}} = \sum_{i=0}^{n} EF_i \times \frac{BA_i}{BA_{tot}}$ (3) " |
| The results describe seasonality pattern found in emission factors for N20, CO and CH4. The authors find that N20 has seasonality trends opposite to CO and CH4, where the latter indicate incomplete combustion. Statistical significance are mentioned, but not reported in detail with respective results in section 3.2. Even though it is marked in Table 3, examples should be provided in the text. | In the revised manuscript we now refer explicitly refer to the significance of the results in the abstract, results and discussion:<br><br>in sect 3.1: "only the slight differences in open grasslands and the 14% and 34% increases in $N_2O$ EF for open cerrado and typical cerrado, respectively, were statistically significant using a two-tailed t-tests with unequal variance at a 90% significance level."<br><br>in sect 4.1: "intraseasonal variability was smaller compared to the variability within EDS or LDS campaigns, and the difference was not statistically significant ($p<0.1$) |

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| The results are then discussed in detail and contextualized using earlier publications, offering the reader to understand where earlier findings could be confirmed and where uncertainties, especially for N2O, still persist. It underlines the importance of reporting spatio-temporal variabilty in each measurement campaign also in global studies.<br>The discussion contains a detailed description of uncertainties arising from sampling strategy, multi-day burning fires, and emission factor calculation. To avoid confusion, please also cite the original study where these numbers were taken from (it is correctly done in the methods, but worth repeating here on page 15, line 2). | We added the references to the discussion |
| p. 15, lines 14-23: The discussion of the role of peat carbon contributing to carbon combustion in Cerrado<br>fires is somewhat arbitrary, since peat combustion was not explicitly measured in these experiment, nor was the carbon storage in organic soils quantified or its proportion in the study area quantified. I would suggest to carefully discuss the wider implications of burning organic (peat) soils in the Cerrado. | After closely examining the conditions under which peat burns, we decided that we cannot state with certainty that peat burned in the humid grassland fire we measured. Since the higher carbon content of 56% was based on this assumption, we have reduced this to 48% which is also used for the other cerrado species. We then recalculated the results leading to lower EFs for humid grasslands by ~15%. This did not alter any of the main findings of the study. We have added the following text to the manuscript:<br><br>Sect. 4.4.2:<br>'The carbon content in humid grasslands is based on the assumption no peat, which has a higher carbon content of ~56% (Susott et al., 1996), was combusted in the fire.'<br><br>Sect. 4.4.3:<br>'Based on our measurements, we cannot conclude whether peat from the soil underlying the humid grasslands contributed to the fuel mixture.' |
| The key finding of this study is clearly the fact that lower N2O emissions were found that could impact global N2O budgets if the burning conditions measured here are representative of all savannah areas which are a large contributor to global biomass burning. However, the conclusion should also contain key results (numbers) for the EF factors for CO, CH4 and N20, incl. their uncertainty range. | Added to the conclusion:<br>'WA EFs over the combined cerrado vegetation in EESGT for CO, $CH_4$ and $N_2O$ where 48 g kg$^{-1}$, 0.78 g kg$^{-1}$ and 0.11 g kg$^{-1}$ , respectively in the EDS. In the LDS, WA EFs were 41 g kg$^{-1}$ for CO (-15% from EDS), 0.68 g kg$^{-1}$ for $CH_4$ (-13% from EDS) and 0.12 g kg$^{-1}$ for $N_2O$ (+17% from EDS). Apart from the intraseasonal $N_2O$ EF decrease in grasslands and increase in typical cerrado, we did not find major seasonal differences that were statistically significant.' |

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| p. 8, line 12: please explain BA abbreviation | It refers to burned area as observed by satellite observations. We included “burned area (BA)” in the abstract |
| p.9, line 25: it should read "In Figs. 5-7 the green diamond" | We changed it in the manuscript. |
| p. 12, line 11: explain abbreviation RSC | It refers to Residual Smouldering Combustion. This is now written out the first time we refer to the abbreviation |

In addition to the above-mentioned improvements we have made based on the reviewer suggestions, we have added some references to recent work that we feel improves the quality of the manuscript. Namely:

“Although no fuel moisture measurements were done during the 2018 campaigns, measurements from 2017 showed limited drying occurring from June to September, with respective average fuel moisture content declining from 63.8% to 55.4% for live grass and 11.7% to 7.2% for dead grass (Santos et al., in press).”

‘The decline found in $N_2O$ EF from open grasslands that have not burned for some years (Fig. 7) may be related to the increased dead to live grass ratio of the fuel mixture as found by Santos et al. (in press).’