BIOGEOSCIENCE – Comment on egusphere-2025-3501 – 25/08/2025
Response to comments by Anonymous Referee #1

The author's comments and responses are written in blue, and the comments of Anonymous Referee #1 are in black.

Overall, this paper is a useful addition to the literature. Better characterizing greenhouse gas fluxes from tropical soils, and identifying drivers, is a timely and important research question. The combination of automated chambers and eddy-flux, especially for N_2O, is very novel for tropical forests. Overall, given the well-known spatial and temporal heterogeneity of N_2O fluxes even in much more homogenous ecosystems, I am not surprised that fluxes were not well explained by simple environmental variables, even with the data density of this paper. This is a dataset that will certainly be of interest to many people. Several of the methodological lessons learned (such as lack of storage of N_2O and CH_4 under the canopy, revealed by vertical profile measurements) are also likely to be of use to other researchers.

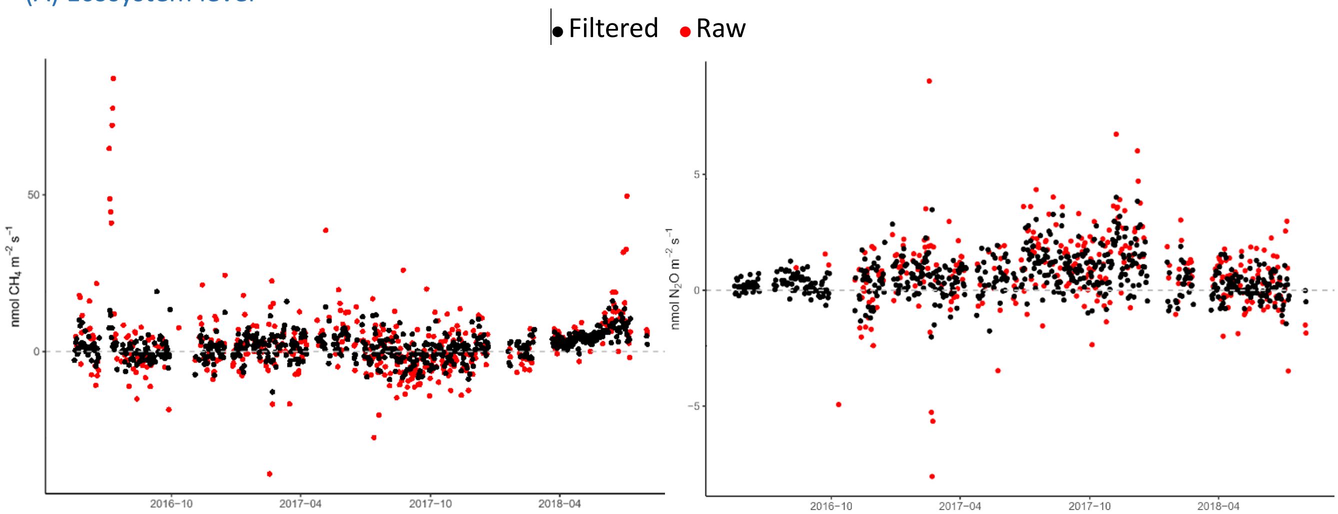
Response: We thank Referee #1 very much for his / her positive feedback and constructive suggestions.

I have one significant concern that I think merits serious consideration- the choice to exclude high fluxes from analysis (and indeed not to present them at all, making it very difficult to judge how important they might be). Specifically, the authors did not present (or include in analysis) any fluxes outside the 5^{th}-95^{th} percentile (per line 248), even after rigorous data cleaning steps that should have weeded out any anonymously high fluxes that were methodological artifacts. I realize that it is very difficult to scale rare, high fluxes without very good estimates of their probability. However, I do not thing that dismissing them entirely makes any sense, and no specific rationale or citation was given for the choice. Rare, very high N_2O fluxes are not at all uncommon in tropical forests in my personal experience, but rarely do we have the data density (as we do here!) to judge their potential importance. These excluded fluxes- depending on their magnitude, could be potentially important for net ecosystem emissions, especially because they're probably quite skewed- extreme production events could be somewhat common but extreme consumption events likely are not.

To summarize- I am not necessarily suggesting that all data needs to incorporated into scaling, but I would strongly suggest 1) presenting the relative magnitude of the excluded fluxes compared to the data that was included. Were they common and somewhat high? Or more rare and extremely high? 2) At least conducting some sort of sensitivity of means, medians etc to the inclusion or exclusion of these omitted values (including perhaps making a range of assumptions about their probability, in the case of very high outliers). I also would hazard, and add caveats, against comparisons with any other rate fluxes from tropical sites that may indeed have included hot spots and hot moments in their scaling efforts. Overall it seems counterintuitive to highlight the heterogeneity of soil GHG fluxes and then ignore a potential large fraction of the variation.

Response: This is a very relevant concern, particularly given the highly variable nature of the CH_4 and N_2O fluxes. For clarity, we now present the average daily fluxes based on the raw data (fluxes computed by the EDDYPRO and SOILFLUXPRO programs), rather than the 5^{th}-95^{th} percentile range. Overall, it has no impact at the ecosystem level. Figure 1 shows that considering the raw data has little effect on the calculated daily fluxes of CH_4 at the ecosystem and soil levels. Only a few episodic production events (two in July 2016 and June 2018) and no remarkable consumption events are observed at the ecosystem level. Meanwhile, high N_2O fluxes are much more frequent at the soil level throughout the study period, although this is not so visible at the ecosystem level.

(A) Ecosystem level



(B) Soil level

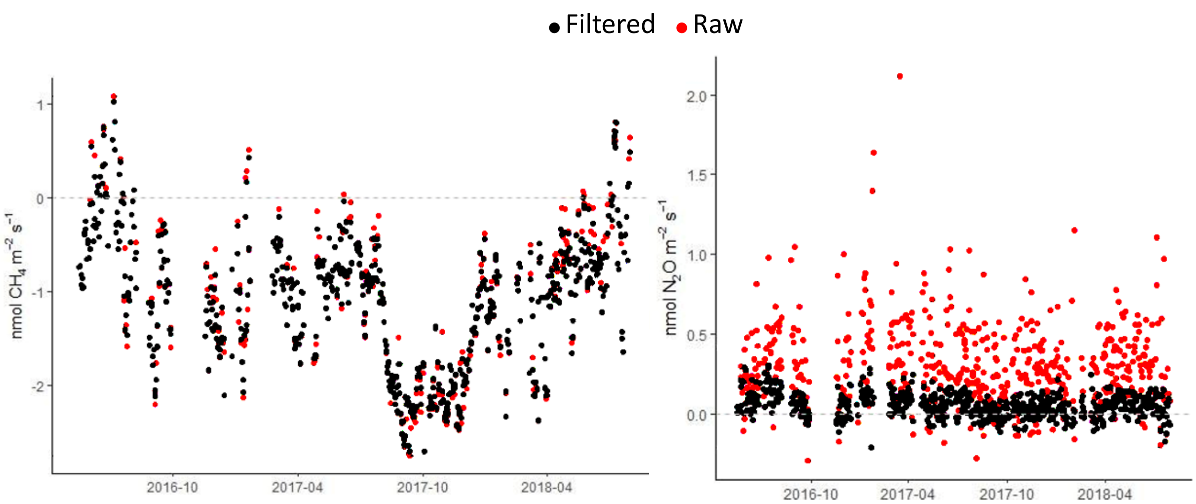


Figure 1. Seasonal courses of average daily (A) ecosystem and (B) soil fluxes for CH_4 (left-hand panel) and N_2O (right-hand panel), from 17 May, 2016 to 2 August, 2018 in the Guyaflux tropical forest, French Guiana. Red dots represent the average daily fluxes calculated with the raw data and black dots those calculated with the 5^{th}-95^{th} percentile data.

To summarise, regarding your two suggestions:

1) See Figure 1 for a comparison of flux databases without and with high fluxes (black and red dots, respectively). The high fluxes are particularly common, but not so high, for soil N_2O fluxes, while they are comparably very rare and extremely high for ecosystem CH_4 fluxes. These observations will be included in the Discussion section.
2) To complement this, see Table 1 for descriptive statistics (means, standard deviations, and medians) showing the effect of capping thresholds on our main analytical results in the wettest and driest seasons in particular. Major changes, highlighted in light green. At the ecosystem level, the two peaks in CH_4 occurred during the wettest season, with no effect on the mean and median

values. However, during the driest season, more consumption events tend to lower the mean and median values. Regarding N_2O fluxes, as mentioned above, although there are no extreme peaks, high fluxes tend to increase N_2O emissions at soil level, but have no noticeable effect at ecosystem level.

Table 1. A), B) Mean, standard deviation (SD) and median ecosystem and upland soil CH_4 and N_2O fluxes for the wettest and driest seasons in the Guyaflux tropical forest, French Guiana.

A) BEFORE: Preprint databases

	Wettest			**Driest**		
Fluxes	**Mean**	**SD**	**Median**	**Mean**	**SD**	**Median**
Ecosystem flux (nmol$_{CH4/N2O}$ m^{-2} s^{-1})						
CH_4	2.9	3.9	2.8	-0.8	3.8	-0.6
N_2O	0.5	0.7	0.4	0.5	0.8	0.6
Upland soil flux (nmol$_{CH4/N2O}$ m^{-2} s^{-1})						
CH_4	-0.8	0.5	-0.8	-1.8	0.5	-1.8
N_2O	0.1	0.1	0.1	0.0	0.1	0.0

B) AFTER: Revised databases

	Wettest			**Driest**		
Fluxes	**Mean**	**SD**	**Median**	**Mean**	**SD**	**Median**
Ecosystem flux (nmol$_{CH4/N2O}$ m^{-2} s^{-1})						
CH_4	3.3	6.2	3.3	-1.7	6.4	-1.8
N_2O	0.6	1.0	0.5	0.6	1.2	0.7
Upland soil flux (nmol$_{CH4/N2O}$ m^{-2} s^{-1})						
CH_4	-0.5	0.8	-0.7	-1.4	1.2	-1.8
N_2O	0.3	0.3	0.3	0.2	0.3	0.2

Finally, Figure 2 shows all the daily mean fluxes, calculated from the raw data. This is the same as Figure 1, but with the colours indicating the different seasons and showing the conservative 1st and 99th percentiles.

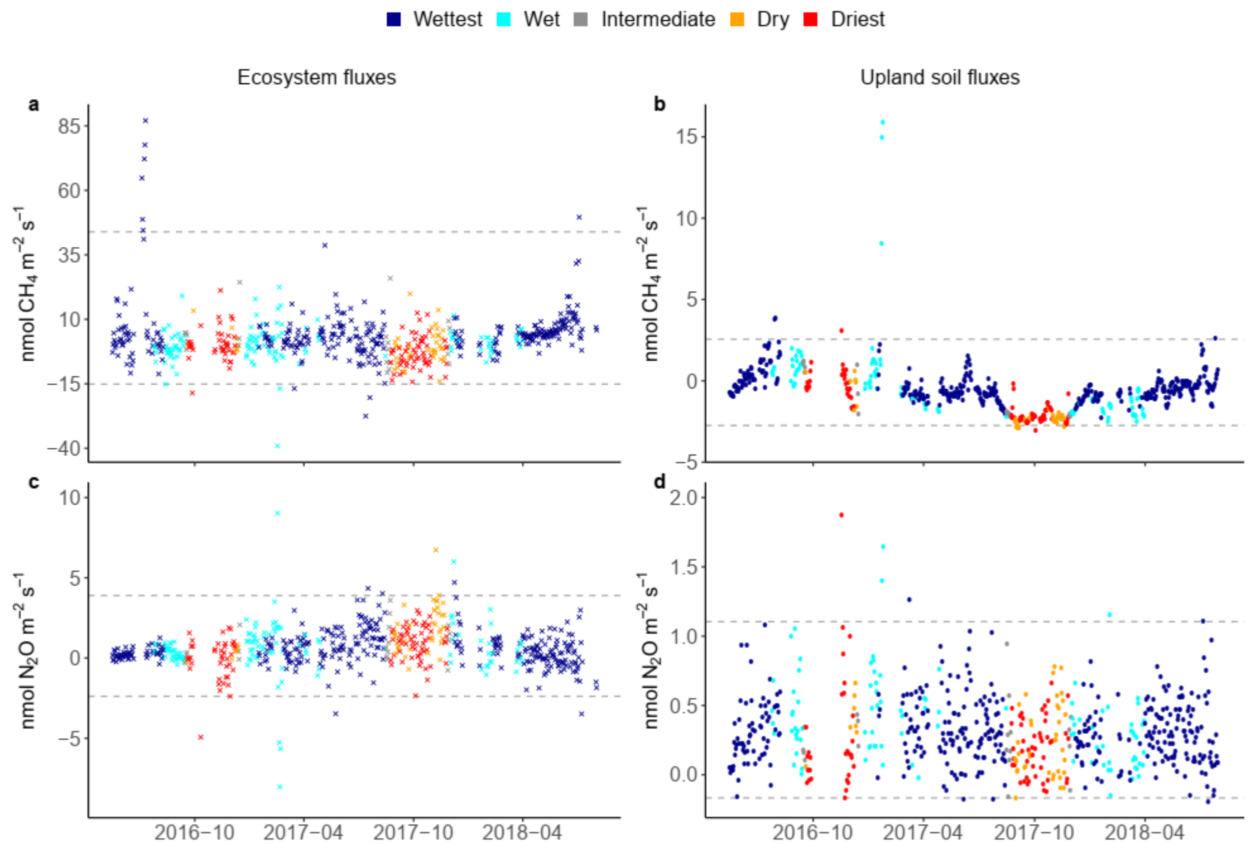


Figure 2. Seasonal courses of the raw average daily a) ecosystem and b) soil fluxes for CH_4 (top panels) and N_2O (bottom panels) for the full datasets from 17 May, 2016 to 2 August, 2018 in the Guyaflux tropical forest, French Guiana. The 1st-99th percentile ranges of the flux values are represented by the horizontal dashed lines. Colours illustrate the wet, intermediate, and dry seasons, and for two contrasted seasons, defined as the wettest (dark blue dots) and the driest (red dots).

We will revise the text to include other rate fluxes from tropical sites that have incorporated hotspots and hot moments into their scaling efforts, e.g. Dealman et al., (2025).

Daelman, R., Bauters, M., Barthel, M., Bulonza, E., Lefevre, L., Mbifo, J., ... & Boeckx, P., 2025. Spatiotemporal variability of CO_2, N_2O and CH_4 fluxes from a semi-deciduous tropical forest soil in the Congo Basin. Biogeosciences. 22, 1529–1542.

Finally, data should be posted in an accessible database online in keeping with the specifications of this journal (rather than ‘on request’)

Response: We fully agree. Data status will be updated and we will provide in the final version of this manuscript a link (e.g. Zenodo) for online access to all data included here