

Answer to Referee3: comment on EGU sphere-2024-2346

This work presented GHG fluxes from tropical forest in Congo Basin where there are large gaps of knowledge. By combining automatic chamber and manual chamber methods, both temporal and spatial variability are examined. Soils of this study site was shown to be large sources of CO₂ and N₂O with high spatiotemporal variations, highlighting the importance of extensive research.

We thank the reviewer very much for this positive feedback

Some more questions are listed below:

1. *Please provide more details in 2.3.1 if the automatic chamber is opaque or not, this determine the measured CO₂ fluxes are NEE or respiration.*

Thank you for noticing; this is important information that was not in the article. We added in Line 105 that the chambers were opaque.

LINE 105: “The opaque chambers (0.5 m x 0.5 m x 0.15 m, length, width, and height) were controlled by a central steering unit consisting of a valve-tubing system connecting chambers to two portable analyzers ... “

2. *Line 130 described the manual chamber was permanently installed into soil, when they are installed and do you take into account any effect caused by the installation? Did you do quality control of fast box fluxes measurement as for automatic chamber? What's the percentage of bad quality measurements that are discarded?*

The section about the fast box measurement was indeed missing some crucial information for the reader to understand the method we applied correctly.

The installation of the manual chambers took place in March 2023. The chamber measurements used in this study were carried out in August 2023 and so the effects of installation can be discarded. We have now added this information now in Line 128-129, stating:

LINE 128: The four GEM plots on the CongoFlux site were divided into twenty-five subplots of 20 m by 20 m and in each subplot, one soil chamber was installed in March 2023 to be measured using the fast box method (Hensen et al., 2013; Wangari et al., 2022).

The quality control performed for the fast box measurements was the same as for the automated chambers, except that measurements with low R², were also individually checked for their quality. Only 5 data points were removed. The fluxes were measured manually with an analyser where the increase in greenhouse gas concentration could be seen visually on the user interface of the analyser. Bad seals or other problems were easily detected and the measurement was then restarted. Therefore, this small amount of poor quality data is as expected. We added this information to Line 138:

LINE 138: The quality control of these fluxes was similar to that of the automated fluxes, with the addition that fluxes with a low R² were also individually checked for their quality.

3. *It's not clear where the environmental variables are measured, is the "each chamber location" in Line 95 refers to which kind of chamber or both?*

This was indeed not clear. We have added a sentence stating that these variables, nl VWC and soil temperature, are measured at the automated chamber locations and not at the fast box locations.

LINE 95: At each automated chamber location, two water content reflectometers were installed ...

4. *Since automatic chambers are at plot CF1, could you compare their results with fast box result in same plot to have an idea of the performance of the two methods?*

Thank you for bringing this to our attention. The automated chambers were located to the west, just outside the CF1 plot, so the fast box chambers of the CF1 plot were closest to the automated chambers. However, even the closest fast box chambers were already between 10 and 60 meters away from the automated set up. It is expected that CH₄ and N₂O can already vary a lot between sites within only several meters. Selecting the fast box chambers located at the CF1 plot, closest to the automated chambers, we can make the following comparison for CO₂, CH₄ and N₂O. The fast box measurements from the CF1 plot for CO₂ are quite comparable with those of the automated chambers over the same time period. The spread for the fast box method is a bit larger, which is to be expected since we have more locations and smaller chambers. In both the automated and the fast box measurements, positive fluxes for CH₄ are present, but the measurements are dominated by negative fluxes. Especially in the second half of August the fast box fluxes tend to be more negative than the fluxes measured with the automated chambers. For N₂O no real comparison can be made due to the malfunction of the N₂O analyzer of the automated soil chamber set-up. Therefore the measurements of July and September from the automated chambers are compared to the measurements of August of the fast box chambers. Our results show that the fast box measurements are generally higher than the automated measurements. The mismatch of dates could lead to a discrepancy in the averages, especially because we see a slight increase in flux for some automated chambers in early August and then a decrease again at the end of August, which could indicate a period of higher fluxes that is missed here. Line 376 notes that this discrepancy could also be due to altered soil conditions at the automated chamber locations due to the long term deployment on the same location.

We will add figures to the supplementary material which illustrate the above points with a small explanatory text to give the reader insight into the performance of the two methods.

"To evaluate the two methods used in this study, i.e. fast box and automated chamber method, a comparison can be made between the measurements of the automated chambers and the measurements of the fast box chambers closest located to the automated chambers (plot CF1), during the overlapping time period. The fast box measurements from the CF1 plot for CO₂ are quite comparable with those of the automated chambers over the same time period. The spread for the fast

box method is larger, which is to be expected since there are more locations of the fast box chambers and the chambers are smaller in size. In both the automated and the fast box measurements, positive fluxes for CH₄ are present, but the measurements are dominated by negative fluxes. Especially in the second half of August the fast box fluxes tend to be more negative than the fluxes measured with the automated chambers. For N₂O no real comparison can be made due to the malfunction of the N₂O analyzer of the automated soil chamber set-up. Therefore the measurements of July and September from the automated chambers are compared to the measurements of August of the fast box chambers. Our results show that the fast box measurements are generally higher than the automated measurements. The mismatch of dates could lead to a discrepancy in the averages, especially because we see a slight increase in flux for some automated chambers in early August and then a decrease again at the end of August, which could indicate a period of higher fluxes that is missed here. This discrepancy could also be due to altered soil conditions at the automated chamber locations due to the long term deployment on the same location”

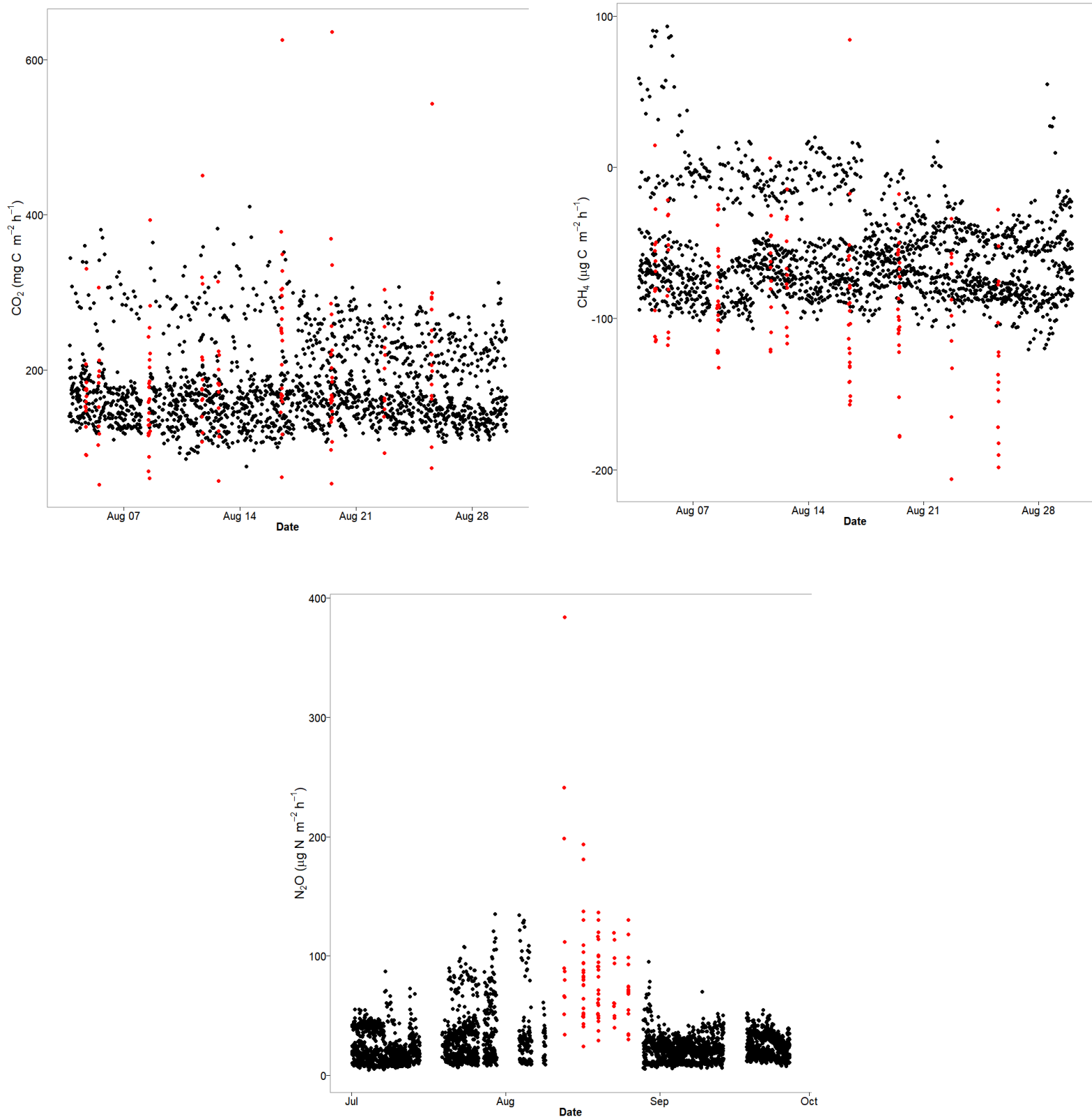


Figure 1: Flux measurements for CO_2 , CH_4 and N_2O , with in red the measurements from the fast box chambers in plot CF1 and in black the measurements from all automated chambers.

5. N_2O emissions are highly related to soil nutrient availability, do you have information about the spatial variation of soil N among chamber locations? Table S2 shows the soil properties data but where the soils are sampled and how they can represent the different chamber measurement locations?

The article did not mention where the soil property data was measured. We have added to the caption of Table S2 that these measurements were made in the CF1 plot.

We do not have information on nutrient availability or soil N for all chambers separately. The CF1, CF2 and Mi5 plots are all dominated by Haplic Ferralsols and have a clay content of around 30% to 40%, while the area of Mi2, which is the plot furthest away from the others, situated slightly lower, is dominated by both Haplic and Xanthic Ferralsols and has a slightly smaller clay content, between 20% and 30%. Mi2 is therefore slightly different from the other plots, but all soils are Ferralsols, kaolinitic, acidic with a pH in water less than 4.5, poor in organic carbon and in exchangeable cations. Therefore, only one set of soil parameters is included in the article. To give the reader more information about the homogeneity of the soils, we have included the following soil map in the Supplementary Material (Figure S10) and added a reference to a soil map, i.e.: “Gilson, P., Van Wambeke, A. and Gutzweiler, R.: Carte des Sols et de la Végétation du Congo Belge et du Ruanda-Urundi, 6: Yangambi, planchette 2: Yangambi. Notice explicative. INEAC, Bruxelles, 1956”.

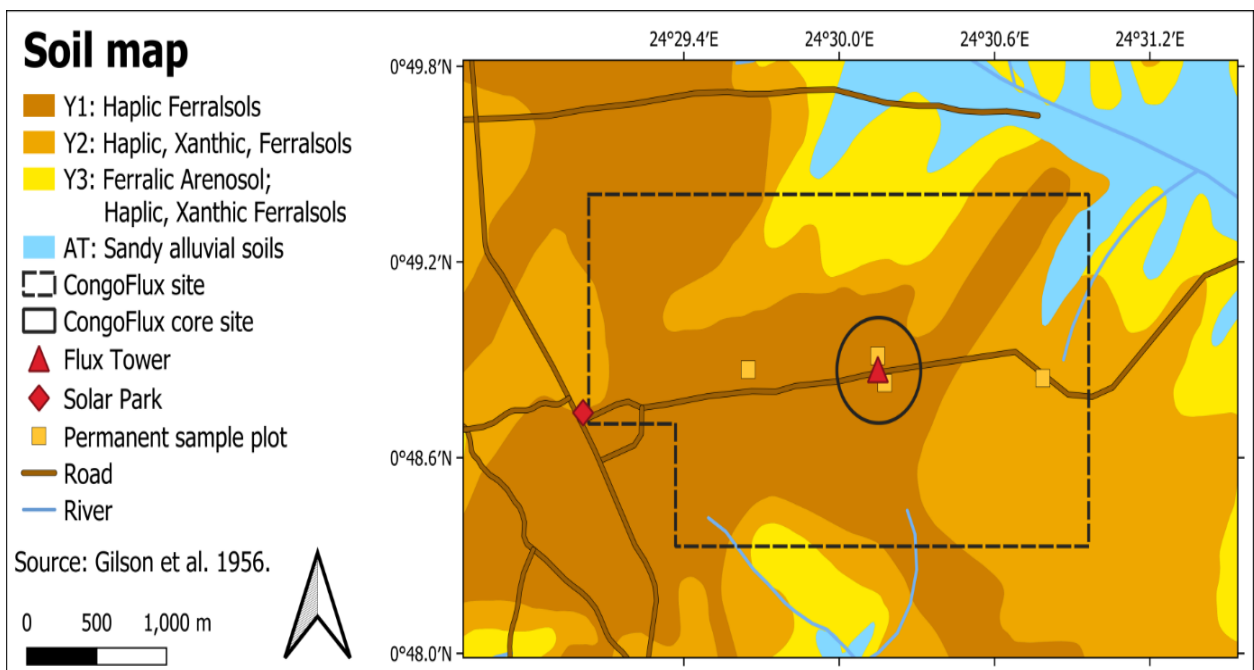


Figure S10: Soil map of Yangambi with the CongoFlux climate site (0°48'52.0" N 24°30'08.9" E) in the black dotted line tower and the squares indicating the locations of the 4 sampling plots (CF1, CF2, Mi2 and Mi5). Source for the map is: Gibson et al., 1956

6. *Since the observed CH₄ emissions are not explained by moist soil or rain event, do you have more information can explain this? How about the ground vegetation in different plots, especially in the chamber location which show emissions throughout the period.*

The forest, understory and ground vegetation are homogeneous in the four different plots. The four plots are completely inventoried and are comparable in species distribution. The chambers were randomly placed and in most of them ground cover vegetation was present, but due to the limited height of the chambers no mayor understory growth was possible. Visual inspection, did not reveal specific differences between the chambers in terms of vegetation and there was no clear difference between the times when a chamber was emitting or absorbing CH₄. Similarly for the automated chambers, there was no visual indication of whether a chamber was emitting or absorbing.

7. *Please check and clarify if the data comes from automatic chamber or fast box chamber in all table and figure captions.*

Thank you for reading the captions thoroughly. I added in each caption if the shown metrics/measurements are either from the automated or the fast box chambers.