Main Points

The manuscript presents a study investigating monthly CO2 and CH4 fluxes from mangrove soils in the Amazon across contrasting seasons (wet and dry) and topographies (high and low). This study is suitable for publication in Biogeosciences and is relevant to the community, especially with the focus on spatial and seasonal fluxes. The methods used are robust and the data presented support the conclusions. However, the paper structure and the presentation of the data could be improved.

We are very grateful for your corrections and observations. We think your considerations and, especially, corrections are very important. We hope they have met your expectations, but if you still need more effort from us, please do not hesitate to contact us.

The manuscript suffers from lack of structure, presentation of results in the discussion but not the results section (e.g. correlations), repetition of results in the discussion, and a lack of synthesis of previous literature findings with current study findings. This makes the discussion hard to follow and understand. Please rewrite the discussion particularly addressing the issue of stating facts from the literature without giving context on how they are relevant or improve understanding of your findings, removing results into the results section, deleting those sections which are repetitive of the results, and rearranging to include all GHG discussion first before moving onto the C stored in biomass. Additionally, the discussion would really benefit from discussing results in context of explaining observations, drivers through correlations and comparisons to other studies in terms of magnitude of fluxes but also patterns or drivers found.

We use correlations to try to explain the fluxes, so Table 5 was included in the discussion and not in the results. We also changed the position of carbon biomass discussion in the text. We understand that each result or significant correlation observed in this study was compared with results found in the literature. However, we preferred the results found only in the tropics.

Additionally, the authors should go through the manuscript and ensure there are no grammatical issues or places where too many words are used that make the sentences difficult to understand. With this, the manuscript would be much easier to understand for the reader.

We try to improve as much as possible, and for that, we hire a sworn translator.

Scientific Points

A lot of space is given to the aboveground biomass and carbon stored there, however, this is not the main point of the paper and provides minimal impact. It would be better to tie this into the offset from the GHG emissions in the discussion to justify the value in the paper. For example, calculating how much carbon is stored and how much is emitted through soil emissions, however, to do this the best way you need belowground C stocks too and I don't think you measured these?

Thank you very much for the comment and you are right that we do not measure carbon below ground. Below ground biomass was cited in methods (line 165) to say that we

It is not clear how the statistical analysis was performed as it is not clear how the data was averaged. For the seasonal data is it average monthly fluxes in the wet compared with average monthly fluxes in the dry season? For the spatial comparison it is stated in Line 182 'between the different sites' but is this the sampling sites or between high and low topographies? It is also not clear when a t-test and when an ANOVA was used, the caption for Table 1 only mentions Kruskal-Wallis. If a t-test was used then this should be paired when comparing seasons because it is the same sampling sites being investigated. A Pearson correlation was used to determine relationships between gas fluxes and soil properties, however, gas fluxes were taken monthly and soil properties only once per season. Were the correlations performed on seasonally averaged gas flux data?

Thank you very much for your questions, as they were important to improve the text. I will answer your questions below:

For seasonal data, are monthly average wet season flows compared to average monthly flows in the dry season?

Yes, monthly data for each station has been grouped together for comparison. In Table 1 we show the monthly fluxes, comparing topographies for each month (n = 16), and different lowercase letters show significant statistical variation. Also, in each seasonal period, we compare the topographies (n = 96), and statistical comparisons are also made with lowercase letters. Capital letters compare seasonal flow (n = 96) within each topography.

For spatial comparison it is indicated in Line 182 'between different locations' but are these the sampling locations or between high and low topographies?

Thanks for the question. We improved the text.

It is also unclear when a t test and when an ANOVA was used, the legend of Table 1 only mentions Kruskal-Wallis. If a t-test was used, it must be paired when comparing stations, because it is the same sampling sites that are being investigated.

We used the t-test to verify if there was variation between treatments where the distribution of results was normal. When we found a significant variation between the means, we used ANOVA with Tukey's test analysis, according to the statistical program used by us. Only the gas flows did not have a normal distribution, the other analyzes presented in the work showed a normal distribution.

A Pearson correlation was used to determine the relationships between gas flows and soil properties, however, gas flows were measured monthly and soil properties only once per season. Have correlations been performed on seasonally averaged gas flow data?

Thank you for asking, we have improved this in the text and hope it is clearer. Correlations were made in the months in which the soil samples were collected, both in the dry season and in the rainy season.

Data from Table 1 would be better presented in a graph instead. I think this is Figure 4 but why is that so far through the paper? The point of the paper is looking at CO_2 and CH_4 fluxes and I cannot see them clearly presented until the discussion. I think it is really great to provide actual flux values as lots of studies do not, but these could be presented in the SI.

We thought it best to present a table with the mean values and standard error of the mean in the results to facilitate comparison with other papers. However, in the discussion, we chose to make a graph because visually it is easier to compare with the tide. I don't know what SI means.

I suggest presenting CH_4 fluxes as mg m-2 d-1 as the values are very small as g m-2 d-1

We chose g m-2 d-1 to give a visual comparison with CO_2 fluxes, and we also found some articles published in this same way.

Technical Points

Line 16 – contrasting topographical gradient should be replaced with contrasting topographies

We accept the suggestion and change the text.

Line 18-20 – this sentence is confusing and has some grammar issues, please rewrite. This is often true through the manuscript so please read through and improve sentence structure throughout to aid understanding.

We accept the suggestion and change the text.

The abstract does not include the fluxes of CO_2 and CH_4, instead the variation between topographies and season is first discussed. Please include the values first and then state the variation.

We accept the suggestion and change the text.

Line 21-22 – These mention CH_4 fluxes between high and low topography but are contradictory. Please rewrite with the correct observations.

We accept the suggestion and change the text.

Line 24-26 – This sentence is confusing and needs rewriting with more context, you are stating the GWP of the mangroves through CO2-equivalents but it is not clear.

We accept the suggestion and change the text.

Line 29 – replace macro tide with macrotidal

We accept the suggestion and change the text.

Line 38-40 – This does not fit with the previous sentence and perhaps needs moving earlier in the paragraph

We accept the suggestion and change the text.

Line 51 – The flux unit needs spaces between g, C and yr

We accept the suggestion and change the text.

Line 52-66 – This could be restructured so that the estimates of CO2 and CH4 emissions from tropical mangroves are presented together and then the effects of flooding as a control on CO2 and CH4 fluxes discussed.

Related to the point above, there are some issues with the structure of the introduction making it difficult to follow and preventing the knowledge gaps and importance etc being clearly presented.

We accept the suggestion and change the text.

Line 60-61 – Sulphate reduction generally inhibits methanogenesis, as you discuss in the discussion, but here you say sulphate reduction increases CH4 formation.

We take this information from Purvaja et al. (2004), who wrote the following sentence: ...Methanogenesis is the prevalent terminal process in anoxic freshwater sediments and sulfate reduction in anoxic marine sediments.

Line 67-71 – I think the objectives of the study could be clearer. Spatial variation is being investigated but it is specifically high versus low topography, I would add an extra sentence stating this and that the seasonal variation captures wet and dry seasons. This can then lead to flooding and salinity being key controls you are looking at. Also mention the controls of soil properties on these fluxes are being investigated.

We accept the suggestion and change the text.

Line 68 – pristine may be a better description than non-anthropized

We accept the suggestion and change the text.

Line 77 – coastal strip, should this be a coastal strip/area of mangroves?

This was done; mangrove area

Line 78 – Am type, best to say tropical monsoon

We thought it best to continue with the classification used to define the tropical monsoon climate, as it is better known in climatology, and we put in parentheses the classification of tropical monsoon climate.

Line 90-91 – Average mean salinity – is that in the river water or in the mangrove sites?

As can be seen in Figure 1, the Mojuim River forms the estuary of the São Caetano de Odivelas region. In the month where the greatest amounts of rain occur, the water is less salty, and in the months where the rains are less, the river water is saltier. Throughout the year the waters of the places where the measurements were carried out (mangrove) were salty.

Line 106 – Four sampling sites - are these what you later call stations? It was not clear to me in the paper if the sampling sites were later referred to as stations or if you are referring to something else? When you state in the results there was no difference between station are you comparing low and high topography or sampling sites at the same topography?

We changed the term sampling site to plot and we think that the sampling design may have become clearer.

Line 110 – flux for each chamber was measured – at this point it is not clear if a chamber is equivalent to a sampling site, or if there are multiple chambers at each sampling site. I think you can just say gas fluxes were measured during periods…

We changed the term sampling site to plot.

Line 111 – states when the low topography was measured, was the high topography measured at the same time or when was this measured?

This was done

Line 114 – replace 'by a macro tide dynamics' with 'by macrotidal dynamics'

This was done

Line 119 – Describe the sampling locations before this section, and then have these subsections talking about what was measured and how. You reference here being the same as the gas flux sites, but we haven't had details of those yet so I think presenting the sampling locations/plots first will make everything clearer

This was done

Line 129 – Soil sampling and environmental characterisation was measured once during wet and dry season, so when the Pearson correlations were calculated, was this done with seasonal flux data? I don't think this was very clear so please state this in the statistical analysis section.

Line 133 – soil samples were properly stored – please give details instead of writing this.

This was done

Line 152 – You switched from gas flux measurement to flow measurement, be consistent throughout and use gas flux measurement.

This was done

Line 152 and 155 – Suggest using T_{air} with air as subscript, same for T_s for soil temp

This was done

Line 156 – Remove sequentially

This was done

Line 159 – Should be flux measurements

This was done

Line 161 – how were plots randomly selected?

The plots were selected according to the topography, that is, in the low topography, where the tide entered every time, and in the high topography, where it almost did not enter. The random selection was for the locations of the flux rings, that is, in a circumference of 10 m radius we threw the PVC rings and where they fell they were placed.

Line 169 – Please give details of the standard gas used for calibration

This was done

Line 177-178 – So the 6% of data with weak regression were considered as zero?

This was done

Line 182 – different sites, is this between the high and low topography?

This was done: Yes, between topography

Line 186 – Remove 'and' after with.

This was done

Line 188 – Please add the details of the relationships between gas fluxes and soil properties to the results section.

Figure 2 – Axis label Dez should be Dec

Line 200 – Rearrange the gas flux data to first present the mean and range of the fluxes and then discuss the stats and differences spatially and seasonally.

Line 203 – Should this say only differed significantly?

Line 203 – Replace among with between

Table 1 – The presentation of the stats in this table is very confusing. Do lowercase letters compare monthly fluxes between high and low topography, and uppercase letters compare dry versus wet seasonal data for each topography? As stated above I do not know what the stations refer to and so I don't understand some of the comparisons – maybe the uppercase letters are not comparing dry versus wet but something to do with the stations?

Line 213 – Add here that this is seasonal data comparison now

Paragraph on line 222 – This would be clearer if it was rearranged to start saying greenhouse gas fluxes were only sig different between topograpohies in the dry season where co2 fluxes were higher at the high topography and ch4 fluxes were higher at the low topography.

Line 225 – I am not sure what you refer to here with 'with this' and so I am not sure if you are presenting here the fluxes over the dry season or across all topographies?

Line 229-242 – Here you sometimes say high versus low topography and sometimes between stations. As mentioned earlier I am not clear on what the stations are referring

to, in any case it would be best to stick with the same naming e.g. always talking about high versus low topography.

This was done: We changed station to seasonal, and made it clearer in the text where you pointed out the difficulty of understanding.

Line 234 – remove variable

This was done

Line 249 – Replace CT with TC, here and elsewhere

This was done

Line 258 – Replace MO with OM, here and elsewhere

This was done

Line 266 – Tar should be Tair?

This was done

Line 271 – Vv is not defined, please define here

Thanks for the observation, the translation was not correct, as Vv means wind speed (Ws). This has been modified in the text.

Line 292 – Replace e with and

This was done

Line 293-294 – I think you mean to say rainier than long-term average in the dry and less rainy in the wet season than the long-term average, because on figure 2 ppt is higher in the wet and lower in the dry.

This was done: It is important to consider that when compared with the climatological average (1981-2010), the year under study was rainier in the dry season (2017) and less rainy in the wet season (2018).

Line 298 – Here you present the total carbon rate – do you mean the total carbon fluxes? The units are in CO_2 not C so I am not sure how this is carbon flux. How was this total emission calculated? Through converting CH_4 emissions to CO_2-equivalent emissions using sustained global warming potentials?

We calculated the weight percentage of C in each molecule (CO_2 and CH_4) and multiplied by the fluxes separately (1.82 g C/m2/d for CO_2; and 0.10 g C/m2/d for CH_4) and made the sum of two values. We corrected it in the text because when the translation was performed there was an error in the values.

If figure 4 is the data from table 1 plotted onto graphs, then why are there no statistical differences presented on here?

In Table 1 there was an error in the statistical analysis, as the CO2 fluxes were not different in the dry season, however the fluxes were different in the rainy season. We redone the statistical analysis, and the other results are correct.

Figure 4 – I suggest a different naming scheme for topography, using T_high and T_low I am automatically thinking of temperature and then I was trying to work out what the temperature differences were.

This was done

Line 315-316 – Why not compare the annual CH4 flux, like you did for CO2?

This was done

Line 314-323 – Here it is stated that CO2 is higher than literature values and CH4 is lower but this is just stated with no discussion of why this may be true, for example, do you have less flooding due to combining the low and high topographies in this analysis? Is it due to soil properties here being less favourable for methanogenesis and more favourable for aerobic respiration?

This was discussed below.

Line 324 – Here the discussion on biomass is in the middle of all the gas flux discussion, move this to after the gas flux has been discussed.

This was done

Line 333-334 – I'm not sure how your results show the mangroves are more productive than previously known. You have C storage at lower capacity than estimated for brazilian mangroves, then state a primary production for tropical mangrove forests with no relation to your measurements here (unless I missed it) and then say the mangroves are more productive than previously known.

This was done: The sentence that addressed mangrove productivity was removed, as we did not study this, and we added the following sentence: The biomass found in the Mojuim River estuary does not seem to be different from the biomass found in other Amazonian mangroves, however much smaller than that found in other mangroves Brazilians.

Line 372-374 - This sentence is very hard to follow. This is an example of where the whole manuscript could benefit from another proofread to check for clarity. Additionally, to reduce sentence length where unnecessary text is used that makes the point of the sentence harder to understand as the reader.

This was done: The results show that the physical parameters do not act in the fluxes in a standardized way, and their influence depends on the topography and seasonality.

Line 379 – High tide or rainy season? Because all fluxes are measured at low tide I think. If this is not correct please make this clear.

This was done: …especially during the rainy season when the tides were higher.

Line 388 – replace generates with favours

This was done

Line 389-392 – Please also rewrite this sentence

It was rewritten.

Line 409-410 – Better correlate dto which characteristics?

Thank you for the question. We rewrite the sentence: The dry season was the period in which we found the greatest amount of significant correlations between CO2 efflux and soil chemical parameters.

Line 410 – Positive or negative correlations?

Here we are reporting that only these soil chemical variables (C/N ratio, OM, and Eh) correlated with CO2 flux in both seasons. However, when we look at Table 5, we see that in both seasons the correlation of the C/N ratio and OM with CO2 was negative, and the correlation of Eh with CO2 was positive.

Line 415 - Here this is an interesting point but it seems you are saying that higher soil moisture should give a lower ch4 efflux, but you also show and state earlier that lower topography with more flooding has higher ch4 due to anoxic conditions. I think it would be good to really refine these points and discuss them together. This is another example of where there is lots of comparison and citations of other literature but it is not always pulled together in a coherent way.

As can be seen below, and in the text, it has already been corrected.

Line 424-425 – Here you say increasing soil moisture increases gas diffusion rates but earlier you said high soil moisture decreases gas diffusion rates

We accept. Line 412 - The soaking of the soil reduces gas diffusion rates …

Line 430 – DO you mean here that during the dry season the high tides cause anoxic soil conditions, or are you comparing dry and wet seasons?

Thank you for the question. We are saying that it is the period when only high tides produce anoxia in mangrove soil with low topography. We improved the text.

Line 430-432 – I am not sure what this is relevant to.

We accept.

Line 433 – I am not sure why this is relevant, you are not discussing sulphate reduction but CO2 and CH4 fluxes, and this sentence does not seem to link to your next points clearly.

We accept.

Line 441-444 – Is there a reason that this same mechanism would not be occurring in the mangroves you are comparing your results with?

Thank you for the question, but I'm not saying that in other places this mechanism is not happening, I'm just saying that in the area we studied this mechanism may be more intense.

Table 5 gives correlation coefficients with annual data, so it would be good to plot the annual fluxes onto figure 4.

We accept.

Line 451 – This was not clear to me. Are you saying that tidal movement is more important for flooding in the dry season, therefore, there is also higher salinity?

No, we are just saying that due to less precipitation in the dry period, there is less influence of the river in the estuary, consequently, the waters become saltier. Likewise, as it has a smaller volume of water, only the low topographies are periodically visited by the tides.

Line 462-463 - Here you say salinity is negatively correlated with CO2 but this paragraph earlier states that high sulphate leads to increased CO2. There are lots of these instances and I think the discussion could really benefit from more structure and focus into the synthesis of previous work on drivers and patterns related to this study, rather than stating lots of observations from the literature and then saying in this study we found X.

Your observation was very important, however, our results showed that there was only a significant negative correlation with CO2 in the rainy season (Table 5), and in this sense; we decided to remove the sentence that is bringing doubt. We think that is important to leave the discussion on sulfate in the text because with this information we have one more source of CO2 for the atmosphere, and not just the fluxes being the result of a metabolic function of respiration, and decomposition of organic matter.

Line 498-500 – Consider using the sustained global warming potential instead – moving beyond global warming potentials to quantify the climatic role of ecosystems. Scott Neubauer and J. Patrick Megonigal, Ecosystems. 2015

We accepted and it was added to the text.