

General comment

The manuscript “Greenhouse gas fluxes in mangrove forest soil in the Amazon estuary” examines CO₂ and CH₄ fluxes from mangrove soils and evaluates topographic and seasonal variations. Moreover, environmental drivers such as vegetation structure and soil characteristics are studied. I highly agree with the comments made by RC1. The topic of the paper is timely and fits the scope of Biogeosciences. The study design is appropriate, and the data set sufficient to answer the stated research questions. However, the manuscript is hard to follow and should be streamlined. It would be helpful to put some of the results (e.g., detailed statistical analysis of all parameters) into a supporting information and report only relevant findings. The general structure and story line should be more focused.

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.

Specific comments

Abstract

L 13 – 14 First time reading “especially in a scenario of global climate change” I thought you would test the impact of climate change on GHG in mangroves. Maybe rephrase as “to assess their impact on climate change”.

In the abstract, the inclusion of the phrase *in a global change scenario* was suggested by an editor, as the article will be included in this topic. In an attempt to improve the understanding of the phrase, we changed it to: *particularly in the current scenario of global climate change*.

L 17 – 18 Delete this part of the sentence and use the extra words to give more quantitative results, such as gas fluxes.

We change for: *The plots for the trace gases study were allocated at contrasting topographic heights*.

L19 – 22 Write how much higher (x-times higher) fluxes were between sites/seasons. Do never start a sentence with “only”. Change this throughout the manuscript.

We rewrote the phrase and included the found values: *In the spatial variation, the CO₂ flux was greater in the high topography (7.858 g CO₂ m⁻² d⁻¹) compared to the low topography (4.734 g CO₂ m⁻² d⁻¹) in the rainy season, and the CH₄ flux was greater in the low topography (0.128 g CH₄ m⁻² d⁻¹) than in the high topography (0.014 g CH₄ m⁻² d⁻¹) in the dry season.*

Introduction

L28 – 30 Move this sentence to the study site description or the aim paragraph of the introduction. Then start with (tropical) mangroves in general. Consider restructuring the first paragraph by starting with carbon storage in mangroves and benefits for climate

change. Then state that it is important to consider GHG outgassing as offset of the carbon storage.

This has been done.

L41 Change “attributable” to “driven by”.

This has been done.

L50 Write “CO2 outgassing” instead of “CO2 production to the atmosphere”. Make clear which statements in this and the next paragraph are specific to mangrove and which to estuaries/coasts/vegetated coastal wetlands. Preferably use only mangrove publications, there are enough publications to underline each of your statements.

This has been done. Alongi’s book(2009) presents a functional overview of mangrove forest ecosystems; how they live and grow at the edge of tropical seas, how they play a critical role along most of the world’s tropical coasts, and how their future might look in a world affected by climate change. The study of Rosentreter et al. (2018a) quantifies seasonal pCO2 and CH4 concentrations and emissions along the salinity gradient of three tropical mangrove-dominated estuaries in Australia.

Formatado: Realce

L55 Confusing statement. Consider rephrasing.

This has been done.

L61 How does reduction of sulfate produce CH4?

Purvaja et al. (2004) wrote: One expects a stimulation of methanogenesis and hence of methane emission during monsoon, because the impact of freshwater should shift the electron flow from sulphate-reducing bacteria to methanogens. We have changed the text and hope it is clearer now

L67 Be more specific what you mean by spatial and seasonal variation.

This has been done.

L70 Remove years but describe in more detail which drivers you were testing.

-This has been done. We don't quite understand what you mean by "drivers"

Methods

Please add GPS coordinates of your stations in the text.

This has been done.

L77 “exclusively untouched mangrove forests” use “pristine mangroves”. Consider splitting this sentence.

This has been done.

L86 Use tidal “amplitude” instead of “height”.

This has been done.

L109 – 111 This sentence is not a part of the study site. Put it into “Flux measurements”. Is suggest putting “Greenhouse gas flux measurements” as 2.2, since this is your focus.

This has been done.

L120 When did you conduct the floristic survey? Report dates.

This has been done.

L130 Why did you take only very shallow soil cores? It sounds like you measured pH and redox at the same spot where you took the soil sample. I hope it was just next to it. Please clarify.

It is clear that the pH and redox potential measurements were performed prior to collecting soil samples for the laboratory, ie with intact soil. We used a depth of 0.10 m because from the literature review this is where the fluxes happen.

L137 I personally would not capitalize all parameters, but wright “Organic matter...”.

We think it is important to specify and not generalize as being just MO, as these parameters will appear in the results.

I agree with RC1 that the abbreviations should be changed.

This has been done.

L150 When did you conduct the soil sampling? Report dates.

This has been done.

L160 Also add dates of chamber sampling.

Sorry, I don't understand, do you want to put all the dates that the flows were measured? Flows were measured every month from July 2017 to June 2018, on waning or waxing moons.

L164 I personally would have measured above the mangrove roots since these are important parts of the mangrove ecosystem. At healthy mangroves, spots without roots are rare, thus including them yields more representative flux rates for mangrove soils. Something to consider in your next study.

Thanks for the observation, we will take it into account for the next study.

You need to add more info about the flux measurements. How often did you measure per month? One or more rings? Did these rings stay at the same spots?

Flows for each chamber (total 8 rings per plot) were measured once a month, during waning or waxing moon periods. I added in the text that the rings remained in place until the study was completed.

Consider matching headings with the results headings. The wording and also the order.

This has been done.-

Results

The results section is very hard to read. I would only report values of each parameter and describe general trends without using any statistics. Then add a section where you look at the statistics, but only in regard to the GHG not of the statistics between the drivers.

-We think statistics are part of the results and important to show where the differences are.

3.1 Carbon dioxide and methane fluxes

- Fig 4 (put table 1 in SI)
- We don't understand what you mean here and what SI means
- Describe values and trends for CO₂ and CH₄ in sperate paragraphs

We put the flows of CO₂ and CH₄ in the same paragraph because we think it is important to compare not only how the flux of each gas behaves, but also to compare between them. If we put each one in different paragraphs, the text can get tiring, and difficult to compare the behavior of the two gases.

3.2 Weather data

We think that showing that there is a seasonality in the climate before showing the gas results is important, as this justifies dividing the year into two seasonal periods.

We think that figure 2 and figure 3 show different things, as figure 2 shows the sum of rainfall for each month, during the years from 2017 to 2018 and for the period from 1981 to 2010. Figure 3 shows the measurements carried out at the same time the flows were measured. Placing the two figures in the same place would perhaps be difficult for the reader to understand these differences.

- Fig 2 + Fig 3

3.3 Soil characteristics

If your intention is to join the two tables, it would be very difficult to put on the same page with the richness of details, which we think are necessary for the presentation of the results, and then for the discussion.

- Table 2 + Table 3

Formatado: Inglés (Estados Unidos)

Formatado: Inglés (Estados Unidos)

3.4 Vegetation structure and biomass

- Table 4

3.5 Drivers of greenhouse gas fluxes

- Table 5 (also add correlation of all other parameters, to shorten the table you could only keep significant correlations and mention in the text which parameters were not significantly correlated to the GHG)
- I would not distinguish between single months for the correlations, but focus only on wet and dry seasons

Alternatively, you could only use subsections 3.1 – 3.4 from above. Start each subsection with describing values and trends of each parameter. The second part of each subsection should briefly report the stats between the GHG and the parameters (not amongst parameters!).

In the same way that we wrote for evaluator 1, the correlation table was used to discuss and try to explain which environmental factors are correlated with the fluxes, and in this sense, we would like to leave table 5 in the discussion.

In all tables use mean \pm standard error instead of mean(standard error).

This has been done.

Discussion

Generally, try to link your results with the literature more closely. Often you have one sentence about one study and then and an vaguely related sentence about your study. You need to link those “bigger/smaller than, similar to, supported by/contradicting to...”

Possibly use the following structure:

4.1 Carbon dioxide and methane fluxes

- Compare fluxes to literature and discuss differences
- Separate CO₂ and CH₄ in paragraphs

We put the flows of CO₂ and CH₄ in the same paragraph because we think it is important to compare not only how the flux of each gas behaves, but also to compare between them. If we put each one in different paragraphs, the text can get tiring, and difficult to compare the behavior of the two gases. We ask if possible to leave it the way it is.

4.2 Drivers of greenhouse gas fluxes

- Possibly get subheadings for parameters similar to results section
- Discuss drivers and find literature backing up your statements, only focus on significant differences but do not repeat statistics

Formatado: Inglés (Estados Unidos)

Statistical correlations between lines 365-372 are not repeated, as they are not shown in table 5.

L 309 Add a, b, c, and d to the figure. Reduce scale for c and d.

This has been done.

L294 – 295 To speculative – delete.

This sentence was requested by an editor, for the article to have a link with the topic where it will be published (global climate changes).

L 295 – 299 Also needed in results section, here only short repetition. What do you mean by total carbon rate? Separate CO₂ and CH₄.

L 301 Sulfate reduction? Explain.

Make sure that all studies you compare your results to used similar methods and did not examine water – air fluxes instead of soil – air fluxes.

Fluctuations in redox potential altered the availability of the terminal electron acceptor and donor and the forces of recovery of their concentrations in the soil, such that a disproportionate release of CO₂ can result from alternative anaerobic degradation processes such as sulfate and iron reduction (Chowdhury et al., 2018).

Calculate all GHG fluxes in the discussion in the same unit to make comparisons easier.

The units were placed differently in the text, to facilitate comparison with the cited article. For example: in line 302-304 Shiao and Chiu (2020) published their results in g CO₂ m⁻² d⁻¹, but Alongi (2009, LN 305-306) published their results in mmol CO₂ m⁻² h⁻¹. For this reason, we put the units in a different format in the text.

L318 What was expected?

In lines 314-315 it is written that Rosentreter et al. (2018b) estimated production of 26.7 mg CH₄ m⁻² h⁻¹ for mangrove soils in tropical latitudes (0 and 5°), for this reason, we write that our values were lower than expected.

4.2 Mangrove biomass: would only focus on the impact on GHG. This section interrupts the flow of the manuscript.

This has been done.

L336 Larger flood volume during ebb tides? Explain.

Translation problem, already fixed: Mangrove areas are periodically flooded, with a greater volume in syzygy tides, mainly in the rainy season.

L433 – 435 I do not understand your general focus on sulfate reduction. This is an alternative process to methanogenesis. Always focus on CO₂ and CH₄ production.

This has been taken from the text.

The difference between different topographies can probably be explained by differences in chemical soil characteristics.

You're right.

L493 Which authors?

This has been done; Rosentreter et al. authors (2018c)

Conclusion

495 – 498 Be more specific. What seasonal trends? Rainfall compared to climatology?

This has been done: Due to the rainfall variation compared to the climatology, that is, rainier in the dry season and drier in the rainy season, the differences in fluxes may be an effect of global climate changes on the terrestrial biogeochemistry at the plant-soil-atmosphere interface, making it necessary to extend this study for more years.

Add a sentence about the general relevance of the study.

Formatado: Fonte: (Padrão) Times
New Roman, 12 pt