Biogeosciences Discussions

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Comment on bg-2021-69

Anonymous Referee #1

Referee comment on "Partitioning carbon sources between wetland and well-drained ecosystems to a tropical first-order stream - Implications to carbon cycling in the whole watershed (Nyong, Cameroon)" by Moussa Moustapha et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-69-RC1, 2021

Review Biogeosciences MS No.: bg-2021-69

The manuscript "Partitioning carbon sources in a tropical watershed (Nyong River, Cameroon) between wetlands and terrestrial ecosystems – Do CO2 emissions from tropical rivers offset the terrestrial carbon sink?" by Moussa Moustapha et al. address an important question of the sources of organic materials fueling the high CO2 emissions from tropical rivers and streams, which is within the scope of BG. The manuscript contributes especially with relevant information increasing the understanding of the hydrologic influence on the C dynamics in African aquatic environments. The discussions that drive the conclusions still need more support from the literature. The overall methodology is robust but needs some clarifications. The results would benefit from some extra description especially regarding the relationships between discharge and the main variables considering the entire period instead of the binned evaluation for only 3 seasons that do not show relationship. These extra results would strengthen the conclusions. Several key results are not shown ("data not shown"). The title is not very clear and the question in the title is not really answered. The abstract could have a short justification highlighting the importance of such study, and the sentences describing the results need to be rewritten to improve the flow. Data could be further explored, especially regarding the temporal variability, and extra figures could be added as supplementary information. In conclusion, the manuscript presents a valuable database that will contribute to the understanding of the carbon cycle and CO2 emissions from streams in the understudied Africa region. However, several points need to be considered before the manuscript is suitable for publication.

General comments:

The as many parts of the text that is hard to follow and not so precise. Careful English revision is needed.

The temporal evaluating would benefit from monthly estimates of C degassing, lateral input, metabolism, and export to the ocean. The annual budget should then be calculated considering the temporal variability instead of the annual average. It would be interesting

to compare the final result of both estimates.

Since the seasonal variability is regulated by hydrology, it would be good if the authors could explore correlations between discharge and the different C compartments observed in the rivers.

Section 2.4.2 is hard to follow, see specific comments below. Please reformulate it. The authors could also make a schematic figure to help explain the lateral input of carbon from these two sources. Please, also include information about the direct input of POC from the forest to the streams.

It is unclear if the site Mengong outlet is a wetland or if it is a 1 order stream draining a wetland. Also how representative is this environment as a 1^{st} order stream in the entire Nyong River basin?

It seems that the authors assume that the input of C via forest groundwater observed in the spring is the same for all streams regardless of order. Wouldn't the input of groundwater increase with stream order, since the catchment area is much larger. Consequently, wouldn't the potential input of pCO2 from groundwater directly to the streams increase with stream order?

Plotting and testing the relationship between the main variables and discharge using sampling events instead of binned into only 3 seasons would strengthen many points of your discussion.

The authors could include more information to cover what is the proportion of carbon derived from wetlands in high-order streams? An estimate of the input of POC from the forest canopy would also be interesting.

The discussion in many cases is speculative and lacks support from the literature. I acknowledge the lack of data for African rivers, but you make comparisons with a few temperate systems without mentioning the many studies carried out in the Amazon basin containing useful information that should be included in your discussion. Check for example Johnson et al 2008, Rasera et al 2008, Amaral et al 2019, Salimon et al 2013, Neu et al 2011, Scofield et al 2016, Ellis et al 2012, among others. The discussion would also benefit from information about other potential fates of C.

Borges et al 2015 discuss the different wetland-river connectivity between rivers in the Congo and Amazon basin. The connectivity in the studied catchment is similar to which one? How would you describe how the patterns you found in this study for both conditions and larger rivers?

The main conclusion of the larger contribution of wetlands is speculative because groundwater input of C directly to high-order streams was not measured. So, the limitations for this conclusion need to be mentioned.

The terrestrial sink is barely mentioned in the discussion, and you don't really answer the question in the title.

Figures

You could make separate figures showing the annual variability and the statistical difference among sites. This would give a better overview of the variability. Then you could replace this new figure as Figure 3 and use Fig 3 as supplementary material to describe the season variability of physicochemical parameters. TA could also be moved to the supplementary materials. Please also present figures or tables presenting the relationships stated in the results where you say "data not shown".

Specific comments:

Abstract

L20-21. Explain the gradient groundwater to the main stream to mention that groundwater was measured in the forest (non-flooded?) and wetlands.

L23. Please report the pCO2 value.

The abstract is hard to read. Maybe start with a short contextualization and focus on the overall results instead of describing every single result.

L30-31. Please mention the heterotrophic respiration and CO2 emissions from the river above when you describe what you measured.

L34-36. Please clarify what you mean by "unique terrestrial source", and specify what you mean with the "whole amount of carbon". I read this sentence many times and I'm still not sure I got the point. Are you highlighting that wetlands are the most important source of carbon to rivers? Please rewrite this sentence to make your message clearer.

Introduction

L38-41. Please rewrite in fewer sentences, merging some of this information to give better flow.

L69. I noticed you cite three different studies by Borges from 2015 in the introduction (Borges et al 2015, Borges et al 2015a, Borges et al 2015b) but you only have one reference in the Reference list. Please correct this inconsistency.

L77-79. You could mention how this study benefits from this M-TROPICS effort. Otherwise,

this piece of information is loose here and could be removed.

L79-82. Rewrite the study objectives more directly and clearly. You are evaluating the changes in C concentration across groundwater to different stream order over the seasons.

L86-87. You did not assess the complete terrestrial C export. Please specify only the component analyzed (groundwater). Change "terrestrial ecosystem" to non-flooded forest groundwater or something similar.

L89-90. You need to give more context to clarify the study hypothesis. What is the link between the net C sink and the riverine C budget?

Methods

Describe the wetlands in more detail. Are they flooded forest or open areas with grass? Do they differ between the headwaters and high-order streams?

Please number the equations.

L97. Remove the "the" before swamps.

L99- Change "experiences" to has.

L106. Mengong source and outlet are not displayed in Fig 1.

L107-109.

L110. Export is misspelled "epxorted".

L113. Start saying that this is the first order basing.

L115-117. Needs a reference or should be rephrased using "likely" instead of "eventually".

L113-126. Please rewrite more concisely and clearly. Try going straight to the point of why this information is useful.

L.129-130. It is not clear if the Mengong source is only groundwater.

L130. Explain how samples were taken from the stream. Using the Niskin bottle?

L132. State what TA stands for.

L134-142. This part needs to be rewritten. The physicochemical data explanation is very fragmented. You could just say that from Jan to March you used one probe and after that another. After that the details about calibrations.

L143-161. State the number of replicates you have for each analysis.

L217. What do you mean by terrestrial groundwater?

L220. What the "r" in "[C]GWr" stands for? Define what is FexGW.

L222-223. Please reformulate this sentence. The flow of what? Please specify. Why the

flow rate unit is in metric not volumetric? Clarify what surface area the swamp drain? Is it the sub-basin area of the non-flooded forest? What is the total area of wetland in the catchment?

L223. Please be consistent using wetland or swamp throughout the text.

L228-229. Explain how did you estimate DOC and DIC from this study.

L230. Need citation for the negligible surface runoff.

L239. Include the site depth in table 1 and mention in the methods that it was measured.

L279-282. Merge these two sentences.

L280. Substitute "peaked" by significantly higher. Peaked works for a temporal description of a site, but to compare different sites is better using higher or lower than.

Results

Section 3.4. Please also describe the results after accounting for the respective areas of the streams in t Cyr-1.

Discussion

L349. If you are not testing this hypothesis, rephrase the sentence using "suggesting that…". Also here, mention how deep is the groundwater level and how far the groundwater is from the organic layer of soil. Information regarding the C distribution in the soils would be helpful.

L358-359. Wouldn't this then be groundwater respiration?

L362-363. pCO_2 does not change significantly between seasons. How can this explain the high O_2? The O_2 is higher than I would expect for groundwater. Could this be a sampling artifact? Since this was a seep and you have the water flowing through a pipe, the water may have been oxygenated, and a lower volume of water flowing during the base flow period would get oxygenated faster. If that is the case and considering that most of the DIC in the groundwater was as free CO_2, is it possible that your pCO_2 may be underestimated?

L372-374. What type of vegetation predominates in the wetlands, C4?

L377-379. Couldn't this also be attributed to the deposition of inorganic materials due to the reduced water flow in wetlands in comparison with streams?

L379-382. A similar process wouldn't also happen in forest soils with trees and their roots reaching the groundwater and supplying labile OM below the lateritic layer?

L403-404. In Figure 5 you don't show a relationship, but only a difference between low and high water. Make a correlation test.

L419. Change "confirms" to suggests.

L421-423. Explain why substantial input of pCO_2 via groundwater is not expected to sustain high pCO_2 in high-order streams.

L443. What do you mean by “invested”?

L461. Add inside parenthesis what are the components of this ratio, and why you show three components and only two for Ciais et al 2013?

Tables and Figures

Table 1. Is the slope unit correct? What slope is this? The average basins slope?

Tables 2 and 3. Explain if the NA is because samples were not collected or because it was below the detection limit, or another reason.

Figure 1. Add River order in the legend. It could be good to display river order in a shade of blues to differentiate more from wetlands. What is the unit of the coordinates? Why the site Yaounde is shown with a large red dot?

Figure 2. Do you mean river discharge? Please show the historical mean and variability of monthly discharge.

Figure 6. Present the results after multiplying by the respective areas of the entire basin and river's surface. Also, add the unit in the figure caption.