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Comment on bg-2021-69

Anonymous Referee #2

Referee comment on "Partitioning carbon sources between wetland and well-drained ecosystems to a tropical first-order stream – implications for carbon cycling at the watershed scale (Nyong, Cameroon)" by Moussa Moustapha et al., Biogeosciences Discuss., https://doi.org/10.5194/bg-2021-69-RC2, 2021

Review for: Partitioning carbon sources in a tropical watershed (Nyong River, Cameroon) between wetlands and terrestrial ecosystems: Do CO2 emissions from tropical rivers offset the terrestrial C sink?

Overview

This manuscript by Moustapha et al. present a substantial collection of physicochemical and carbon data across stream orders in the Nyong basin in Cameroon to partition fluxes and attempt to close the C budget in this basin. The contribution of C flux data from tropical streams and rivers, groundwater, and from Africa is exciting to see, though the manuscript has several points that need attention before publication. There are general editing issues (typos, missing words) that will help focus the paper and a general polishing of the writing will help. In the results and discussion, words like 'obviously' and 'probably' should be removed following interpretation of the results the statistics. I believe a hypothesis driven approach will help the authors examine their data at a finer temporal scale and focus the broad application of statistics at a finer level to account for more of the variability in the dataset.

General comments

The data collection spans one year from 6 sites in the Nyong basin and attempts to separate inputs (terrestrial vs wetland groundwater) and exports (evasion and export). However, there should be greater focus towards a higher temporal resolution of the fortnightly measured variables and the hydrology. Separating the hydrograph and seasonality into 3 categorical sections is too coarse of an approach when a higher resolution is capable and likely overstates the continuous nature of seasonality. Further to this point, I don't recall much discussion of 2016 compared to 'the average' year. Particularly for evasion, more data spanning hydrologic variability is needed from across the globe and is in the dataset for the manuscript, but not presented.

The evaluation of C inputs and exclusion of respiration needs further discussion. The methods to measure pelagic respiration are stated, presented, and discussed, but not included into the budget. I fully agree that including this small amount of CO2 from in-stream processes is minimal compared to groundwater and wetland contributions but excluding it does not make sense to me. I see two options, though there may be others: 1) include the in-stream component respiration into the larger budget and empirically show this flux is much smaller the other input fluxes or 2) remove the respiration component entirely and refer to these data in supplementary material or as unpublished data that are not on the same order of magnitude as the other fluxes.

The chamber method used leads me to think option 2. While the dark chamber or respiration chamber method is fine for large rivers and lakes (e.g. Borges et al. 2019), this approach focusing solely on pelagic processes in low order streams and rivers are not sufficient and understate the influence of the benthos in the transition from benthic to pelagic processes that occur in mid-order rivers (Reisinger et al. 2021). The authors acknowledge some of the issues with respiration in the discussion section, but they fail to include the data even though it is available.

There are broad issues with units throughout the paper, and I recognize conversion between the units varies between scientific communities or journals. Presenting concentrations and fluxes as both moles and grams is a little confusing and the units need specification of what is being presented (mmol CO2-C or mmol CO2). Basin scale fluxes are presented as both Gg and tons of C. I would stick to the metric unit (Gg) or convert to Pg, which are used in other C flux studies and the readership for this paper will be more familiar with. The presentation of units between mol and g is something I deal with in my own work, so I empathize with the authors.

There is a structural issue regarding the statistics that I think can be resolved with presenting hypotheses. At the end of the introduction, only one hypothesis is stated and is unclear to what extent this is revisited later. While this paper is a C budget and perhaps not best suited to hypotheses, I suggest adding several hypotheses to guide the presentation of the data and focus the statistical approach. There are interesting questions about temporal and spatial hydrologic variability, stream order position, rainfall, etc. that can be used to ask questions and lead to testable hypotheses within the dataset. These hypotheses can help clear up the statistical approach, which appears to have been a broad application of ANOVA to all the data (see specific comment below). I think a list of focused hypotheses will lead to a cleaner presentation of the statistics and results section of the paper, while also allowing the main question in the title of the paper to be answered

explicitly.

Specific comments

- L30-31: what are the units for respiration here? As mmol C, mmol CO2-C, mmol O2? Be specific. Also, in L29 can the units here be in metric (e.g. Pg C)
- L40: I think the word 'evasion' is missing before the Raymond 2013 citation.
- L41: 'compare' change to 'compared'
- L44: See Drake et al. 2018, Tank et al. 2018, or Gómez-Gener et al. 2021 for updated values of global CO2 emissions from inland waters.
- L82: I appreciate this explicit designation of the fluxes measured in this study. However, in the abstract, estimates of heterotrophic respiration were mentioned, but not here even though this production of CO2 through in-stream metabolism can be a small but non-trivial source of CO2 (Rocher-Ros et al. 2019).
- L83: Only one hypothesis?
- L99: Scientific names for these plants might be more useful to a broader audience
- L102: Is the Mengong catchment within the Nyong (I see this is answered in L113)? Is the rainfall measured here characteristic of the wider basin? Help the reader by giving context to your study area
- L106: I would re-cast 'stream orders'; groundwater is not a stream order. Something like: 'We sampled groundwater and surface waters, including streams across Strahler orders 1-6' (if that is indeed the case).
- L107: 'gauging gauges'. Change to 'gauging stations'. The table has 'stations', I would follow that.
- L110: Is 200 m3/s the annual mean? What is the temporal variation, as you've indicated there is seasonality in flow? Also, typo 'or' is meant to be 'of'. 'Epxorted' typo as well
- L113-126: This section should be shortened and edited
- L128: Personal preference for the Oxford comma
- L163: I have to assume the cool box is also a dark box that prevents light. I'm not sure the pelagic approach to respiration is the most representative approach to study in-stream CO2 production especially in streams and small rivers, as much of the biological activity is occurring in the benthos. You may be underestimating the in-stream contribution to CO2
- L203: We are in Section 2.4, I think you mean Section 2.3
- L205: be specific with units: mmol CO2-C or mmol CO2? You then convert to Gg in the next sentence. Pick one of grams or mols and stick to it through the whole paper. Again, in L209, why convert into t C? Most C flux units are as Pg or Gg. Make it easy for your readers by not over-converting between units
- L236: what are the units an^{-1}? Is this an annual basis (i.e. $year^{-1}$)? Be consistent
- L238: What are the explicit units here (CO2-C or CO2)?
- L247: Unit issues again
- L264: 'a given parameter'- be more explicit. You have measured a tremendous number of parameters, as fluxes, concentrations, etc. How is the reader to know if you 1) ran a correlation for everything measured or 2) focused on specific fluxes? I think there is an opportunity to be specific here in the statistical approach that would be aided by defining hypotheses or explicit relationships in the introduction that are missing in the

introduction. I appreciate that the C accounting is not as a hypothesis driven approach, but you are also examining seasonality, stream order, and Q-C plots that could benefit from generating testable hypotheses in the data.

- L272: what are the O2 units? Be specific and say percent saturation.
- L280: 'peaked significantly'; peaked suggests change over time, but this comparison is between sites. Re-cast as 'DO was highest in the So'o'. The wording of the statistical inference in L281-2 needs cleaning up.
- L282: Here are the data to answer a hypothesis related to temporal variation of these variables
- L324: 16% seems higher than 'fairly balanced'. In the results section, I would simply state the 'difference was 16%' rather than qualifying as 'fairly balanced', which is a judgement that merits discussion later in the paper.
- L341: 'soil OM respiration' reads as if the soil OM is doing the respiration. Re-cast as 'respiration of soil OM in the unsaturated zone'
- L343: 'probably'- do the papers cited at the end of this sentence give any clarity or more definitive data to guide this statement?
- L352: '50 times higher'; be explicit, what is the concentration or ppmv?
- L355-6: 'During base flow, precipitation was low…' I hope so! Switch the order of this statement 'Low rainfall resulted in lower flows than the other seasons…' or similar. Same language issues in L357.
- L443- 'invested'; not sure that is the word to use in this case
- L449: Based on your budget, but you acknowledge you didn't include respiration, which is a flux you measured but chose not to include! I agree that groundwater and wetlands are likely large contributors to stream C but you have the data to make the comparison to in-stream processes. You make this comparison in L454, but I don't see why not include in the budget, even it its less than the error of the other input fluxes
- L453: typo 'trough'; delete everything after 'atmosphere'
- L 474: there is no discussion of the 16% difference mentioned in the results, that seems important to bring up again

Tables and figures

Table 1- how representative are each of these streams of the broader orders they represent across the basin? 'Averaged annual' change to 'Mean annual…' and use yr^{-1} in the units. Can you provide a brief overview of the gauging stations as a footnote or in a supplementary file?

Table 4- Is the first column the different stream orders? Why was respiration only measured in 2 sites, the text says in all sites? The units in the table are an issue: umol, mmol, and Gg. The gas exchange rates seem low; was there any attempt to evaluate change in k600 over time and changes due to changes in discharge?

Figure 2- are 'Days' day of the year? Day since start of the project? Days in the water year? Please change to a date to help your readers. Also, why not show the data from all the streams with a gauging station?

Figure 3- If Tukey's post-hoc test compared the seasons, why not use the groups from that test above or below each boxplot to designate the significant groupings? The horizontal bars and asterisks are distracting. The axis text and titles could be bigger. Also, is this figure and Table 2 showing the same information? I think the figure is more valuable than the table.

Figure 4, 5- same comment about Tukey letter groupings as Fig 3

References

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