

Interactive comment on “High organic carbon burial but high potential for methane ebullition in the sediments of an Amazonian reservoir” by Gabrielle R. Quadra et al.

Anonymous Referee #2

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This paper estimates organic carbon (OC) burial and describes patterns in sediment methane concentration based on extensive sediment coring (114 cores over two time periods) in an oligotrophic Amazonian reservoir. The authors describe their data set as unique given 1.) the lack of studies that look at both organic carbon burial and methane concentration/emission dynamics and 2.) the lack of Amazonian studies focused on reservoir organic carbon burial. While there is a lack of organic carbon burial estimates from reservoirs (relative to the number of greenhouse gas emission estimates), I think the authors have somewhat overstated the novelty of their findings (at least in terms of the magnitude of OC burial they report). For example, I am confused as to why the authors classify their reported burial rates as “high” (e.g. in the title of the paper

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and elsewhere). The mean rate of $91 \text{ g C m}^{-2} \text{ yr}^{-1}$ they report appears to be more towards the lower end of the reservoir OC burial rates reported by Mendonca et al 2017 (looking at Figure 1 of that paper). Also, while studies that have looked at both OC burial and greenhouse gas emission are rare, the ones that exist should be discussed. I recommend that the authors reference Jacinthe et al. 2012 and Teodoru et al. 2012 as part of this discussion.

Overall, I think this dataset is quite novel and worthy of publication, but the presentation and data analysis deserve more time and thought than has currently been invested. For example, the positive relationship between sediment methane concentrations and sediment OC burial (currently reported as a figure in the supplement) seems worthy of its own figure and of more interpretation. It is also interesting that the sediment methane concentrations did not differ significantly between the rising and falling limb of the reservoir hydrograph. This finding could be highlighted more in the context of other work that has been done to look at water level as a driver of methane emission. I am also surprised that the authors haven't placed their findings in the context of other work that has been done on Curua Una to estimate GHG emissions (Duchemin et al. 2000). Duchemin and colleagues estimated $42.5 \text{ mg CH}_4\text{-C m}^{-2} \text{ d}^{-1}$ ebullitive + diffusive emissions, which could be compared to the C burial estimated in this study via CO₂-equivalents.

Line by Line Edits

Line 22: add “and emitted” after “produced”. . . it is important to be clear that production is different than emission

Lines 23-25: this sentence is rather vague and doesn't add very much to the abstract as currently written. I suggest highlighting the lack of studies that look at both OC burial and GHG emission in reservoirs— with no studies focused in the Amazon

Line 34: change “indicate” to “suggest”

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Line 51: change to “estimates of”

Lines 63-64: Maybe describe regions where there is a particular lack of OC burial data? Also, you might describe briefly the difference between total C burial and organic C burial somewhere here (since you are focused on organic C rather than carbonates).

Line 86: The fraction of methane that is emitted via ebullition vs. diffusion varies from system to system (where ebullition is not always the dominant pathway).

Line 95: First whole-reservoir OC burial estimate in what context? In an Amazonian reservoir? Clarify.

Lines 129-130: How did you spatially distribute the cores? Randomly? Stratton et al. 2019 is a good reference for the importance of sampling across multiple regions of the reservoir (which is not done often— more often burial estimates are collected from a single site/region).

Figure 1: I think the inset map would be more helpful for an international readership if the whole shape of South America was shown (rather than just Brazil).

152: change “exactly” to “exact”

154: omit word “approximately”

Lines 166-168: What did you do after adding acid? Was this a qualitative test (looking for evidence of fizzing?) or did you re-analyze for C after adding acid?

Lines 179-188: Did you measure atmospheric CH₄ concentrations here? More detail on the equations/calculations would be helpful.

Line 181: I don't think it is necessary to mention “an R script” unless you are citing a specific existing R package.

Lines 190-194: Again, equations would be helpful for describing how OC burial rates were calculated.

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Line 205: The spatial analysis for pore water CH₄ saturation and C:N was done with fewer data points right?

Lines 206-212: I'm unclear how the land cover data was used in this paper.

Line 244-246: Why are they likely to receive larger sediment inputs? Higher catchment area: surface area ratios?

Line 288: Get rid of second "in"

Line 301-302: See my general comments. This is not convincing as currently written. I think the authors need to show a breakdown of estimated OC burial by latitude or by climate zone to make this point more convincing.

Line 331: Change "dominating" to "dominant"

Line 334: The lack of a relationship between OC burial rate and C:N ratio is interesting.

Lines 337-339: This seems like a pretty ancillary comment and isn't very convincing the way currently written/visualized.

Line 346: add "for" in btween "accounting" and "the"

Line 347: add "us" in between "allow" and "to"

Lines 375-377: Seems like this information about linkages belongs in the introduction.

Line 383-392 and throughout: It would be helpful to more thoroughly describe to the reader why, in this case, you think the pool of CH₄ in the sediment is indicative of the flux out.

Lines 388-389: Why not just use 100% saturation then? It makes it more comparable to other studies and less confusing.

Line 264: I haven't heard to term 'muddy lake area' before. Also, run-of-river reservoirs are probably ones where fine sediment is transported all the way to the dam.

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Lines 275-276: I thought you used spatial interpolation (not an average)?

Figures 1,2, and 4: I find the picture of the houses are awkward and I don't think they really add much to the figure.

References Duchemin, É. et al. Comparison of greenhouse gas emissions from an old tropical reservoir with those from other reservoirs worldwide. *Verhandlungen Int. Ver. Theor. Angew.* 27, 1391–1395 (2000).

Jacinthe PA, Filippelli GM, Tedesco LP, Raftis R. 2012. Carbon storage and greenhouse gases emission from a fluvial reservoir in an agricultural landscape. *Catena* 94: 53–63.

Stratton, LE, et al. 2019. The importance of coarse organic matter and depositional environment to carbon burial behind dams in mountainous environments. *JGR* <https://doi.org/10.1029/2019JF005005>

Teodoru CR, et al. 2012. The net carbon footprint of a newly created borealhydroelectric reservoir. *Global Biogeochemical Cycles* 26 (art. GB2016).

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