

Interactive comment on “A Fast-response automated gas equilibrator (FaRAGE) for continuous in situ measurement of methane dissolved in water” by Shangbin Xiao et al.

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Response to Anonymous Referee #1

Major comment: Given that gas analyzers were used that simultaneously measure both CH₄ and CO₂, I really think that the authors should show the system's performance for CO₂ as well. In L363, the authors write that have CO₂ data but focus on CH₄ for simplicity, but this choice makes life much less simple for all the researchers that want to measure both CH₄ and CO₂, and therefore need to do all the CO₂ testing themselves. Showing the CO₂ results would make this study much more useful and applicable for a much wider community, and certainly render more citations to this paper. At the very

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minimum, include the CO₂ performance tests in the supplementary information, but I'd rather see that the CO₂ data is fully integrated in the paper, including the title.

Response: We totally agree with the reviewer that CO₂ should be included to the manuscript. We will integrate CO₂ throughout the manuscript and include CO₂ into the title. Minor comments:

Title: Include “carbon dioxide”.

Response: We will include CO₂ in the revised manuscript.

L13. Freshwater lakes and reservoirs are aquatic systems, so that's a repetitive formulation. Simplify.

Response: We will change “freshwater lakes and reservoirs” to aquatic systems.

L48-49. This sentence omits that dissolved CH₄ concentration is very strongly a function of methanogenesis, this should be added.

Response: We will add “In addition to formation processes that lead to CH₄ accumulation” in the revised manuscript.

L69. Not only phytoplankton, but also other microbial life forms. I suggest to reword to “biological”.

Response: We agree that many microorganisms might be involved and thus the word “biological” is more appropriate. We will make this change in the revised manuscript.

Figure 1. The heart of the equilibrator is the gas-water mixing unit, and the gas-water separation unit. These should be illustrated much more clearly, as a technical drawing, such that people can build them themselves. The pictures in the SI don't really help very much.

Response: We agree the drawing should be improved. We will prepare a technical drawing to replace Figure 1.

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L150-154. This text could go to the figure caption.

Response: This text is already part of the figure caption.

L155. Use full word "Laboratory"

Response: We will change "Lab" to "Laboratory".

L178. The 13 m tubing length is not mentioned in this list, but it's shown in the figures.

Response: Thanks for pointing this out. We will add 13 m to the text.

L193. Mention which these various methods were.

Response: We will describe explicitly what the methods are in the text.

L204. From what I read, the depth from which peristaltic pumps can pump up water is physically limited to about 14 m. So how come you could pump water from 30 m depth?

Response: Pump head that the pump needs to overcome is related to vertical distance of the pump to water surface only and unrelated to the vertical position of water intake. Thus, often there is only < 0.5 m pump head when the FaRAGE is placed in a small boat.

L210. Was the effect of boat speed on equilibration tested? Depending on the type and placement of water intake, bubbles might start to form when driving too fast.

Response: We did not try speed higher than 10 km h⁻¹. The driving speed should be chosen according to the spatial resolution that the users would like to have. In our case, 17 m spatial resolution (spatially averaged) was achieved at 5 km h⁻¹ driving speed corresponding to 12 s response time (see line 322-324). Bubbles were not observed at 10 km h⁻¹ speed when the water intake is mounted on the side wall of the boat, 0.5 m below water surface. Driving too fast is not recommended as it may harm the CTD probe.

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L229. Please give this correction equation.

Response: The correction equations for CH₄ and CO₂ are shown in Fig. 2a and b, respectively. L255. No details on statistical methods or tests are given, yet it says "significantly" here. Which test were performed, and what test statistics did they return?

Response: Thanks. Indeed, statistical tests were not performed. We will change this word to "substantially" and give mean \pm standard derivation.

L260. Please rephrase, "while extended response times" is unclear. Fig.2, panel d. Change the right y-axis colour to red (such as in panel c). Also, why is the red point for 13 m tubing length not connected to the other red points, and how come that its response time is so much longer for high-to-low than for low-to-high, and also so much longer than for the 8 m tubing?

Response: Thanks. This is an incomplete sentence. We rephrase the sentence to "A 91.8% equilibration ratio can be achieved by extending the tube length to 13 m while extended response times are expected." We will change the right-handed y-axis color to red in panel d. The red point for 13 m tube length severely deviated from the well-fitted power function. The reason is partially mentioned in line 262-264. The sharp increase in response time of high-to-low is a result of increased resistance of the gas-water mixture flow. The instability started from 13 m tube length and became unacceptable when tube length is 18 m. We will add a few words to explain this a bit more.

L373. I would be more careful with this statement. You can state that the equilibrator was not negatively affected by high phytoplankton density, but you haven't tested suspended sediment, so it's not sure it would work in e.g. in a turbid river. You can't exclude that for sustained operation in a turbid system, a filter in the water intake might be required.

Response: Thanks. Indeed, so far the device has never been tested particularly in turbid rivers with suspended sediment particles. We will point this out explicitly and

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suggest that a filtration unit for the water intake might be needed in turbid rivers.

L383. Unclear what this sentence means, please rephrase.

Response: Thanks. We will correct this in the text.

L408. "potentially be" instead of "be potential".

Response: Thanks. We will correct this in the text.

Supporting information: L32. Coupling instead of couple.

Response: We will correct this in the text.

Fig.S1. The pictures of the syringes don't show much, and don't help those who want to build their own. Use better pictures and include a technical drawing.

Response: We will improve these in the revised draft.

L120. This is not a complete sentence.

Response: Thanks. We will rephrase this sentence.

Fig.S3. Please also show the corresponding depth profiles of CH₄ and CO₂ at this sampling occasion, such that the reader can judge in how far phytoplankton density might have affected measurements.

Response: We will add depth profiles of CH₄ and CO₂ into Fig. S3.

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