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Interactive comment on "Evaluating stream CO_2 outgassing via Drifting and Anchored flux chambers in a controlled flume experiment" *by* Filippo Vingiani et al.

Anonymous Referee #2

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The study by Vingiani et al. compares gas transfer velocities (k600) using 2 different chamber designs (Flexible Foil and Standard) under different conditions (drifting vs anchored) to evaluate accuracy and uncertainty of k600 in rivers using the chamber method. The authors conclude that the flexible foil chamber may be a useful tool to estimate k600 under anchored conditions in low-order streams. The study fills an important research gap that will be of great interest to the scientific community. The manuscript is well organised and well written. My comments are mainly in regards to introduction and methods and intended to help to improve this manuscript. The results and discussion section were thought through and easy to follow.

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Discussion paper

L26 greenhouse gas emissions

L33 might be helpful to show Eq. 1 here

L37 Yes, k can vary in space and time, which is a very important characteristic. I suggest to expand the aspect of spatiotemporal heterogeneity. Maybe the authors can add some examples or numbers to give us a better understanding how much k can vary in space and time in rivers? This could be then also used in the discussion of spatial k600 of drifting k600.

L40 Are there k models for rivers other than from Raymond et al. 2013? If yes, do they also use wind, current and slope? I'm surprised to see only one reference here.

L55 a floating "flying" chamber design with flexible chamber walls has also been successfully used by Rosentreter et al. 2017 and Jeffrey et al. 2018

L58 Yes, local CO2 sources such as groundwater inputs change surface water CO2 concentration, but how would they interfere with local k?

L69-70 This may be exaggerated. For example, the study by Rosentreter et al. 2018 compared k of CO2 in mangrove surrounded creeks, lakes, main river channel, and a bay and in direct comparison to a dual tracer experiment and found good agreement between the two methods (5% discrepancy). Lorke 2015 compared drifting vs anchored chamber measurements. Jeffrey et al. 2018 compared chamber measurements in different sections of an estuary. etc... so this has been discussed before and also quantified.

Was there a fan attached inside the two chambers? Did you test for evenly distributed air circulation inside the chamber?

Did you test for temperature artefacts inside the chamber? Was the temperature constant during chamber incubations?

L126 what CO2 sensors? Please add brand, model, and accuracy of CO2 sensor and

CO_2 analysis.

L127 Roughly, how long did you conduct chamber incubations (runs) for? minutes, half an hour? an hour?

L134-135 Is this a problem? Even if chamber concentrations inside were not atmospheric, you can still use the change of concentration for estimating k, no? If you measured CO_2 every 30sec over the duration of the chamber incubation, then you have a start and end concentration over time (F) that you applied in Eq.2 and Eq.3. Meaning only the difference between start and end concentration is important (slope) and not the concentration itself. I'm curious to hear if the authors agree or disagree.

L139 Were the atmospheric concentrations outside close to 400 ppm?

L193 do you mean increasing "linear regression"? If yes, what was your threshold r2?

L250-251 this sentence could be deleted as this is also mentioned in the Table 3 caption.

Figure 4b shouldn't this be k600, not k?

While this study greatly contributes to our understanding of appropriate chamber design and conditions (drifted vs anchored) of the chamber method in general, I wonder how good this chamber method is in predicting the CO_2 flux in comparison to other k methods and empirical k models? For example, were CO_2 fluxes measured in the flumes better predicted by k600 derived from the chambers measurements in this study than predicted from k600 models (e.g. Raymond et al. 2013, Ulseth et al. 2020)? Or more practically, would the authors recommend to use FF chamber anchored mode over the k600 model by Ulseth et al. (2020) based on energy dissipation for estimating CO_2 fluxes in rivers? Do the empirical models under or overestimate the flux?

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