

## General comments

The study provides a valuable dataset given its high spatial and temporal resolution and a variety of sampling methods, which is rare in the current literature on methane dynamics in inland waters. Therefore, the study has a good potential to offer original insights on the subject, with a unique perspective on spatial and temporal patterns and methodological biases. Data collection, curation, and interpretation are generally appropriate (although I have a limited expertise in the EC technique). However, the structure of manuscript, the presentation of the results, and the discussion around them can be vastly improved. I would like to acknowledge the hard work of the authors for producing this manuscript, and I am confident it will be suitable for publication after some modifications following external feedback.

### *Goal definition*

To help the reader follow the logical structure of the study, it would be helpful to define the aims of the research in a more specific manner. The gap that the authors are filling with their research is not clearly stated in the introduction. For instance, at page 2 line 25-26: “*many questions about reservoir emission behaviour remain*” is very vague. While the authors state that they “*investigate biophysical drivers of CH<sub>4</sub>*”, they should be more clear about how their study differs from multiple other studies investigating CH<sub>4</sub> aquatic drivers, and how their unique dataset enables them to tackle more specific still unanswered questions on the subject. For instance, are the drivers similar at different temporal scales? How different method capture or miss those drivers and what are their biases/uncertainty when upscaling?

### *Main message*

The manuscript provides a lot of scattered new information, however, the main conclusions are diluted and not clearly highlighted in the manuscript. Defining the study aim will help on that matter, but the authors also need to choose a few key results and conclusions and structure the manuscript to focus on them. The fact that the manuscript contains 3 tables and 12 figures (+10 supplemental figures) clearly reflects this issue!! Authors should select a few central figures and tables, and move the ones presenting secondary information to the supplemental document, but overall, the number of figures should be drastically reduced (main and supplementary). Accordingly, the structure of the discussion, the abstract, and the conclusion should be adapted to put the focus on the main findings.

### *Results presentation and discussion*

The structure of the discussion is confusing. For instance, the first section named “*Biophysical drivers*” also outlines spatial and temporal trends, and the CH<sub>4</sub> drivers is also discussed in subsequent sections. Following previous comments, authors should find a more logical structure for discussing results. In general, the literature context for discussing the results can be improved, as the authors make little comparison with results from previous similar studies. Presentation of the results, especially in figures, should be streamlined as there is a lot of repetition.

## Specific comments

- Line numbering should be continuous, not restarting on each new page.
- Page 2 line 17: “*in space in time*” replace by and
- Page 9 line 3: “*elevated are positively*” replace by and
- Page 9 line 11-12: “*The period...smaller median*” this sentence could be simplified as follows: ...if 1) the difference between daytime vs nighttime  $F_{CH_4}$  median was >50 %.
- Section 3.1, the title of this section could be replaced by “Temporal patterns in  $F_{CH_4}$ ” since it does not only focus on seasonal trends.
- Page 9 line lines 22-26: the two sentences are repetitive and can be combined into one.
- Page 10 line 2 “*in contrast...*” and line 11-13 “*This difference...*”, page 11 line 2-3 “*Much of this behaviour...*” statements like these belong in the discussion section.
- Page 10 line 20-25: Was there any investigation done concerning the  $CH_4$  drivers on a day to day scale? It seems like an important component if looking at drivers at different temporal scales.
- The first paragraph of section 3.3 belongs to the method section. The second paragraph of this section could be moved to section 3.1 as it relates to the temporal measurements and drivers of  $CH_4$ . Also, main drivers of  $CH_4$  derived from the ANN analysis should be mentioned in this result section rather than just referring to the figure.
- Section 3.4 should be restructured to present the overall budgets from different methods and comparing them before discussing the differences between years which was already discussed in section 3.1.
- The first paragraph of section 4.1 mostly contains information that belong in the method and results sections.
- Page 13 line 11-12 “*Our analysis...*” authors should be careful with this statement as they have not performed an analysis that specifically support that statement. The cited figures are only visual aids but do not include any statistical testing of this hypothesis.
- Section 4.2.1: here the authors should include a wider range of literature studies linking  $CH_4$  to Chla at global spatial scales, in several temporal studies, and discussing its known link to pelagic oxidic methane production.

- Section 4.2.2: When talking about diurnal CH<sub>4</sub> drivers, authors mention that non-diurnal factors may contribute to the variability in CH<sub>4</sub>. While these other factors may influence CH<sub>4</sub> on different temporal scales, by definition, they do not affect its diurnal variability. Thus, I do not see the point in mentioning them when talking about diurnal variability, and the authors should hypothesize another explanation for this.
- Page 14 line 28 “*static P*” this term is not previously defined.
- Page 15 line 2-3 cumulative F<sub>CH<sub>4</sub></sub> high and low here means overestimate and underestimate the mean? The sentence is not clear.
- Page 15 lines 12-14 “*In contrast...*” I don’t understand this part.
- Page 15 line 15 remove “nevertheless”
- Page 15 line 18 and line 20: year missing for Deemer et al. reference.
- Page 15 lines 24-26 “*The two open-water...*” there is no context explaining what the Knox et al. (2019) analysis is. I do not understand this comparison and the conclusion drawn from it. This should be reformulated.
- Section 4.3: the last 3 paragraphs of this section are quite hard to follow and should be rewritten to improve clarity.
- Page 16 lines 14-16 “*These levels of emissions...*” in their study authors do not test any large scale pattern related to productivity or latitude so I suggest removing this statement.
- Authors do not discuss the limitations and potential biases of the EC method compared to other techniques, and do not discuss the reasons behind a more elevated flux when using this method. This should be addressed.
- Table 3, the warm-season definition should be moved to the title of the table since it applies to all presented data.
- Figure 1 legend, line 3 “, *and spatially...*” remove the “and” here.
- Figure 2, here it is difficult to compare the results of different methods, for that, I suggest putting them on top of each other in the same graph. Also, panels b and c represent only ebullition (unless the legend is wrong) while other panels are integrated CH<sub>4</sub> flux measures, so it is a bit confusing to put them in the same graph. At least, it should be clearly indicated on axis label.
- Figure 4: Panels a and b are a repetition of the same data, remove one.
- Figure 5: it is quite difficult to distinguish any spatial or temporal pattern with these types of graph. A heat map may be more suitable.

- Figure 7: this could go in the supplementary information.
- Figure 11: this could be included in figure 3, which already has the temperature time series. Also, in the legend avoid statement that belong in the discussion.
- This figure does not deliver clearly its message. Physical drivers should be plotted on top of the flux to be able to see any visual correlation between the 2, and ideally perform a statistical analysis to corroborate any correlation.