Review of manuscript essd-2022-346
"GRiMeDB: The global river database of methane concentrations and fluxes" by Stanley et al.

GriMeDB is a valuable compilation of published and unpublished global data of methane (CH_4) concentrations and fluxes in flowing waters (rivers and streams), and the add on of values for CO_2 and N_2O. This valuable data set can support improving global and regional carbon and nitrogen budgets.

It is well known that rivers are generally emitters of relevant greenhouse gases to the atmosphere (i.e., CO_2, CH_4 and N_2O), and an updated global compilation in fluvial systems was very much needed, especially as the authors point out, with the increasing density of measurements over the last years in response to improved technologies. Such compilation was necessary in order to better quantify the role and contribution of fluvial systems to greenhouse gas emissions, as well as to better identify current geographic gaps.
The authors not only compiled these data sets into one single source, but also carefully curated the data in order to standardize the data base (e.g., use of same units in concentrations, daily aggregated values). Additionally, they provide interesting information as a result of statistical analysis showing trends in the data available regarding spatial coverage and temporal trends, over- and under-sampled areas and values with respect to channel types. These results certainly bring new opportunities and recommendations for future studies.
The GriMeDB data base includes detailed information on the methods used for quantification of the three methane emission pathways (diffusion, ebullition and plant- mediated transport), pointing out the large dominance of diffusive fluxes, followed by total fluxes (sum of diffusion and ebullition). Hence, they also provide information regarding gaps in current methodologies.
The data is easy to access and handle, organized in tables with clear description in headers for any user. The manuscript is well written and contains clear flow charts that explain to the reader the protocol followed for the preparation and curation of the data sets. The graphic work is also clear and contains summarized information of the global data base analysis. I have only few recommendations/comments and minor comments in the hope that these can be useful to the authors.
I can only thank the authors for the great effort put in this work. I am sure that the great effort made by the authors to compile this data set will be greatly appreciated by the community, and therefore I recommend the publication of this work in ESSD.
Thank you for these kind comments and your positive endorsement of our efforts.

General comments:

- The authors mentioned that the diffusive fluxes have large uncertainties due to the various methods used to calculate the gas transfer velocity *k* in the different studies. This is a well-known issue, and k is the most uncertain parameter, and what brings the largest uncertainty to any diffusive gas calculation. I wonder if the authors are able to provide in this context:

1) An estimate of uncertainty in the flux calculation to estimate the error of the comparison between fluxes?

2) This might be out of the scope of this study, but having an overview of all the studies and summarizing the >25 different references for *k* model sources, can the authors provide an own view/recommendation of the "best model", or at least "most commonly used" model, for estimation of *k* in fluvial systems? This can benefit greatly to future studies to at least make use of a common model, allowing for a reduction in the uncertainty between studies for comparison purposes. This might vary in channel type though, but a distinction between e.g., hydraulic models, wind speed-based models, might hint at a best approach.

We are hesitant to go down this path of recommending a "best model" for *k*, as this would take quite a bit of additional effort (that is, we feel it is beyond the scope of this already lengthy paper). Further, there are two excellent papers (Raymond et al. 2012; Hall & Ulseth 2020) that delve into this topic in substantial detail, analyze performance of different models, and address topics such as when/where wind speed models may become relevant in rivers. Nonetheless, we added text to the discussion noting the large and concerning number of approaches used to estimate k, and that considering the consequences of different choices may be facilitated by methodological information included in GRiMeDB.

- Can the authors assess the uncertainty reduction that the data compiled in GriMeDB provides when compared to the estimate contribution of fluvial methane emissions or wetland streams (WS category) in the current global methane budget (Saunois et al., 2020)? In fact, the dominant bottom-up inventory of inland waters in the global methane budget is from wetlands, and including rivers and streams to these budgets might contribute to reduce the difference between top-down and bottom-up approaches.

A comparison to current budgets e.g., global methane budget should be assessed in order to compare the previous knowledge and added value that GriMeDB gives in reducing the uncertainty of carbon fluvial emissions.

We agree with this comment. Estimates of uncertainty and improved estimates of fluvial emissions have been made. However, because of the significance of these topics, addressing them will be presented in a separate manuscript.

- The authors do not mention in the manuscript if GriMeDB has the potential to be a living data base with a call to scientist to inform and/or deposit new (self-curated) data and to keep this data set growing.

The current GriMeDB contains I believe the majority of studies published with CH4 data in fluvial systems, but this list is not exhaustive, especially with missing recent published works (some in spotted under sampled regions), such as:

Canning et al., 2021, https://doi.org/10.5194/bg-18-3961-2021
Castro-Morales et al., 2022, https://doi.org/10.5194/bg-19-5059-2022
Patel et al., 2022, https://doi.org/10.1016/j.watres.2022.119380 Wesley et al., 2022 (still work on discussion, unpublished), https://doi.org/10.5194/egusphere-2022-549
Zhao et al., 2022, https://doi.org/10.1016/j.envpol.2021.118769 Zhu et al., 2022, https://doi.org/10.1038/s41467-022-31559-y

Maybe some of these studies, do not meet the requirements for GriMeDB, but it is just an example of current works that could be potentially added to the data base.

We thank the reviewer for pointing us toward these references. We were familiar with all but one of them; however, most appeared or became known to us after we had submitted our data package to EDI for publication and thus were not included. We needed to stop entering data at some point in time! But we have been amassing these and other recent relevant papers for a later update and they will definitely be part of this update (discussed below).

Additionally, and as part of my comment, can the authors provide some sort of protocol for sampling and curation of future or current available data set that are not yet part of GriMeDB and can help the authors to include and expand GriMeDB with community contributions. An example of such living data base is SOCAT (https://www.socat.info/), which provides clear protocols for scientists that wish to contribute with their data sets to this growing data base. This might not be on the scope of the authors at this stage, but given that they host the method it would be interesting if a call to the community can be done on the interest of keeping GriMeDB growing with a certain quality control.

Even if there is no current perspective by the authors to include more data sets to the current data base, an added short protocol as part of this manuscript would be extremely useful. Such protocol can include, e.g., parameters to measure and report (e.g., concentration in certain units), method used to determine *k*, measurement or information of other parameters (e.g., channel type following Strahler scale, channel slope), in a way that it can facilitate future additions of new data sets to GriMeDB.

Already the authors provide certain general recommendations (e.g., determine and report detection limits and include samples falling below these limits, include information on habitat conditions, studies expanding temporal dimensions are encouraged, routine CH_4 measurements with as part of water quality monitoring programs are encouraged), that can also be included and summarized more clearly in a protocol, with potential of including recommendations for e.g., *k* parameterization to be used. If the authors cannot provide a protocol at this stage, I encourage them to add a section 4.3. in the discussion section with "Recommendations for future studies".
This comment about the future of GRiMeDB has been very helpful and triggered substantial reflection about how to manage this resource from this point on. It is our hope to make this a living database, at least for now, so we added text to the conclusion regarding our intent to provide future updates. We have also taken the step of generating a data submission form based on the current structure of GRiMeDB and a 'cookbook' (*sensu* SOCAT) describing the fields, defining fields required for data to be included, how to enter data, identifying preferred units, and how to submit the information. As is stated in the manuscript, this information is now available at stanley.limnology.wisc.edu.grimedb.

We also added some suggestions for core data that would be most helpful for future analyses to the Conclusion section. I do not think we are at the stage of developing a more formal sampling protocol yet, and believe that doing so would be best done with broader input from the research community (a discussion we hope to have in the future). But we hope that these new additions inspired by the reviewer's comments are steps in the right direction.

Minor comments:

P4,
L4 – How the authors assessed the quality control in unpublished data sets?
There are 7 listed unpublished datasets, 5 of which were provided by authors of this paper, and 2 were provided by colleagues we know and trust. Thus, there was no formal QA/QC process beyond making sure the data made sense during the data entry process.

L84 – EU Zenodo is missing
Zenodo omission corrected.

P7,

L141 - it is better at this stage to mention that R package was used and not until section 2.5

We added in the citation to R here, but also left further details about other packages in section 2.5.

L159 - It is missing the code NORM in Table 1, it is only mentioned in the caption of Fig. 14

We have added the 'NORM' category to Table 1.

P10,

L222 - it is necessary to add explicitly the units of concentrations and fluxes in each column, where it corresponds, in Tables A3 and A4, otherwise it is only possible to visualize the units by accessing the headers at the tables directly.

Units have been added to rows defining concentrations and fluxes in Tables A3 and A4.

P21, L371 - there is a dot instead of a comma after the parenthesis

Fixed

P22,

L396 – I believe the words "between CH_4 physical site attributes" need to be removed, so the sentence can only read "As with relationships between CH_4 concentration of flux and water chemistry parameters … "

This sentence is now: "As with relationships between CH_4 and physical site attributes…"

L398 – Did the authors try to calculate correlations of Figs. 12 and 13 per latitude bands? They can be biased due to density of observations but at least some meaningful correlations might be seen between the selected parameters and methane.

We only reported regression results for unbinned CH_4 concentrations/fluxes vs latitude (and basin area; results in Table S3) and hadn't included results from a similar binned analysis given the weak relationship revealed in Fig. 12. Following this comment, we re-analyzed the data after binning (using bins shown in Fig. 8) and again did not find evidence of a consistent relationship between CH_4 and latitude.

L401 – refer here to Fig. 13a L403

– refer here to Fig. 13b

Done

P23, L408 – define here IMP as (impounded reaches), as all the other listed channel types were defined in this paragraph, the same for TH (thermogenic CH_4 inputs) in L415.

Done

P25, Fig. 14 – These site-averaged concentrations need to be normalized to sample size so variations can be reduced due to the varying sizes and a better comparison between channel types can be done.

We used the non-parametric Kruskal-Wallis test because it is robust in cases of unequal sample size. And in general, the intent of this and other figures is to be exploratory and suggestive of what can be done with the data rather than providing rigorous analyses to identify drivers/predictors. However, we did re-run these tests after dropping poorly-represented sites (those with <10 observations) to reduce substantial differences in sample size. This did not substantively change the test outcomes.

P29, L551 – "compared **TO** our previous efforts"

Done

P30, L610 – additionally data assimilation models will strongly benefit from the GriMeDB database

Suggestion incorporated

P31, L628 – "… the expansion of GHG data **FOR** world streams and rivers …"

Done

Hall, R.O. Jr. and A.J. Ulseth. 2020. Gas exchange in streams and rivers. Wiley Interdisciplinary Reviews: Water 7 (1), e1391.

Raymond, P. A., et al. 2012. Scaling the gas transfer velocity and hydraulic geometry in streams and small rivers. Limnology and Oceanography: Fluids & Environments, 2, 41–53.