

## **Douglas et al- Response to reviews- 2<sup>nd</sup> revision**

**We thank the two reviewers for reviewing the manuscript a 2<sup>nd</sup> time, for their overall positive assessment, and for their helpful suggestions for further clarification and improvement of the manuscript. Our specific responses to both reviews are below in bold type. We have also further revised the manuscript to clarify the text and avoid redundancy.**

### **Reviewer 2**

Second review of “Global geographic variability in freshwater methane hydrogen isotope ratios and its implications for emissions source apportionment and microbial biogeochemistry” by Douglas et al.

The authors have incorporated the numerous suggestions that were raised from the different reviewers in considerable detail. The results are now discussed in a more balanced way regarding previous publications. It is not an easy paper to digest, as each section has its own in-depth discussion, but this reflects the complexity of the subject. Otherwise, the presentation quality is high in terms of structure and clarity of language. The core of the paper is the use of statistical tools to detect correlations. It is a very useful exercise even if it turns out that often no clear relations can be found. This is not always surprising given the rather limited number of datapoints and the many parameters that are involved. In my opinion, the discussion sometimes goes a bit too far in such cases, trying to find out which parameter would cause which effect. Such discussions could be reduced, which would also reduce redundancies between different sections. In some cases, possible signals are mentioned, but then it is stated in the next sentence that the effect is not significant. This could also be skipped, but I leave these points for consideration of the authors. Otherwise, I only have a few minor comments.

**We thank the reviewer for their positive assessment. We have edited the manuscript to simplify the results and discussion section where possible, notably in sections 3.3, 3.4, 3.5, and 3.6. We have largely omitted discussion of results that are not statistically significant.**

Specific comments:

Abstract L23 ff: Related to my general comment, would you really expect to find one dominant process that explains the residual variability? I think it is not really surprising that there is not a clear result, given the vast differences in the conditions in the various datasets. This could be left out.

**This statement was in response to previous studies (Waldron et al., 1999; Chanton et al. 2006), who had asserted that specific processes were dominant in controlling residual variability. We discuss this in section 3.4. However, we appreciate that the abstract could be simplified by omitting this, and we have done so, focusing instead on the general finding of a complex set of processes controlling residual variability.**

L58 ff: The methods represented by the references also include isotope ratio mass spectrometry.

**We have added to this sentence to acknowledge the complementary use of isotope ratio mass spectrometry**

L104: subscript 4

**We fixed this typo.**

L119: Remove: “The isotope notation used in this study is briefly introduced here.” This is standard notation, not only used in this study

**This was a holdover from the original manuscript when we had some specific derived isotopic terminology introduced in this section. We have now omitted this sentence as suggested.**

Table 1 and Section 3.8: Although the authors did not agree with my comment on the small errors of the d13C signatures of the fossil fuel sources, I still think it is valid. I acknowledge that the estimates come from published literature, but I am still skeptical. Given that the reported signatures span a range of about 50 ‰, the fluxes are uncertain, emissions and signatures can change over time, etc., I wonder whether the flux weighted average signature is really known to  $\pm 0.5$  ‰. I think this could be mentioned as additional uncertainty, in particular since there is a clear discrepancy between the bottom-up and top-down estimates for d13C.

**We acknowledge that uncertainty related to the relative fluxes and isotopic signatures of fossil fuel emissions from different regions and resource types (i.e. conventional vs unconventional reservoirs) could add additional uncertainty to the average value and 95% CI applied in our model. It would be challenging to quantify this uncertainty with available data, and doing so is beyond the scope of this study. But we have added statements about this in section 2.4 and 3.8.**

**Reviewer 3:**

The authors have made extensive and well-considered revisions to the manuscript. I support publication of this work in Biogeosciences.

**We thank Dr. Hornibrook for his review and positive assessment.**

Minor corrections

Line 18: “is similar observations from in incubation experiments”

> Sentence unclear. Was this meant to say?: “similar to observations from incubation experiments”

**This was a typo- we have fixed it.**

P25, line 44; Awkward sentence: “Comparing the broader categories of inland waters and wetlands with a we do find a significant”

**This was also a typo- we deleted a phrase that was confusing our meaning here.**