

General comments of the reviewer, author response below

Evaluation of the Interactive effects of plant functional groups and water table on CH₄ fluxes in a boreal fen is exciting research and could confirm our understanding of the controls on CH₄ fluxes in fen peatlands. Similar assessment studies have been conducted after the study years of 2001-2004. One of strengths of research is that the emissions are partitioned based on vegetation components. This manuscript is concise and written very well with clarity and supports most of the earlier and later similar studies in discussion section. Introduction covers relevant literature and provides clear objectives that are achieved in results and aligned with conclusions. The paper merits publication once improved as per comments.

The study results confirm many reported findings that water table level is the dominant control on CH₄ fluxes, with vegetation components affect fluxes only under natural (or higher) water table level conditions. On the other hand, authors conclude that results are relevant for evaluating peatland CH₄ flux responses to changing climatic conditions. I believe authors could interpret the study conclusions carefully. To my analysis, these results are relevant for fen peatland (higher water table level) CH₄ fluxes only. The results may not be applicable to bog peatland where water table level (in most cases) is deeper than Lakkasuo study fen (natural site) where mean CH₄ fluxes decreased to zero (0.03 ± 0.03 CH₄ m⁻² month⁻¹) after water table drawdown; Therefore authors may project the results relevancy to fen peatlands responding to changing climatic conditions. I notice that authors missed a significant opportunity of developing CH₄ emission factor for upscaling emissions for similar fen peatlands. The emission factors could be beneficial in reporting national or IPCC level CH₄ emissions. Authors could look at Alm et al. 2007, Couwenberg and Fritz 2012, Levy et al. 2012 (GCB), Wilson et al. 2016, Strack et al. 2017 and few peatland CH₄ studies from Western Canada.

Study sites - Was the study site divided into two (wet or natural, and drier or WLD) in 2001 or 2002? It is given how far apart (radially) the two sites were, specifically, how far was the ditch from the wet site? Additionally, being the peatland complex (eccentric), did the authors verified if the two sites were similar in water table level and vegetation composition? These types of field investigations require additional (necessary) work so that the results obtained are solid.

Was the ditch draining to some larger ditch/drain? Authors need to extend and clarify on sites, their chemistry and manipulation

It would be methodologically challenging to create secluded vegetation removal treatments even after using paraffin wax, for example:

- In PS, sedge stubbles/roots could still mediate fluxes
- I believe that removal leaves underground roots/rhizomes, a large amount of substrate, which could result in undesirable data

The authors need to explain how these problems were resolved. Based on earlier findings (for example, Conrad 2009, Hanson et al. 2000), they could support their removal treatments with several justifications – Lignin or associated polysaccharides are not but simpler carbohydrates or photosynthates are the dominant substrates. Clipping or removal disrupts the photosynthates movement to roots, which may not support dominant substrate-dependent CH₄ production. The explanations could also help discuss the water level × vegetation component interaction for CH₄ fluxes

The underlying mechanisms of CH₄ production/release are established; however, authors need to briefly mention in the discussion to help the reader learn or refresh their understanding. The authors need to add some discussion (or sub-heading) on the water table level – vegetation interaction.

We thank the reviewer for the positive overall statement about our manuscript and the comments that helped us to improve our manuscript.

First, we have now specified in the Abstract and Conclusions that our results are applicable for fen peatlands. Second, we have added the suggested CH₄ emission factor calculation, please see L178-179 and L229-230.

The description of the study site and experimental design have now been modified so that all requested information should be more easily found in the text, including pH and more specific information about the water level manipulation (L100-101, L114-120). We would like to thank the reviewer for the interesting insights related to the vegetation manipulation used in this study. We have now added for example a new regression model describing the relationship between sedge leaf area and CH₄ flux (from L195 onwards) as well as extended the description of the methods (from L99 onwards). We would like to keep the original subheading “Water level regulates the role of the vegetation” in the discussion instead of mentioning interaction in the subheading. However, this section has now been extended to include discussion about the new regression model (L364-371).

We agree that after vegetation removal treatments the sedge stubble and roots could still act as conduits for CH₄, and the dead roots and rhizomes could provide substrate for methanogenesis. We have discussed these aspects in Discussion in the section “Delay in the plant removal treatment effect”. Based on the literature, and our own observation of stable fluxes and no more sedge regrowth, it seems that the substrate supply from the decaying roots and rhizomes was exhausted, and the aerenchymatous pathway disappeared, by the 3rd year of the vegetation manipulations. Our quantitative results on the contribution of the vegetation components to the fluxes is based on that year’s (2004) data.

We have also discussed the points mentioned by the reviewer of the tissues of high lignin content being less favoured substrate for methanogenesis and having a positive relationship with methane oxidation rates (L319-322), and that the photosynthates and fresh carbon compounds transported through the roots are the main substrate for methane production (L42-50).

Specific comments, author response indented below each specific comment

Line 13. The hyphen used here is inappropriate and could be replaced with a comma

Replaced as suggested.

Line 14. Which growing seasons?

Specified as suggested (L13).

Line 15. Insert “each of” after “of”

We thank for the comment but think the sentence is more concise without the addition.

I notice the use of super- or sub-scripts is inconsistent. Also, acronyms are not described in their first instances

Super- and sub-scripts as well as acronyms have now been checked throughout the text.

What could be the reasons the shrubs component attenuated the fluxes? References could be used for discussing ideas

We have added discussion on this matter in addition to the existing discussion from L285 onwards.

Line 22. What authors mean high here? Better say natural. Alternately, give how high?

Changed as suggested (L22).

Line 23. Change “in” with “to”

Changed as suggested (L23).

Line 24. Drawdown is a general term when mentioning climate change impacts; could be replaced with “deepening”

We understand the point of the reviewer, but would like to keep the word ‘drawdown’ here as it has been used widely in this context (e.g Strack et al. 2007, Freeman et al. 2012, Kokkonen et al. 2019).

Line 77. How the Lakkasuo peatland complex is an eccentric raised bog – a brief explanation would be helpful for the reader to understand how a nutrient-poor, oligotrophic fen existed within a bog.

We have specified the description on L95 and L100.

Line 81-87. Any visual/coverage estimates (numbers)?

Cover estimates have now been added as suggested (from L 102 onwards).

Line 100. I notice the use of spacing between a digit and a sign (- or +) is not consistent throughout the manuscript

These have now been checked.

Line 102. Additional dot

Corrected

Line 110. Length × Width

Specified as suggested (L139).

Line 124. Water table level

Based on literature this is an issue of personal taste and in here, and in most of the works by our group, we have decided to use term water level. We have now made sure throughout the manuscript that the use of the term is consistent.

Line 129. Any reference for species-specific Gaussian curves?

A reference has been now cited in the sentence (L157).

Line 153-154. I notice authors tested here WL and Veg differences and provide results later in the results section)

Line 238-241. Interesting to note that this study (2001-2004) compares results with earlier as well as later studies

We have tried to include the most relevant references.

Figure 3. Add significance letters

We have now added the letters.