

## ***Interactive comment on “Greenhouse gas emissions from boreal inland waters unchanged after forest harvesting” by Marcus Klaus et al.***

**Anonymous Referee #1**

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General comments: This paper discusses the impact of forest harvesting on greenhouse gas emissions of boreal inland waters. This is done by analyzing four catchment sites, two of which were affected by forest clear cutting. Overall, the approach of the “Before-After/Control-Impact”-analysis is sound and, in general, the methodological approach is described adequately. However, in some cases more detailed information is necessary as pointed out below (‘specific comments’). The study shows the impact of forestry activity on groundwater GHG concentrations and reveals the importance of the role of the riparian buffer zone-stream continuum although no clear conclusion on the mechanistic role can be drawn.

Specific comments: P2, L30: specify the measurement period more precisely (Jun – September?)

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P2, L33: what is ‘normal’ precipitation? Better: close to the long-term average of xx mm

P3, L16: ‘water chemistry’ is not the right term here. Maybe merge paragraph 2.3 and 2.4 under ‘Water sampling and physicochemical analysis’.

P3, L17-18: ‘... and the deepest point of the lake (Fig. 2) as described in S2.’ (Consider also to reorder this sentence so that the described sampling activities match with the description in the supplement because the next sentence refers to S1, while the following paragraph refers to S2 again.)

P3, L21: spatial variability in CO<sub>2</sub> and CH<sub>4</sub> concentrations within streams, ...

P4, L3: ‘Filtered water samples’ also from streams and groundwater wells? Maybe specify here again, since in the first sentence you write ‘To characterize lake color, ...’ and this could lead to the impression that you are talking about lake water samples only in the second sentence.

P4, L7: you measured TP but never mentioned in the results. Why?

P4, L24-33 in Figure S3 you indicate that you also used bootstrapping when modelling the k<sub>600</sub> for lakes, but you never mention this in the text where you describe how you obtained the gas transfer velocity

P5, L17-18: you use Equ. (1) also to calculate CH<sub>4</sub> and N<sub>2</sub>O fluxes, right? So c should be the respective gas concentration (not CO<sub>2</sub> concentration).

P6, L13: why did you set the ‘after’ period to 2013-2015? Shouldn’t it be 2013-2014 if you want to analyze the clear-cut effects only (without the influence from site preparation)? Did you look at any trends/effects in the individual years after the clear-cut?

P6, L6: ‘paired difference’ – did you do all the measurements at the different sites at exactly the same time? If not, did you account for that in the LME?

P6, L10: what were the results of the pseudo-BACI?

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P6, Results: in general, when you present (mean?) values, indicate that those are (multi-?)seasonal means etc. For example, on P7, L4 you write 'Whole lake temperatures (ranging from 12.8-16.5 °C) ...' – but that's the range of the mean values and not of the entire measurements, right? (also check those numbers; different from Table 2)

P7, L4-5: I think the wording here is confusing because temperature did not decrease but it actually increased only more so in the control. Any idea/explanation for that?

P7, L25: 'medium effect size of +533  $\mu\text{M}$  or +56%' – 533  $\mu\text{M}$  is the slope of your LME, but since you included lake pair as random effect also on slopes, you should get two slopes! Is this the mean? This also applies to all the results/tables where you present slopes/effect sizes. How do you get the 56%?

P8, L29 ff: Discuss your results in the same order as you present the results.

P9, L4: enhanced organic matter degradation, but maybe also increased organic matter input due to forestry activity in the first place?

P9, L5: actually, the explanation would be the reduced CH<sub>4</sub> oxidation

P9, L21: info/effects on wind speed are summarized in table 2, not table 4.

Not sure if you can draw any conclusions on additional forcing on air-water gas exchange velocities, since you actually didn't measure wind speed above the lake. Also considering this, it would be interesting to see the effects on lake water GHG concentrations. Did you check this? If there are no significant effects, maybe just mention this in the first sentence of paragraph 3.3 (i.e. 'Forest clear-cuts did not affect lake water GHG concentrations (data not shown)').

P9, L27: however, this does not explain the results for CH<sub>4</sub>?

P9, L38-39: 'The relative pH decrease of 0.5 units...' – but the Effect size (slope) of pH in Table 2 is 0.00.

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P18 ff: check all your tables for consistency (i.e. compare with the numbers you write in your results).

P19, Table 2ff: p-value: maybe highlight significant effects

P22, Figure 1: A)-C) not really clear what is shown in the pictures. Is A) and B) the same lake but picture taken from different angles? Is B) also before the clear-cut? There is no dashed line in C)? Why are there pictures of only two of the four field sites? Figure 2: Nice. Maybe exchange C) and D) to have the lakes in the same order as in Table 1

P23, Figure 3: Boxplots instead of bars; also for Figure 6 and 7.

P24, L5 (Figure 4): what is 'minimum ice extent'?

P26, L14 (Figure 7): 'summarized as arithmetic means over ten bootstrap runs that take between-chamber variability into account (see Fig. S3)'. In Figure S3, bootstrapping is only indicated for the BACI statistics. From the Figure and the text it is not really obvious how you used bootstrapping and how you take between-chamber variability into account.

Supplement, P1, L34: how did you account for the much higher measurement height of the wind speed at Stortjärn?

Technical corrections:

In general, use passive voice ('atmospheric fluxes were quantified' instead of 'we quantified atmospheric fluxes'. Also, introduce abbreviations the first time the respective spelled-out word is used and use abbreviations throughout the rest of the manuscript (i.e. for carbon (C), greenhouse gas (GHG), ...).

P1, L10: 'greenhouse gas (GHG)'; use abbreviations throughout the rest of the manuscript.

P1, L23: 'carbon (C) and nitrogen (N)'; use abbreviations throughout the rest of the

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manuscript.

P2, L10: 'oxygen (O<sub>2</sub>)'; use abbreviations throughout the rest of the manuscript.

P2, L25: 'site preparation' (be consistent with the use of hyphen)

P2, L26: 'CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>'

P2, L32: '1-3 °C'

P3, L32-33: 'At the deepest point of each lake, at the stream master site and at the groundwater wells. . .'

P4, L24: For both lakes and streams gas transfer velocities (k), the water column depth that equilibrates with the atmosphere per unit time, were obtained as described in the following. (Use passive voice, no comma after "streams", no hyphen in "gas transfer")

P4, L26: 'wind speed'

P4, L37: delete 'respectively'

P5, L2: 'sub-reach'

P5, L20-21: 'Atmospheric CO<sub>2</sub> and N<sub>2</sub>O concentrations were 425 ppm and 350 ppb (median of biweekly in-situ measurements), respectively, and atmospheric . . .'

P5, L40: ' . . . were the arithmetic mean flux of all chambers located at the respective depth.'

P6, L3: 'site preparation'

P6, L9: 'soil sampling' – before you just talking about groundwater sampling so try to be consistent with the wording. See also P7, L7.

P6, L12: (Pinheiro et al., 2015) is the citation for the R package so put it after "'lme' function"; also give citation for the program R and mention which version you used.

P7, L4: '16.5 °C'

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P7, L8: delete 'Here'.

P8, L1: the symbol for mole is 'mol' not 'M', i.e. 99 mmol m<sup>-2</sup> d<sup>-1</sup>. See also L4, L5, L10.

P8, L6: delete 'clear' (it's double)

P8, L14: 'mmol m<sup>-2</sup> d<sup>-1</sup>'

P8, L16: 'varied from 1.2 to 1.3 mmol m<sup>-2</sup> d<sup>-1</sup> in the control stream and from 0.07 to 0.18 mmol m<sup>-2</sup> d<sup>-1</sup> in the impact streams'

P8, L22: delete 'linear mixed-effects models' or just use abbreviation

P8, L26 and L28: 'μmol m<sup>-2</sup> d<sup>-1</sup>'

P9, L2: 'However, aquatic GHG emissions are also fueled by direct catchment inputs of the respective dissolved gases'

P9, L8: replace 'in average' with 'on average'

P20, Table 3: 'Effect size of forest clear-cutting on DIC and CH<sub>4</sub> concentrations (μM) in groundwater in the impact catchments.'

P25, L4 (Figure 5): replace 'lakes' with 'streams'

P25 f Figure 6 and Figure 8: delete 'dissolved'

Supplement, P2, L17: 'dissolved inorganic carbon (DIC)' – you already use the abbreviation before (e.g. in L8 and in the main text)

Supplement, P14, Table S4: check numbers! "Before" should have the same values as in Table 2, right?

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