Interactive comment on "Short-term effects of thinning, clear-cutting and stump harvesting on methane exchange in a boreal forest" *by* E. Sundqvist et al.

Anonymous Referee #1

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The manuscript by Sundqvist et al. compares short-term field campaigns of CH4 soil-atmosphere exchange using an automated static chamber system for different intensities of biomass removal, e.g. control, thinning, clear-cut and stump-harvesting. They also measure soil hydrological indicators such as soil moisture and water table depth as well as soil temperature. Campaigns were carried out in different times of the year. The authors find that with increasing biomass removal the soil becomes a CH4 source, whereas the soils are mainly sinks under control and thinned treatments. The authors attribute increased wetness of the soil as a consequence of reduced evaporation as the reason for the soils becoming CH4 sources.

The manuscript is well-written, results are presented logically and undergo a reason-

able interpretation.

There are issues with the data analyses I believe you should clarify before I can recommend the paper for publication.

This centers on improvement of the description of multiple linear regression and should include quantification of the residual variance NOT explained by your dataset. This is important information since your now choose to include statistics to support your data. This will also provide you with a more solid basis to discuss your data when it comes to the relationship between CH4 exchange and environmental factors. I have listed my detailed comments below.

1. Introduction The introduction was very well-written with an excellent choice of literature. It really framed your study good and made me wanted read what you found.

2. Methods 2.1 Site description Overall, I think your site description lacks a map of the site. A map with topography and the sites, chambers, GWD wells indicated would help the reader to see how the sites were located relative to each other as well as rule out that hydrological changes following harvest is also an effect of topography (see comment later).

Page 4643, line 22. Insert "organic" before "carbon"

Page 4645, line 3-4: Please specify for how many plots/treatments bulk density was determined.

Page 4645, line 12-13: This is a comment to how you filter you data.

1) Does a R2=0.3 and RMSE=0.1 mean that they were significantly different than zero? Why did you choose these numbers specifically? Why not 0.25 and 0.09 for that matter or any other combination? While RMSE is good for time series data it is less well suited to as a comparable fit statistics in your case because it scales with the flux magnitude, e.g. the higher the flux the higher the RMSE. Instead using the normalized RMSE (NRMSE) where the RMSE is divided by the difference of the max and min value of

Interactive
Comment

the time-series, in your case chamber data, will give you a metric that is independent of flux magnitude.

2) More importantly, what was the minimum flux detection (MDF) value for your system and how does it work with the arbitrary values of R2 and RMSE? Your chambers are quite large and with a calculation time of only two minutes, your flux detection limit might be substantial. You should make sure prior to data analyses to filter out fluxes that fall within the interval [-MDF:MDF] because this cannot be distinguished from instrument noise. If you report this you convince the reader that the fluxes in the manuscript are true fluxes. Because you have a large number of points from each enclosure it is easy to get a significant fit even though the flux is low. In that case I believe it is more crucial to know if the fluxes are larger than inherent instrument noise. Currently, you do not present this and it would also be helpful for other studies if you could provide a flux detection limit for a system like yours and show a way to apply. A very simple way to assess it would be to calculated MDF using the factory specifications of the precision of the concentration measurement of the Los Gatos: MDF=precision (ppm or umol m-3)/time (2 minutes). I strongly recommend to assess the MDF of your system and compare all your fluxes against this value. If your fluxes are well outside of the critical interval, you should not change the analyses, but if some fluxes are filtered out based on this you should redo the analyses with this newer dataset. I know this could have some implications for you, but should not change the outcome as it is all the small fluxes that are filtered out. However, rigorous reporting of the systematic errors in chambers measurement is far too often omitted in papers and is needed to get rid of false-positive conclusions.

Page 4645, line 22: Mention which environmental variables you analyze in the Spearman rank correlation and specify if this is done separately even though it might be obvious from the table.

Page 4645,lin 23: replace "multilinear" with "multiple linear"

Page 4645, line 24: You need to provide more detailed information on how the stepwise regression was performed. Was it backward, forward or both? What criteria were used in the selection process: R2-values, p-values, others?

3 Results

Page 4646, line 13: Maybe replace "lower" with "deeper"? Be consistent throughout manuscript.

Page 4647, line 3-6: This paragraph is basically repetition of the above text. I recommend deleting either figure 2 or 3 as they show the same results in different formats. Personally, I like figure 3 more because you have environmental variables included. Also, you should include soil hydrology on Figure 3.

Page 4647, line 16: replace "multilinear" with "multiple linear"

Page 4648, line 7-8: This finding contradicts what you write in the introduction that CH4 production is stimulated more by temperature than CH4 oxidation. I did not find a discussion about this.

Discussion

Page 4648, line 25-26. You attribute the variations in water table depth to treatment effects and less so on seasonal effects. However, one factor you do mention at all is topography. Your site description is lacking information on topography and the relative position of you treatments in the landscape. For example, if your clear-cut and stump-harvesting plots were located downhill of undisturbed and thinned a part of the lower water table depth could also be a topographic effect. When the trees are cut down the topography would also exacerbate the topographic effect moving the water table even closer to the surface. However, you do not touch on this in the discussion. I think you should convince the reader here that this is not an issue.

Page 4649, line 8-10: This is not a surprise as they were the only factors included in your analyses. Furthermore, given the nature of your dataset with many observations,

the relationship will appear as significant. I do not doubt the validity of this in your manuscript, but on the other hand you must have a lot of unexplained variance (or do you? This is not mentioned in any of the tables) that you do not address satisfactorily.

Page 4649, line 26-29 & Page 4650, line 1-11: I really like this result and the idea of a hierarchal causal relationship with CH4 exchange is interesting.

Page 4650, line 16-18: Why is there a negative correlation with temperature? This seems counterintuitive and at this point in the manuscript you should discuss this discrepancy in more depth. Is it because of measurement bias or is it a natural phenomenon?

Page 4650, line 19-26: Again, this paragraph leads nowhere and you should conclude on it or leave it out. Since you did not measure the freely available N fraction it becomes rather speculative.

Page 4650, line 29: "seemed" is a rather vague term. Do you have any data to back this up, like bulk density? If you have include it here.

Page 4651, line 12-18: See also the following publications on afforestation and CH4. Peichl et al. 2010 Global Change Biology, 16, 2198-2212. Christiansen & Gundersen (2011), Biogeosciences, 8, 2535-2546. Barcena et al. (2014) Applied Soil Ecology, 79, 49-58.

Page 4651, line 19: Change "upland forests" to "forest landscapes". Grunwald et al. (2012) state that CH4 fluxes from forested landscapes (including upland and wet forests) is likely biased towards too high uptake because upland forests are overrepresented and hot spots/wet soils of CH4 production are not adequately accounted for in inventories.

Tables

Table 2. Following your idea on Page 4649, line 26-29 & Page 4650 what if you divided Table 2 up into correlations between ST, SM and GWD and CH4 uptake and CH4

production respectively. You make a data for each plot containing only uptake and production, respectively, and do the same analyses. It would be interesting to see if CH4 uptake and production respond similarly. Instead of a table this could be visualized using different colors for positive and negative correlations. Just a suggestion to able to get more in to details on the governing factors and also maybe address the contradictory result that fluxes are negatively correlated to temperature. Also, CH4 oxidation and production are carried out be totally different organisms and an outstanding question is whether they respond similarly to environmental change and also the magnitude of response to change as indicated by the correlation coefficient.

Table 3 Insert "Correlation" before "Coefficients" How should these coefficients be understood? Are they the r-value for separate comparisons? However, this seems to contradict the multiple linear regression method. However, I really wondered what was going on because and if it was individual contributions from the multiple linear regression the sum should be maximum 1 (perfect fit. . .hmmm). However, for example, the sum of coefficients for April 2010 for the thinned plot was 1.27 (better than perfect?). You do indicate in the caption that it was only included if it contributed to explain the variance of CH4 exchange rates, but fail to explain what the value really represents. This should be explained in detail in both the Data Analyses section as well as here in the caption. As you use stepwise regression you should get an overall model fit and an r-value for the complete model. Also, you should be able to get how much each factor in the model contributes to that r-value in the complete model, but it can never be >1! In the table I believe it is very important that you also specify the residual variability not explained by the model, as this supports the r-values. I think there are two things you should do to improve Table 3. 1) Overall readability. Explain in detail in M&M how you get these r-values and also how you can distinguish the contribution of each factor to the overall model fit. 2) Add the R2 for the overall model, as it will give the reader an idea of how much of the variation in the CH4 exchange that is explained or not by the model. This will also give you more leverage to discuss your data.

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