

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.

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We are grateful for the comments on our manuscript by Anonymous referee #1. Here are our point-to-point responses.

Methods 2.1 A map of site topography showing the plots and GWD wells will be provided in the revised manuscript. The exact chamber locations will not be seen very clearly in such overview map, since chambers are located close to each other in comparison to the distances between the different plots.

Page 4643 Organic will be inserted before carbon.

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Page 4645: Bulk density was determined for the 5 chamber locations at the undisturbed plot and for the 4 chamber locations at the thinned plot. This will be added to the manuscript.

Page 3634, line 12-14:

1. R2 values >0.3 was chosen since this was the limit when the fluxes were significantly different from zero. A few outliers that passed the R2 limit were sorted out based on RMSE as a way to support why they were sorted out. $RMSE > 0.1$ was determined visually. The NRMSE will be used for the revised manuscript as suggested by the referee.

2. Minimum flux detection limit (MDF) can be calculated as $MDF = \sigma/t$, as suggested by the referee, where t is the measurement time for one specific measurement and σ is the standard deviation for the concentration measurement. According to Los Gatos specifications, 1 sigma equals 1 ppb for 5 seconds of measurements of a constant CH₄ concentration. We use this as a per second value since nothing else is given. If considering measurements of a constant concentration, the measured value would fall within ± 2 sigma of the real value, so that variation in measured concentration would be 4 ppb. For a measurement time period of 120 s, the maximum concentration changes over time would be: $dC/dt = 0.004/120 \mu\text{mol mol}^{-1} \text{s}^{-1}$. The MDF could then be calculated as $MDF = (0.004 * P * V_{\text{chamber}}) / (120 * n * R * T * A_{\text{chamber}})$, where P is the standard atmospheric pressure (Pa), R is the ideal gas constant ($\text{J K}^{-1} \text{mol}^{-1}$), n is the number of moles, T is the air temperature in the chamber (K), V_{chamber} is the chamber volume (m^3) and A_{chamber} is the chamber area (m^2). For a chamber the size as ours, with a volume of 0.11 m^3 and an area of 0.2 m^2 the MDF for a single measurement would be 2.8 $\mu\text{mol m}^{-2} \text{h}^{-1}$ if temperature is assumed to be 15 degrees celcius. The MDF value should then be divided by the square root of the number of measurements. For daily average values of hourly measurements this value would hence be reduced to $< 1 \mu\text{mol m}^{-2} \text{h}^{-1}$ and even more reduced for seasonal averages. It is important to consider that fluxes below the MDF cannot be securely detected, but small fluxes could very well be real and we don't agree with the referee that they should be sorted out.

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The estimation of MDF will be included in the revised manuscript.

Page 4645, line 22: The environmental variables, soil temperature, soil moisture, and water table depth will be mentioned in the revised manuscript.

Page 4645, line 23: Multilinear will be replaced by “multiple linear”

Page 4645, line 24: The stepwise regression analyses were performed by bi-directional elimination. P-values were used in the selection process. This will be added to the manuscript.

Results Page 4646, line 13: We will replace lower with deeper as suggested by the referee.

Page 4647, line 3-6: We will rewrite or delete this section so that it is not a repetition of what is found in the text above. We agree with the referee that figure 2 and 3 shows roughly the same results and we also prefer figure 3. Hence, figure 2 will be deleted in the revised manuscript.

Page 4647, line 16: multilinear will be replaced by multiple linear.

Page 4648, line 7-8: The result is difficult to explain since we only measure the net flux of CH₄ and not the production and oxidation separately. From soil temperature profiles measured at the clear-cut and stump harvested plots we can see that during the measurement period, changes in surface temperature (associated with periods of cloudy conditions and precipitation) at 5 cm depth are larger than at 20 and 40 cm depth. According to the literature, CH₄ production is more enhanced by temperature increases than what CH₄ consumption is. However, methanotrophs are expected to be located closer to the soil surface than methanogens and the larger temperature increase at the surface might compensate their lower response to temperature, which could explain why net CH₄ exchange is negatively correlated to soil temperature during this period.

Discussion: Page 4648, line 25-26. We agree with the referee that this is important

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information that should be included in the manuscript. The clear-cut and stump harvested plots are located uphill from the thinned and undisturbed plots and hence topography should not explain the rise in water table at the clear-cut and stump harvested plots. This will be shown in a topography map that will be included in the revised manuscript.

Page 4649, line 8-10: We will include an R2 value in table 3 showing how much of the variance that is explained by soil temperature, soil moisture and water table depth all together.

Page 4649, line 26-29: Thank you!

Page 4650, line 16-18: see comment above for page 4648, line 7-8:

Page 4650, line 19-26. We agree with the referee that since we do not conclude on this paragraph, we should leave it out.

Page 4650, line 29: We do not have data on the bulk density to back this up. It is based on visual inspection and interpretation.

Page 4651, line 12-18: Thank you. We will include the suggested references in the discussion.

Page 4651, line 19: We will change upland forests to forest landscapes.

Table 2: Thanks for the suggestion. We will try this out and see how it contributes to the understanding of the governing factors of CH4 exchange. The mean exchange rates given in table 2 are however net exchanges and thus, the combined effect of production and oxidation that, most likely, occur simultaneously.

Table 3: The coefficients given in the table are not R-values. This should have been stated clearly in the Method section. The coefficients are the number that the variables would be multiplied with if CH4 exchange were to be modeled. The analysis is made on standardized data to adjust for the disparity in variable sizes, which makes the

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coefficients comparable. A variable with a larger coefficient has a higher impact on the CH₄ exchange. Standardization for a data point x was made by $(x-x_{av})/x_{st}$ where x_{av} is the average of all data points and x_{st} is the standard deviation of all data. We will add an R² value for the overall model so that it is possible to see how much of the variance in CH₄ exchange that is not explained by the environmental variables included in the analyses.

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