Response to referee nr 1.

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.

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. R^2 values >0.3 was chosen since this was the limit when the fluxes were significantly different from zero. A few outliers that passed the R^2 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 $MDF = \frac{\sigma}{t}$, 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, 1σ equals 1 ppb for 5 seconds of measurements of a constant CH_4 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 $\pm\ 2\ \sigma$ 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:
$\frac{dC}{dt} = \frac{0.004}{120}$ µmol mol^{-1} s^{-1}. The MDF could then be calculated as
$MDF = \frac{0.004 * P * V_{chamber}}{120 * n * R * T * A_{chamber}}$, where P is the standard atmospheric pressure (Pa), R is the ideal gas constant (J K^{-1} 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 µmol m^{-2} h^{-1} if temperature is assumed to be 15˚C. 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 µmol $m^{-2}h^{-1}$ 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. 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 CH_4 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, CH_4 production is more enhanced by temperature increases than what CH_4 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 CH_4 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 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 R^2 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 CH_4 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 CH_4 exchange were to be modeled. The analysis is made on standardized data to adjust for the disparity in variable sizes, which makes the coefficients comparable. A variable with a larger coefficient has a higher impact on the CH_4 exchange. Standardization for a data point x_i was made by $x_i = \frac{x_i - \bar{x}}{\sigma}$ where $\bar{x}$ is the average of all data points and σ is the standard deviation of all data. We will add an R^2 value for the overall model so that it is possible to see how much of the variance in CH_4 exchange that is not explained by the environmental variables included in the analyses.

Response to referee nr 2

We are grateful for the comments on our manuscript by Anonymous referee #2. Here are our point-to-point responses.
- The word organic will be inserted before "carbon" in page 4643, line 22.
-The word multilinear will be replaced with multiple linear wherever it appears in the manuscript.
- The word "the" will be inserted before "year" at page 4648, line 24.
- We will replace the word "form" between take and years page 4651, line 11.

List of Changes

Row 114) *Inserted based on comment from referee nr 1:* (Fig.1)

Row 118) *Changed:* simulate continuous cover forestry *(instead of stimulate continuous forestry cover)*

Row 168) *Inserted:* (Fig.1)

Row 171-172) *Inserted:* Some of these pipes are shown in Fig.1.

Row 178) *Inserted based on comment from referee nr 1 and 2*

Row 213) *Inserted based on comment from referee nr 1:* at the undisturbed and thinned plots

Row 227-242) *This section is changed based on comments from referee nr 1:* Fluxes with an r^2 value higher than 0.3 were generally kept for further analyses. An r^2 of 0.3 was the limit when the fluxes were significantly different from zero. A few outliers that passed the r^2 limit were visually sorted out based on normalized root mean square error. Data kept for further analyses corresponded to 98 % of the data at the undisturbed plot, 97 % of the data at the thinned plot, 84 % of the data at the clear-cut plot and 77 % of the data at the stump harvested plot.

Minimum flux detection limit (MDF) was calculated as $MDF = \frac{\sigma}{t}$, where t is the measurement time for one specific measurement and σ is the standard deviation for the concentration measurement. For a chamber the size as used in this study, the MDF for a single measurement is 2.8 µmol m^{-2} h^{-1}. For daily average values of hourly measurements this value is reduced to < 1 µmol $m^{-2}h^{-1}$ since the MDF value should be divided by the square root of the number of measurements. It is important to consider that fluxes below the MDF cannot be securely detected, but small fluxes could very well be real and therefore they are kept in the analyses.

Row 250-251) *Inserted based on comment from referee nr 1:* soil temperature, soil moisture, and water table depth

Row 251) *Inserted based on comment from referee nr 1:* separately

Row 253-262) Inserted based on comment from referee nr 1: The stepwise regression analyses were performed by bi-directional elimination. P-values were used in the selection process. The analysis was made on standardized data to adjust for the disparity in variable sizes, which makes the outcome of the analyses, the coefficients, comparable. The coefficients are the number that the variables would be multiplied with if CH_4 exchange were to be modelled, a variable with a larger coefficient has a higher impact on the CH_4 exchange. Standardization for a data point x_i was made by $x_i = \frac{x_i - \bar{x}}{\sigma}$ where $\bar{x}$ is the average of all data points and σ is the standard deviation of all data. An R^2 value for the overall model was also calculated showing how much of the variance in CH_4 exchange that is not explained by the environmental variables included in the analyses.

Row 279) *Changed based on comment from referee nr 1:* deeper (*instead of lower*)

Row 288) *Changed due to discovered errors in data sorting, see comment 2 below:* 17 μmol m^{-2} h^{-1} *(instead of 13.1)*

Row 290) *Changed based on comment from referee nr 1:* (Fig. 3), (*instead of former Fig.2 which was deleted)*

Row 292-294) *Changes in ranges due to new sorting based on NRMSE instead of RMSE and corrections for measurement location S^2 see comment 2 and 3:* Fluxes ranged from -7.2 to -11.6 μmol m^{-2} h^{-1} at the undisturbed plot, from -0.3 to -8.6 μmol m^{-2} h^{-1}at the thinned plot, from –3.0 to 32.5 μmol m^{-2} h^{-1} at the clear-cut plot and from -2.9 to 73.0 μmol m^{-2} h^{-1} at the stump harvested plot (Fig.3)

Row 304) *Changed:* U_4 *instead of U_2*

Row 305) *Changes based on comment from referee 1 & 2:* multiple linear, (*instead of multilinear. Multilinear is further changed to multiple linear wherever it appears in the manuscript)*

Row 314-316) *Inserted based on comment from referee 1:* However, according to the r^2 value of the overall model there are lot of unexplained variance in the CH_4 exchange at all measurement locations.

Row 333) *Changed:* 6 measurement locations, *instead of 5 measurement locations*

Row 351-354) Inserted based on comment from referee 1: The clear-cut and stump harvested plots are located on a plateau which is uphill from the thinned and undisturbed plots and hence topography should not be responsible for the higher water table at the clear-cut and stump harvested plots (Fig.1).

Row 375) *Changed:* U_4, (*instead of U_2*)

Row 392-400) *Inserted based on comment from referee 1:* The result is difficult to explain since CH_4 production and oxidation are not measured separately. Soil temperature profiles at the clear-cut and stump harvested plots (data not shown) show 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. 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 CH_4 exchange is negatively correlated to soil temperature during this period.

Row 416) *Changes based on comment from referee nr 2:* take years, (*instead of take from years)*

Row 419-424) *Inserted based on comment from referee nr 1:* Increasing CH_4 uptake with time after afforestation can be an effect of an increase in the population of CH_4 oxidizing bacteria with time (Barcena et al., 2014) or better soil diffusivity and soil aeration with time (Christiansen & Gundersen, 2011; Peichl et al., 2010). A better soil aeration with time could be due to an increase in root biomass, which means that the roots over time loosen the soil and absorb more water (Peichl et al., 2010).

Row 429) *Changed based on comment from referee nr 1:* forest landscapes, (*instead of upland forests)*

Row 464-464) *Inserted based on comment from referee nr 1:* Bárcena, T.G., D'Imperio, L., Gundersen, P., Vesterdal, L., Priemé, A., and Christiansen, J.R., Conversion of cropland to forest increases soil CH4 oxidation and abundance of CH4 oxidizing bacteria with stand age: APPL SOIL ECOL, 79, 49-58, 2014

Row 474-476) *Inserted based on comment from referee nr 1:* Christiansen, J.R., and Gundersen, P., Stand age and tree species affect N2O and CH4 exchange from afforested soils. BIOGEOSCIENCES, 8, 2535-2546, 2011

Row 575-577) *Inserted based on comment from referee nr 1:* Peichl, M., Arain, M.A., Ullah, S., and Moore, T.R., Carbon dioxide, methane, and nitrous oxide exchanges in an age-sequence of temperate pine forests, GLOB CHANGE BIOL, 16 (8), 2198-2212, 2010

Row 675-676) *Changes in correlation coefficients in table 2, based on sorting on NRMSE instead of RMSE, as suggested by referee nr 1.*

Row 683-685) *Changes based on comment from referee nr 1:* Coefficients from multiple linear regression analyses. A value is given only if the variable significantly contributes to explain the variation in the CH_4 exchange. The r^2 shows how well the variables all together explain the variance in the CH_4 exchange. S.m represents soil moisture, S.t, soil temperature and W.t, water table depth.

Row 687-690) *Changes in coefficients in table 3, based on sorting on NRMSE instead of RMSE and correction of error in script, see comment 3.*

Row 693-695) *Inserted figure caption for new Fig 1:* Fig.1. Schematic picture of the different plots and some of the ground water pipes. Three more pipes are located within the clear-cut and at the stump-harvested plots, but are covered by the plot symbol. The background consists of a digital elevation model showing the height above sea level for each square meter.

Row 767) *Changed:* U_2, *(instead of U_4)*

Comments:

1.) Since one figure is added (Fig. 1) and one figure is removed (former figure 2) the former figures have got new numbers when needed.

2.) Based on comment from referee nr 1, sorting of the data was done based on normalized root mean square error instead of root mean square error. This resulted in small changes in the amount of data kept for analyses, average fluxes at the different chambers, correlation coefficients in table 2 and coefficients in table 3.

3.) While checking all the analyses again a few minor errors were found. Some data at plot S^2 had been removed by mistake and adding those increased the average emissions at this measurement location from 54 to 74 µmol m^{-2} h^{-1} which in turn increased the average emissions at the stump harvested plot from 13.1 to 17 µmol m^{-2} h^{-1}. There was also an error in the script for multiple linear regressions resulting in some errors in coefficients, at the thinned plot, which is now corrected. The corrections have no implications for results or discussions.

4.) Referee number 1 suggest that we divide up table 2 in one uptake part and one production part and see how CH_4 uptake and CH_4 production respond to the environmental variables. This is not possible since we only measure the net CH_4 exchange. It is possible to divide the data in one net emissions part and one net uptake part, but it is very tricky to make any conclusions based on such analyses since production and uptake can, and often do occur simultaneously so we cannot know at a net emission location for example if we have a reduced uptake, an increase in production, or both. To separate the production and uptake processes would be very interested indeed, but need to be done already at the time of measurement which require different equipment than what we have.

5.) Two sections were deleted based on comments from referee nr 1.

Former Page 4647, line 3-6: The measurement locations at the managed plots showed a large variability in CH_4 exchange ranges and temporal behaviour (Fig. 3b–d). The measurement locations at the undisturbed plot were consistently CH_4 sinks throughout the measurement period (Fig. 3a).

Former Page 4650, line 19-26: Higher N content in the soil at the clear-cut and stump harvested plots could also possibly contribute to reduced consumption and shifts to emission of CH_4 (Thibodeau et al., 2000; Bradford et al., 2000), although we did not measure the fraction of total N that was freely available. Overall the total N content was higher at the clear-cut and stump harvested plots than at the undisturbed and thinned plots (Table 1), which is possibly due to fertilization that took place in 1976, 1988 and 1998. However at measurement location S2, which showed the highest emissions of CH_4, the N content was relatively low.

6.) Figure 2-5 are updated with values that correspond to the new data sorting.
7.) Referee nr 1 suggest that we add soil hydrology to figure 3. We do not think this brings any added value for the figure. In contrast to soil temperature, soil moisture varies

a lot at the different measurement locations. Adding a graph with soil moisture for 5 different locations in each part of the figure would make the figure, which is already very detailed difficult to read. Information on soil moisture can be found in table 1. Water table depth is only measured continuously at 2 locations, one near the thinned and undisturbed plot and one near the clear-cut plot. We think water table is better shown as an average for the different measurement locations which is shown in figure 4. Information on the water table ranges is also in table 1.