Reply to review #1 by Lars Kutzbach.

* **LK** - Lars Kutzbach
* **A** - the authors

The authors would like to thank the referee for the feedback. We will update the manuscript with more detailed descriptions of the site, the instruments, the methods and the models.

General comments

LK: *The scientific methods are in general clearly described. However, I think that the model runs should be described in more detail (section 2.6). Regarding the model architecture, it is ok to refer to previous publications; but more information on input variables is needed for the evaluation of the results of this manuscript. Which input variables on which temporal resolution were needed for the different vegetation classes?*

A: Air temperature, evapotranspiration, precipitation and snow depth were used as input variables for the model. The data was collected at the site's meteorological tower on a half-hourly temporal scale and gaps were filled with the data collected at the Chokurdakh airport meteorological station, located 30km away from the study area. The inputs were then resampled to daily time scale. The model was parametrised per vegetation type and the same input variables were used to model CH_4 fluxes from different vegetation types. This information will be added to the PEATLAND-VU model description section.

LK: *Regarding the eddy covariance flux calculations, it should be written if and how a density correction (water dilution) for the CH4 fluxes was applied.*

A: Zona et al., (2009) and Parmentier et al., (2011) found that fluctuations of air temperature are dampened after transport of the air through the sampling line and correction for water dilution is small for the same methane analyser, therefore density fluctuations correction (Webb et al., (1980)) was not applied to the data set. This sentence will be added to the eddy covariance measurements section.

LK: *The authors give proper credit to related work. However, also the work of Schmid and Lloyd (1999) should be explicitly cited in the discussion. I suggest to also using the term "sensor location bias" introduced by Schmid and Lloyd (1999) when discussing the results. Generally, it should be made clearer what the "target quantity" is. Is it the up-scaled flux for the 1 km2 square around the eddy covariance tower? Or is it the eddy covariance flux? I would argue that the target quantity is typically not the eddy covariance flux as this could have a "sensor location bias". To evaluate such a possible bias, the target quantity (or area of interest, respectively) has to be clearly defined. (Schmid, H.P., Lloyd, C.R., 1999. Spatial representativeness and the location bias of flux footprints over inhomogeneous areas. Agricultural and Forest Meteorology 93 (3), 195–209.*

A: The authors admit that the "sensor location bias" was not considered in the original manuscript. We will change the discussion to explicitly include the "sensor location bias" term. Our target quantity is the eddy covariance flux. The main question we're trying to answer in this study is whether the methane emission model performs well as compared to the EC measurements. We argue, that as long as dynamic EC footprint is considered, it doesn't really matter where exactly the EC tower is located. If the plot scale model performs well, then weighing emissions by the footprint functions should provide a quantity directly comparable to the EC flux. Of course there's a number of other factors that would influence this approach, such as classification and spatial resolution of the vegetation map, performance of the footprint model, etc. But in the current study we're fairly confident that these factors introduce only a small bias to the final result.

Specific comments

LK: *Page 3931, line 9: Please define more specific what your "area of interest" is. "Whole area" is vague.*

A: In this context, the "area of interest" would be an area in a typical fetch of an EC tower.

LK: *Page 3932, lines 11-12: How much are these Yedoma ridges elevated relative to the drained lake basin?*

A: ~20m.

LK: *Page 3932, line 14: Please explain what the "terrace" is in this context. Is the "drained lake basin" equal to the "terrace"?*

A: Yes, the "drained lake basin" is considered the "terrace".

LK: *Page 3932, line 16: What is the surface height of the floodplain relative to the "terrace"?*

A: The floodplain is approximately 1-2m lower than the terrace.

LK: *Page 3932, line 18: What is the typical vegetation height on the floodplain besides the levees?*

A: ~50cm. This information was added to the site description section.

LK: *Page 3932, line 21: How far was the EC tower from the terrace-floodplain border?*

A: Nearly 250m.

LK: *Page 3933, lines 16-17: Please indicate the software you used.*

A: We used the home-made software written in MATLAB code by Michiel van der Molen. The software is designed to calculate fluxes by following the EUROFLUX methodology (Aubinet et al., 2000) with the addition of angle of attack dependent correction (Nakai et al., 2006).

LK: *Page 3933, line 18: Please write if and how a density correction (water dilution) for the CH4 fluxes was applied.*

A: Zona et al., (2009) and Parmentier et al., (2011) found that fluctuations of temperature are dampened after transport through the tube and correction for water dilution is small for the same methane analyser, therefore density fluctuations correction (Webb et al., (1980)) was not applied to the methane fluxes. This sentence will be added to the eddy covariance measurements section.

LK: *Page 3934, line 2: How good was the energy closure?*

A: van der Molen et al., 2007 reported 99.8% energy balance closure. Parmentier et al., 2011 report similar closure.

LK: *Page 3936, section 2.6: Please give more information on the input variables for the model runs for the different vegetation types.*

A: Air temperature, evapotranspiration, precipitation and snow depth were used as input variables for the model. The data was collected at the site's meteorological tower on a half-hourly temporal scale and gaps were filled with the data collected at the Chokurdakh airport meteorological station, located 30km away from the study area. The inputs were then resampled to daily time scale. The model was parametrised per vegetation type and the same input variables were used to model CH_4 fluxes from different vegetation types. This information will be added to the PEATLAND-VU model description section.

LK: *Page 3937, line 15: Why in this wind direction larger flux source areas?*

A: This is due to higher frequency of stable atmospheric regime occurences for the winds coming from this sector.

LK: *Page 3938, line 4: The indication of the unit in the equation is not necessary, and in my view even misleading. The equation would be also valid for other flux units.*

A: Units removed from the equation.

LK: *Page 3939, lines 10-15: I think that Eq. (5) is mathematically inconsistent with Eq. (3). Phi indicates in Eq. (3) the footprint probability density at a given coordinate. In Eq.(5) you refer to the integrated footprint probability function over all pixels of a specific vegetation type i. Please define the mathematical symbols here more clearly.*

A: There is indeed some confusion in the mathematical symbols in Eq. (5). The integrated footprint probability density function symbol in Eq. (5) will be replaced with Φ symbol.

LK: *Page 3941, line 3: I suggest adding "temporal" before "correlation"*

A: Added.

LK: *Page 3943, lines 24-25: Did you really use the same temperature and water level measurements for different vegetation types? This sounds strange to me. Or do you mean that you used only one input variable set for each vegetation type? Please clarify.*

A: Yes, we used the same set of input variables for all the different vegetation types. But the methane emission model was parameterised differently per vegetation type.

LK: *Page 3944, line 10: Please precisely describe how this standard deviation was calculated? Does it reflect*

temporal variability? Or was it calculated from error propagation for each flux value?

A: The standard deviation was calculated based on daily samples of the EC measurements. Therefore it indeed reflects temporal (diurnal) variablility.

LK: *Page 3945, line 12: Why should a larger dataset deliver better correlation? I would think that you have to expect lower R2 with higher N.*

A: The latter part of the sentence was removed as it introduces confusion and doesn't contribute significantly to the discussion.

LK: *Page 3945, lines 19-22: I think that this overestimation does not allow the conclusion that the model up-scaling approach did not sufficiently account for hot-spots. The next sentences give a better explanation for the mismatch, i.e. that the eddy covariance system sees a different contribution of vegetation types than was present in the total area of interest (1 km2 square map). Here, you could refer to the "sensor location bias as introduced by Schmid and Lloyd (1999).*

A: The paragraph will be changed to accommodate the "sensor location bias" concept.

LK: *Page 3946, lines 17-19: Is this statement related to the modeled or measured CH4 fluxes?*

A: Modelled and upscaled by AW average fluxes.

LK: *Page 3956, Fig. 4: I think that also in this figure an explanation how the map classes refer to the TD1, TW1, FW2 and TW4. These abbreviations are not really intuitive for me.*

A: The legend will be changed to more clearly show how the original vegetation map was re-classified into van Huissteden et. al., (2005) classification.

LK: *Page 3957, caption of Fig. 5: Are really just "a" typical 80% cumulative flux distance and "a" footprint function maximum shown? Or are these averages of the quantities over some period, e.g. the study area?*

A: We are sorry for introducing ambiguity. These are indeed not "a" typical 80% cumulative flux distance and "a" footprint function maximum, but are averages of the calculated values for both measurement periods, binned by wind direction.

LK: *Page 3958, caption of Fig. 6: I think that explanations of vegetation type abbreviations would help the reader.*

A: Explanations will be added to the figure caption.

LK: *Page 3959, caption of Fig. 7: What do you mean with "markers"? Fig. 7: I recommend using different symbols than white circles for the up-scaled model results in the right-side panels. The white circles in the left-side panels were used for the eddy covariance flux measurements. Generally, one explaining sentence for the right-side panels would be helpful.*

A: The symbols will be changed to avoid confusion. Explanation of the right-side panels will also be added. They are basically scatter plots of EC measurements (x-axis) vs. AW and FW fluxes (y-axis).

LK: *Page 3960, caption of Fig. 8: Please explain the symbols used in the graph D and Dveg in the caption.*

A: Explanation will be added to the figure caption.

Technical Comments

LK: *Page 3933, lines 12-13: Please reword. Only the anemometer and the sample intake were installed at 4.7 m height; the cavity ring-down spectrometer was not.*

A: Sentence changed.

LK: *Page 3933, line 22: Insert comma before "any".*

A: Inserted.

LK: *Page 3933, line 23: Insert comma after "However".*

A: Inserted.

LK: *Page 3934, line 25: Insert comma before "and".*

A: Inserted.

LK: *Page 3937, lines 11-12: Insert "the" before "flux footprint climatology", "footprint function" and "average". Insert comma before "and".*

A: Inserted.

LK: *Page 3941, lines 14-16: Please rewrite this awkward sentence. It is difficult to understand.*
A: The paragraph containing the sentence will be changed as per the comments by Anonymous Referee #2.
LK: *Page 3943, line 14: Consistent tense: "reported".*
A: Corrected.
LK: *Page 3944, line 26: Remove comma before "because".*
A: Removed.

References

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