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Interactive comment on "Evaluation of a plot scale methane emission model at the ecosystem scale using eddy covariance observations and footprint modelling" *by* A. Budishchev et al.

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General comments

This manuscript evaluates methane emission time series derived from a plot-scale process-based wetland methane flux model with landscape-scale methane emission measurements by the eddy covariance methodology. Two approaches for up-scaling the plot-scale model results to the eddy covariance flux source area were applied and compared: First, by using the distribution of five vegetation types (that are related to typical CH4 flux strengths) in a static area of interest (1 km2 square) with the eddy covariance system in its center; and second, by using the distribution of the five veg-

etation types within the dynamically changing source area of the eddy covariance flux measurements (modeled for 30 min intervals) weighed by the modeled footprint probability density function. The study addresses an important problem of quantitative biogeochemistry in terrestrial ecosystems: How can results of biogeochemical models and field measurements that are often representative for different spatial scales be compared in the most suitable way? Typically, terrestrial ecosystems are heterogeneous on various scales; and this heterogeneity needs to be considered when comparing measurement and model results on different spatial scales. Therefore, the manuscript is relevant for the publication in BG.

The paper does not introduce fundamentally new ideas, but presents an interesting approach to combine existing model and measurement data on CH4 fluxes from a Siberian tundra site with existing micrometeorological footprint modeling and up-scaling concepts, which to my knowledge has not been published before like this. The manuscript presents substantial conclusions about the performance of the applied PEATLAND-VU model as well as the need for incorporating footprint modeling when evaluating plot-scale model results with eddy covariance measurements. The interpretations and conclusions are well supported by the results.

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

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.)

The title is clear, and the abstract provides a clear and concise summary of the paper. The manuscript is well structured and written in fluent, precise and clear English. There are only few orthography mistakes (see technical comments).

I recommend the publication of this interesting and well-written manuscript in Biogeosciences after considering my comments above and below.

Specific Comments

Page 3931, line 9: Please define more specific what your “area of interest” is. “Whole area” is vague.

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

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

Page 3932, line 16: What is the surface height of the floodplain relative to the “terrace”?

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

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

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

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

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

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

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

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.

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.

Page 3941, line 3: I suggest adding “temporal” before “correlation”

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.

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?

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.

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).

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

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.

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?

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

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.

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

Technical Comments:

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.

Page 3933, line 22: Insert comma before “any”.

Page 3933, line 23: Insert comma after “However”.

Page 3934, line 25: Insert comma before “and”.

Page 3937, lines 11-12: Insert “the” before “flux footprint climatology”, “footprint function” and “average”. Insert comma before “and”.

Page 3941, lines 14-16: Please rewrite this awkward sentence. It is difficult to understand.

Page 3943, line 14: Consistent tense: “reported”.

Page 3944, line 26: Remove comma before “because”.

Interactive comment on Biogeosciences Discuss., 11, 3927, 2014.