

## ***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.***

### **Anonymous Referee #2**

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In the present manuscript, the authors apply an existing peatland methane emission model in combination with a satellite derived vegetation map to calculate the spatially and temporally resolved emissions of a Siberian tundra landscape of 1 x 1 km size. The model had been calibrated with chamber measurements at the same site for the main vegetation classes. The model results are validated using eddy covariance (EC) flux measurements of about 6 weeks (from 2 years) at the site. For the validation of daily average fluxes, two approaches are used: a) comparing the EC flux to the 1 x 1 km areal average modeled emission and (b) comparing the EC flux to the footprint weighted emission within the 1 x 1km study area. The same comparison is made for upscaled chamber fluxes. The study demonstrates the importance of considering (and

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quantitatively accounting for) the footprint of EC measurements when they are compared to other flux data (modelled or measured). It also demonstrates that the vegetation classification used for modelling and identified with satellite information works well for the study area. The topic is fitting well in the scope of the journal. While the experimental work and data evaluation appears to be mostly of good quality, there are some shortcomings in the presentation of the work, that need to be improved before final publication. The detailed comments are listed in the following.

## GENERAL COMMENTS

- 1) It is not fully clear, to which extent data and results presented in this study have been published before. This needs to be declared very clearly at the end of the introduction or at the beginning of the methods section.
- 2) In my view the terms "ecosystem scale" and "plot scale", which are very important in the present study, need some initial consideration and a clear definition, how they are used here. Both terms are not well defined a priori and can potentially be used in different ways.
- 3) It is misleading and not appropriate to mix the problems of upscaling and of EC footprint weighting, as it is done in Section 2.8 and in other parts of the manuscripts. Upscaling in the present context is a self-standing task to apply plot scale model simulations (or chamber measurements) on larger spatial scales. It has per se no direct relation to EC measurements. On the other hand, the footprint weighting distribution is a specific characteristic of EC measurements (to account for their limited and varying spatial representativeness) that is not directly related to ecosystem modelling and upscaling applications. Thus formulations like "3.3 Upscaling by FW average" are confusing and must not be used.

The two issues should be clearly separated in the text. The term upscaling should be used to describe the combination of the peatland model with the satellite derived vegetation map to infer the spatially and temporally resolved methane emission in the

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study area. On the other hand, the terms "footprint weighted (FW) averaging" and "area averaging (AW)" should be used to describe the validation (of the upscaled methane emission) with EC measurements by two different procedures.

4) For illustration and interpretation of the two validation procedures (AW and FW average), it is necessary to show the average or typical footprint location/distribution within the 1 x 1 km map. The footprint information in Fig. 5 is definitely not enough. The difference between the AW and FW average obviously depends on the position of the footprint depending on the wind direction statistics. Therefore it is essential for the manuscript to show the specific distribution of wind directions and thus footprint locations in the validation period.

#### SPECIFIC COMMENTS

5) p3931, line 3: In my view this statement is not really true. The EC technique for methane cannot be generally considered as low in costs or low in power supply needs.

6) p3933, line 17: Since the angle of attack correction is not commonly applied in EC studies, the effect of this correction should be described.

7) p3934, line 1: "An energy balance analysis of the system...". With the measurement system (instrumentation) described here, an energy balance analysis cannot be performed. Beside net radiation and ground heat flux, especially an EC measurement for water vapour is needed.

8) p3934, line 3-8: Cospectra for different wind speeds should not be averaged (only if wind speed normalised frequencies  $f^*z/u$  are used). In addition I cannot see a  $-4/3$  slope for the wT cospectrum where it is most expected.

9) p3934, line 9-12: Due to the problems mentioned in 7) and 8), this statement is not justified.

10) p3934, line 13: What are the reasons for gaps in the EC measurements? Which quality control and rejection criteria were used?

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11) p3934, line 18f.: Where have these chamber measurements been performed (location on the map)?

12) p3935, line 2: Specify, what "GeoEye-1" is.

13) p3936, line 3: What does "plot-scale model" mean here? Does it mean that the model was one-dimensional? (see also comment 2).

14) p3937, line 1-3: how many cases (stable and unstable) were affected by this criterion?

15) p3937, line 11: This is not a useful flux footprint climatology of the EC tower! A real footprint distribution would be needed (see also comment 4).

16) p3938, line 24: F\_FW rather represents the "footprint integrated methane flux" than the "ecosystem scale methane flux". These two scales are not identical as illustrated by the results of the present study.

17) p3946, line 16/17: This is a misleading statement. It is not the area-weighted upscaled flux (which is the final quantity of interest!) that underestimated the EC flux. In contrast it is rather the EC flux that obviously overestimated the upscaled flux, due to non-representative footprint coverage! (see also comment 3).

18) p3946, line 22-24: This is a somewhat misleading formulation. It seems to imply that footprint weighted averaging should generally be used to upscale the model results to larger scales? This would be wrong because the footprint weighting is only necessary (and meaningful) for comparison to EC measurements, and nothing else! (see also comment 3).

19) Fig. 5: The different shades of blue are not well distinguishable here. Better use clearly different colors for the different vegetation classes as in Figs. 6 and 9.

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