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Interactive comment on "Interpreting eddy covariance data from heterogeneous Siberian tundra: land cover-specific methane fluxes and spatial representativeness" *by* Juha-Pekka Tuovinen et al.

Anonymous Referee #2

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The manuscript by Tuovinen et al. aims to use a detailed footprint analysis of a flux tower in Northeast Siberia to identify sensor location bias, while making use of high resolution satellite imagery. I think this study is interesting but, like the other referee, I think this paper could be a lot more effective. I agree with much of what is said in the other review, but I have a few additional comments.

First of all: if sensor location bias is your main goal, this can be done a lot easier through an analysis of the land cover classification from the satellite image. The heterogeneity of the landscape is already captured in there, and by taking the average of a

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hypothetical footprint area at random points within the satellite image, it can be clarified which locations resemble the larger area the most. A rough estimate of the footprint would be required but this would be a lot simpler than the approach in the paper.

As for the footprint area itself: the choice of the Korman and Meixner model is curious. There have been many advances in footprint analysis since, see for example Kljun et al (2015) who described a two-dimensional footprint model that already gives the footprint contribution for each part of the footprint. The model is freely available at http://footprint.kljun.net for Matlab, R and python.

If the authors had used this model, they could have simplified a large part of the methods, which would really help with the readability of the paper. At present, the long list of equations makes it hard to follow what the direction of the paper is, especially since many of them are not referred to later on. Like the author referee said, we don't need textbook knowledge. Sections 2.1 and 2.2 should be drastically shortened to only those equations directly relevant to the paper.

Also, I don't understand why there are not more flux chamber measurements in the area, but only from bare soil. The spatial heterogeneity of methane fluxes can be much better identified from direct measurements rather than the inverse method presented here. Please, when reporting EC methane flux measurements, use nmol/m2/s rather than micrograms.

Finally, the authors should put their research in a better context compared to existing literature. The discussion is very limited, and previous studies that have had detailed footprint analyses or emphasized the spatial variation of methane fluxes are either ignored or referenced too briefly. See for example Matthes et al (2014) and Maruschak et al (2016) for two prime examples, but also the paper by Parmentier et al. (2011) which you do cite but without mentioning that it also dealt with methane flux heterogeneity. There are many more, and this needs to be recognized.

Other comments:

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Page 2, line 27: it would make more sense to mention only natural emissions, since this paper focuses on that. This number of 560 Tg/yr is anthropogenic plus natural.

Page 3, line 13-15: this has been known for decades, and should not be presented as something new. See for example Christensen, 1993; Torn and Chapin, 1993; Whiting and Chanton, 1992.

Page 5, line 27-28: a table with vegetation descriptions for each class would be helpful.

Page 6, line 9: have you considered NDWI as another wetness index?

Page 10, line 23: is this normalization necessary? This paragraph seems like a complex way of simply saying that you have some unknown data in your average. In any case, at 1.4 km from the tower the effect would be negligible.

Page 12, line 23: which Eriophorum species? Not all of them are high emitters of methane, like Eriophorum vaginatum.

Page 15, line 6-7: "the areal coverage of the LCC within the study area"? what do you mean? The LCC map?

Page 17, line 27: this feels like cheating. The tower is not representative for the larger region, so you reduce the region. Please don't.

Page 18, line 2: there's no doubt that lakes are a significant source of methane in the Arctic. Please rewrite this sentence to remove the suggestion that it may not be (e.g. 'Nevertheless, Arctic lakes and ponds emit significant amounts of CH4 in general).

Page 31, figure 1. Please don't use a continuous color map for land cover. Use discrete colors.

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