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# *Interactive comment on* "Eddy covariance methane flux measurements over a grazed pasture: effect of cows as moving point sources" *by* R. Felber et al.

**Anonymous Referee #1**

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General Comments

This manuscript reports eddy covariance measurements of methane over pasture for several months, including periods both with and without presence of grazing cows. The pasture was subdivided into several fenced paddocks whose contributions to the measured fluxes were computed with an established footprint model. The cows represented strong point sources, compared to the relatively small methane fluxes from the pasture soil. The main goal of this paper is to assess what detail of position information for these sources is required to obtain accurate annual methane budgets: do the positions of these point sources need to be tracked individually in time, or are records of the periods of herd presence in each paddock sufficient? Or, can even an averaged



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stocking density for the whole farm, without any cow position information, still lead to acceptable accuracy?

The experiment was well-designed for the purpose. The detail of data analysis presented is very thorough and presented in a logical order. The goal stated above is achieved, with the result that records of the herd grazing appear sufficient.

I wondered why the paper considers only CH4. Surely the same kind of analysis could be undertaken for CO2 and water vapor? The analytical problem would be the same, but the weights of "soil" (ecosystem) and animal contributions would be different. Because of the different weights for the different gas species, it might then be possible to arrive at conclusions how the weights affect achievable accuracy.

A question not addressed is: were there differences in the performance of the footprint model (and, hence, the animal vs soil partitioning of fluxes) between stable and unstable stratification? I would hope that it was not too hard to separate the data in Tables 1 and 2 into two classes according to stratification.

A point for the Discussion: the footprint model assumes that the cows emit the CH4 at ground level. However, that is not strictly true in reality, with some fraction of the gas being emitted higher up. What would be, qualitatively, the effect of the idealized ground-level assumption on the total emission estimate: an overestimate or an underestimate? The question is relevant because the authors select the "near cows" class (where any such height effect would matter most) as their "most reliable" data.

Specific Comments

Title: "eddy covariance" implies that a "flux" is measured, so one word can be dropped to avoid redundancy

Abstract L 13 replace "guess of" by "estimate from"

P 3423 The site, climate and management details are perhaps too comprehensive for a study that is mainly focused on the effects of position-time information, and not on



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the greenhouse gas budgets per se. For example, I do not see the relevance of the site's history (L 16) or of whether this was a climatically unusual year (L 11-14) when the final budgets presented are only for half a year anyway.

P 3424 L 11 Are paddocks 2 and 5 those later labelled "near cows" and the other four "far cows"? It would help to clearly state that here already.

P 3426 L 4: Should "bi-passed" be "bypassed"?

P 3426 bottom: It would be interesting to compare the CH4 time series (Fig. 2a) to that of temperature or water vapor for the same period, to get an idea what part of the variability is due to the passing of turbulent eddies and what part to the emissions from moving point sources.

P 3428 bottom: Why is the "plausible range" for tilt angle not symmetric around zero?

P 3429 bottom and Table 1. It is not clear to me why the GPS and PAD method end up with different numbers of runs. That introduces the possibility of bias because the datasets are not matched. If outliers were removed for one method, the same periods should be removed for the other method also. However, why were "outliers" removed at this stage anyway? Is it not the nature of the beast (pun intended) that a single emitter in a location with high footprint contribution could cause high fluxes, and would the explicit point-source modeling not capture this?

P 3438 L 5 Why is Fig 11 only for the "near cows" class? Did the "far cows" follow the same pattern? If not, that might give clues why the mean emissions differed between these two classes.

P 3439 L 16 "Obviously. . . possible only due to the GPS" does not seem correct. Surely, knowledge of the paddock being grazed and wind direction would suffice to identify the majority of runs with "uncontaminated" soil fluxes.

P 3440-3441 In Section 4.2, it is not easy to follow the argument. The first paragraph seems mainly concerned with random errors, first of flux and footprint model, then of



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roughness length (which is a separate issue). The second and third paragraphs deal with the observed discrepancy between “near cows” and “far cows” (which requires a bias for explanation, not random error). It would help to subdivide the first paragraph further, and to state early in each paragraph what its subject will be.

P 3440 bottom: “Additionally [insert comma] variations of the wind direction. . . amplify the effect of moving.” I do not understand this sentence.

P 3441 L 22 “Hence the over-/underestimation tended to be balanced for the near cows cases”. Was that actually tested, by picking example runs for different footprint-maximum locations and analyzing the cow position data for these? Or is the statement just qualitative arm-waving? Since the authors argue later that the near-cows GPS method was the “most reliable” one, it is important to show that bias was indeed small.

P 3441 bottom. Could it be that emissions at elevated level (from standing cows) contribute to a bias of the “near-cows” results, but less so for the “far-cows” class? With a measurement height of 2 m only, it may matter whether the sources are at ground level or at up to 1.5 m height. A good tool to assess this would be a Lagrangian model.

P 3444 L 13 Can the observed overall inhomogeneity of the cow density distribution be related to the locations of drinking-water supplies?

P 3444 bottom: The animals in Laubach et al. were not “grazing”, they were fed silage, and the locations of the silage and water supplies go a long way to explain why the animal distribution was uneven. This should be clarified.

Table 2 It would seem fair to include columns of “near cows” and “far cows” combined, to show how much the authors’ preference for “near cows” affects the result.

Table 2, caption. The passage “for different distances . . . (near, far)” should be placed before “and without cow position information”, because it applies only to the first two methods.



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Table 2: On first reading, I was confused by the two entries in the top row under "FIELD", each with its own footnote and no connection stated between the two. Perhaps it would be better to have only one footnote stating "The first number is.... The second number is...".

Table 3: Include the numbers from the present study for comparison (so the reader does not need to search for them in the text).

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Interactive comment on Biogeosciences Discuss., 12, 3419, 2015.