Interactive comment on "A simple calculation algorithm to separate high-resolution CH$_4$ flux measurements into ebullition and diffusion-derived components" by Mathias Hoffmann et al.

Anonymous Referee #1

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General Comments

The authors present the validation and application of a data processing algorithm, which allows to distinguish and quantify erratic (ebullition) and diffusive CH4 emissions detected in an automatic chamber time series. This approach facilitates automatic data analysis of chamber measurements, which is an important step towards an improved comparability of these measurements. Secondly, it allows to identify erratic events of CH4 release from wetland ecosystems and to quantify the magnitude of

this release in comparison to merely diffusive emissions. This is important, as many studies have so far focused on diffusive emissions, which account only for a fraction of the total CH4 emissions. The authors thus provide a very useful tool that serves to advance the processing of data derived through automated chamber measurements. It is thus within the scope of AMT and of high interest to the scientific community. I find the study very interesting and useful, but I have a range of suggestions how the paper could be significantly improved.

According to the aims and scope of AMT, the journal's aim is to foster scientific discussion about advances in measurement techniques and data processing methods. Therefore, in my mind, the focus of an AMT paper should be to describe a method in a way that others can easily understand it and use it for their own research. With this in mind, I would like to suggest that the authors put more emphasis on explaining the method they use. The paper is a bit short in details about the data processing and the validation of the method and puts more focus on the results from a field campaign. Those are important, but it should be clear that the method is the main point and that the field study served as a test of the method's applicability and potential.

My second main suggestion is that the authors should include more details about the validation of the method and a more thorough discussion of the potential errors. The reader is, at the moment, unable to judge whether this automated data analysis will always lead to accurate results or when it might fail. Also, it is unclear whether this automated data analysis yields better or worse results than manual data analysis, whereas each measurement is looked at and fitted individually. It is also unclear how the algorithm handles data gaps, disturbances and artifacts. Would it work with other automated chamber systems as well or only with yours? Finally, plant-mediated transport is important. Does your algorithm only work at sites where plant-mediated transport can be excluded or is there potential to further develop the algorithm in the

future so that plant-mediated transport could be included?

Specific Comments

p. 2, line 43
The validation of the method in the lab should be mentioned in the Abstract.

p.3, line 67
I would mention here that CH4 is a greenhouse gas, which explains the relevance of CH4 flux measurements in the very beginning of the paper.

p. 5, line 140
I am wondering if the order of the subsections could be changed. The way it is structured, most emphasis is on the field measurements, whereas I have the feeling that the focus should be on the algorithm and its validation, and then on the field measurements. Not sure if it is possible to change the order though, because obviously information about the chamber system is needed before the algorithm can be introduced.

p. 5, line 153 and following
Do you have references for the composition of the vegetation? Has the study site been described previously?

p.6, line 165
The chamber system seems to be quite sophisticated. Is it a commercial system or did you develop it? Is it described elsewhere? If yes, please add references.

p.6, line 175
- Explain overcompensation or maybe show it in the Figure.
- Fig. 3 is referred to here, but Fig. 2 hasn't been mentioned yet. I suggest to adjust the order of the Figures.

p.6, line 179

Several questions remain open. 1) Over which time period were the measurements performed? This is mentioned in the abstract, but the information should be included here as well. 2) Were the chambers vented after each 10 min measurement? 3) How much time passed when the system switched to the next chamber? The reason for this question is the following: If you pump the analyzed air back into the chamber, you will have contamination every time you switch (i.e. air from chamber I is still in the analyzer, you switch to chamber II, air from chamber I will thus be returned to chamber II).

p. 6, line 181
- What was the water depth of the studied system?
- You say that temperatures were recorded at different (i.e. multiple?) water depths, but the only water depth you give is 5 cm above the sediment surface?

p. 6, line 191
I have a general question regarding the data analysis. Shouldn't you discard data after each ebullition event? The reason is the following: Let's say the chamber is closed and you have diffusive emissions in the beginning. They are driven by the gradient between water CH4 concentration and chamber CH4 concentration. After an ebullition event, the CH4 concentration in the chamber is enhanced over the normal boundary layer concentration, therefore, you will have reduced diffusive emission. Isn't that a systematic error? Can you estimate the magnitude of this error?

p. 6, line 192
Even though the script has been described elsewhere, I'd suggest you give a brief summary of the data processing nevertheless. Otherwise it will be hard for the reader to follow.

p.7, line 199
You should list which values were used for the user-defined parameters (maybe as a Table)

p. 7, line 207

I think it would be good to include a flow chart to support your explanation of how the algorithm works. It would make it easier to follow. In general, the description of how the algorithm works could be a bit more extensive and possibly be supported by graphics (e.g. flow chart, example data)

p.7, line 216
"To exclude measurement artifacts triggered by the process of closing..." This information should appear earlier in the Section, you should describe first which data is discarded and then how fluxes are derived from the remaining data.

p. 7, line 222
This is a nice way to validate the algorithm for ebullition events. Was the algorithm also somehow verified for the diffusive flux? Maybe previously? This would be an important information.

p.8, line 235
At present, the Results and Discussion Section is not very well structured and it is easy to mix up the different experiments. It has to be made clear that what you did was a two-step approach: First you validated the algorithm by testing it under lab conditions, second you applied the algorithm to field data. The reader could be under the impression that you're validating your method with field data, but of course it is the lab measurements that support your theory. The field data is to show how useful your algorithm is for the quantification and interpretation of fluxes. Therefore, I would like to suggest to structure the Results and Discussion Section into 3.1 Validation of the algorithm through laboratory measurements, 3.2 Application of the algorithm to field data, 3.3 Overall performance of the algorithm. That would help the reader distinguish the different experiments. I think that the lab measurements need more discussion – it is the evidence that your method works for ebullition events. But you should also discuss potential errors. In 3.3 you could evaluate the overall performance of the algorithm, the advantages it has, but also include a discussion of potential errors.

p.9, lines 267-270
Your reasoning is: In the literature, it has been shown that CH4 production is related to temperature. Therefore, our measurements show a pattern that relates CH4 to temperature. But actually the reasoning is the other way around: You find in your data that CH4 is related to temperature. This is in accordance with the literature.

p.9 lines 282-286
You do have the data to support this theory (you mention that you measured the water temperature at different depths). I suggest to use your data to prove your theory.

p. 10, line 297
What exactly is the correlation between temperature and ebullition fluxes? I'd suggest to either give a correlation coefficient here or to include a Figure.

p.10, line 308
Does the contribution of ebullition to the total flux (in %) also exhibit a diurnal pattern?

p.10, line 317
In what I suggested to be Section 3.3, I would recommend that you also include a short outlook as to which further developments the algorithm requires and what its potential is to be used as a general tool for automated chamber measurements (kind of what you're doing in your conclusions). Do you think it is possible to integrate plant-mediated fluxes in the future or is your algorithm only applicable in systems where these can be neglected? You should also answer the question under which circumstances the performance of the algorithm might be poor, and which errors can be expected. Could just anyone who measured a chamber time series use your algorithm and get reliable results? Do the flux estimates derived with your algorithm have a robust error propagation estimation?

Fig. 2
This Figure would benefit from annotations (e.g. the fan, the chamber, water tub). "Injections of gaseous mixture amounted to ..." - this information is not relevant in the

caption and is already given in the text.

Fig. 3
This Figure is not very readable and very complex. To make it easier for the reader to understand the Figure, I suggest the following changes: Data points should be bigger, it is almost impossible to distinguish open and black circles. Axis labels should be bigger. The Figure needs a legend that allows the reader to see what the dashed/solid lines and open/black circles denote without having to read the caption. At the same time, if this legend is included, you can remove the extensive and somewhat complicated descriptions of dashed/solid lines, open/black circles in the caption. Why was no death band applied in a and c?

Fig. 4
The data points should have error bars. The axis limit could be reduced to 7. If r^2 is shown, I'd suggest to also show p and the calculated slope and intercept of the regression line.

Fig. 5
This is a very interesting way to present your data. However, similar to Fig. 3, the Figure is very complex and not easily readable. I would like to suggest bigger labels, and a legend like I said in my comment above. A general question, does the bottom slice of the pie (i.e. 6 o'clock on a normal clock) correspond to 12 o'clock noon? If this is correct, then maybe it is good to warn the reader that what he normally perceives as 6 o'clock is not 6 o'clock in this Figure. I think it would be a good idea to have an "example clock-pie" with the actual hours (Let's say, 0:00, 6:00, 12:00, 18:00) next to the Figure so that it is easier to understand the clock-concept at first glance, otherwise the clock-concept might be a bit misleading.

Technical corrections
p. 2, line 46
change to "given in the literature"

p.3, line 77
What does "at all scales" refer to?

p.5, line 148
change to "in the beginning"

p.5, line 150
change to "were reported"

p.5, line 156
"below the chambers"

p.7, line 203
"outlier"

p. 7, line 222
I am unsure about "reasonable controlled conditions". I'd suggest to delete "reasonable"?

p. 8, line 232
change to "were calculated"

p. 8, line 262
"explanatory approaches could be addressed" - I think the wording needs to be changed here.

p. 9, line 286
"This dynamics are ..." should be changed to "These dynamics are"

p. 9, line 291
daytime and nighttime are sometimes written as day time and night time throughout the text (here it is just most obvious because there are two different versions in the same sentence). Please check the article for consistent spelling of those terms.

p.13, line 393

I think the title of that publication should be "Automated modeling of ecosystem CO2 fluxes based on periodic closed chamber measurements: ..."

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