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Interactive comment on "Calculations of automatic chamber flux measurements of methane and carbon dioxide using short time series of concentrations" *by* N. Pirk et al.

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We thank the reviewer for the thorough review of our manuscript and the suggested improvements.

Regarding the mentioned reply to Ana's comment about the water vapor dilution effect, we would like to add the sentence proposed in our reply, but preferably not emphasize the issue in the manuscript, because it might distract the reader from the key points we want to make. Another option would be to include it as supplemental material to the main article.

The following list describes our view on the raised points, and the changes we propose

to implement into the manuscript.

1. Please state more clearly the aim of the study; did you want to improve the available models or to show the differences between the sites?

The aim of our study was indeed two-fold: On the one hand, we wanted to improve the understanding of the processes, which give rise to curvilinear changes in concentration time series from flux chambers. One the other hand, we wanted to find out what kind of effect the used model has on the resulting fluxes, and how large the overall differences typically are. The reason we included five different sites was mainly to test how general our findings are.

To clarify our objectives in the manuscript, we propose to add a sentence to the last paragraph of the introduction, so that it starts with: "Here, we aim to improve the understanding of the processes leading to curvilinear concentration time series of chamber flux measurements, and quantify differences between flux estimates derived from different models. Such an analysis can only be meaningful if random experimental uncertainties are kept to a minimum. [...]"

Moreover, we propose to append a subclause to the following sentence of the abstract: "We used more than 50000 such flux measurements of CH_4 and CO_2 from five field sites located in peat forming wetlands to calculate fluxes with different models, quantify the curvilinearity of the concentration time series, and test the general applicability of curvilinear models."

2. I was wondering why do you call the fluxes calculated using the linear regression independent flux estimates? It is the same measurement using the same technique and measurement device at the same time and at the same plot. In my opinion it would be more obvious for the reader if you just call it the linear flux estimate.

The reason that these linear flux estimates were called "independent" is that they were not calculated in this study, but merely taken from already published datasets from

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other studies (see references in the manuscript). But we acknowledge that "independent flux estimates" might be misleading, and propose to change this to "reference linear estimates" throughout the entire manuscript. Actually, in Figure 1 these linear fits are already labeled as "Reference", which we would hence keep unchanged.

3. In the text you mainly focus on the site where the difference between fluxes calculated using different regressions is small. In Table 2 it is shown that the difference between linear and exponential might be up to 20%. Maybe you could include some ideas on the differences between the sites which might lead to such different results? Or are there other reasons for these differences?

We believe that the differences between the sites seen in Table 2 can be attributed partly to natural differences between the site conditions, and partly to the instrument setups and flux calculation algorithms.

As an example of natural differences, Fäjemyr typically shows relatively small CH_4 fluxes, about one order of magnitude lower than the other sites. This results in a lower signal-to-noise ratio of the flux estimate, which is also apparent in the relatively low R^2 value of the CH_4 flux comparison at this site. At Stordalen the R^2 values are similarly low, but here the underlying reason is that the concentration time series fluctuate more because no fans are used so mix the air in the chamber headspace. Due to this noise we believe that the differences seen at Fäjemyr and Stordalen are not as significant as elsewhere, so we focused the key points of the manuscript a little more on the sites with higher R^2 values (where also the differences of the flux estimates tend to be smaller).

To elaborate some more on the site differences and clarify the text, we propose to change the following sentences of section 3.1, paragraph 3:

Originally: "Table 2 shows these summary (all chamber) statistics for all sites. It shows the effect of the different flux estimation procedures, as well as site-specific differences. For example, the difference between reference and exponential estimates of CH_4 fluxes at Zackenberg, Kobbefjord and Fäjemyr is lower than at Adventdalen where the refer-

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ence (linear regression) is applied for the full 3 min window (and not manually to the initial slope)."

Change to: "Table 2 shows these summary (all chamber) statistics for all sites. It shows the effect of the different flux estimation procedures, as well as site-specific differences. At Adventdalen, where the reference linear regression is applied to the same 3 min window as the curvilinear models, the R^2 values are highest and the linear flux estimates can never give larger (absolute) values than the curvilinear models. At Zackenberg and Kobbefjord, where the reference linear estimates are derived from a time window which is manually adjusted to the initial slope, the differences between reference and exponential estimates are reduced. At Stordalen, where no fans are used to mix the air in the chamber headspace and different methods are used for positive and negative CO_2 fluxes of the reference linear estimates, R^2 values are lower and hence the shown differences are less significant."

The following sentences about Fäjemyr, the NDFE model for CH_4, and the comment about the large spatial variability would stay unchanged.

4. Maybe you could give a more detailed advice on the tape for the sealing of the closing lid. Such information might be interesting for other research groups which use automatic chamber systems.

The difference of the leakage effect on curvature as shown in Figure 4a stems from the use of two different kinds of gasket tapes used to seal the edge of the closing lid. Both kinds were self-adhesive, about 5 mm thick, and 1 cm wide. The tape labeled "Before" corresponds to foamy sealing tape, with a high porosity like a sponge. "After" corresponds to P-profile rubber sealing tape. We propose to clarify this by changing the labels in Figure 4a so that "Before" becomes "Foam", and "After" becomes "Rubber". In our experience however, the most important thing to keep in mind when sealing flux chambers is to make sure (and test) that none of the used materials emit gases that effect the measurements themselves.

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5. I do not understand how you can justify the use of linear regression if the difference to the flux calculated using exponential regression can be up to 20%. Even though there is a large variability in nature it is important to calculate the fluxes as accurate as possible.

We absolutely agree that flux calculations should always be carried out as accurately as possible, no matter how large the spatial variability may be in nature. We do not wish to make the impression that 20% differences due to the choice of flux models are irrelevant because the spatial variability on a few meters is even larger. But the effect is there (across all sites, models, and gases of this study), and the question arises what the flux data is used for, what is reported, and how it can be interpreted.

For example, in Mastepanov et al. (2008), where a flux pattern from the Zackenberg ecosystem is reported, the different chambers are treated as replicates of the same flux measurement and hence means and standard deviations of the set of chambers are reported. According to our findings in the present study, the uncertainties related to the choice of flux model would be smaller than the reported uncertainties in this case.

However, if one was to investigate the spatial variability or find process parameterizations on the plot-scale, we believe that the methods used for flux calculations can have a significant effect on the results, especially when environmental conditions like wind speeds change the flux estimates. Note however, that the differences reported in Table 2 of the present study merely give estimates of the overall differences, and therefore cannot describe such episodic effects.

We propose to clarify this by changing the following sentence in the abstract:

Originally: "The flux differences from independent linear estimates are generally found to be smaller than the local flux variability on the plot scale."

Change to: "Despite significant episodic differences between the calculated flux estimates, the overall differences are generally found to be smaller than the local flux

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variability on the plot scale."

References:

Mastepanov, Mikhail, Charlotte Sigsgaard, Edward J. Dlugokencky, Sander Houweling, Lena Ström, Mikkel P. Tamstorf, and Torben R. Christensen. "Large tundra methane burst during onset of freezing." Nature 456, no. 7222 (2008): 628-630.

Interactive comment on Biogeosciences Discuss., 12, 14593, 2015.