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Interactive comment on "Measurements of CO_2 exchange with an automated chamber system throughout the year: challenges in measuring nighttime respiration on porous peat soil" *by* M. Koskinen et al.

Anonymous Referee #3

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General comments

Chamber based measurements are a valuable tool for monitoring greenhouse gas fluxes in general and CO2 fluxes in particular and automated systems offer some obvious advantages over manual measurements. Unfortunately, there is little standardization regarding chamber construction and data evaluation. This manuscript describes an automated chamber system and does some detailed data analysis to derive the optimal method for CO2 flux calculation. Since there is not much peer-reviewed literature

giving comprehensive methodological advice on CO2 measurements using automated chambers (in particular under harsh climatic conditions), this manuscript offers a valuable contribution. One of the strengths of this manuscript is that it tries to derive the best fitting procedure using objective, statistical criteria. However, for finding the best fitting procedure the authors need to focus more on minimizing potential bias, which is more important than getting better precision. The authors have also made some decisions that seem purely empirical or even subjective. I believe that the manuscript needs to be improved in this regard.

Furthermore, the authors need to make it more obvious, which parts of the abstract, results or conclusions are specific only to their chamber system and which are more generally applicable. E.g., in the abstract the authors report that the time period of 120 – 240 s after chamber closure was best suited for deriving the flux, but only in the conclusions they stress that this should be adjusted for each site.

The authors should check all tables and figures carefully for their importance and provide the less relevant as supplementary material or remove them entirely.

Specific comments and technical corrections

I like your introduction. It is very well written and readable and provides a sound justification for the study.

P14196/25 Please remove "probably". The overwhelming majority of GHG flux measurements has been conducted using chambers.

P14197/3 I somewhat disagree. There is still an open debate about the best method for N2O and CH4 flux calculation; so it's not really straightforward. And before optical methods for N2O measurement became available, CO2 measurements had the advantage of much better precision and time resolution.

P18197/8 *en*closed

P18197/13 I agree, but please explain briefly why knowing small-scale spatial variation is desirable (other than the different ecosystem components).

P18197/25ff This seems more focused on N2O than on CO2. I think at this point you should be more CO2-specific.

P14198/1 Automated chambers also influence the plot. Even if we do not consider the chamber itself, just the collar could offer some protection from wind and could even attract mice and other small animals. See also: J. Pumpanen, B. Longdoz, W. Kutsch (2009): Field measurements of soil respiration: principles and constraints, potentials and limitations of different methods. In Soil Carbon Dynamics: An Integrated Methodology, eds Werner L. Kutsch, Michael Bahn and Andreas Heinemeyer. Cambridge University Press 2009.

P14198/6+7 I think you should be more specific here: If we were able to fully understand and model the C-cycle it would already be excellent.

P14198/15 I think you mean derivation and not "integration".

P14199/4ff You should also give references to the NDFE model [1] and the Hutchinson-Mosier model [2, 3]. These references explain (not with a focus on CO2, but principles should be similar at least for respiration) what kind of non-linear relationship can be expected from physical theory. A polynomial as you used might not be the best approximation.

[1] Livingston, G.P., Hutchinson, G.L., Spartalian, K., 2006. Trace gas emission in chambers: A non-steady-state diffusion model. Soil Sci. Soc. Am. J. 70(5), 1459-1469.

[2] Hutchinson, G.L., Mosier, A.R., 1981. Improved Soil Cover Method for Field Measurement of Nitrous Oxide Fluxes. Soil Sci. Soc. Am. J. 45(2), 311-316.

[3] Pedersen, A.R., Petersen, S.O., Schelde, K., 2010. A comprehensive approach to soil-atmosphere trace-gas flux estimation with static chambers. European Journal of Soil Science 61(6), 888-902.

P14199/26 Hope is important, but you probably "expected".

P14200/10 Did you build the systems on-site or did you install them there? Please give the time period of measurements here.

P14200/14 What do you mean by "outcomes"?

Table 1 You give quite a few graphs in the manuscript and I don't think you need to give such detailed information about vegetation if your focus is on methodology. Maybe provide this table as supplementary material?

P14201/13ff I don't see why you describe these EC measurements here, in particular, measurements from years before your chamber measurements. You don't seem to give/use results from these measurements.

2.2 Description of the chamber system I think it would help readers a lot if you provided some technical drawings as supplementary material.

P14201/27f 2 cm doesn't seem sufficient, in particular in such low-density soil [4]. How did you use moss to seal against gas flow?

[4] Hutchinson, GL Livingston, GP, 2001, 'Vents and seals in non-steady-state chambers used for measuring gas exchange between soil and the atmosphere.', European Journal of Soil Science, vol. 52, pp. 675-682.

P14202/27 Do you mean selection of the chamber?

P14203/4ff It is sufficient to mention briefly that other analyzers can be connected to the chamber system. Remove most of this paragraph since you don't show any results from this.

P14203/22 see above

P14204/23-25 So, you logged CO2 concentration every second and chamber temperature only ever 10 seconds? That is unfortunate.

P14204/15ff Why did you average? You should use the original data for fitting. You should also convert molar concentration to mass concentration prior to fitting. For that you would need to interpolate temperatures, but the resulting mass flux would still be more precise, in particular if the chamber heats up non-linearly during the measurement.

P14205/5 Knowing snow depth is crucial since it changes chamber volume. So what does "approximated visually with the aid of a solid measure" mean? Why did you coincide measured depth with snowfall/thawing events?

P14205/10ff How (and against what) did you test the fit? Describe the statistical measure you used for comparison. Why did you choose second-degree polynomials and not, e.g., some kind of exponential function? This needs a good rationale. Why did you choose 100 s? Were chambers closed for 16 min? How often per day? How many flux measurements did you use for this test?

P14205/20ff If your chamber is stable and air tight, wind shouldn't be so much of a problem. However, a major problem can be condensing water on the chamber walls. In my experience, CO2 dissolves excellently in freshly condensated water.

P14206/1 You tested which model to use with a minimum time period of 100 s, but calculated fluxes with 60 s. Why the discrepancy?

P14206/3ff Why did you move the flux calculation windows by 30 s and not by 1 s? Again, why did you choose 60 s windows for flux calculation? It is important that you not only consider precision (expressed as SD), but also potential bias. At which time point did you calculate the concentration-time gradient? In theory, you need it at closing time and the farer away from that your fitting window is the more biased the result could

be.

P14206/11 Please use the word "test" carefully. A hypothesis test is a very much clearly defined procedure. I guess you mean "examined" here.

P14206/20ff This is a bad idea and I see that the other reviewers already explained why. So I won't have to.

Equation 2 Lloyd and Taylor use R_{10} and E_0 as symbols for the parameters. I suggest doing the same.

P14207/17ff Respiration from peatlands strongly depends on groundwater level. Possibly you don't fully account for this if you fit the model for whole seasons and all chambers together. How variable was groundwater level over time and space?

P14208/15f Did that mean chamber temperature always equal ambient air temperature? Did you see condensing water at the chamber walls?

P14208/27 Please explain why you didn't use the heating preemptively. Did returning heated air to the chamber influence chamber temperature?

Fig. 2 What does the loess smoothing add to the graph? You don't discuss it in the text. There are a lot of overlapping points, which is always unfortunate in a graph. I don't like the legend. I think it is not needed, but if you would like to keep it, place it in a more obvious position. I think you can omit the label of the x-axis.

P14209/20f I'm happy that you didn't use this approach as it is biased towards removing lower fluxes.

Fig. 3 Please give the time of day for the examples.

P14210/20 I don't see how "pressure disturbances" can explain decreasing concentration in the beginning if the flux was positive. In general, pressure fluctuations should cause a push-pull effect that pumps soil air into the chamber and leads to rapid increase of concentrations.

P14210/23ff Fig. 4 seems dispensable. There are other processes that could cause curvature, e.g., the chamber not being fully airtight. Please add time of day to the caption of Fig. 5.

P14211/16ff This paragraph should be in Methods.

P14212/14+15 Language could be improved. “made” is not the best word here.

P14212/16 As I’ve asked before, why didn’t you move by 1 s steps?

Fig. 6 It’s difficult extract any information from these graphs. You should consider other possibilities to give the information.

P14212/25+26 I’m not convinced. Just because the flux estimates are most precise in this window it doesn’t mean they are least biased. I consider minimizing bias (minimizing systematic error) more important than maximizing precision (minimizing random error). You’ve tested first where to start a 60 s window and subsequently how long this window should be. The two optima are not independent. You should test both simultaneously.

P14214/13ff If the time span is sufficiently short, the linear fit will always be a good approximation. The only problem is defining “sufficiently short” (which might depend on the flux) and having sufficient data in this time span.

P14214/24-26 You should make that more obvious in the Methods section.

Fig. 8 You discuss this figure with regard to fan speed, but I can’t find fan speed in the figure.

P14215/22 Please don’t use r^2 to compare precision. You have nicely used RMSE before.

P14216/14 But haven’t you decided to use the 120-240 s window for flux calculation?

P14216/29 I can’t find Table 3.

Interactive comment on Biogeosciences Discuss., 10, 14195, 2013.