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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 #1**

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The authors address the important question of year-around measurements of soil CO2 fluxes in boreal peatland forest ecosystems by the use of automated chamber systems. Wintertime CO2 fluxes through a snowpack below forest canopies are in general poorly understood and quantified, making this study highly significant. The authors thoroughly scrutinize the challenges of automatic chamber measurements on peat soils in boreal ecosystems and highlights the importance of examining the optimal way of calculating fluxes for a given system and site.

The manuscript is well-written and easy to read and follow. It was a pleasure to read



the manuscript. The title clearly reflects the content of the paper. The results are presented in a clear and concise way and are systematically and excellently discussed. The conclusions are clearly supported by the results.

General comments

This appears to be an ambitious and solid study on an important topic. Year-around measurements of carbon fluxes, with a high temporal resolution, in boreal ecosystems are often highly challenging and, in the case of soil CO2 fluxes, often neglected. I only have a few concerns that are related to the methodologies used and the site descriptions.

The different sites are descried in reasonable detail when it comes to ground vegetation, moss and peat layers but not much is mentioned about the forest cover. How dense are these forests (e.g. trees per hectar, Leaf Area Index etc.)? What are the canopy heights? I also lack a bit more details on the EC measurements. Which instruments were used? At which heights were they placed? This combined with information of the forests is important information if one tries to understand the impact of atmospheric turbulence measured above the forest on chamber measurements below the canopies.

Another concern is how the raw CO2 data was handled. The Li-840A gas analyzer measures H2O as well as CO2, yet no water vapor dilution correction on CO2 concentrations appears to have been done. The effect of this correction may be minor at high CO2 flux rates but most likely not at low flux rates. Why was this effect not accounted for in the study?

In wintertime, sample air was released into the measurement cabin (page 14208, line 29). Was this the case for all wintertime measurements or just measurements done when the heating was turned on? Was this data used for further analysis? If so, what would the possible effect of the under pressure created in the chamber on the CO2 fluxes be? Was this examined? On page 14212 (lines 10-12), the authors recognize

that over- and under pressure conditions in the chambers may result in biased flux estimations. On that same topic, on page 14201 (line 27), you mention that the collars are inserted only 2 cm in the moss layer and then sealed with more moss and peat. At the same time, you acknowledge that placing a chamber directly on snow (page 14210, line 5) can result in disturbed measurements. Do you consider measurements on a highly porous moss layer to be less sensitive to wind disturbances than measurements on a snow cower?

Specific comments and technical corrections

Page 14197, lines 2-3: Are measurements of CH4 and N2O fluxes and its interpretation straightforward? Explain how this is straightforward or I suggest that this sentence is removed (it does not add much to the Introduction anyway)

Page 14197, lines 7-8: This sentence implies that dark or covered transparent chambers cannot be used to measure ecosystem respiration.

Page 14201, lines 13-19: I think you should mention here when the chamber measurements were done rather than on page 14204 (lines 6-7) since at the Kalevansuo site, the EC measurements had stopped when the chamber measurements were done.

Page 14202, line 11: “a 12 cm fan” is not a very clear description of a component that is so crucial in the chamber system and in the analysis. It is important to know which air flow rate the fan gives at 12V (or whatever voltage was applied to the fans during different stages).

Page 14202, lines 12-14: I particularly like the placing of the outlet tube in the airstream of the fan to ensure proper mixing of the return air. Very good!

Page 14203, lines 26-29: Did you make sure/measure that all old air in the tubes were removed? This assumption you make implies that there is no mixing of air in the tubes. Condensed water in the tubes may also cause a delay in the CO2 response.

Page 14204, line 15: Why was data averaged into 5 s intervals? Why not use all data



for the linear regression? I assume this was done to reduce the effect of noise of the gas analyzer (see later comment on that).

Page 14204, line 23: Why are fluxes expressed in units of g CO2 m-2 h-1 rather than pure SI units ($\mu$mol m-2 s-1 or nmol m-2 s-1? People working in different types of ecosystems tend to choose different units and thus, making direct comparisons of data from different sites/ecosystems more difficult.

Page 14204, lines 23-26: This assumption means that 10 cm of snow on the ground (in the chamber) results in a change of chamber height with 10 cm. Is this really a reasonable assumption? And how would it affect the fluxes if the porosity of snow is 90%? 50%? 25%? Would it have been possible to take snow samples (outside the chambers) to estimate the porosity at every time the snow depth in the chambers were approximated?

Page 14205, line 5: An “e” is missing in “the”

Page 14205, lines 12-13: These 30 s of data that was excluded, is that the very first 30 s of a measurement, i.e. the 30 s used to flush the tubes from old air?

Page 14206, lines 20-22: If you remove all zero and negative fluxes and keep all positive fluxes (that fulfills the other filtering criteria), you will get biased results. In this way, you accept noise in the gas analyzer that results in (small) positive fluxes and discard all (small) negative fluxes due to noise. In my experience, random noise in the Li-840A can result in apparent fluxes in the order of $\pm$ 0.5 $\mu$mol m-2 s-1 $\approx$ 0.1 g CO2 m-2 h-1 (in a controlled lab environment when the Li-840A is flushed with a calibration gas).

Page 14207, lines 9-11: I assume “daytime respiration” means daytime measurements with covered chambers but maybe you could make that more obvious.

Page 14208, lines 12-16: It is good that you measured air temperature inside the chambers (and that the sensors were shielded and ventilated to some extent, a detail many miss) so you could check that you did not have any rising temperatures in the

chambers. However, did you compare air temperatures inside chambers and outside of the chambers (close to the ground)? Perhaps air in the chambers was always warmer than ambient air? Did the heat shields shield the air temperature probes also when the chambers were fully open?

Page 14214, lines 18-28: You only used dark respiration data and found a better fit for the linear fit than for the polynomial fit if I understand this right? Were the results/conclusions similar for daytime data? Did you explore if it would it be possible to use different fit types for daytime versus nighttime data?

Page 14215, lines 6-7: What is meant by "general dynamics"? At page 14197 (lines 2-3), you highlight the differences between CO2 fluxes and CH4 and N2O fluxes and here you give the impression that it is more or less the same thing.

Page 14215, lines 9-13: You mention that the fan speed was "high" and "low" during different periods but what does this actually mean? Can you be more precise in terms of air flow rate through the fan or air speed within the chamber? "High" and "low" is a bit vague. Page 14215, lines 14-16: Why was this measurement sequence chosen? If you start with a measurement with the fan speed set at "high" and then follow up with a measurement at "low" fan speed, you may already have "ventilated" the chamber. Is it possible that you would have gotten different results if you have started with "low" fan speed followed by "high" speed?

Page 14224, Table 1: Why different significant figures in the table?

Page 14228, Figure 3: Where is the dCO2/dt value? If I understand the caption/figure correctly, only the dC/dt values from the linear fits are presented?

Page 14234, Figure 9: Again, "high" and "low" fan speed is very vague.

Page 14235, Figure 10: It is unclear from the methods section and from this figure caption where u* was measured (which height) and how relevant these numbers are at ground level under the canopies. Why was chamber fluxes calculated with 30-90 s



data when you have shown that 120-240 s data was the best for this system and site?

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