This document contains point-by-point responses to the comments of referee #1. Comments by referee are in blue, author responses in black and changes in the manuscript in italics.

Referee #1, David Bastviken:

This manuscript describes an approach to automatically ventilate a floating flux chamber to measure CO2 fluxes across water-air interfaces, building on a previously presented chamber with a CO2 sensor. The timer regulated ventilation of the chamber described here represents a development to restart the measurement time periods for automated repeated flux measurements over long periods. The proposed solution for chamber venting appears straightforward and has a low cost which would be advantageous if working properly. in general this type of development towards simpler and more cost-effective measurements of greenhouse gas fluxes are important for improved flux assessments around the world, and also small improvements in design can lead to profound progress. I think this manuscript has potential to contribute significant such improvements if the below comments can be appripriately addressed. Hence, I would first like to thank the authors for their work and interst in improving greenhouse gas measurement methods. I think this as a very important and timely field of reserach.

We thank Dr. Bastviken for his supportive and very constructive review. We have followed his suggestions as closely as possible in the revised version.

General comments:

1. Please describe previous work to develop chamber wenting approaches and differences relative to the suggested approach already in the introduction. One such approach is cited later in the text (Duc et al. 2012 in EST; please note that publication on the web was 2012 but the real publication was 2013 so it should be Duc et al 2013), but there are other approaches for e.g soil/plant/wetland chamber types that could be of interest to give an overview.

We agree that previous work on the subject should be mentioned earlier in the manuscript. *We have expanded the third paragraph of the introduction. Here, we mention different ways to obtain automated measurements of gas fluxes and new approaches which have been used on lakes. However, we think that a more detailed overview of existing methodology used in other research (e.g soil flux studies) is not within the scope of this study. The Duc et al. reference has been corrected.*

2. A key is the time-frame and power consumption of the chamber venting. We tried a similar approach when working with the automatic chamber development presented in Duc et al 2013 EST. At that time we found that it took rather long time to vent the chamber completely, which in turn made the pumping consume a lot of power and also resulted in a loss of measurement time (this was a main reason why we moved on with an approach that opens the chamber to reduce venting time). It would be nice to learn more about how these problems were tested and handled in this study. Seemingly in accordance to our findings, Figure 3 indicates that background CO2 levels were not reached in the 7 minutes pumping time used - the minimum chamber headspace after pumping was always between 700 and 800 ppm also during periods when the background was 500 ppm. This may have been a small problem in the test case where pCO2 was very high, but could lead to biased fluxes under some conditions. How long pumping time would be needed to ensure that the

background levels were rached inside the chamber? What implications would this have on the power consumption of the system?

The key to this kind of setup is indeed the power consumption of the air-pump which is the main limiting factor of the deployment duration. Using the air-pump is attractive due to the simplistic operation and installation.

The trade-off between the duration of the air-pulse and measurement period needs to be considered when deploying the chamber and is easily adjusted accordingly. We have tried longer air-pulse durations than the 7 minutes in the presented example which yields headspace concentrations closer to background levels. The pumping of air is a “thinning” process which means that headspace concentrations initially drops rapidly and then more and more slowly during an air-pulse. Ensuring background levels were reached at the start of every measurement cycle would thus require long pumping times in the order of 10-15 min. The gap between headspace concentrations after an air-pulse and ambient levels is also influenced by the flux/gas exchange velocity, from the new figure 4 (see also response to comment number 5) it can be seen that headspace concentrations are close to ambient levels during periods of low CO2 flux (figure 4). Doubling the pumping time would result in approximately half the measurement time. However, we do not think that it is necessary to always reach background levels in order to determine the flux rate, especially when we use the linear increase (slope) to calculate the gas flux. If water pco2 levels are lower the response is the same as long as the headspace concentrations are changed when air is pumped through the chamber. Of course, this is only a problem when the co2 flux is from water to air.

In short, we tried to find a balance between getting close to ambient levels and a low air-pulse duration. These considerations on air-pulse duration versus deployment duration are only relevant when battery supply is limited. If a large battery on the shore, a buoy or dedicated neighboring floating chamber is supplied the duration of the air-pulse can just be increased.

In the manuscript, we have added information on the power supply (see also comment number 3 below) and the expected deployment duration using this kind of setup. A sentence in the discussion is also expanded by mentioning what should be considered when setting the air-pump pause/pulse time. Further considerations related to these issues are also discussed in the supplementary text.

3. With respect to the above, what was the power consumption and power limitations? How long time did the solution presented here work (please give detailed specs on what batteries were used)? Would this be a suitable technique for long-term use in the field with respect to power consumption and if so, how would this be done?

The power consumption of the air-pump is approximately 1.5 W. Using 8 standard 1.5 V AA batteries results in deployment durations of around three to four days. We definitely see this as a viable option for longer-term monitoring (> 6-7 days) but would probably use another power supply or decrease the measurement frequency.

Information on the batteries used in the example has been added in the methods section. This information as well as additional information on the expected deployment duration with the mentioned batteries has also added to the discussion.

4. In the proposed design the pump and battery is placed on top of the chamber. How much does this increase the chamber mass and does this influence flux rates? The desire to minimize chamber mass is mentioned in the discussion, suggesting to put larger batteries elsewhere. Could also the pump together with the battery be placed in a separate floating box next to the chamber to remove the chamber mass issue?

The increased mass on top of the chamber in the suggested design is around 400 grams. We have used traditional chambers next to the described chamber and did not find any differences in performance between the two. We have added a bit more floating material to compensate for the increased weight compared to the manually operated floating chambers. The air-pump and battery could indeed be moved away from the chamber itself. In the manuscript however we only wanted to present the simplest example of construction.

The weights of the parts have been added in the supplementary text. Also in the supplementary text, considerations regarding placement of the air-pump/battery are discussed.

5. Data from the real in-situ test is given for one day only. This data is too limited for readers to evaluate the potential of the approach. Ideally data from longer time periods covering variable weather conditions should be presented. Can such data be presented? If not, how can the system performance under variable weather conditions and system characteristics be analyzed/assessed and shown convincingly in other ways? In addition, please give real measurement data from the CO2 sensor to illustrate variability in raw data (not smoothed curves as in Fig 3c).

The presented data in figure 3 is during a restricted time frame in order to facilitate decent graphical presentation. However, we acknowledge that the time frame is too restricted to convincingly show the potential of this approach.

We have, therefore, included a new figure 4, which show data from the same deployment covering a longer period as well as the time frame shown in figure 3 (marked in gray). We show raw data from the CO2 sensor (a) and calculated flux (c) along with wind speed (average and gust wind speed, b) to show the response of the floating chamber/measurements during variable wind conditions. This offers a much better impression of the performance of the floating chamber during a normal deployment in the field. It also shows the measurement response to variable mean wind speeds and wind gust).

The plots showing raw data from the CO2 sensor in Figure 3 (a and c) have been changed to show points instead of lines (raw data from sensor, where the molar ratio (ppm) have been converted to atmospheric partial pressure (uatm)). The data points themselves are thus unchanged, but the representation is just changed from lines to points.

6. Is the test of gas transport through the long open pressure equilibration tube valid for all weather conditions? Could e.g. wind-induced pumping effects or convection cause more rapid gas transfer than in the laboratory environment? How to not risk any substantial gas transfer under any weather conditions i

We do not have good reason to believe otherwise. If any losses or gains due to episodic weather events occur, we should be able to see this in our measured chamber headspace CO2 concentrations as a deviation from linearity. During our field tests with deployments spread across the year (September, October, January, April and May) we have never observed that this problem show up.

7. Please expand the technical description and give full details, perhaps as supplementary information. For example, please provide a detailed step-by-step guide on how to build the system with instructive pictures and component lists. A key for widespread use is easy access to such details and good instructions for persons with no background knowledge in e.g. electronics.

We agree that detailed information was sparse in the original manuscript.

In order to expand the technical information in a proper way, we have attached it as a supplementary text. This text gives close up pictures of the setup and notes which should facilitate easy assembly. Also in this text, is a list of parts, including weight (as part response to comment nr. 4) and suggestions on where to acquire theme.

Specific comments:

8. Equation 2 made me a bit confused: If the term dC/dt is the change in partial pressure (atm) over time - is it then really correct to multiply with the ambient pressure (Pamb)? This would lead to atm*atm in the unit later on. If I understand this correctly, the multiplication with Pamb makes sense to me only if dC is change in molar fraction, i.e. (ppm/10ˆ6) over time.

This is indeed a mistake of ours.

The equation has now been corrected by removing the Pamb expression.

9. Page 6, line 13-15: I am not sure I understand this sentence. Schilder et al. 2013 (Spatial heterogeneity and lake morphology affect diffusive greenhouse gas emission estimates of lakes, Geophysical Research Letters) showed that it is important to consider local k variability on lakes. It seems like the sentence is saying the opposite?

This sentence is indeed confusing. The paragraph discusses estimation of k in relation to temporal variability of the air carbon dioxide partial pressure above the water surface. We realise that this sentence does not really add anything to this context.

The sentence has now been removed to avoid confusion.