Author response to comments of Referee #1

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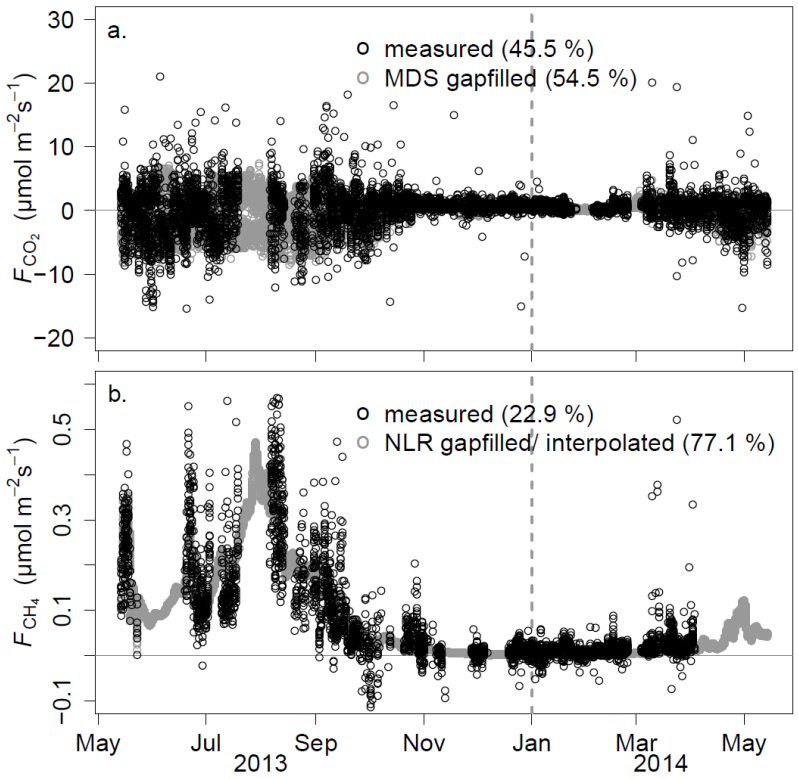
We thank Anonymous Referee #1 for the valuable and constructive comments, which helped us to further improve this manuscript. Below you will find the comments of Referee #1 followed by our responses which are marked in blue.

1. In the manuscript there are lengthy descriptions of gap-filling of the eddy covariance data, and the coverage of the actual data is presented in Table 1. However, there is very little information about the timing of these gaps, I was hoping for a bit more open policy about the shortcomings of the data. In row 310 there is a remark that data from April and May are missing from Figure 3 because the sensor was dismantled. Are there other similar longer gaps in the data? Where?

We added an appendix presenting the data coverage of CO_2 and CH_4 fluxes within the study period. We cross-refer to Fig. A1 on page 7 in line 185.



"Figure A1: Measurement coverage of a) CO_2 and b) CH_4 fluxes within the study period. Gapfilling results of the $MDS_{CO2nofoot}$ and $NLR_{CH4nofoot}$ approaches are added as grey circles."

2. The term "polytrophic" is not very commonly used in the lake science, I suppose it means a shallow, polymictic and eutrophic lake. However, as the term is not very commonly known, I think the paper would draw more interest if the title was "… polymictic and eutrophic lake …" or "… a shallow eutrophic lake …".

This comment is based on the very first submitted draft of this manuscript. However, this draft was slightly changed according to the quick reports of the Referees, which was necessary to publish the manuscript for interactive discussion. As suggested in the quick report, we changed the term "polytrophic" to "eutrophic" and thank Referee #1 for this suggestion. We now further replaced "eutrophic shallow lake" by "eutrophic and polymictic lake" in line 111 on page 4. In addition to the

suggestions in the quick reports, we applied few small changes to the very first draft to further improve the manuscript. Thus, the lines mentioned by Referee #1 are shifted.

3. The writers stated that summer 2013 was exceptionally hot and dry and as a consequence the water level dropped considerably rising again the next winter. As the lake is very shallow, I was wondering how much the fluctuation of the water level affected the lake are (i.e. area covered with water). Was the water area considerably larger in winter than in summer? One of the main findings of this study is that open water and vegetated areas had very different gas fluxes. How much did the fluctuating water level (or dry land versus water covered land) effect the results?

During summer particularly areas with a wintertime very shallow inundation of the soil were exposed, pertaining especially parts of the emergent vegetation stands. We did not map the fluctuations of soil inundation and aerial images, which could help to define the extent of inundation, are not available for the periods with highest and lowest water table. Nevertheless, in summer the detection of inundated and exposed areas would be hampered by the vegetation hiding the surface. We could not observe a considerable decrease of the spatial extent of the open water body, as emergent vegetation mainly covers the shallower edges of the water body. Water table modelling would require a digital terrain model (DTM) with a very high height accuracy, as the study site itself is on average less than 0.5 m above sea level. The most accurate available DTM covering the site is the DTM5 with a height accuracy of 0.25 to 1 m, which is not sufficient to represent the microtopography.

Changing coverages of exposed versus inundated soil most probably have an effect on the difference of the surface type fluxes. However, for profound statements long-term measurements covering more than one summer will be necessary. In addition, we expect the effect of water level changes to be very variable within the open water body, as the bottom is characterised by a distinct microtopography (see also response to comment 3 of Referee #2) and therefore different vulnerability to changes. Thereby, eddy covariance measurements can only provide limited information.

We changed lines 476-479 on page 16 to the following: “Unusual warm and dry conditions and associated water table lowering during summer 2013 might have triggered a shift from anaerobic to aerobic decomposition due to the exposure of formerly only shallowly inundated soil and organic mud. However, this effect mainly concerns emergent vegetation stands. We could not observe a considerable decrease of the spatial extent of the open water body, as emergent vegetation mainly covers the shallower edges of the water body.”

4. One of the findings of this study is that convection brought about a diurnal fluctuation of CH_4 flux. If this is true, most likely convection contributed also on the diurnal fluctuation of CO_2 flux. Have you considered this when calculating e.g. NEE?

We did not consider convection within NEE modelling and the calculation of the surface type fluxes so far. However, we agree that thermally induced convective mixing might also have an effect on the diurnal fluctuations of NEE. Nevertheless, open water is characterised by remarkably lower CO_2 exchange rates than emergent vegetation.
According to our response we add the following paragraph to the discussion on the diurnal variability of CH_4 emissions (page 14, line 398): “Apart from CH_4, thermally induced convection potentially contributed also to the diurnal fluctuation of the CO_2 flux at our study site. According to Eugster et al. (2003) penetrative convection might be the dominant mechanism yielding CO_2 fluxes during periods of low wind speed, especially in case of a stratification of CO_2 concentrations in the water body. Ebullition triggered by convective mixing might be less important for CO_2 than for CH_4, as concentrations of CO_2 are most often low in gas bubbles (e.g. Casper et al. 2000, Poissant et al. 2007, Repo et al. 2007, Sepulveda-Jauregui et al. 2015, Spawn et al. 2015). Further investigations should

focus on the controls of the diurnal patterns in CO_2 and CH_4 exchange based on additional measurements, e.g. gas concentrations in the water, methane oxidation or plant-mediated transport."

Detailed comments:

5. Page 11, row 310: Please add 2014 to avoid misunderstandings (April and May 2014 not shown …)

We changed the paragraph according to our response to comment Nr. 5 of Referee #2 and added the respective year to the months.

6. Page 15, row 432: Extra bracket at the end of the sentence.

A cross-reference to Table 4 was missing. We already corrected this prior to the publication of the manuscript for interactive discussion as can be seen in line 435 on page 15 (for shifted lines see response to comment 2).

7. Figure 2. It is not quite clear here is the fluxes are for the whole EC area or for the AOI.

Fig. 2 presents the daily fluxes for the EC source area. We added the missing information to the figure caption: "Figure 2: Temporal variability of environmental variables and ecosystem CO_2 and CH_4 exchange within the EC source area. Seasonal course a) of water level (Wlevel), cumulative precipitation (Cum. Precip) and air temperature (T_{air}), b) the daily CH_4 flux (gapfilled, $NLR_{CH4nofoot}$) and c) the daily NEE (gapfilled $LUT_{CO2nofoot}$) and component fluxes (modelled R_{eco} and GPP, $LUT_{CO2nofoot}$). "

8. Figure 6. It is not quite clear what does the density describe. Please clarify.

We thank the referee for this suggestion. We use a smoothed 2d kernel density estimate to illustrate the abundance of the CO_2 and CH_4 fluxes dependent on the fractional coverage of open water within the EC source area. The plot was created with the command smoothScatter of the R package graphics. The graph is based on flux data from 15 May till 14 September 2013, as the dependence of the flux variability on the source area coverage of open water is most pronounced during summer.
We changed the figure caption to the following: "Figure 6: Impact of the fractional coverage of open water (Ω_{water}) within the EC source area on the measured fluxes of CO_2 and CH_4 (15 May to 14 September 2013). The abundances of CO_2 and CH_4 fluxes in dependence on Ω_{water} are illustrated by a smoothed two-dimensional kernel density estimate. The variability of CO_2 flux rates decreased with increasing Ω_{water}, whereas the variability of the CH_4 flux increased."