Referee 5

- The sedimentation rates are not contextualized in the introduction or objective, but they are highlighted in the methods, results and discussion. One important point is that this ms would benefit from reporting changes in Organic Carbon Burial instead of Total Sedimentation rates. Authors should include the profile of Organic Carbon Content in the sediment at least in part of the lakes to reduce speculation in the discussion section (page 9, lines 8-20). Lakes studied here could have high organic burial even showing low total sedimentation rates and vice versa.

We fully agree with this comment. Unfortunately, our organic carbon data set is not complete (or not fully reliable). Therefore, we decided to present only the total sedimentation rates. The data will be crossed with organic carbon data in the future (however, not in this paper) to present the organic carbon burial.

- Authors should reformulate the study design section to clarify differences of sampling between static and dynamic chambers. Also, they should report what lakes are assessed for each method, as there are figures with 1, 3 or 4 lakes. It's very confused in Figures 2,3, 4, 6 7 8 and 9 if lakes are different lakes or the same in different seasons.

This study design section has been thoroughly reformulated and detailed. The information on the two procedures, the conditions that led to the choice of each procedure, date, number of samples, water column depth, collection times, size of the lakes, (etc.) are now described in the text and in the table. To this, we added 2 pictures of the collection procedure in supplement S1. We cannot show all the collects. We selected some daily cycles representative of what happened in the lakes depending on the conditions. In Fig 2, we have chosen different lakes but on a given date, in order to allow to ignore variations of weather conditions. See below the main changes:

Study design section:
"Gas fluxes from the lake to the atmosphere were measured using 32-L polyethylene floating chambers, having a base area of 0.195 m^2. The main conditions during the field campaigns are summarized in table 1. Two procedures were used for these measurements with fixed or slowly moving chambers. The procedure using slowly moving chambers (Photo 2 Supplement S1) was favored when the water level was sufficient and the lake diameter not too large to allow to cross from one bank to another. In this case, depending on the lake diameter, a train of 3 to 6 floating chambers was attached, leaving a gap of 10 meters between two successive floating chambers. Floating chambers were placed in the water every minute at a distance of about 30 m from the lake shore, and then slowly pulled toward the opposite bank at a maximum rate of 5 m min^{-1}. This experimental design allows for scanning the various water column heights, with the least turbulence disruption to the lake surface. To minimize artificial turbulence effects, foam elements were adjusted so that a maximum of 2 cm of the chamber penetrated below the water surface. The collects were carried out once each chamber reached a distance of about 30 m from the opposite bank. The collection times were variable since the first chamber reached the other margin in approximately 20 to 25 minutes, whereas the last chamber took about 35 to 40 minutes. When the water level was too low, or the lake too wide, we opted for a procedure with fixed floating chambers (Photo 3 Supplement S1). In order not to disturb the sediment just below the chamber, they were anchored with a 10-m line to avoid drifting. The line was equipped with a float to the vertical of the anchor. The chambers were located from the center to the border of the lake, and the collects were carried out after 20 min from an inflatable boat with shallow draft. Due to the low water column, it was not possible to place a bubble shield to prevent bubbles from reaching the chamber. Therefore, the results represent the sum of both fluxes by diffusion and ebullition. For each chamber, gas samples were collected in duplicate (about 2 minutes apart) through a 60-mL syringe. Then they were transferred into 30-mL glass bottles, previously capped with gas-tight, 10-mm thick butyl rubber septa and aluminum caps, and evacuated with a hand vacuum pump at 0.75 kPa. Air samples were also collected at the departure of the chamber train for the ambient gas

levels. Gas fluxes were calculated by the linear change in the amount of gas in the chambers as a function of sampled time. Thus, for example for a 6-chambers protocol, the mean and standard deviation on 12 measurements are presented as single gas emission value and error bars, respectively, for a given hour that corresponds to the launching of the first chambers. This operation was repeated every two or three hours or in order to present a complete 24-hour cycle."

Table:

Table 1: Date, location, lake characteristics and general conditions during greenhouse gas emission monitoring.

Date	Type of lake (name) Surface km^2	Weather conditions	Phyt. Bloom conditions	EC range $\mu S.cm^{-1}$	pH range	DOC $mg.L^{-1}$	Procedure Numb of chambers	Water column range meter	Time of gas coll. Minute
Sept. 13, 2012	Black (P) 0.087	Sunny	-	1400-1599	8.81-8.99	51	Fixed 3	0.3 – 0.8	20
Sept. 14, 2012	Green (V) 0.109	Sunny	Moderate	2420-2888	9.48-9.73	236	Fixed 3	0.1 – 0.4	20
Aug. 30, 2013	Black (P) 0.091	Sunny	-	1715-1855	9.21-9.33	37	Fixed 3	0.3 – 1.1	20
Sept. 1, 2013	Green (V) 0.109	Partially cloudy	Strong	2302-2410	9.67-9.78	265	Fixed 3	0.1 – 0.5	20
Dec. 2, 2014	Green (M) 0.053	sunny	No	2014-2204	9.37-9.51	102	Sl. moving 6	0.1 – 0.4	23 to 43
Jul. 7, 2015	Green (M) 0.055	sunny	No	1940-2030	9.28-9.37	82	Sl. moving 3	0.1 – 0.4	21 to 37
Sept. 10, 2015	Green (G) 0.285	Sunny (evening storm)	Strong	34000-35100	10.3-10.44	326	Fixed 3	0.1 – 0.2	20
Sept. 12, 2015	Black (P) 0.093	Strongly rainy	-	1382-1450	9.3-9.4	36	Fixed 3	0.4 – 0.7	20

And Supplements:

Photo 2: Gas collection from a train of 6 slowly moving chambers on green water lake M in the absence of cyanobacteria bloom (December 2014). The first floating chamber has just reached the point of collection. Two samples will be collected in each chamber. The average of these 12 samples will provide 1 flux data for each gas (CH_4, CO_2 and N_2O).

Photo 3: Gas collection from a set of 3 fixed floating chambers on Lake G with strong bloom condition (September 10, 2015). Two samples will be collected in each chamber after 20 min. The average of these 6 samples will provide 1 flux data for each gas (CH_4, CO_2 and N_2O). Note that the ebullition of the lake due to O_2-supresaturation has started.

- Overall, all legends are very poor and should be fully revised (e.g. no mention on each lake and season analyzed, number of sampling or even what means symbols and bars, such as a question: Mean and standard error?). In addition, authors should name (e.g. A, B, C...) panels of each figure.

We agree. The captions have been strengthened. The lake is now mentioned in the caption and the date in the Table. The number of samples is given in the table, and the meaning of the error bars is specified in the text. The figures are grouped into different panels and we opted for colored figures in order to reduce the confusion associated with the superposition of the error bars. See table above, and for example Fig. 5 and 7 below:

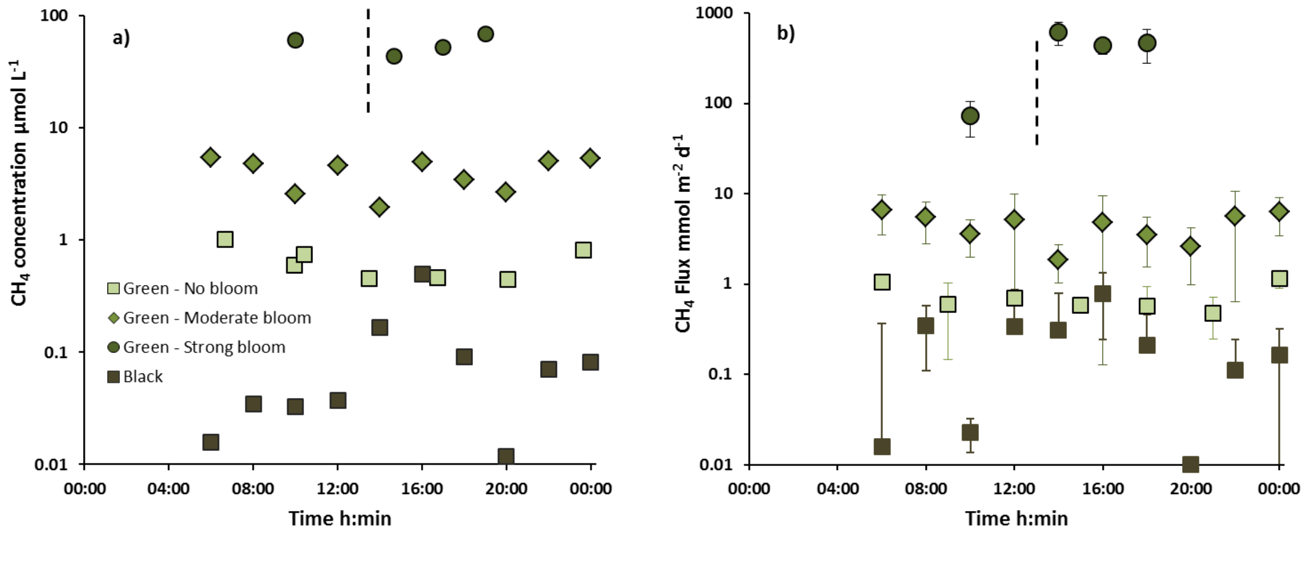

Figure 5: (a) Dissolved methane concentrations at the top of the water column, (b) and methane fluxes over 24 hours monitoring in black water lake (lake P) and green water lakes for no- (lake M), moderate- (lake V) and strong- (lake G) bloom conditions. Due to the logarithmic scale used, some negative values of the error bars (denoting standard deviations) are not drawn. The dashed line represents the beginning of the ebullition in lake G (13:20).

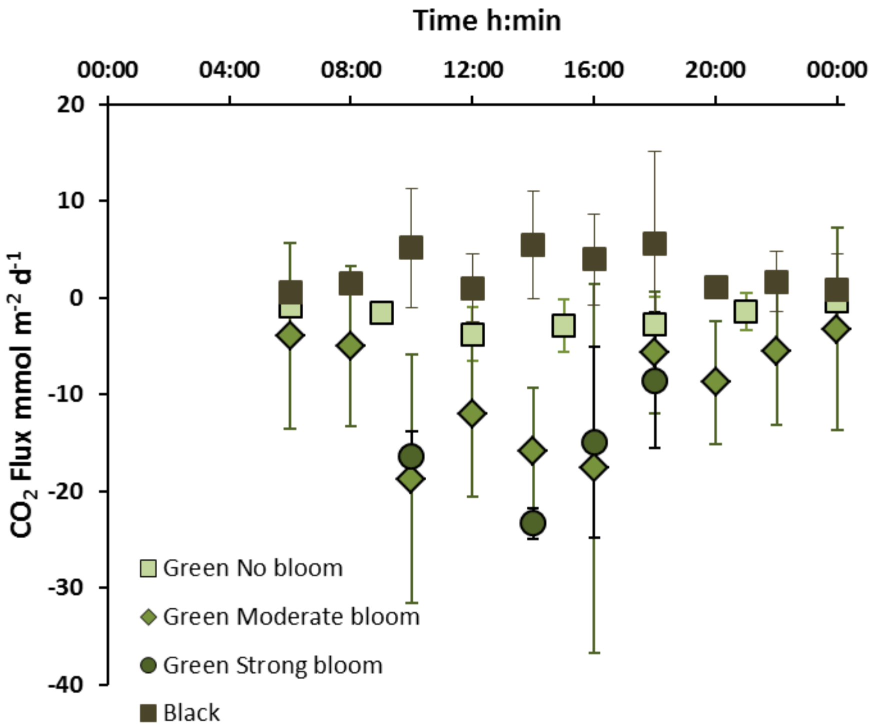

Figure 7: Daily cycle of carbon dioxide fluxes showing emission from black water lake (P), and increasing consumption with increasing magnitude of the cyanobacterial bloom in green water lakes for no- (lake M), moderate- (lake V) and strong (lake G) bloom conditions.

- The ms would benefit from any statistics treatment for Figures 6, 7, 8, 9 and 10, such as a two-way ANOVA to test the effect of different lakes and time on each key variable.

We agree with the suggestion, but we decided not to introduce ANOVA treatment at this stage of data publication on this lake system. The data set is still too thin. But we have received funding to continue this research on other types of lakes (lakes with red waters, crystalline waters or non-alkaline lakes). This type of statistical processing will be applied to the complete data set at the end of the project.

- The discussion section shows confused subsections (e.g. which were wrong like sedimentation rates within “Diversity of surface waters” or vague like “Specificities of green water alkaline lakes”). All subsection titles in the discussion section might be removed or fully revised. Authors should take care with the expressions“significant” or “significance”, as they have not already addressed any statistics with their dataset.

We agree and decided to remove all subsection titles. “Significance” and “significant” were changed for “importance” and “important”.

- Also, speculative discussion on aerobic production of methane should be better addressed or removed (page 9, lines 23-31). The aquatic primary producers produce a very labile OC substrates to methanogenesis and their blooms could favor anaerobic production in the sediment, which is not necessarily oxic as waters. Indeed, few millimeters within the sediment might be enough to get anaerobic mineralization sites (see Sobek et al, 2009, Limn. & Oceanog.). Your study design does not allow interpretation on aerobic methane production in these shallow lakes.

We agree, this speculative discussion was removed from the manuscript. See also reply to other referees.

- Other unnecessary speculative discussion is the role of CH4 microbubbles to the total outgassing (page 10, lines 18-21). Authors should compare dissolved CH4 in surface waters with that evasion rates from chambers. They have a clear study design to confirm the role of bobbles on CH4 evasion to the atmosphere, which is not properly considered. Finally, authors should cite references to their comparisons (page 10, lines 21-22). In relation to air-water CO2 fluxes, auhors should discuss your results with the global review for alkaline lakes from Duarte et al. (2008, J. OF GEOPHYSICAL RESEARCH)

We agree. In the new manuscript, we focused on the differences between lake V and G (both with strong bloom development) to highlight that CH4 behaves quite differently on these two lakes. In particular, we introduced the calculation of the CH4-K600 that shifted from about 1.3 to above 4 when O2-bubbling started. In the discussion, our data are compared with the results obtained by Duarte et al. (2008). See below:

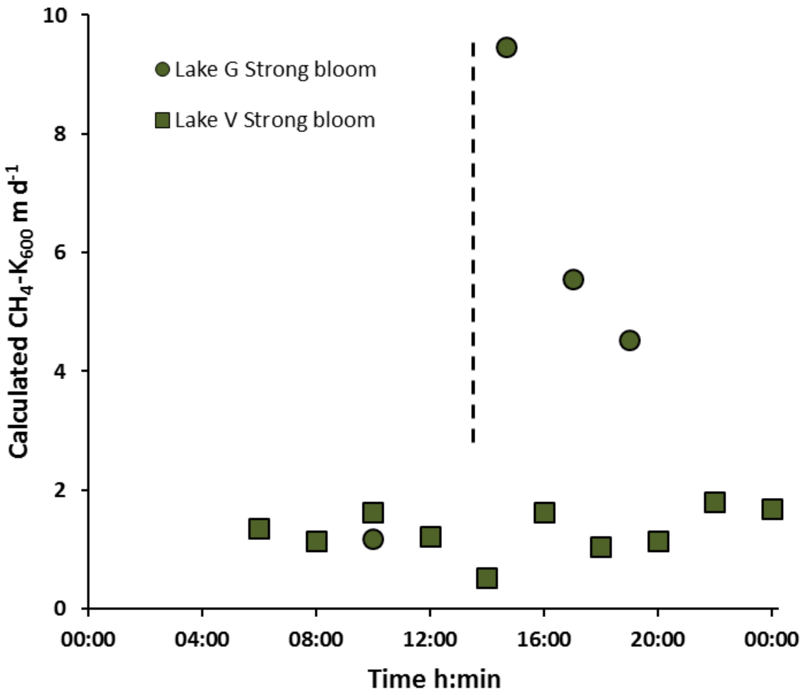

Figure 6: Calculated exchange gas coefficient for Methane in lakes V and G in strong bloom condition. The dashed line represents the beginning of the ebullition in lake G (13:20).

Discussion section:

“The consistent change in the calculated K_{600} values (Fig. 6), which coincided with the occurrence of the abrupt generalized ebullition of lake G, emphasize that CH_4 behave quite differently in these 2 lakes.”

And also:

“A rough estimate makes it possible to evaluate the consequences on annual emissions. For black-water alkaline lakes, emission estimates are of the order of 790 mmol m^{-2} y^{-1} and 73 mmol m^{-2} y^{-1}

for CO_2 and CH_4, respectively. In agreement with the observations of Duarte et al. (2008) from global review for saline lakes, black-water alkaline lakes of Nhecolândia are closer to a group of saline lakes with pH below 9, which are generally stronger sources of CO_2 to the atmosphere. However, in our case their contribution appears much lower than the mean value calculated by these authors (2.16 against 81-105 mmol m^{-2} d^{-1}).
By contrast, green-water lakes behave similarly to saline alkaline lakes with pH greater than 9, which are more productive and consequently have lower CO_2 partial pressure, and are commonly weak CO_2 sinks. For these green-water saline lakes, it appears necessary to consider several situations throughout the year. On the basis of the fluxes measured outside the bloom period, the annual CH_4 flux estimate revolves around 285 mmol m^{-2} y^{-1}. This value is slightly lower, but of the same order of magnitude (about 520 mmol m^{-2} y^{-1}) as that calculated by Bastviken et al. (2010). Based on 4 years of observation (2012-2015), a year can be divided into approximately 200 days without bloom throughout the rainy season, 100 days with moderate phytoplankton bloom during the dry season, and 65 days with a bloom magnitude sufficient for the O_2–supersaturation to be reached for 3 hours per day. Taking into consideration these seasonal variations, the methane flux estimate may reach 8,850 mmol m^{-2} y^{-1}. In the latter case, no-bloom, moderate-bloom and extreme-bloom conditions represent about 2 %, 5 %, and 93 % of the yearly CH_4 emissions, respectively. This estimate highlights the importance of O_2 microbubbles on the annual methane emission, a process not considered in conventional Fickian diffusion calculations (McGinnis et al., 2015), and suggests the need to better define during which periods of the year, under what weather conditions, with what bloom magnitude, the O_2 bubble point is exceeded. An estimate of the CO_2 consumption from green water lakes is about 1,140 mmol m^{-2} y^{-1}, distributed in 28 %, 10 %, and 62 % during no-, moderate- and extreme-bloom conditions, respectively. Similarly, it is of about 1976 µmol m^{-2} y^{-1} for N_2O, distributed in 18%, 44% and 38%.

- It is not clear how could authors interpret from their results the influence on early rainfall in this subsection of discussion. The ms show same lakes before and after the rainy season. Therefore, this discussion might be possible, but the authors do not explore their results.

Actually, it is not exactly the same conditions. When the bloom disappears, the lake evolves back in a situation similar to the "no-bloom" conditions, except the pH in the sediments that is lower of about 2 units. It is possible that the GHG fluxes are impacted by the drop in pH. We therefore mention at the end of the manuscript, in the section "future directions" that measures will have to be carried out specifically after the disappearance of the bloom.

- In order to better address the upscaling, authors should clarify the source of the number of days without and with moderate or intense phytoplankton blooms (e.g. do they have any own dataset or only visual impression from these lakes? Or other source?).

OK, it comes from our own observations. We have now mentioned in the ms: “Based on 4 years of observation (2012-2015), a year can be divided into approximately 200 days without bloom throughout the rainy season, 100 days with moderate phytoplankton bloom during the dry season, and 65 days with a bloom magnitude sufficient for the O_2–supersaturation to be reached for 3 hours per day.”

In addition, authors did not discuss any role of the observed daily variation on the upscaling.

The consequences of the observed daily variation are now in the discussion (see above “…and suggests the need to better define during which periods of the year, under what weather conditions, with what bloom magnitude, the O_2 bubble point is exceeded.”
Since upscaling is not really the topic of this article, but will be developed in the future, this aspect is also addressed in the conclusion of the manuscript. “The difference in gas fluxes among the type of lake implies that it will be necessary to resort to remote sensing tools capable of discriminating them, but also to monitor the development of the phytoplankton bloom throughout the season for

any perspective of a regional GHG contribution estimate from surface water to the atmosphere. Lakes with green and black waters are the most common among Nhecolândia's alkaline lakes, but there are also red- and crystalline-water alkaline lakes, not to mention a wide range of freshwater lakes for which few data are available. In any case, all these lakes cannot be treated as one or two functional types."

MINOR COMMENTS

- Authors should revise the confusion related to the term "algae blooms", as other primary producer considered important (cyanobacteria) is not algae. A better term might be phytoplankton bloom. They should revise this term over the whole text.

It has been changed to "Phytoplankton bloom" throughout the ms.

- References are lacking in the analytical methods (e.g. page 5, section 2.2.2), and a fully revision is still needed for each method.

There was indeed a lack of reference to biomass measurements by fluorescence. However, this measure giving little information, since it was most of the time over-range, was removed from the manuscript as suggested by other referees.

- Authors should include a point after the term "wetland" in the page 9 (line 11).

OK, done.

- The sentence "Consistent with Martins (2012). (...) throughout the season" (page 9, lines 7-8) should be rephrased to anything like "Our results confirmed previous evidences on the different functioning of black and green water alkaline lakes (Martins, 2012), ... "

It has been rephrased as suggested.

- What season do you mean in this complement "despite a very close mineral chemistry throughout the season" (page 9, line 8)?

Actually, it was throughout the seasons. Changed to "… despite a very similar mineral chemistry throughout the seasons."

- Page 10 (line 12): "strong sunshine" or "high incidence of solar radiation"?

OK, it has been changed

- The terms "fast or quick calculations" over the text should be replaced to anything like "rough estimates" (e.g. page 11, lines 5 or 14-15).

OK, Changed, see above reply.

- Authors should clarify that this ms assessed the variability over time and not spatially within the lake. They might complement the sentence "within the lake" to "within the lake over the daily cycle and year seasons".

OK it has been included.

- It's vague the sentence "...to estimate GHG emissions" (page 11, lines 20-21). What do authors mean? A regional or a global context? The GHG emissions of one of the freshwater wetland of the world? In addition, this conclusion without any argument seems speculative.

We mentioned "to estimate lakes annual GHG emissions"

- Figure 1: Images need scale and source.

Scale and sources have been incorporated. See below at the bottom of Fig. 1

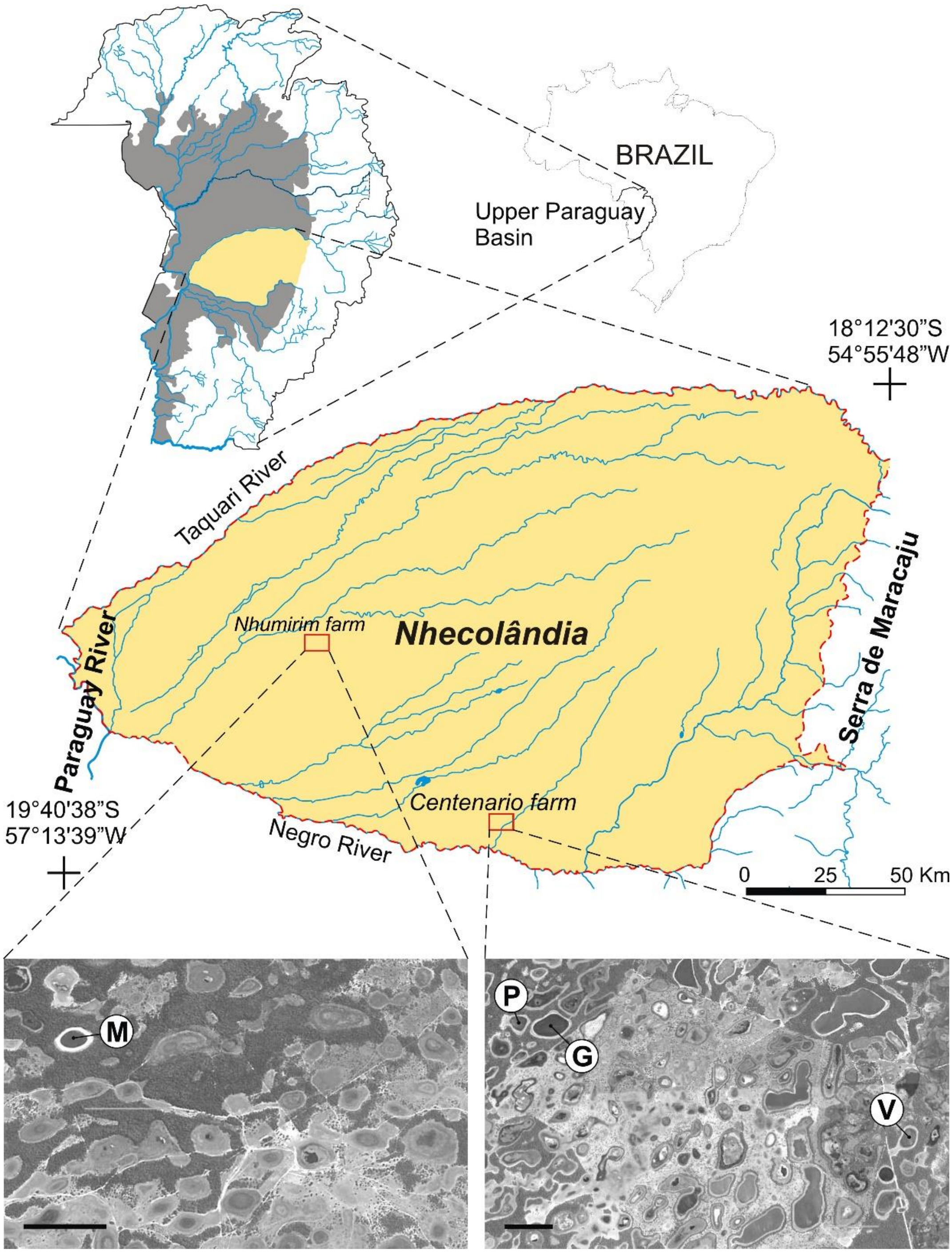

Figure 1: Location of the Pantanal wetland, Nhecolândia region, Nhumirím and Centenario farms and studied lakes. Satellite images are from Google Earth^{TM} (bar = 1 km).

- Figure 4: What exactly means filled and dashes lines or the arrow? This kind of description should be also in the legend.

The content in caption has been updated. See below:

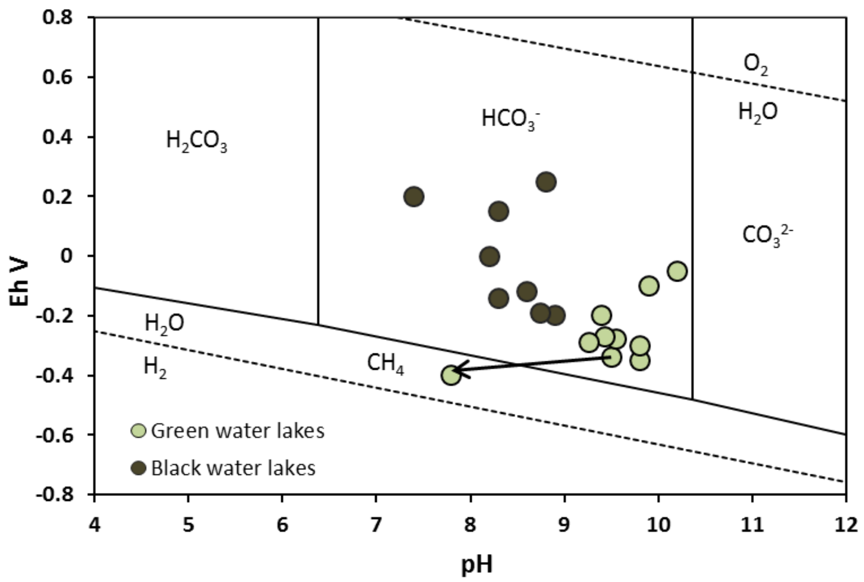

Figure 3: Oxidation – reduction potential and pH conditions in lake sediments. Note the drop in the pH value (arrow) occurring from September 10 to 11, 2015, in lake G after rainfall and disappearance of the cyanobacterial bloom.

- Figures 6 and 7: Air-water fluxes and dissolved concentrations of a given gas should be in a same figure with two panels

We agree. Figures have been grouped into a single one with two panels. See below:

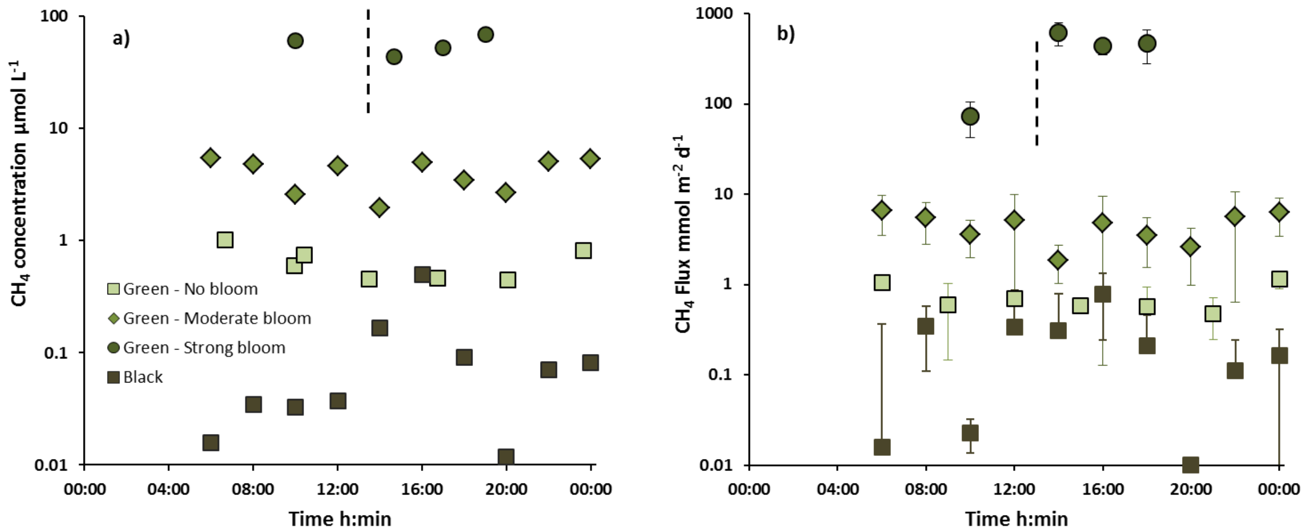

Figure 5: (a) Dissolved methane concentrations at the top of the water column, (b) and methane fluxes over 24 hours monitoring in black water lake (lake P) and green water lakes for no- (lake M), moderate- (lake V) and strong- (lake G) bloom conditions. Due to the logarithmic scale used, some negative values of the error bars (denoting standard deviations) are not drawn. The dashed line represents the beginning of the ebullition in lake G (13:20).

- Figure 9: I did not understand why both CO2 and CH4 of the lake P is separated in another figure? Authors should organize all data in a same way among figures.

We agree. Black and green water lake results have been drawn on the same figure, see for example for CO2:

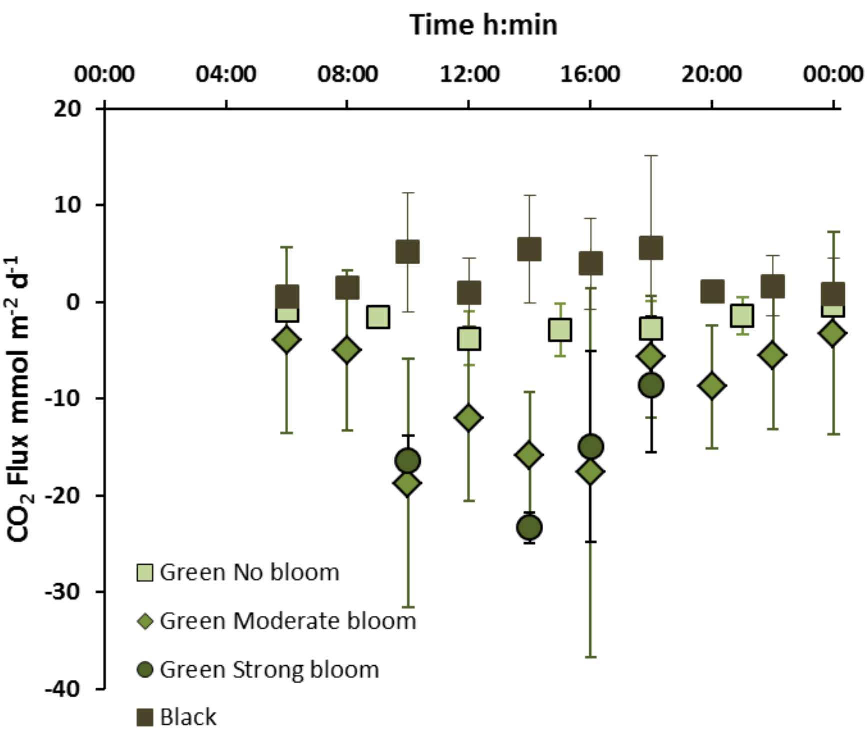

Figure 7: Daily cycle of carbon dioxide fluxes showing emission from black water lake (P), and increasing consumption with increasing magnitude of the cyanobacterial bloom in green water lakes for no- (lake M), moderate- (lake V) and strong (lake G) bloom conditions.