

**Response letter to anonymous referee #2 (C8165–C8167, received and published: 22 January 2014) on Biogeosciences Discuss., 10, 19485-19508, 2013**

**Referee's Comments:**

This paper reports original data of methane and N<sub>2</sub>O sources and emissions from a subtropical reservoir. GHG emission from lakes and reservoirs is an important topic and more data need to be produced, especially in the subtropical systems where there is a lack of data. However, I believe the authors were unable to translate the message they want to convey considering the database they have. There is a gap in both spatial and temporal scales and the manuscript could be improved considering the collection of more data. Additional information is needed regarding methods section, especially about the chamber measurement, the k value and the wind speed measurements. I cannot recommend the publication of the paper in the form it is presented. See below some specific comments.

**Specific Comments:**

Materials and methods - There is a gap in this manuscript related to the spatial and temporal variability of CH<sub>4</sub> and N<sub>2</sub>O production and emission. The results are based only in two stations and five days of measurements in one single month. I don't agree that it is enough for a subtropical system with 19 ha. Moreover, the authors used anchored surface floating chambers to capture methane emission by bubble and diffusion over 5 consecutive days sampling every 24 hours. After many hours the air inside the chamber can be oversaturated, reducing the real flux. What did the authors do to avoid the oversaturation inside the chamber? The authors also need to discuss the implication of the turbulence created by an anchored chamber, which can disturb the real flux. I also recommend the authors to avoid using "GHG source and emission", since they did not measure CO<sub>2</sub>.

**Response:** The aim of the presented manuscript was to better understand CH<sub>4</sub> and N<sub>2</sub>O production and consumption (in sediments and water column) and emission rates at two sites (one deep and one shallow). We therefore conducted a comprehensive study where we measured total water-air and sediment-water fluxes, as well as CH<sub>4</sub> and N<sub>2</sub>O concentrations in water column and pore water. To gain further insights into CH<sub>4</sub> and N<sub>2</sub>O production or consumption processes, sediment-water flux incubations were also conducted. The focus of this study was not on spatial variability in emissions as we acknowledge estimating whole storage fluxes is heavily reliant on adequately understanding the ebullition area and rate. However, we

are thankful that both referees expressed their concern in regard to the representativeness of the data set in terms of spatial and temporal variability. To address the referee's concerns over spatial variability across the whole storage we conducted an additional study in February 2014. The new study examined the spatial variability of total and diffusive water-air fluxes and gives therefore insights into the representativeness of the comprehensive study results. In particular the new study shows if the CH<sub>4</sub> and N<sub>2</sub>O emission data from the comprehensive study agree or differ from other deep and shallow sampling sites of the dam. Surface floating chambers were deployed in this spatial emission study at four deep and four shallow sites distributed over the whole reservoir (Section 2.2.1 and Fig. 1). The results are presented and discussed in the updated manuscript (Section 3.2, Section 4.2 and Fig. 6).

The surface floating chambers were lifted out of the water and flushed with air after each sampling every 24 hours, the 24 hour incubation was repeated on 5 consecutive days. The chambers were not left on the surface water for 5 consecutive days. A more detailed description of the sampling is added to the updated manuscript (Section 2.2.1). We measured flux rates which were linear up to 48 hours (data not presented) showing that sampling every 24 hours will not reduce the real flux by oversaturation.

The anchor system of the chambers is now also described in more detail in the updated manuscript (Section 2.2.1). To limit ebullition and reduce turbulences within the chambers, an anchor system was used at two opposite sides of the chamber. Both chamber sides were connected by ropes to a sub-surface floating buoy which was again connected by ropes to an anchor on the reservoir ground. For all sampling periods chambers were approached by very low speed with the boat to limit external disturbances.

The use of the expression "GHG source and emission" is avoided throughout the updated manuscript.

Flux measurements – how do the authors estimate the k values? Reference is missing here. Moreover, how was the wind measured? The authors should present the wind data or at least mention if the wind was constant during five days.

**Response:** The piston velocity k was estimated using the model of Wanninkhof (1992). Detailed information and references are now added to the updated manuscript (Section 2.2.1). Further, we describe how the wind was measured in the updated manuscript (Section 2.2.1) and present the wind speed data in the updated Supplement Material (Supplement, Figs. S2 and S3).

How did the authors get the reservoirs storage curve?

**Response:** Depth specific surface areas were used to generate a storage capacity curve using the Cone Formula (Duggal and Soni, 1996). Detailed information of how we generated the reservoir's storage curve is now added in the Supplement Material (Supplement, Text with Fig. S1).

Statistical Analyses – The authors use one-way analysis of variances (ANOVAS) to evaluate differences between sampling sites and sampling days. One of the assumptions of this analysis is that samples are independent which is the case.

**Response:** Thank you for the comment.

Results - Are CH<sub>4</sub> results shown in mg CH<sub>4</sub> m<sup>-2</sup> d<sup>-1</sup> or mg C-CH<sub>4</sub> m<sup>-2</sup> d<sup>-1</sup>? What about the N<sub>2</sub>O units? Moreover, fluxes are in mg m<sup>-2</sup> d<sup>-1</sup> while the concentrations are in nmol L<sup>-1</sup>. I recommend using the same unit throughout the text. What was the relationship between the wind speed and the CH<sub>4</sub> diffusive emission? Can the wind speed explain the lower contribution of CH<sub>4</sub> diffusive emission?

**Response:** The flux rates are now presented in mg CH<sub>4</sub> m<sup>-2</sup> d<sup>-1</sup> for the CH<sub>4</sub> results and mg N<sub>2</sub>O m<sup>-2</sup> d<sup>-1</sup> for the N<sub>2</sub>O results. Moreover, flux results as well as concentration results are presented as suggested in the same unit throughout the whole text and figures of the updated manuscript.

The wind speed is highly unlikely to explain the lower contribution of the diffusive methane emission in regard to the total methane emissions. The average wind speed over the 5 consecutive measurement days was  $1.6 \pm 1.4 \text{ m s}^{-1}$  which is comparable to the 30 year average ( $1.75 \text{ m s}^{-1}$ ) for the nearest BOM weather station at Mount Glorious (Bureau of Meteorology, 2013). The required piston velocity to generate the observed total methane emissions without accounting for ebullition need average wind speed to be at least double the observed average.

Discussion - The discussion is incomplete and some data reported in the results section are not in the discussion. For example the variation in nitrite and nitrate over the sediment incubation time. The discussion about the findings of Green et al. 2012 is unnecessary.

**Response:** Data that was reported in the results section of the manuscript (e.g. nitrite and nitrate variations of sediment incubation) is now discussed in the updated manuscript

(Section 4.1.3). The discussion about the findings of Green et al. 2012 is in its original form removed and a new paragraph using this reference is inserted in the discussion of the updated manuscript (Section 4.1.3).

**Minor corrections:**

Abstract - Page 1 Line 7 – The reservoir was a net source since waters were supersaturated with CH<sub>4</sub> and N<sub>2</sub>O – Please, avoid the word “net” and consider to say that the reservoir was a source.

**Response:** The word “net” is now avoided and the reservoir is described as a source in the updated manuscript (Abstract).

Page 19494, lines 18-24 – Please considerer to rewrite the sentence in order to make it clearer.

**Response:** The sentence is now rewritten in the updated manuscript to make the content clearer (Section 3.1.2).

Page 19495, line 7 and 15-17 – how did the authors test the differences between reservoir layers? It is not in the methods section. If one-way ANOVA was used, check if the sample can be considered as independent samples.

**Response:** The differences between reservoir layers were tested with one-way ANOVA's and the missing test description is now added in the method section of the updated manuscript (Section 2.4). Values were generally log transformed where necessary to ensure normality of distribution and homogeneity of variance (Levene's test).

Page 19495, line 25 – It seems to be a mistake, but in the text the authors mentioned that zero oxygen concentration was found after 48 hours. In the figure 5a after 48 hours the oxygen is still higher than 75  $\mu\text{mol L}^{-1}$  and the concentration was zero after 100 hours. Is the text wrong?

**Response:** The text is correct. This was a mistake in Fig. 5A. The figure is now corrected in the updated manuscript (Fig. 5A).

Page 19495, line 5 and 6 – “main contributor” is written twice. Please, check it.

**Response:** The referee's comment refers to page 19496. “Main contributor” is now deleted once in the updated manuscript (Section 4.1.1).

Page 19495, line 9 – A period is missing. On table 1 the authors present the range of methane emission rates from different reservoirs, but the unit is  $\text{mg CO}_2 \text{ m}^{-2} \text{ d}^{-2}$ . Should the unit be  $\text{mg CO}_2 \text{ eq m}^{-2} \text{ d}^{-1}$ ?

**Response:** The referee's comment refers to page 19496. The period was omitted and is now inserted in the updated manuscript (Section 4.1.1). The unit of Table 1 was wrong and is now corrected to  $\text{mg CO}_2 \text{ eq m}^{-2} \text{ d}^{-1}$  (now Table 2).

Reference - Please check the reference section - the references Beutel et al. 2008 and Mendonça et al. 2012 used here are not cited in the text.

**Response:** The reference Beutel et al. 2008 is mentioned in the text (Section 4.1.2). The reference Mendonça et al. 2012 is not used and is now deleted from the references in the updated manuscript (References).