

We would like to thank the Referee #1 for his/her comments. Bellow, bold paragraphs are our response (AR).

While the manuscript has great potential in regards to the science that is presented, major revisions in terms of manuscript presentation need to occur. I understand that English may not be the first language of the authors, however, editing for writing, grammar, spelling, and structure is needed. I addressed many of these writing/grammar issues within my specific comments – but stopped commenting on them in the discussion (for the most part).

AR: As suggested by the Dr. Tom J. Battin, we took advantage of an editing service (last page of this document). The editing service also suggested small changes in the title that could be considered to the final version (The effects of river inflow and retention time on the spatial heterogeneity of chlorophyll and water-air CO₂ fluxes in a tropical hydropower reservoir). All the specific comments are addressed bellow.

Specific Comments

Page 3, Line 4: Re-cast sentence, perhaps ‘In tropical regions, high temperatures and the flooding of forests intensify GHG emissions.’

AR: Done. “In tropical regions, high temperatures and forest flooding has intensified GHG emissions”

Page 3, Line 10: Clarify sentence. I’m assuming the authors are referring to different regions of the reservoir could impact CO₂ dynamics because of flooded biomass, river input of organic matter, primary production and dam operations. The word ‘system’ is vague. I suggest re-casting sentence to make the point clearer.

AR: Sentence clarified as suggested. “Different regions of the reservoir may have different CO₂ dynamics because of flooded biomass, river input of organic matter, primary production and dam operations.”

Page 3, Line 12: I suggest re-casting this last sentence. I understand the point the author’s are attempting to make, but I find this sentence to be very vague and not convey very much information. Make the sentence more active and concise. Heterotrophic and autotrophic activity drives reservoir CO₂ concentrations in subtropical, tropical, and temperate regions.

AR: We rewrote the sentence. “Furthermore, both heterotrophic and autotrophic activities influence the CO₂ concentrations along reservoirs located in subtropical (Di Siervi et al., 1995), tropical (Roland et al., 2010; Kemenes et al., 2011) and temperate areas (Richardot et al., 2000; Lauster et al., 2006; Finlay et al., 2009; Halbedel and Koschorreck, 2013).”

Page 3, Line 18: 'habitat conditions linked to' not needed

AR: Removed

Page 3, Line 19: Re-cast sentence. Also, hydrodynamic factors, such as retention time and river inflow, may influence the phytoplankton communities and growth.

AR: We rewrote the sentence. "Additionally, hydrodynamics factors, such as retention time and river inflow, may influence the phytoplankton communities and their growth."

Page 3, Line 22: 'budget' should be 'budgets'

AR: Changed.

Page 3, Line 23: should be either 'tropical hydropower reservoirs' or 'a tropical hydropower reservoir'

AR: We changed to "on tropical hydropower reservoirs is still unclear"

Page 3, Line 30: 'by river and the dynamic of river inflow' unclear, re-cast

AR: We changed to "The interactions of large nutrient loads injected by rivers and the dynamics of river inflow can determine the spatial heterogeneity of phytoplankton distribution"

Page 4, Line 2: '....strongly influenced by river.' River flow? Nutrients? Please clarify.

AR: We changed to "Consequently, the river inflow may affect primary production along a river/dam axis in hydropower reservoirs that are strongly influenced by rivers with high nutrient levels."

Page 4, line 6: 'respective impact'. Unclear. Is 'respective' needed here?

AR: Removed the word as suggested.

Page 4, line 8: 'in' should be 'on'

AR: Changed

Page 4, line 12: 'cycle' should be 'cycling'

AR: Changed

Page 4, line 29: 'the' before sewage

AR: Added.

Page 5, line 3: 'affected' should be 'effected'

AR: Changed.

Page 5, line 9 - Please combine/re-write this paragraph and the one directly following. Within these two paragraphs, the authors describe methods for collecting pCO₂ and chl samples. The first sentence of the 2nd paragraph (Page 5, line 14) is not a proper topic sentence for this paragraph. Most of this paragraph describes pCO₂ methodology. Please re-cast accordingly.

AR: We combined the paragraphs as suggested.

“We considered 42 stations in the Funil Reservoir (28 were located along the main body of the reservoir, Fig. 1) for the spatial analyses. Water samples to determine Chl and pCO₂ were obtained between 9:00 and 12:00 Local Time (LT; UTC/GMT -3 hours) on March 1, 2012 (at the end of the rainy season, at high water levels) and on September 20, 2012 (at the end of the dry season, at low water levels). Samples were taken from the surface (0.3 m) on the same day to limit the effect of diurnal variations on the results. We measured Chl using a compact version of PHYTO-PAM (Heinz Walz GmbH, PHYTO-ED, Effelrich, Germany). The pCO₂ data were determined using a water-air equilibration method. In a marble-type equilibrator (Abril et al., 2014; Abril et al., 2006), the water was pumped directly from the lake and flowed from the top to the bottom (0.8 liters per min), whereas a constant volume of air (0.4 liters per min) flowed from the bottom to the top. The large gas exchange surface area promoted by contact with the marbles accelerated the pCO₂ water-air equilibrium. The air pump conducted the air from the top of the equilibrator through a drying tube containing a desiccant (Drierite), then to an infrared gas analyzer (IRGA, LI-840, LICOR, Lincoln, NE, USA) and back to the bottom of the equilibrator (closed air circuit, Abril et al., 2006). For each station, the lake water and air were pumped through the system for two minutes before the pCO₂ from the IRGA stabilized to a constant value.”

Page 5, line 9 – “the’, not needed – ‘ start sentence with ‘Water samples for chl and PCO₂ were taken’. ‘the determinations’ is not needed.

AR: Changed to “Water samples to determine Chl and pCO₂ were obtained”

Page 5, line 14 – delete ‘the’ before Chl

AR: Deleted

Page 5, line 16 - ..'the water pumped'... 'is' needed before pumped

AR: Added

Page 5, line 19 – conduct should be conducts

AR: Corrected

Page 6, line 7 – 'picks' should be 'peaks'

AR: Corrected

Page 6, line 14 – I suggest writing a topic sentence. A list of the data collected isn't an appropriate first sentence. Please check this throughout the manuscript – especially the methods section.

AR: We added a topic sentence in the paragraph.

Page 6, line 26 – similar to the comment above – this paragraph describes methods for pCO₂ calculations and collection and analyses of inorganic nutrients, yet the first paragraph is on calculation of pCO₂. Re-cast /re-write into two paragraphs

AR: We re-organized the paragraphs.

“Samples for alkalinity (ALK), total phosphorous (TP) and nitrogen (TN) analyses were taken monthly. The ALK was determined by the titration method (APHA, 2005). For the TP, the samples were oxidized by persulfate and were then analyzed as soluble reactive phosphorus. The TN was determined as the sum of the organic fraction measured with the Kjeldahl method and the dissolved inorganic nutrients. A laboratory analysis of the TP and NP was performed based on standard spectrophotometric techniques (Wetzel and Likens, 2010).

We calculated the pCO₂ from the surface water over one year near the dam using the measured pH and alkalinity. The calculations included the dependence on temperature for the dissociation constants of carbonic acid (Millero et al., 2002) and the solubility of CO₂. We used the hourly data of pH and temperature and the monthly data of alkalinity collected at station S28 (Fig. 1).”

Page 7, Line 19 – Equation 3 does not exist. Check equation numbering and references to all equations within the text, there seems to be an equation missing.

AR: We corrected the numbers.

Page 8, line 1 – SIMA da – I think should be SIMA data?

AR: We corrected.

Page 8, line 3 – ‘the’ before riverine

AR: We corrected.

Page 8, line 12 – delete ‘the’ before station; 2 meter should be 2 meters

AR: We corrected and used “m” instead of “meter(s)” throughout the text.

Page 8, line 17 – Sentence is awkward. ‘Measured turbidity was 29 and 11 NTU...’

AR: We changed to “The turbidity values of 29 and 11 NTU that were measured during the rainy and dry seasons”

Page 9, line 6 – condition should be conditions

AR: We corrected.

Page 9, line 8 – zone should be zones

AR: We corrected.

Page 9, line 9 – ‘considered data’ , please re-cast or clarify (data used?)

AR: We changed to “The simulations started 4 days before our study period.”

Page 10, line 6 – M*D11A1 L3? Please clarify what is this product or products (also check singular vs plural when referencing this product). Is this a data set? If so, please reference it as such. At this time, it is unclear within the text.

Similarly in the following paragraph regarding cloud cover, ‘product’ is actually generated data using these different algorithms, correct? Please clarify, re-cast as needed throughout the text.

AR: We agreed with this reviewers’ comment and changed the paragraph to:

“To complement river inflow temperature data collected in situ, we used the Moderate Resolution Imaging Spectroradiometer (MODIS, Justice et al. 2002) level 3 Land Surface Temperature (LST) product (named M*D11A1, see Wan 2008 for more details) to estimate the temporal variation of

temperature at the reservoir's inflow. The M*D11A1 is a standard remote sensing-based product, generated using a split-window algorithm and seven spectral MODIS bands located in the regions of the shortwave infrared and thermal infrared bands. This algorithm is based on the differential absorption of adjacent bands in the infrared region (Wan and Dozier, 1996). The M*D11A1 product have been validated at Stage 2 by a series of field campaigns conducted between 2000-2007 and over more locations and time periods during radiance-based validation studies. Accuracy is better than 1 °C (0.5 °C in most cases). This product is generated up to four times each day (i.e., 10:30 h, 13:30 h, 23:30 h and 2:30 h) and is delivered in a georeferenced grid with 1 km of spatial resolution in a sinusoidal projection by the National Aeronautics and Space Administration Land Processes Distributed Active Archive Center (NASA/LPDAAC)."

We also changed the following paragraph to:

"The cloud cover fraction over the Funil Reservoir was estimated using a MODIS Level 2 Cloud Mask product (named M*D35L2, see Ackerman et al., 1998 for more details). The algorithm used to generate the M*D35L2 product employs a series of visible and infrared threshold and consistency tests to specify confidence that an unobstructed view of the Earth's surface is observed. This product is generated up to four times each day (i.e., 10:30 h, 13:30 h, 23:30 h and 2:30 h) and is delivered in a georeferenced grid with 1 km of spatial resolution in a sinusoidal projection."

Page 10, line 27 – 'a MATLAB program' – seems vague. Clarify (i.e. is this a program the authors wrote? A known program?), what kind of calculations were used?

AR: We added more information in the paragraph:

"Finally, MATLAB® routines were used to calculate the river inflow temperature and cloud cover fraction time series. The river inflow temperature (°C) time series was computed using the preprocessed M*D11A1 data by extracting the temperature values from the pixel located within the Paraiba do Sul River channel near the Funil Reservoir entrance. The cloud cover fraction (dimensionless) time series was obtained using the preprocessed M*D35L2 data by computing the ratio between the cloudy pixels and the total pixels covering the reservoir surface."

Page 10, line 29 – This sentence should be included in the previous paragraph.

AR: We changed as suggested.

Page 11 – Likely more common to write the results section in the past tense. Please check and modify where needed.

AR: We checked the entire section and modified.

Page 11, line 8 – delete ‘the’ before primary production

AR: Deleted

Page 11, line 13 – I suggest changing ‘showed to be’ to ‘was’

AR: Changed as suggested.

Page 11, line 14 – change ‘The spatial data showed’ to ‘There was’ (spatial is assumed given this result is regarding spatial variation)

AR: Changed as suggested.

Page 11, line 16 – re-cast sentence – maybe ‘The average spatial pCO₂ was...’

AR: Changed to “The spatial average of pCO₂ during”.

Page 11, line 18 – ‘drastically’ should be ‘drastic’

AR: Corrected

Page 11, line 20 – ‘on’ should be ‘of’

AR: Corrected

Page 11, line 22 - ... and higher values of pCO₂... move to discussion

AR: This sentence was moved to the discussion as suggested.

Page 11, line 23 – ‘The chl’ should just be Chl Or Chl data

AR: Changed as suggested.

Page 12, line 1 – include a ‘the’ before spatial data

AR: Added.

Page 12, line 7 – ‘calculated by’ should be ‘calculated from’

AR: Corrected

Page 12, line 19 – re-cast sentence; ‘... we assumed the equations...’, I don’t think ‘assumed’ is the proper verb here, perhaps ‘used’. Also the sentence could be more concise.

AR: We changed the paragraph to:

“Because we sampled temperature on a sub-daily scale over the year, we used the equations proposed by MacIntyre et al. (2010) to calculate k_{600} , which also incorporates the turbulence from heat loss. The turbulence from heat loss, especially overnight, often exceeds that from wind mixing in tropical lakes that tend to have low wind. However, the estimates using Cole and Caraco (1998) formulations to calculate k_{600} did not significantly change our results (Table 1). Due to the large sample size of the temporal data (hourly data), significant differences were observed between the estimates, primarily in the dry-autumn when the surface temperature decreased after the warm-summer ($t = 1.96$, $p < 0.05$). The CO₂ flux over the year at the station near the dam varied from –104.7 to 175.88 mmol m⁻² d⁻¹. The average flux was -0.1 ± 39.8 mmol m⁻² d⁻¹ and median was -7.4 mmol m⁻² d⁻¹. We observed a substantial uptake of CO₂ between October and December (rainy-spring) (Table 1). From January to July, the lake lost substantial CO₂ via degassing (Table 1). The uptake of CO₂ from the atmosphere was also prevalent between July and September (dry-winter). A summary of all other data collected over the study period is shown in Table 2.”

Page 12, line 22 – ‘However,...’ – this sentence is unclear. What ‘estimates’ were compared? Also ‘changed’ should be ‘change’

AR: We changed the paragraph. Please, see last comment.

Page 12, line 24 – delete ‘of’ before flux

AR: Done

Page 12, line 28 – ‘studied’ should be ‘study’

AR: Corrected

Page 13, line 1 – This paragraph needs to be re-organized/re-written. Topic sentence? Also why are the authors presenting results from the spatial data set here, and not in the previous results section?

AR: We removed the spatial data results from this section and combine with the previous paragraph.

Page 13, line 7 – re-cast sentence, not a topic sentence and too long

AR: We rewrote the first part of the paragraph.

“We observed significant differences between the thermal structures during the rainy and dry season (Fig. 5). During the rainy season, thermal stratification only occurred in the transition zone during the daytime, at approximately 16:30 LT, when a maximum of 33.1 °C and a minimum of 27.8 °C was observed at the surface and bottom, respectively (Fig. 5a). In contrast, the temperature was vertically homogeneous at nighttime.”

Page 13, line 20 – ‘were’ should be ‘was’

AR: Corrected

Page 14 – ‘buoyance’ should be ‘buoyancy’ throughout the manuscript

AR: Corrected

Page 15, line 27 – The carbon budget discussion in this paragraph is over-reaching, especially given the lack of data on sedimentation rates and CO₂/CH₄ outgassing directly from sediments. Furthermore, the 2nd sentence (line 29, ‘Although there is...’) is unclear (i.e. ‘...composed by phytoplankton and methanogenesis...’ – I’m am unsure what the authors are attempting to convey).

AR: We clarified the second sentence. “Although there is no data to support this statement, we hypothesize that (i) the burial of organic carbon composed by phytoplankton and (ii) methanogenesis are important carbon pathways for the carbon fixed by the phytoplankton in the Funil Reservoir, as reported in natural eutrophic lakes (Downing et al., 2008).”

Page 16, line 4 – Yes, it is common for reservoir residence time to be driven by dam operations. However, given figure 4b – did the retention times by season differ significantly? The mean difference in retention time between wet and dry seasons was around 10 days? Is this a big enough difference to drive significant changes in CO₂? I believe I understand what the authors are trying to convey: Reservoir volume and retention time vary by season. Seasonal attributes such as river inflow and river plume location within the reservoir vary, which then drives chl and CO₂. I suggest downplaying retention time, and focus more on river plume dynamics.

AR: This is an excellent comment and we believe that the following sentences are sufficient to clarify and avoid major changes in the manuscript. We considered that the difference of 10 days is big enough to drive changes in CO₂ because the Funil Reservoir is relatively small and the average of retention time is only 32 days. This difference of residence time imply in a water level variation of approximately 10 m (average reservoir depth is 20.2 m, Figure 3). When we simulated the reservoir changing only the river inflow characteristics without changing the residence time (water level/volume), the transition zone remains almost at the same location (but with some different hydrodynamic characteristics) for the rainy and dry seasons. If the transition zone location does not

change, hypothetically, the high levels of CO₂ observed in the riverine zone will be restricted to a small part of the reservoir. We did not include these simulation data because we tried to focus in the reservoir carbon dynamics instead of model simulations.



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