

## ***Interactive comment on “River inflow and retention time affecting spatial heterogeneity of chlorophyll and water–air CO<sub>2</sub> fluxes in a tropical hydropower reservoir” by F. S. Pacheco et al.***

### **Anonymous Referee #1**

Received and published: 3 July 2014

#### General Comments

The manuscript entitled ‘River inflow and retention time affecting spatial heterogeneity of chlorophyll and water–air CO<sub>2</sub> fluxes in a tropical hydropower reservoir’ by Pacheco et al. focused on the interaction of primary production of a tropical reservoir and the potential for CO<sub>2</sub> efflux. The strong correlation between chlorophyll and pCO<sub>2</sub> was quite compelling. This particular finding that this reservoir can act as a sink for CO<sub>2</sub> given its high production, in part due to anthropogenic nutrients and seasonal effects was interesting and contrasts with how we often think of reservoirs as sources of CO<sub>2</sub>.

The authors also discuss the pros and cons of measuring CO<sub>2</sub> fluxes either spatially

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or temporally. I follow the authors' discussion line that reservoirs and lakes are heterogeneous in regards to potential CO<sub>2</sub> fluxes and this variability in CO<sub>2</sub> fluxes across a reservoir (and through time) in turn can make a BIG difference when budgeting C cycling for these systems. However, this discussion point needs more focus and needs to include why these systems vary spatially besides the seasonal shift of the inflow (see Maeck et al. 2013 ET & S – nice paper on 'hot-spots' of methane emission). Also, the research presented in this study is primarily focused on surface water. The driver behind why reservoirs are thought of as CO<sub>2</sub> sources is because of the high rates of sedimentation that can occur compared to natural lakes and rivers (not just the original organic matter when the reservoirs were new). The authors briefly discuss this concept, but I think more attention is needed here. I don't think the sediments can be completely ignored.

Furthermore, regardless of which data set used to calculate CO<sub>2</sub> fluxes, the error around the CO<sub>2</sub> fluxes was quite high. I think caution is needed here in regards to the conclusions given the high variability of the estimates. In a statistical framework, the flux measurements do not significantly vary between the 2 methods or by season (Figure 4). The lack of significance weakens the authors' argument of where and when samples taken determined whether this particular reservoir was a source or a sink for CO<sub>2</sub>. I think this discussion point needs more clarity in light of the data presented here.

Reaeration calculation – The equation (equation 2) to convert from K600 to K is incorrect. This incorrect equation is very worrisome in regards to the CO<sub>2</sub> efflux calculations. Also if the lake is stratified, why not take that into account when calculating reaeration (k)? Please see my specific comments below in regards to estimation of k.

Grammar – verb tenses and articles need to be checked throughout the manuscript. I understand the perhaps English is not the authors' first language, but I think another round of editing would be beneficial. See my specific comments below. I made indications of where I found grammatical errors, however I did not thoroughly check the entire manuscript, especially towards the end.

## Specific Comments

8533, Line 6 – ...'we investigate..' – should be investigated

8533, line 16 – '...fluxes was...' should be 'fluxes were...'

8533, line 17 – 'considering data..' re-cast, sentence is awkward. The average calculated CO<sub>2</sub> fluxes were x based on temporal data near the dam versus x using the spatial data collected throughout the reservoir.

8533, line 20 – '...change completely the role...' perhaps re-cast. Be more specific – the take home message is that using temporal vs spatial data to calculate CO<sub>2</sub> fluxes results in the reservoir acting as a sink or a source of CO<sub>2</sub> (which can have implications towards regional and global C budgets).

8535, line 4 – change investigate to investigated

8535, line 5 – 'old and stratified' to 'old, stratified'

8535, line 13 – change factor to factors

8535, line 14 – change conclusion to conclusions, also 'regarding carbon cycle in reservoir' - 'regarding carbon cycling in Funil Reservoir' or reservoirs or this reservoir.

8525, line 20 – m a.s.l. – I'm not familiar with these units.

8525, line 21 – Cwa? Koppen system? Please clarify.

8535, line 17 – LT? Time zone designation?

8538, line 15 – '...the samples was..' should be 'were'

8529, equation 2 - This equation is not correct. The correct equation to calculate  $k_{CO_2}$  from  $k_{600}$  is:  $k_{CO_2} = k_{600}(S_c/600)^{-0.5}$

$k_{600}$  is the  $k$  for a Schmidt number ( $S_c$ ) of 600 at a given temperature (not necessarily at 20C, as incorrectly stated in line 2 on the same page – please correct/clarify).

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What  $k$  was used?  $K$  at 20C or  $k$  at temperature? Given the description of equation 3, I am assuming at temperature and not at 20C. Please clarify.  $K$  at temperature should have been used to calculate CO<sub>2</sub> fluxes.

Units? Line 1, same page –  $k$  units are described for equation 1. However, to be consistent, please clarify all units of each component of the all equations throughout the manuscript (especially in regards to  $k$  – since  $k$  can be described as a velocity (units of distance time<sup>-1</sup>) or a coefficient (units of time<sup>-1</sup>)).

This error in reporting equation 2 is worrisome. Is the incorrect equation 2 a typo or were the  $k$  values miscalculated throughout the manuscript? What about units?

Also, regarding the calculation of  $k_{600}$  from Cole & Caraco 1998, did the authors consider using other equations for  $k_{600}$  which may account for the stratification of the reservoir? The reservoir was stratified at the time of sampling. Why was that not taken into consideration for calculating reaeration? Given previous literature on reservoirs & impoundments on CO<sub>2</sub> outgassing, sedimentation is often a high source of CO<sub>2</sub> (and other green house gases). I wonder if not taking into account the stratification of the lake, a component is missing in regards to scaling up CO<sub>2</sub> fluxes. Such equations are described in Staehr et al. 2012 Limnology & Oceanography (57(2), pages 1317-1330)).

8539, line 16 – please include the equation and units used to calculate  $k_{600}$  for the riverine zone.

8540, line 6 – Re-cast sentence into two separate sentences.

8540, line 14 – delete floating ‘)’ after 1991

8540, line 26 – I don’t quite follow what is meant by ‘numerical domain’. I follow that some measure of continuous data or transect was converted to discrete subsets, but what exactly – I don’t follow. Please clarify.

8541, Paragraph starting on line 7 – Within this paragraph, the authors describe 2 sub-models that were ‘activated’. Re-cast this section to clarify the role of these sub-

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models.

8542, line 20 – ‘... and median of’... Instead ‘of’ should be ‘was’.

8542, line 22 – re-cast to present the results in chronological order. January to July first, then July to September – it perhaps would be easier to follow.

8544, line 6 - ..water temperature were... should be ‘was’.

8544, line 18 – seasons are – should be seasons were comparable

8545, line 17 - ...associated to the high Chl... should be ...associated with high Chl... .

8545, line 18 – pCO<sub>2</sub> was negatively correlated with Chl... In an old.. or In old hydropower reservoirs... .

8545, line 23 – perhaps this is better: in the transition and lacustrine zones of the Funil Reservoir... .

8545, line 24 – in the riverine... .

8546, line 4 – re-cast sentence, awkward, not concise. I would break this point into more than one sentence.

8546, line 9 – probably ‘measured’ or ‘observed’ would be more appropriate than ‘we found net uptake...’

8546, line 15 – mineralization – of what to what? Transformation? Please clarify. Also include a ‘the’ before carbon.

8546, line 18 – The outflow exported

8546, line 28 – observed

8547, line 1 – sentence beginning with ‘Therefore’ – recast, I am unsure what the authors are trying to convey.

8547, line 5 – insert a ‘the’ before transition zone and this not a full sentence – re-cast

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(I think the authors meant ‘The position of the transition zone of the reservoir moves as a result of the season).

8647, line 7 – restricted

8647, line 8 – recast ‘Differently’, a bit awkward – perhaps ‘Contrarily’

8647, line 15 – insert ‘a’ before density gradient

8647, line 21 – replace ‘a’ with ‘the’ before lighter reservoir water

8647, line 26 – here Chlorophyll a is specifically mentioned. Throughout the manuscript, Chl was used, which I understand was a combination of several chlorophyll pigments. Please be consistent throughout.

8548, line 7 – perhaps recast. The conditions are not right when the surface water is dominated by riverine water. It isn’t until the conditions are more ‘lake’ – like that the conditions are optimal for phytoplankton to bloom.

8548, line 10 – sentence beginning with ...‘The results...’ Please re-cast sentence. Awkward and difficult to discern what the authors are attempting to convey. Also, the sentence following this particular sentence needs to be clarified. I am unsure what is meant by ‘The daily scale variation...’?

Also, quite a few articles are missing throughout the manuscript (I mention this here because in within this paragraph alone – several instances occur). I’ve attempted to correct some of these... but the entire manuscript should be checked. For example – the sentence beginning on line 19, 8548 – there are 4 articles missing: the transition zone, a result, the dry season, and the inflow.

8549, line 3 – reservoirs

8549, line 27+ – spatial heterogeneity discussion? Re-cast/clarify. There are quite a few areas within this entire paragraph that should be re-written. The writing is unclear and too colloquial.

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Interactive comment on Biogeosciences Discuss., 11, 8531, 2014.

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