Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2019-53-RC2, 2019

Biogeosciences Discussions
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EGU

Interactive comment on "The influence of reservoir traits on carbon dioxide emissions in the Belo Monte hydropower complex, Xingu River, Amazon – Brazil" *by* Kleiton R. Araújo et al.

Anonymous Referee #2

Received and published: 17 April 2019

Review of Araujo et al. This manuscript describes the results from a 2-yr study during high and low water seasons on the Belo Monte hydropower complex that consists of two main reservoirs, one of which is defined as a run-of-river and the other as storage. The authors aimed to contrast the impact of these two reservoir types on the CO2 dynamics of the entire complex. Additionally, they contrasted CO2 dynamics across various flooded environments within the complex. The manuscript has some nice data but is predominantly descriptive. Regardless, data in tropical reservoirs is currently necessary and it is interesting to contrast these two types of system. Not to mention the huge dispute over this massive Amazonian project. I have many suggestions for how to improve this manuscript before this paper is ready for publication.

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General comments

1. Be careful with the word ‘traits’ in the title. It implies features that do not vary in time. Is that the focus here? Do you mean ROR vs storage, plus flooded landscapes? That would be okay then. But if that was the case then I did not get the impression enough from your discussion that that was your focus. You need to bring out your main points much more. Try focusing the research questions or objectives more narrowly. This will help you throughout the entire publication.

2. Language overall needs improvement. Too many commas used. Too many sentences that are confusing (many are mentioned in specific comments below).

3. Abstract needs more quantitative results in it

4. Introduction does not discuss the importance of this particular reservoir more.

5. Methods – description of how reservoirs are connected is not clear. In the map figure there appears to be a channel connecting them too. Please improve the description of how the reservoirs interact, including flow directions, which should be on your Figure 2, and individual surface areas.

6. I find section 3.1 of the results very confusing to read and absorb fully. There are a lot of numbers that are perhaps not necessary and very distracting from understanding what you are trying to describe. I would suggest a schematic to help describe the temporal (high vs low water) variability you see that also includes the spatial variability (across environments). You can use weighted markers for the various fluxes and concentrations that correspond to high and low values, if not the real values.

7. Figure 2 – needs arrows for direction of flow.

8. Figure 3 – You can make these 4 plots into just 2 in the following manner: put the white boxplots from (a) and (b) that are pCO2 in the beginning of (c) labeleded ‘High water’ and ‘Low water’, and the gray boxplots that are for FCO2 in the beginning of (d) with the same labels. Also, are the environments in c and d labeled in the proper

order – from one are to another? Or does it not work like that because of the reservoir geomorphology? Either way, I would put downstream the dams on the right side since most people read left to right and you naturally think downstream to the right.

9. Figure 4 – you need units listed for the values; direction of flow arrows would be good; and mention in caption that (a) includes 2 years of data while (b) only has one year (and list which years).

10. Figure 5 – you mention these figures in terms of stats but there are no lines on it and no equations or states in the figure caption.

11. The discussion seems like a bunch of descriptive paragraphs thrown together. It is lacking some cohesive red line to follow and it is hard to locate your main points. Perhaps you can start to fix this by using subsections. Looks like you broke it down into the following: Seasonal variability; Vertical heterogeneity; FCO2; Spatial variability; Comparison to other reservoirs; k600; Operation. These are all just descriptions of data in reality. You want to discuss the most interesting findings of your study and then compare them with other studies. Figure out your few most important findings and try to arrange the discussion around those first. You also measured the system right after flooding, which is when emissions should be highest. This needs to be addressed in your conclusions.

Specific comments

Line 16-17 – did you measure clearwater rivers yourself ? if not, then either change or delete this sentence because it makes it sound like you.

Line 41 – You mention that 'inland waters' have an area of '624,000 km2' and cite who with regards to this number? This number is very small compared to the 2.5 – 5 million km2 range that actually exists for all inland waters surface area coverage. I think you mean to cite only rivers surface area with your 0.624 million km2 value so you need to be specific when you say 'inland waters' and you need a specific reference for this

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river surface area number. But then you cite the 1.8 – 3.8 Pg values, presumably from Drake et al. 2018 and those values are for all inland waters specifically. If you want to discuss inland waters surface area coverage total then you need to use either Downing et al. 2006, Verpoorter et al. 2014 or Messager et al. 2016 or Feng et al. 2016.

Line 45 – clean up language (e.g., don't need 'water' so many times)

Line 50 – should be: 'to the autochthonous respiration of OM deposited'

Line 54 – should explain more how the stimulation of OM decomposition via those two processes actually effects CO2 – similar to how you did in the first half of the sentence saying higher CO2 uptake

Line 66 – I believe it was actually DelSontro et al. 2010 and not 2016

Line 69-70 – Start a new sentence with 'Newly flooded reservoirs..' and then give examples/references of the few poorly studied reservoirs.

Line 73 – should be 'variability' and not 'variation

Line 73 – give the abbreviation for fluxes here '(FCO2)' that you will use the rest of the paper, and delete 'and its relevance for GHG fluxes'

Line 75 – end this sentence with '..complex in eastern Amazon, a tropical region poised to gain XXX more hydropower projects in the coming decades (REF).' This puts your work into a bigger perspective at the end of your intro

Line 83 – the 1984 study is quite old.... Is there nothing newer?

Line 98-100 – in this sentence give the names of the two reservoirs after you mention them.

Line 101 – give more details about these calculates from Faria et al. 2015

Line 104 – once you have given the XR abbreviation for Xingu Reservoir then use it for the rest of the paper, and do you mean 'as islands' instead of 'in islands'?

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Line 107 – ‘classified’ instead of ‘denominated’ – and this paragraph should contain the surface area of these reservoirs already

Line 115 – the residence time of the IR reservoir is still ridiculously short (1.57 days). How do you call that a storage reservoir? Still want to know the surface area of these reservoirs already

Line 116 – should give maximum depths of the reservoirs

Line 117 – why did you give the total surface area of the 2 reservoirs together? You should provide values for the two different reservoirs. If this is difficult because of the difference between rainy and dry season then state this but still give approximate values for the individual reservoirs since you are evaluating them separately.

Line 121 – what is the 25.4 km2/MW? Why should I care about this value? Give some explanation behind your reporting of this value (or don’t report it).

Line 131-132 – I really do not understand your description of water depth sampling. You classified the sampling sites based on their maximum depths? Where did you measure in the water column? If a site was 10 m deep, did you sample at 3 depths? Did you sample 0.3 m, 6 m, and 9 m? Be more explicit with your description here. Why did you pick 60% of max total depth for sampling?

Line 136 – state that the flooded areas sampled were in both reservoirs if that is the case Line 143 – ‘according’ not ‘accordingly’

Line 148 – what did you collect the headspace air in?

Line 150 – how were the gas samples transferred? Via needle and syringe because the vials were pre-capped, I presume.

Line 154-156 – combine these two sentences into one

Line 158 – if you made measurements from a drifting boat in a river, I presume you drifted quite a bit. Did you consider this drifting distance in your measurements of flux?

This is an important point. How far did you drift? You need more details regarding this sampling approach.

Line 161 – 'calculated' instead of 'done' and delete 'the eq. (1)'

Line 168 – use 'erroneous' instead of 'same sampling site'

Line 171 and eq. 2 – you say that k was based on the flux measurements but I do not see them in equation 2. I guess it is somehow in the partial pressure measurements since some are in the chamber but I think this needs a better explanation. You didn't find k using FCO2, but rather using the concentrations in the chamber? That is how I perceive this equation.

Line 176 – need 'respectively' at the end of the sentence

Line 177 – grammar is poor here

Line 184 – give a bit more detail here about how the gas transfer velocities were not calculated from 2016 data. I am guessing it is because the other loggers did not allow it somehow, but I don't see why you couldn't perform the calculations using concentrations from those loggers too.

Line 187-188 – I do not understand why or how these measurements were made according to the water depth classes. Do you just mean depths? And did you do this at each sampling site?

Line 199 – what does 'assessed separately by season' mean?

Line 208 – you should restate here specifically that you are comparing high and low water from 2017 only.

Line 208 – replace 'presented a significant variation' with 'varied significantly'

Line 221 – it gets confusing a bit when you go between comparing seasons to looking at the whole dataset so be specific when you can. For example, I would add 'From the

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overall dataset,' before 'Higher pCO2 was registered..'

Line 223 – I am confused by this sentence and what is respective to each other. Rewrite this one.

Line 228 – Because you only had pCO2 data for 2017 then I guess you couldn't find a correlation between pCO2 and FCO2 in the 2016 data, correct? You need to specific again here and state that the correlation was only for the one method.

Line 232-234 – does it really matter if the two sensors were not cross calibrated in terms of absolute concentrations if it is just the slope of the increase of concentration over time that you need for flux calculations? If it is merely slope then you should be able to estimate and then compare the rates of flux, no?

Line 235-237 – how is it that that the low water season had the highest and lowest FCO2 values but was also homogeneous? This is very confusing.

Line 242-243 – this sentence is kind of just hanging here by itself. Shouldn't it belong somewhere in a paragraph.

Line 244 – I would rename this section a bit more specific to what you are doing: 'pCO2 and FCO2 in ROR versus storage reservoir'

Line 245-246 – if you consider the standard deviation of your measurements then I would say the differences are not so significant between seasons as they then overlap, especially for IR

Line 249 – the difference in IR is much more significant than XR. I would point that out here.

Line 250-252 – I don't understand what you mean here. You did a spatial analysis but lumped all spatially different environments together? I think you mean to say that you compared the total emission from XR to the total emission of IR despite the emitting environment. Is that right?

Line 252-255 – I don't understand how you see no sigficant difference between pCO2 of XR and IR but then suddenly find that XR had pCO2 721 uatm lower. And lower than what? I guess IR. These few sentences are very confusing.

Line 256 – You cannot just present an idea like 'Standing vegetation type in XR flooded areas influenced pCO2' without explaining the data that led you to that conclusion.

Line 264 – use 'especially' instead of 'specifically'

Line 266 – what is a 'gradient pattern downstream'??

Line 272 – again with this 'separately to each season' – I still do not understand what this means. You have to come up with a better way of describing this.

Line 274 – use 'without significant spatial heterogeneity across environments'

Line 275 – use 'k600 strongly correlated with wind. . .' and does this relate to Fig 5b? Should you reference this?

Line 280 – there is not environmental breakdown in the data in Figure 5

Line 287 – so you have water column data? Where is this data?

Line 303 – decrease in what?

Line 344 – what is 'vegetal suppression'? I figured out that it is when you remove vegetation prior to flooding but is this the correct term for this? It sounds very strange.

Line 344-345 – this sentence is too long with poor grammar

Line 354-356 – combine those sentences

Line 356 – how many of the environments? Do you mean all except IR? This is confusing. If it is just IR that is the exception then you need to state it as 'all except IR'

Line 357-358 – negative fluxes can be replaced with 'observed CO2 uptake'

Line 358 – 'light penetration and low suspended sediment'

Line 363-365 – you already spoke about this earlier. Try not to be redundant

Line 370 – need ‘which’ before ‘would’

Line 372-373 – I don’t think you need these values here in the discussion.

Line 387 – can you give a site number for the ‘site downstream IR’?

Line 391 – I don’t think this true and I don’t think you need this sentence about a reference for natural FCO2 values

Line 397-398 – do you mean that the downstream sites resembled river channel sites in terms of pCO2 and FCO2 values? Don’t use ‘traits’ to describe this. Traits more refers to features that don’t vary.

Line 408-409 – are you saying that the old reservoir you are using for comparison is Tucurui? The grammar here is confusing.

Line 412 – what do you mean by hypolimentical waters? It should be ‘hypolimnetic’ by the way. But this just means bottom waters with an implication of stratification, but what specifically do you want to express here?

Line 419 – bad grammar in last sentence

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