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Interactive comment on "Physical-controlled CO_2 effluxes from reservoir surface in the upper Mekong River Basin: a case study in the Gongguoqiao Reservoir" *by* Lin Lin et al.

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Thank you for the comments. We are looking for further proofreading to modify the writing style. 1 What was the land cover before flooding? Response: The right bank of the reservoir was relatively flat, and some small villages sparsely was built at this side. Before flooding, the right bank of reservoir was mostly farmland, uncultivated grassland and the residential lands of villages. The left bank was steep, and landslides frequently occurred in rainy season. Thus, the left bank was either grassland or barren land. Before the reservoir filling, the cover of vegetation accounted 10∼20% of the reservoir valley. 2 What are the water discharge in and out of the reservoir according to sea-

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sons? –What is the average water residence time? Response: The water discharge at the river inlet R1 and R2 in each season can be found in the Fig. 1&2 in this letter. The average water residence time was 0.01 year (Shi et al., 2017) or 1.4 days (See Page 3 Line 9).The inflow of the mainstem and tributary could be found in the figure below (the left panel is the water discharge in the mainstem while the right panel is the inflow from tributary). Noticed that the inflow of the tributary was extrapolated with the instantaneous water discharge during the sampling at Point R2. We have highlighted the daily-operated nature (active storage/mean flow discharge <0.08) and short water retention time in the introduction of the reservoir. The flow can be regulated in a daily cycle while hardly be changed at seasonal scale. Currently we only have the instant water discharge at the outflow during the sampling campaign.

3 Importantly, the seasons must be described precisely and the same nomenclature must be used throughout the article instead of using sometimes summer, winter, spring. . . and at other places warm season, rainy season and even some combination like warm dry seasons. . . The reader is lost. . . Response: The wet (rainy) season spanned from May to October every year while November to April in next year was considered as the dry season (see Page 3 Line 12). When under the control of South Asia monsoon climate, the rainy season is usually warm while the dry season is cold as it usually covers winter and spring. Considering the samples from winter were fewer than that from other seasons (as we have to finish the campaign before the filling of the Miaowei Dam at the upstream) and this could lead to bias in statistics, we combined the dataset according to the distinctive hydrological condition and rainfalls in the wet season and the dry season. Yet in autumn when the wet season came to an end, some emission rates exhibited some different characteristics from other seasons. Thus we presented the data of pCO2 and emission rates in four seasons and separated some extreme high pCO2 and emission rates from other seasons. Yet we will add the detailed classification and the characteristics of the monsoon climate will be to the description of study area. 4 Meteorological information like temperature and rainfall range are required Response: We will put the basic information into the introduction of the reservoir,

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including monsoon, precipitation, air temperature and land covers. 5 the map (figure 1) requires a scale, an orientation and information about direction of the water flow would be welcome. Response: We can add the scale but the scale and orientation can be read from the coordinates marked at the outline of the map. The direction of flow was from North to South at both mainstem and tributary, which is consistent with the flow direction of Mekong River flows from Tibetan Plateau to South China Sea. Later we will add the catchment map of the Mekong River and highlighted the position of the reservoir in Fig. 1. 6 is the reservoir thermally stratified? Well mixed? Monomictic?... Such information is required to be able to understand the seasonal dynamic of a lake or a reservoir Response: Insofar there was no reports on the stratification situation for the reservoir. But we measured the vertical profile of water temperature at Point P3 in some sampling campaigns. It was found the water was well mixed from May to August while in the rest of the year, stratification developed in the pelagic area where water depth is over 5m. The water temperature dropped drastically at 5m below the surface and stabilized deeper onward. The difference in water temperature between surface water and sediment surface was around 2 âĎČ. We can only add some basic statistics data on vertical profiles of water temperature from this research as supplements as we are still examining the quality of vertical datasets. The sampling strategy requires clarification 7 Can we call the station L as a littoral station since it seems to be an artificial island which has developed after sedimentation in the reservoir? In some part of the manuscript it is also called the drawdown area. . . Again, the reader is lost by the inconsistence of the vocabulary. Response: The Point L is a wetland in a reservoir bay formed after impounding due to sedimentation. We will unify the name for consistency. 8 P3-L19 stations P1 to P4 are considered all together whereas a few lines below, only P2-P4 are considered as pelagic stations. What type of station P1 is representative for? Response: Possibly there was some misunderstanding due to the order of introduction. Pelagic points include P1 and P2-P4. The Point P1 was located within the reservoir as no surface velocity was detected here. As the point was permanently flooded, we considered the point as a pelagic point. Of course the Point P2-P4 were also classified

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as pelagic points as they were also permanently and had no surface velocity. 9 Not clear in the sampling strategy and site description but the sampling occurred during the year 2016 (P2L23) while the dam upstream of the study site was completed by December 2016 (Figure 1). Therefore, all the sampling might have been done during the construction which means that the river was heavily disturbed. The construction might have biased the conclusion on the fact that the "pristine river" (as the authors call it) emits more than the reservoir itself. Response: Yes. The sampling campaigns were completed before the filling of the reservoir. We cannot deny that the construction at the upstream might have disturbed the river. However, as the natural flow was not regulated by the artificial dam, we assume that the river was free running and its hydraulic regime remained the same when the reservoir has not been filled. But as the dam slowed down the flow velocity, the turbulence resulted from higher surface flow velocity can be reduced and thus emission rates could be decreased. Hence possibly the emission rates at the pristine river could also be underestimated and the conclusion could be right but conservative, though the bias might exist. As the grouping in the manuscript might be confusing, we will try to clarify the standards in the selection of sampling points. The methodology is minimalist and substantial information is missing to be able to evaluate the quality of the dataset: 10 How many samples were gathered in total? By campaigns? Was the sampling organized by seasons? Response: We are sorry that we did not make it clear in the introduction of sampling scheme. The formal sampling campaign started from April to December, 2016. Totally sixteen sampling campaigns were conducted on the eight sampling points, with a frequency of twice a month. During the formal sampling campaign, 127 samples were collected as we failed to gather the water samples from the Littoral zone in one campaign in October as the area was totally drained at the low water level. Another two preliminary campaigns were conducted in January and March respectively, in which only the riverine points were sampled. We will add these information to the sampling introduction. 11 -P3-L25-30: what are the precision, range and accuracy of the gas analyser? What gas flow was used? Did the author used desiccant? Is there a humidity correction is

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the analyser? What is the volume of the chamber? How were measured the fluxes in the river? At fixed station or drifting with the flow? What was the rejection/acceptance procedure for the measured fluxes? Response: The portable S157 CO2 Analyzer produced by Queen's University Biological Instrument & Technology (Qubit, Canada) was used to measure the CO2 concentration. The S157 CO2 Analyzer is a single channel non-dispersive infrared CO2 analyzer that measures CO2 in 0 to 2000 ppm range with 1 ppm resolution. The built-in pump in the analyzer directly draws the air for analyzer and the desiccant was installed within the intake tube. More information on the analyzer is available at the following website: https://qubitbiology.com/s157-co2-analyzer-0-2000ppm/ The volume of the chamber is 2400cm3 as its height, width and length can be found in Page 3 Line 25. When measuring the fluxes in the river, the chamber was floating and fixed to the piles marking water levels. Generally, we waited for the stabilization of the analyzer to a range of 400∼500ppm (atmospheric pCO2) and kept monitoring the variation of pCO2 in the chamber for 15∼20 minutes via the laptop. The curve was accepted and used for calculation of fluxes once R square reached 0.90. Great fluctuation of concentration was rejected and the measurement would be restarted again. As the properties of the analyzer could be easily found in the company's website, we do not think we need to list them in detail. Details of rejection and acceptance procedure can be found in Tremblay et al. (2005) as we cited. 12 What are the precision and accuracy for Temp, O2, pH, conductivity measurements? This is critical for pH since pCO2 was calculated by pH/Alka method. Details on pH measurements are required Response: The precision of water meter for Temp, O2, pH and Cond are 0.1âĎČ, 0.01mg/L, 0.01 and 0.01μS/cm respectively. The meter was calibrated according to the manual before each campaign begins and the properties were measured three times for an average. The probe for pH was calibrated with three standard solution (pH = 4, 7, 10 respectively) before sampling and the pH would be tested with the neutral solution to examine the accuracy. The pH was generally higher than 8.0 in the Lancang River. But sometimes lower value (<7.0) was also found, we clear the probe and retested the pH. If the value showed consistent results in four times

of measurements, the value will be accepted. Since we followed the standards of calibration and measurements of these water properties, we believe the measurement of pH should be accurate. Information and manual can be easily attained online as we presented the type and company of the meter. 13 Precision and accuracy and detection limit are required for Alkalinity. Response: Water samples were titrated with the HCl solution (see Page 4 Line 9-10) to the point that methyl orange turned orange. The concentration of HCl solution was titrated with NaOH solution each time the acid was prepared. The average concentration of the HCl solution was around 0.024 mmol/L. The precision of 2mL burette used in the titration of water samples is 0.01mL. Therefore, the precision of alkalinity was supposed to be 0.024mmol/L and any alkalinity lower than the value could not be detected. The titration is a popular way to measure the total alkalinity so we do not think we need to explain the solution of acids and discuss the accuracy with too much details in Methodology. 14 pCO2 using pH, Alkalinity and the CO2SYS program. This validity of the methodology was discussed recently by Abril et al. (2015) and (Golub et al., 2017) for inland waters Response: We also noticed that the CO2SYS program might overestimate the system. Since the pH has largest weight in the program, even a slight variation in pH could lead to drastic fluctuation in pCO2. However, we do not think that the selection of methods for pCO2 calculation influenced or contradicted our conclusion that the high emission rates were caused by physical factors. Firstly, the measurements of CO2 emission rates did not rely on the calculated pCO2. The parameters that used for the calculation (alkalinity, temperature and pH) was totally independent from the measurements of CO2 fluxes. As the article emphasizes the importance of hydrological condition and mixing mode in regulating the CO2 emissions at the river inlets and reservoir surface, rather than the pCO2 in surface water. Even though we tried to calculate the outgassing rates with pCO2 and gas transfer rate (Thin-Boundary Layer Model), we finally decided not to include the datasets into the article but simply present an average as a comparison as we noticed that the dataset could be bias. Secondly, as the referee cited from Abril et al., (2015), the calculated pCO2 could be largely overestimated in the acidic and organic-rich wa-

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ters. But in the GGQ Reservoir, even the highest DOC concentration was no more than 2.992ppm (Point P1). Besides, the pH of the Lancang River was always higher than 8.3 (See Table 1), suggesting the environment in the reservoir was alkaline. In such alkaline and organic-poor system, fluctuation of pH could hardly make significant variation in pCO2. Sometimes we also recorded an abnormal increase at some sampling sites as the drifting deadwoods tends to release organic acids during decomposition (as we highlighted in Page 9 Line 14). The abnormal points were separated from the dataset for discussion as they can interfere the results and not quite related to the conclusion. Thirdly, given the random error and systematic errors in the calculated pCO2, the variation of pCO2 might remained the same after excluding the abnormal value as it was used to explain the spatial and temporal variation of the flux. When the correlation between pCO2 and CO2 fluxes were analyzed, the systematic error could hardly cause great bias as the procedure determining the pCO2 was consistent and the aquatic environment did not exhibit large heterogeneity in alkalinity (maybe not applicable to the littoral zone so we separate the point from pelagic area), which might cause the bias in pCO2 calculation according to Golub et al. (2017). Finally, although the head-space equilibrium method could be a better way to measure the pCO2, most of the existing studies on pCO2 in Chinese reservoirs (and sometimes rivers also) used the calculated pCO2 and the inconsistent method possibly impede the comparison to other reservoirs in China and incorporation into the existing database.

15 For chlorophyll: How long after sampling the water was filtered? Were the filters kept in the freezer? What was the precision, accuracy and limit of detection for Chlorophyll, DOC, TOC, TN and TP? Response: The infiltration for chlorophyll started four hours after the sampling campaign finished. The filters were kept in refrigerators. In this study, the precision of the chlorophyll concentration was 0.01mg/L, even though the instrument could detect lower concentration down to 0.1μg/L. Calibration was conducted before the analysis by technician according to manual and the details can be found in the following link: http://www.walz.com/downloads/manuals/phyto-pam/PhytoPamII_2.pdf The precision of DOC concentration was 0.001ppm. Standard samples with a concen-

tration of 1, 2, 4, 5, 7, 10ppm would be tested for a standard curve before the analysis on water samples. The curve was accepted when the R square of regression reached 0.95. Before analysis blank samples (pure water) would be tested first for subtraction. A standard sample was inserted into the sequence with every 10 samples to monitor the operation of instrument. The attained results will be calibrated with the standard samples after the subtraction of blank values. The procedure we followed when measuring TN and TP was the unified standards for the surface water on earth in China. The analysis of TN and TP was similar to that of DOC with the same subtraction of blank samples and calibration with standard samples. The standard curve was only accepted when the R of linear regression reached 0.999. The precision for TN was 0.05mg/L and the limit of detection was 0.20mg/L. The precision and detection limit for TP was 0.01mg/L. The methods, precision, and detection limit of TN and TP can be easily found online. As it was long and easily accessible, we are not going to add it into the methods. We did not publish any TOC data in this article. Please check it again.

16 statistics used for the seasonal and spatial variations were not described the thin boundary method which was used according to P6L10 was not described Response: The methods was cited from Goldenfum and Association (2010) and we assumed an average atmospheric pCO2 of 406μatm. Like the CO2 efflux, significant difference in the outgassing rates was found between riverine sites and reservoir sites ($p<0.01$) but the spatial variation was insignificant within the reservoir ($p>0.10$). No other significant spatial or temporal variation was found in the outgassing rates as it showed quite homogeneous value throughout the year and the reservoir sites. The results and statistics of outgassing rates calculated with the Thin-Boundary Method were deleted because its seasonal and temporal variation was quite similar to that of pCO2. The pCO2 weighted too much in the calculated flux and dominates its variation. Since we have noticed that the calculated pCO2 could be bias, we decided not to discuss the seasonal variation of calculated outgassing rates furtherly but only present an average of these results as a comparison. The calculated rates, however, can be presented in the supplements in case some readers are really interested in it. According to the fact that the sampling

strategy and the validity of the pCO2 dataset is doubtful and the quality of dataset cannot be evaluated in absence of information, it is impossible to go further with the review of this manuscript. Response: We appreciate the referee's reviewing and questioning on the methods applied in the research. We supplemented some information to make the method clearer and further verify the dataset we collected.

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Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2018-244/bg-2018-244-AC2-supplement.zip

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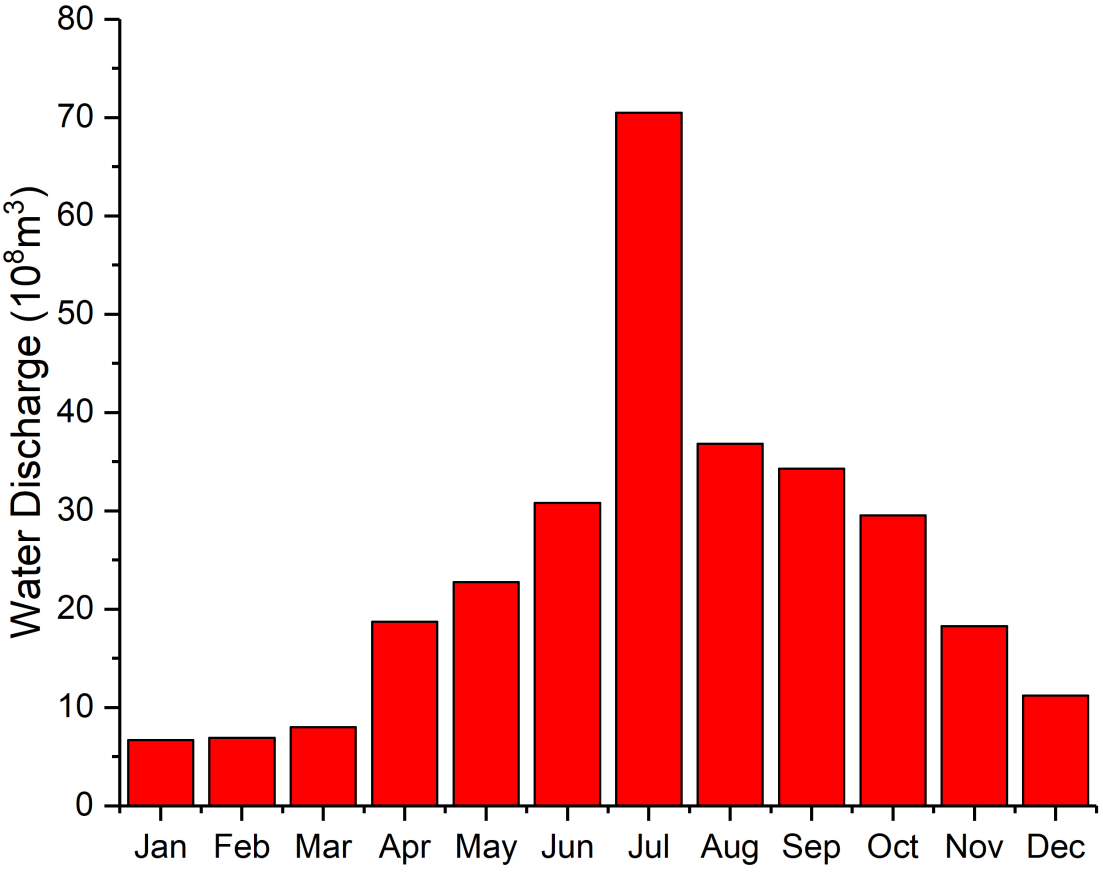

Fig. 1. Monthly variation of water discharge of inflow from mainstem (R1)

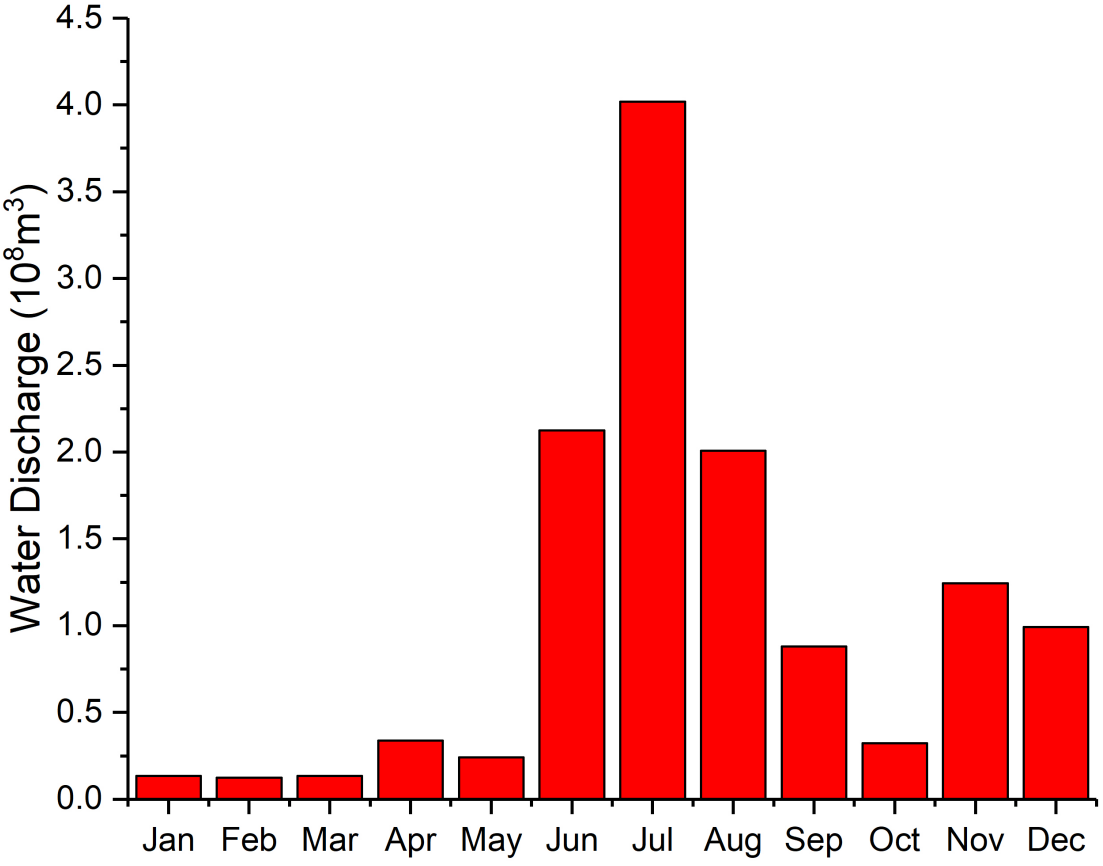

Fig. 2. Monthly variation of water discharge of inflow from tributary (R2)