

## ***Interactive comment on “The monsoon effect on energy and carbon exchange processes over a highland lake in southwest of China” by Qun Du et al.***

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Many Thanks for reviewer's valuable comments and suggestions, which help a lot to improve our manuscript. All the revisions have been marked with red color in the manuscript. The responses point by point are as following:

The study presents several years of energy and carbon dioxide fluxes measured at Lake Erhai. The focus is to investigate the different dynamics of fluxes and their drivers in three sub-periods, e.g. pre-monsoon, monsoon and post-monsoon. The dataset is interesting, the framework analysis and results/discussion comprehensive and well written. I can recommend the final publication in ACP after the following comments

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are properly addressed: 1) I suggest to re-structured the Results chapter. In my opinion subchapters 3.1, 3.2 and 3.3 could be merged and shortened in one sub-chapter related to environmental/atmospheric conditions. So many details on diurnal and seasonal variation of each radiation components is not so interesting and they could also be omitted. Instead, the focus could be more on net radiation, heat storage and turbulent fluxes (H and LE).

Answer: We agree with your point. Details about diurnal patterns of meteorological variables are too many to be interesting for readers. Subchapter 3.3 about the diurnal variation of radiation components has been removed. The results about the atmospheric conditions have been shortened.

2) The CO<sub>2</sub> (and LE) flux data are measured with an open-path (OP) sensor. Generally, I think the use of OP should be avoid over ecosystem where fluxes are expected to be quite small. The authors should add some discussion on this point, and also try to acknowledge the uncertainty due to WPL correction and the potential sign change in CO<sub>2</sub> fluxes.

Answer: In the open-path analyzers, temperature and pressure vary with ambient conditions, so the Webb-Pearman-Leuning (WPL) density corrections (Webb et al. 1980) is necessary to correct for the fluctuations. However, through the standard data processing and quality control, the data measured by open and closed path systems are in quite good agreement. So the open path system is widely used to study the turbulent exchange process between the lake surface and the atmosphere, e.g., an open-path EC system containing LI-7500A was installed to measure LE, Hs, and CO<sub>2</sub> flux in Western Lake Erie (Shao et al., 2015), the turbulent exchange process is studied over a small lake in the Nam Co basin on the Tibetan Plateau based on the measurement with an open-path infrared gas analyzer (LI 7550, LI-COR,Inc.) (Wang et al., 2017), Goldbach and Kuttler (2015) also measured the turbulent fluxes over a suburban reservoir in Germany with an infrared open-path analyzer (LI-7500, LI-COR,Inc.). The WPL correction has a large effect on CO<sub>2</sub> fluxes because it could cause sign change in

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CO<sub>2</sub> fluxes. We evaluate the uncertainty of WPL correction on CO<sub>2</sub> flux based on the raw data from October of 2015. The daily average CO<sub>2</sub> flux with and without WPL correction is  $0.91 \pm 1.95$  g C m<sup>-2</sup> d<sup>-1</sup> and  $-0.25 \pm 2.69$  g C m<sup>-2</sup> d<sup>-1</sup>, respectively. This information has been supplemented in the manuscript. References: Goldbach, A., and Kuttler, W.: Turbulent Heat Fluxes above a Suburban Reservoir: A Case Study from Germany, *J. Hydrometeorol.*, 16, 244-260, doi: 10.1175/JHM-D-13-0159.1, 2015. Shao, C., Chen, J., Stepien, C. A., Chu, H., Ouyang, Z., Bridgeman, T. B., Czajkowski, K. P., Becker, R. H., and John, R.: Diurnal to annual changes in latent, sensible heat, and CO<sub>2</sub> fluxes over a Laurentian Great Lake: A case study in Western Lake Erie, *J. Geophys. Res.-Biogeo.*, 120, 1587-1604, doi: 10.1002/2015JG003025, 2015. Wang, B., Ma, Y., Ma, W., and Su, Z., Physical controls on half-hourly, daily, and monthly turbulent flux and energy budget over a high-altitude small lake on the Tibetan Plateau, *J. Geophys. Res. Atmos.*, 122, 2289–2303, doi:10.1002/2016JD026109, 2017.

3) Related to the previous point, Have the authors made some independent measurements supporting the net uptake of CO<sub>2</sub> for certain periods. Did the authors measure, for example, pCO<sub>2</sub> in the water?

Answer: Sorry, the measurements on pCO<sub>2</sub> are still absent now. However, some researchers have conducted biochemical measurements in Lake Erhai, and the seasonal variation of of Chl a and phytoplankton concentration has been reported (Yu et al., 2014). This could be seen as a support for the CO<sub>2</sub> uptake at some periods. This information has been added in the manuscript. In future, measurements of CO<sub>2</sub> partial pressure will be supplemented to improve understanding on CO<sub>2</sub> exchange rate over Lake Erhai. Yu, G., Jiang, Y., Song, G., Tan, W., Zhu, M., and Li, R.: Variation of Microcystis and microcystins coupling nitrogen and phosphorus nutrients in Lake Erhai, a drinking-water source in Southwest Plateau, China, *Environ. Sci Poll. R. Int.*, 21, 9887-9898, 2014.

Minor comments: - P1L24. "...is the main driver for Hs..." and not "drivers".

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Answer: It has been corrected.

- P2L20. Replace “influence” with “affects”.

Answer: It has been replaced.

- P5L10. “Webb-Pearman-Leuning”.

Answer: The “webb” has been capitalized as “Webb”.

- P5L9. Please explain what is the circular correlation procedure” or give the reference.

Answer: The circular correlation procedure is one of the methods EddyPro provided to compensate the time lags between anemometric variables and gas analyzer measurements, which determines the time lag that maximizes the covariance of two variables, within a window of plausible time lags (Fan et al., 1990). This has been supplemented in the manuscript.

- Eq. 1. Use  $\Delta t$  to indicate the time difference.

Answer: The equation has been corrected.

- P5.L26. I guess 600 meters and 400 meters.

Answer: Sorry for the missing of the units, which have been supplemented.

- P6L1. “. . .post-monsoon period. . .”

Answer: The “Period” has been revised as “period”.

- P6L2. I would rephrase as “. . .filtered based on the footprint analysis.”

Answer: Thanks, the sentence has been revised according to the suggestion.

- P6L14-15. The sentence “The diurnal. . . .period.” is not clear, please rephrase it.

Answer: This sentence has been revised as “The diurnal mean  $T_a$  is the largest during monsoon period, second during pre-monsoon period and smallest during post-

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monsoon period”.

- P6L34. Monsoon is sometime written with capital letters and sometimes not. Please write it consistently trough the text.

Answer: This word has been written uniformly as “monsoon” throughout the manuscript.

- P7L27). Ta was already defined above. Answer: Thanks for your remind. The definition has been removed from here.

- P8L4-5. I would rephrase it as “The atmospheric surface layer is mainly near neutral stratified during the three study periods..”

Answer: Thanks for your suggestion. The sentence has been revised accordingly.

- Sect 3.3. My suggestion is to remove this section.

Answer: We accept this suggestion and remove section 3.3. We agree that the seasonal variation of radiation components is not so interesting as it's mainly caused by solar elevation angle. Our study also shows slight difference between pre-monsoon period and post-monsoon period, so it's not much meaningful.

- P10L15-20. Would the authors expect that there is no phytoplankton during the pre-monsoon period? What is the uncertainty associated with the CO<sub>2</sub> fluxes? Could the authors show the error bars or the confidence intervals in Figure 7? Are the around midday CO<sub>2</sub> fluxes significantly different than zero?

Answer: The seasonal fluctuation of phytoplankton in Lake Erhai has been reported by some researchers. Yu et al. (2014) observed that the concentration of Chl a and phytoplankton in Lake Erhai were higher in mid-summer and autumn and fell down from winter until April. This reference has been added in the manuscript. The error bars have been added in Figure 7, which could show the uncertainty range for CO<sub>2</sub> fluxes. The significant carbon uptake could be observed at midday time, but the peak

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rate varied from year to year. The peak diurnal average CO<sub>2</sub> uptake ranged from  $0.05 \pm 0.73$   $\mu\text{mol m}^{-2} \text{s}^{-1}$  to  $0.53 \pm 1.66$   $\mu\text{mol m}^{-2} \text{s}^{-1}$  during monsoon period, and from  $0.74 \pm 0.89$   $\mu\text{mol m}^{-2} \text{s}^{-1}$  to  $1.62 \pm 1.52$   $\mu\text{mol m}^{-2} \text{s}^{-1}$  during post-monsoon period from 2012 to 2015. This has been added in the manuscript too.

- P11L5. Please correct “period”.

Answer: The mistake has been corrected.

- P11L30. The sentence is not clear. From where do the authors see a correlation between Rn and UDT?

Answer: Sorry. The “Rn” in the sentence should be “Hs”. It has been corrected in the manuscript.

- P12L29-34. The text in this paragraph is somehow a repetition of what has been said above. Please remove/merge the text.

Answer: The text has been merged into the last paragraph.

- P13L21-26. The rain is also enhancing the transport of carbon from land/catchment areas to the water system (lateral fluxes) enhancing DOC in the water (see for example Pumpanen et al., 2014) and potentially the pCO<sub>2</sub>. References: Pumpanen, J., Linden, A., Miettinen, H., Kolari, P., Ilvesniemi, H., Mammarella, I., Hari, P., Nikinmaa, E., Heinonsalo, J., Back, J., Ojala, A., Berninger, F., and Vesala, T., 2014. Precipitation and net ecosystem exchange are the most important drivers of DOC flux in upland boreal catchments, *J. Geophys. Res. Biogeosci.*, 119, 1861–1878, doi:10.1002/2014JG002705

Answer: Thanks for sharing the opinion with us. The rain not only could promote CO<sub>2</sub> uptake by enhancing the nutrients but also promote CO<sub>2</sub> emission by enhancing pCO<sub>2</sub> in the water, which could explain both the negative and positive correlation coefficients between rain and CO<sub>2</sub> flux during different periods in our study. This has been added in our manuscript.

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Please also note the supplement to this comment:

<https://www.atmos-chem-phys-discuss.net/acp-2018-14/acp-2018-14-AC1-supplement.pdf>

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Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2018-14>, 2018.

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