Biogeosciences Discuss.,
doi:10.5194/bg-2016-286-AC2, 2016

Biogeosciences
Discussions

Interactive comment on “Timescale dependence of environmental controls on methane efflux in Poyang Lake, China” *by* Lixiang Liu et al.

Lixiang Liu et al.

liulixiang1982@126.com

Received and published: 21 December 2016

Response to Reviewers (bg-2016-286) This manuscript presents 4 years of CH4 flux patterns in the largest lake in China and environmental factors that influence CH4 flux rates. It falls well within the scope of Biogeosciences, but several aspects need to be improved for publication. Some suggestions: 1) How do you define “long-term”? To me, 4-year observations can be short-term. Also, all the statements related to seasonal or interannual variability need to be justified because CH4 flux rates measured on one day may not represent flux rates of one month. Furthermore, daily CH4 flux rates could have been overestimated, considering that CH4 flux rates are measured during the day each month, when CH4 flux rates were higher than those at night according to diel cycle measurements. 2) All the assumptions are met for regression models? Did you consider any interactions among variables? In addition,

did you also carry out the analysis before averaging the flux rates, with replicates as random effects? If so, how did the results differ from those after averaging? 3) In the discussion section some results were described, which did not appear in the result section. Results and discussion need to be better separated. In addition, the interpretation of the results needs to be better supported in the discussion section, focusing clearly on the core messages, i.e., what the results mean and what we can learn from this study. Answer: We thank the reviewer so much for the constructive comments and suggestions. We have considered all the comments and suggestions carefully in revising the manuscript. Firstly, we avoided using “long-term” as suggested and focused on multi-seasonal dynamics of CH4 effluxes. We totally agree with the Reviewer that the measured CH4 effluxes on one day did not represent the mean efflux rate of the month. We used the daily measurements as sampling points to explore the relationships between the CH4 efflux and environmental variables. We calculated the monthly, seasonal and annual mean CH4 effluxes using interpolation method (e.g. regression or the random forest model). It is true that most of our measurements were taken during the daytime. However, the daytime and nighttime average CH4 effluxes were not statistically different ($p = 0.19$). Moreover, we built our statistical models based on the daytime mean efflux and daytime averages of environmental variables and the nighttime efflux was calculated based on the nighttime averages of the same environmental variables. This avoided the overestimation of daily CH4 efflux. Secondly, we re-analyzed our data for each site and also treated site as a random effect as suggested. As a result, we found that site had no significant effect on the measured CH4 effluxes over the 4-year period. In the stepwise multiple regressions analyses, the same environmental variables were selected in the final model for each site as for the 3-site average though the coefficients of each variable were slightly different, but not statistically significant ($p > 0.12$). The seasonal patterns of CH4 effluxes at individual sites were very similar to the seasonal pattern by averaging CH4 effluxes over the 3 sites. Therefore, we used average values of the 3 sites in our analyses, but we added those information to the result section. Thirdly, we included the interactions among environmental variables in the revised version as suggested (Table 2 in the supplementary material). Finally, we rewrote the result and discussion sections as suggested to clarify relevant issues. 1. Line#47-51, there are too few references to represent the minimum and maximum flux rates in lakes, especially given that those references are from lakes in China and Norway only. Also, if such values can be presented with more studies, how would seasonal variations look like in comparison to diurnal ones? Answer: We agree with the Reviewer that there are too few studies measuring lake CH4 efflux in the literature and the sampling size and frequency was also different among the limited number of studies (Also see Reviewer #1's comments, specific question 5). Therefore, we deleted the range (maximum and minimum) comparison among lakes and focused on comparing the mean efflux of various lakes in the revised version. 2. Line#75-78, can you add references for each variable? Line#64-72 well covered the references for each variable, but this section lacks it. Answer: We added related references in the method section as suggested in the revised version (Page 4/lines 81-84). 3. Line#78-82, it sounds like investigating in large lakes is not important. Please rephrase or add some more sentences to justify the importance of this research. Answer: We added some sentences and references to emphasize the importance of CH4 emissions from large lakes as suggested (Page 5/lines 88-91). 4. Line#86-87, I suggest adding references that describe the previous studies, e.g. Liu et al. (2013). Answer: Thanks for your suggestion. We added references to describe the previous studies in the revised version (Page 5/ lines 97-102). 5. Line#109, what are the species names of Carex? Answer: The species name of Carex in Poyang Lake is Carex cinerascens Kükenth and Carexargyi Levl.etVant. We added the species scientific names in the revised version (Page 7/ lines 123-124). 6. Line#128-146, this section can be written more concisely. Answer: We rewrote this section as suggested in the revised version. 7. Line#166, can decreases in CH4 concentrations right after ebullition events be solely explained by diffusion back to lake water? If CH4 molecules were diffused back to the lake water, partial pressure of CH4 inside the chamber should be very high, inhibiting further emission from lake water

to chamber. Can they be partially from irregular air mixing inside the chamber, which results in errors in CH4 concentrations? Then, the current method for calculating flux rates needs to be reconsidered. Answer: We speculate that the short-term decrease or leveling-off of CH4 concentration inside the chamber after ebullition was mainly caused by the back diffusion of CH4 to surface water due to the high CH4 concentration in the bubbles. This back-diffusion phenomenon has been evidenced for CH4 efflux over water surfaces (Varadharajan et al., 2010; Wik et al., 2013). The ebullition suddenly increased CH4 concentration, and thus partial pressure of CH4, in the chamber headspace, which reversed the normal CH4 diffusion gradient between surface water and chamber space. We do not think irregular mixing is the main cause in the current study because we had a mixing fan running in each chamber during the whole period of measurement. 8. Line#167-182, this section is confusing. It can be written clearly and concisely. Answer: We rewrote this section more clearly and concisely as suggested. 9. Line#200, were water and sediment samples collected at three sampling points for flux measurements? The paragraph from line#229 can be given in a Table. Answer: Yes, we collected water and sediment samples at each of the three sampling sites when taking flux measurements. We added a table (Table 1) to the supplementary material section in the revised version as suggested. 10. Line#241, T test → t-test Answer: Thank you for pointing out the typo. We changed "T test" to t-test as suggested. 11. Line#242, flux rates are measured three times per season and they may not well represent flux rates of one season of the year. Then, can deviation of these three values be used to quantify interannual variability? Answer: We agree that 3 measurements in a season for a given year are not enough to represent the seasonal mean CH4 efflux due to the high temporal variation of the efflux. In the current study, we used 4-year data to compare the seasonal variations, which means 12 data points for each season. We changed the values in Table 1 accordingly by using 12 data points to calculate the seasonal mean effluxes in the revised version (Page 40). For quantifying inter-annual variability we have to interpolate the measured CH4 effluxes to annual efflux through modeling approach. The details of the modeling work were presented in another paper (Liu et al. 2016, in review). We used the model results to compare the inter-annual, seasonal, and diurnal variabilities of CH4 efflux in the Poyang Lake. 12. Line#247, please write what b represents in the equation. Answer: Thank you for your suggestion. Here b is the exponent of the exponential function between CH4 efflux and sediment temperature. We added it to the text in the revised version (Page 13/lines 274-275). 13. Line#278, what do you mean by "inconsistent and obvious"? Answer: This is a typo. We fixed it in the revised version (Page 13/line 310). 14. Line#309-331, this part can be written more concisely. Answer: Rewritten as suggested. 15. Line#331-332, sentences of this paragraph do not support this conclusion. Answer: We deleted the concluding sentence. 16. Line#335, here again, can the absolute values be compared with a few references, which are probably based on different observation periods? Answer: We agree that comparing the extreme values (minimum and maximum) among different lakes is not much meaningful. So, we deleted the relevant text and focused on comparing diurnal patterns. 17. Line#338-342, a larger number of data points can produce wider range of values. Answer: See answers to question #16. 18. Line#345-356, possible explanations can be added, such as potential drivers that can affect diel CH4 flux patterns and their variations (if measured). Answer: Wind speed strongly influenced diel CH4 efflux variations in our study. We discussed this point in the 4.3 section. 19. 4.2 CH4 effluxes in summer, this section contains a lot of new results, which were not presented in the result section. Also, some sentences describe very detailed information from other studies, which hinders the main focus of the paragraph. Answer: We moved them to the "Results" section and rewrote the discussion by focusing on our own results. 20. 4.3 Timescale dependence of wind, substrate availability, and temperature effects on CH4 effluxes, here again, a lot of new results are reported, such as line#410-414, line#436-451, line#457-461 (repetition from result section), and line#462-468. Answer: Again, we moved the results to the "Results" section and rewrote the discussion accordingly. 21. Line#473-475, considering uncertainties related to infrequent measurements (CH4 efflux rates measured on one day may not represent the mean rates of that month),

this kind of statement needs to be corrected. Answer: According to our model-based interpolation we found that July had the maximum monthly efflux, while January had the minimum. This conclusion is coincidently in line with the 4-year measurements though we had only 4-day measurements in each month. Therefore, we think that the conclusion still holds. 22. Table 3, can you add the observation period of each study for better comparison? Also, sorting the rows by lake size and climate would make this Table easier to read. Answer: Great idea! We added the observation period of each study and sorted the rows by lake size in the revised version. 23. Figure 3 and 4, can you add error bars from spatial variability? Answer: We added errors bars from spatial variability for Figure 3 and 4 as suggested in the revised version. âĂČ References: Liu, L. X., Xu, M.: Modeling temporal patterns of methane effluxes using multiple regression and random forest in Poyang Lake, China, Wetland Ecology and Management (In Review). Varadharajan, C., Hermosillo, R., Hemond, H. F.: A low-cost automated trap to measure bubbling gas fluxes. Limnol.Oceanogr., 8, 363-375, 2010. Wik, M., Crill, P. M., Varner, R. K., Bastviken, D.: Multiyear measurements of ebullitive methane flux from three subarctic lakes. J. Geophys. Res., 118, 1307-1321, 2013.

Please also note the supplement to this comment:
http://www.biogeosciences-discuss.net/bg-2016-286/bg-2016-286-AC2-supplement.pdf

Interactive comment on Biogeosciences Discuss., doi:10.5194/bg-2016-286, 2016.

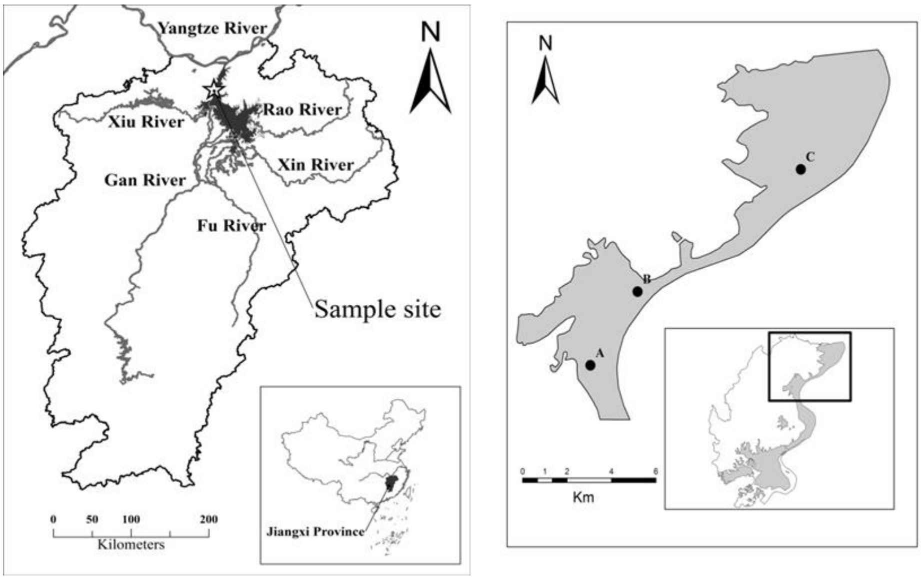

Fig. 1. Location of sampling sites in Poyang Lake.

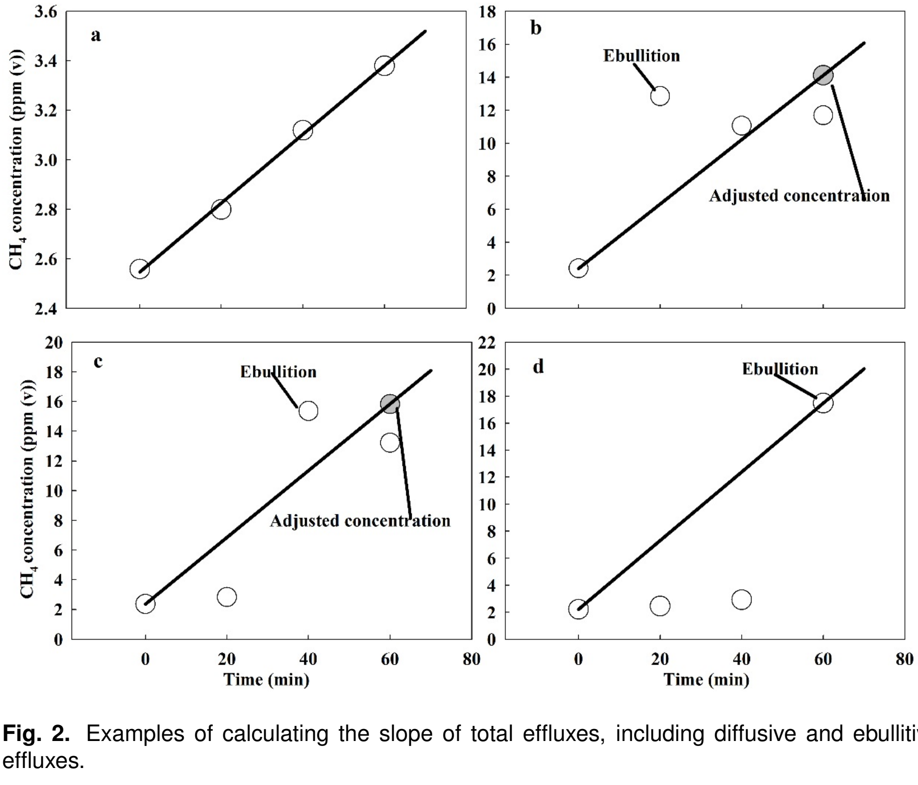

Fig. 2. Examples of calculating the slope of total effluxes, including diffusive and ebullitive effluxes.

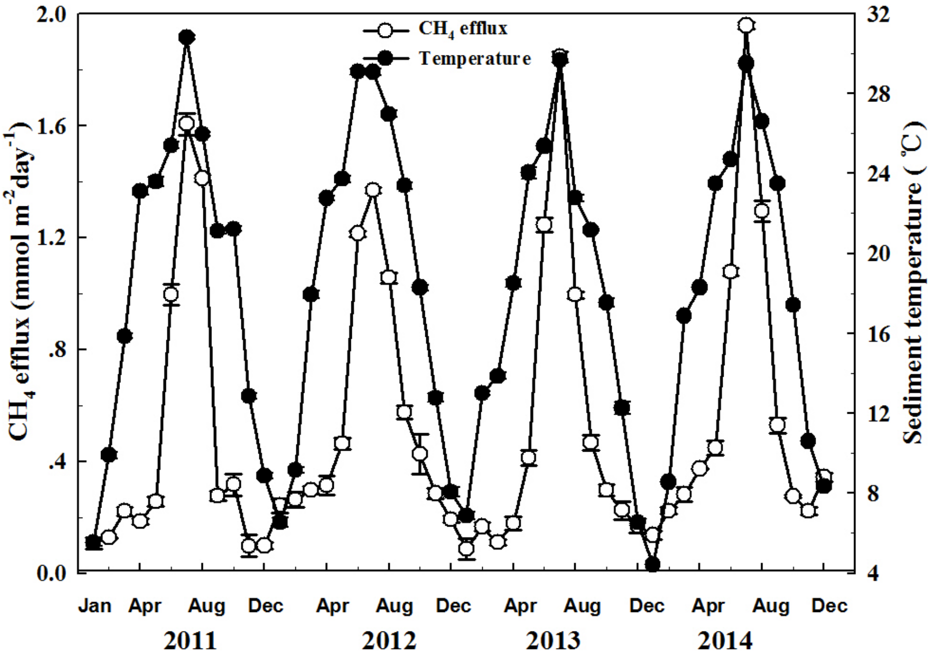

Fig. 3. Seasonal variations of CH4 effluxes and sediment temperatures in Poyang Lake.

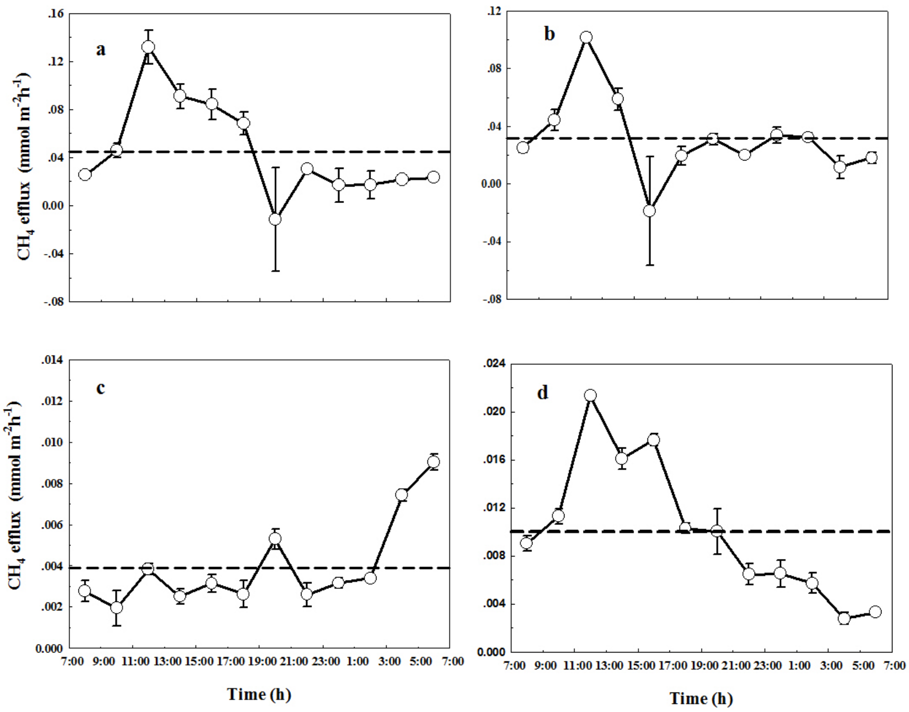

Fig. 4. Diel variations of CH4 effluxes in Poyang Lake.

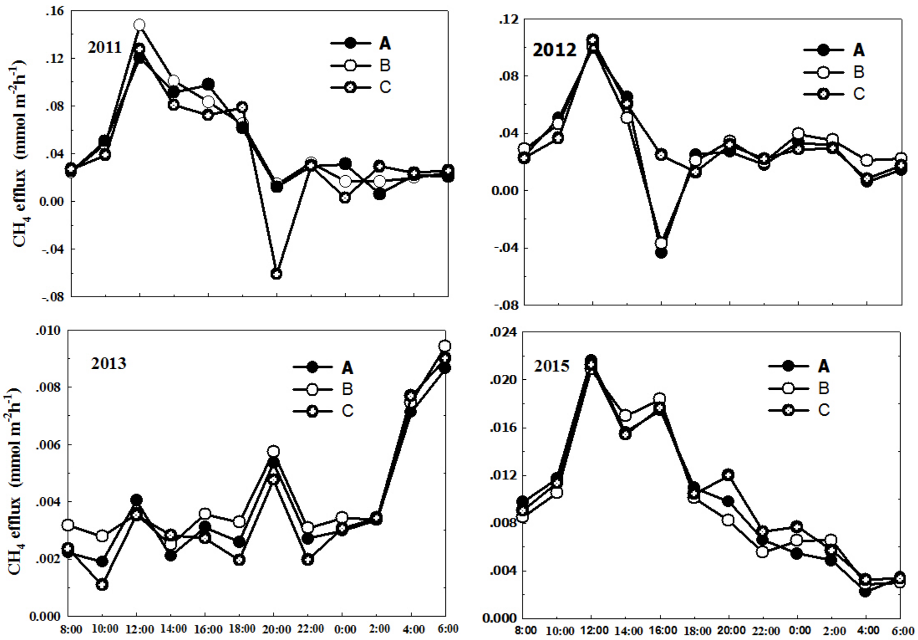

Fig. 5. Diel variations of CH4 effluxes among three sites.

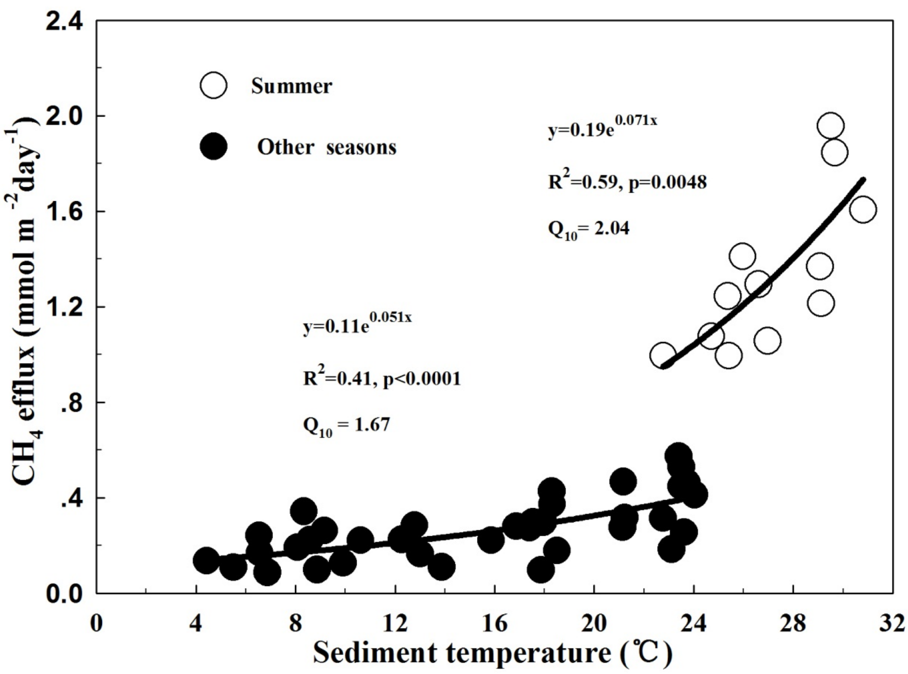

Fig. 6. Relationship between sediment temperature and CH4 efïňĆuxes in Poyang Lake.

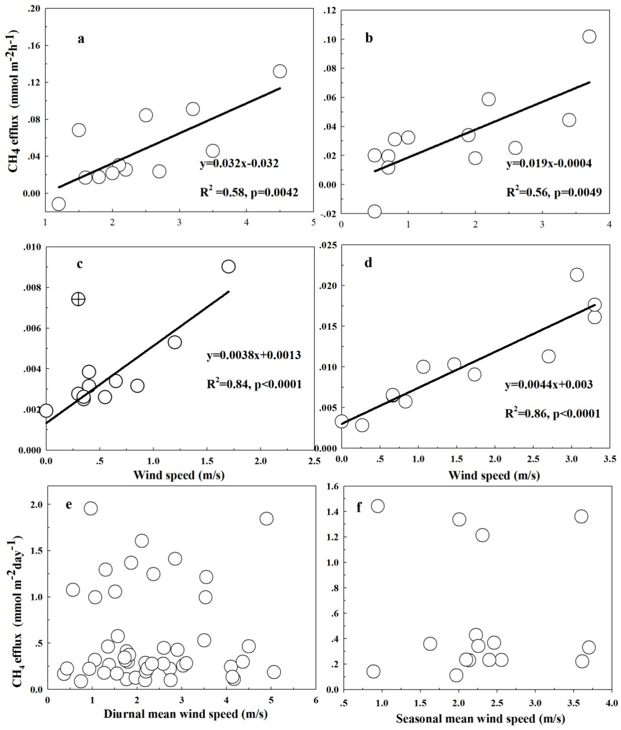

Fig. 7. Relationships between CH4 effluxes and wind speed in Poyang Lake.