

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

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Response to Reviewers (bg-2016-286) General comments The manuscript reports on the temporal patterns of methane (CH<sub>4</sub>) efflux in the largest lake in China and the various factors that influence these fluxes over different timescales. CH<sub>4</sub> efflux was slightly greater than other lakes with an area greater than 1km, but was comparable to that found in tropical lakes. The variables best explaining variation on CH<sub>4</sub> efflux was timescale dependent but, overall, temperature was important over seasonal scales and wind speed on a bihourly scale. The paper is well written despite a few grammatical errors. As the authors point out, there is a lack of data explaining CH<sub>4</sub> effluxes in this region and also in larger, nonalpine lakes more generally. As such, the results from this paper will add to the limited understanding of CH<sub>4</sub> dynamics in these lake types. However, I cannot recommend that this paper be published in its current form. I

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have major issues with a) the premise of the paper, b) some overreaching statements that are made, and c) the statistical approaches used - all have major implications for the generalisation of the results. It is difficult for me to assess the results and technical aspects of this study until statistical changes are made. 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.

1. One major concern is that the study was undertaken in a very small area (three sites with 20km of each other) even though the lake is the largest in China by area (3283sq km). Further, the study sites are situated in a section of the lake that appears to be relatively confined. There is nothing wrong with the site selection. However, the authors cannot make statements about the whole lake because they don't know if the spatial and temporal patterns of CH<sub>4</sub> vary the same way across the lake. They need to qualify in all statements that the research was undertaken in one small section of the lake. It is not a study of CH<sub>4</sub> effluxes from Poyang Lake, but it is a study of CH<sub>4</sub> effluxes from one section of Poyang Lake. Answer: We agree with the Reviewer that the CH<sub>4</sub> efflux in the Poyang Lake has a large spatial variation as evidenced in our previous study which examined the spatial variations of greenhouse gas effluxes (including CH<sub>4</sub>) over the lake with 44 sampling locations. The current study focuses on the temporal dynamics of CH<sub>4</sub> efflux. We chose the 3 sites to roughly represent the average CH<sub>4</sub> efflux of the whole lake based on the results of our previous study (Liu et al. 2013). Therefore, our results reflect the general situation of the lake.

2. Another major concern is a statistical one. The authors use average values from three different locations in Poyang Lake for all analyses. The justification for this was to 'minimize the effect of the spatial variation of CH<sub>4</sub> efflux on the temporal dynamics of the efflux'. However I suspect the main motivation for doing this was because the environmental variables were only collected at one location (it is not clear where the environmental variables were collected). Was this the case? Given that CH<sub>4</sub> was only measured in three locations of the lake, surely the degree of variation between them is very important to a) understand and/or b) account for in statistical analyses. The authors

should re-analyse their results in one of the following ways: Treat each study site as a random effect in mixed effects models so that variation among the three sites is taken into account when investigating the annual, seasonal, and diurnal variation, as well as the relationships with measured explanatory variables. Including site as a random effect would enable the researchers to make more general statements about CH<sub>4</sub> fluxes from Poyang Lake – this is just common practice these days and should be incorporated into the study design / statistical analyses. A random effect for site effectively means that these study sites are a random sample of all potential sites in the lake – this is where the generalisability comes in. Please see Section 8.1.1 (Types of predictor variables (factors)) in Quinn & Keough (2002; Experimental Design & Data Analysis for Biologists) or another similar book for information about mixed effects models and random and fixed factors. Split the analyses into two parts. The first analysis will not average the three study sites prior to the analysis and investigate the spatial and temporal patterns in CH<sub>4</sub> among them. The second analysis could average the study sites (still preferably treat study site as a random factor) and relate this to the measured explanatory variables. Answer: We actually collected environmental variables at each site except water level which was monitored at the Xingzi Hydrological Station. We appreciate the Reviewers' suggestion (also see Reviewer 2's comments) and re-analyzed the data by treating the site as a random effect. We found that the site effect was not statistically significant over the 4-year period. We also re-analyzed our data for each site and found that the differences among the 3 sites were minor with the 4-year mean of 0.53 mmol m<sup>-2</sup> day<sup>-1</sup>, 0.55 mmol m<sup>-2</sup> day<sup>-1</sup>, and 0.54 mmol m<sup>-2</sup> day<sup>-1</sup> respectively. In addition, we found that the seasonal patterns of CH<sub>4</sub> effluxes at three sites were similar and also in line with the seasonal pattern averaged over the 3 sites. Nevertheless, in the stepwise multiple regressions analyses, the same environmental variables were selected in the final model for each individual site as for the average of the 3 sites with the regression coefficients slightly different, but not statistically significant ( $p > 0.20$ ). So we have focused on presenting the site-averaged CH<sub>4</sub> efflux and its dynamics due to the length limitation of the paper. But we explained

the site effect on CH<sub>4</sub> effluxes in the revised version. 3. One more major concern is the notion that this is a long-term study. 4 years is not long term. Remove all reference to this study being long term, including the second sentence of the Abstract which introduces the idea that this research is filling the knowledge gap around the lack of long term research on CH<sub>4</sub> fluxes. Instead, the authors should frame this 'knowledge gap' around the lack of multi-seasonal investigations into CH<sub>4</sub> effluxes – this is exactly what this paper addresses. Answer: We agree and thank you so much for the constructive suggestion. We removed the phrase “long term” and changed the tones accordingly in the text during the version. In addition, we have focused on multi-seasonal investigations of CH<sub>4</sub> effluxes as suggested. Specific comments

1. Line 18. It is stated continuous measurements of CH<sub>4</sub> efflux was measured, but measurements where not continuous. Monthly measurements were made. Change all reference to continuous measurements in the manuscript to monthly measurements. Answer: Changed as suggested in the revised version.

2. Line121-124. Are these parameters an average of the entire lake or for a specific location? Please specify. Answer: These parameters are averages of the entire lake. We added the information in the revised version (Page 7/lines 135-138).

3. Section 2.3. Environmental variables. Where were the environmental variables collected from? Where samples collected at each of the three study sites and then averaged or from just one site? This information is very important. Answer: The environmental variables were measured at each of the three study sites and then averaged over the sites except water level which was monitored at a single hydrological station (national class station). We added more details of the environmental variables in the revised version (Page 11/lines 221-222).

4. Line 331-332. This concluding sentence only relates to the first sentence of this paragraph and does not relate or link to the remaining text in the paragraph. This sentence should only be left if a re-working of the paragraph better supports this argument. Answer: We deleted the sentence because it is not the main point of the paragraph.

5. Line 337-341. An argument is made that this study has lower diurnal variation in CH<sub>4</sub> efflux than other studies and this may be due to differences in sample

size in other studies. I would think that more frequent sampling would in-fact lead to more variation. The authors need to report on how much diurnal variability in CH<sub>4</sub> efflux there was among the study sites. Answer: We agree with the Reviewer that the diurnal range (maximum – minimum) of CH<sub>4</sub> efflux depends on sample size and sampling frequency, which makes the comparison with other lakes less meaningful. Therefore, we deleted the discussion on comparing the ranges of CH<sub>4</sub> effluxes in different lakes, which are not the main focus of the current study (Also see the reviewer 2's comments). Technical comments 1. Line 163-182. The description of how CH<sub>4</sub> efflux due to ebullition is very confusing and long. Answer: We rewrote this part to clarify the confusion in the revised version (Page 10/lines 190-200). 2. From Line 125, where the ebullition and diffusive fluxes are introduced, I would suggest briefly describing how, or how not, the chambers can be used to differentiate these two fluxes. Answer: Chambers cannot be used to differentiate ebullitive and diffusive fluxes. In the current study, the chambers can give the total flux including ebullitive and diffusive fluxes. We rewrote this section as suggested in the revised version. 3. Line 312. Remove 'obviously'. Answer: Removed as suggested (Page 18/line 376). Reference Liu, L. X., Xu, M., Lin, M., Zhang, X.: Spatial variability of greenhouse gas effluxes and their controlling factors in the Poyang Lake in China, *Pol. J. Environ. Stud.*, 22, 749-758, 2013.

Please also note the supplement to this comment:

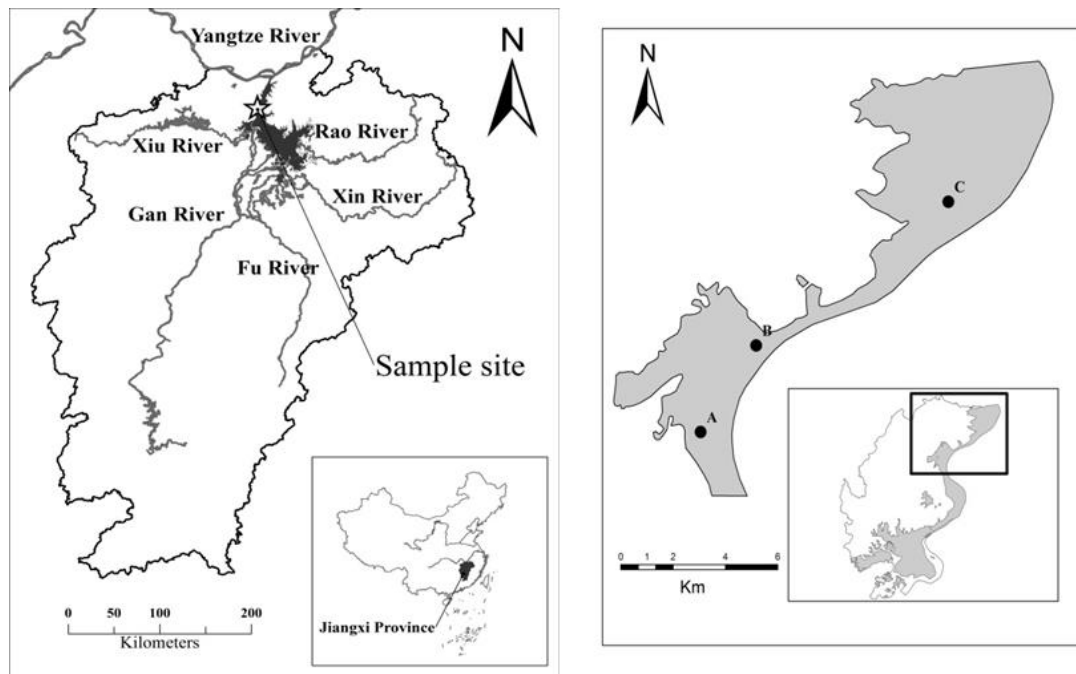
<http://www.biogeosciences-discuss.net/bg-2016-286/bg-2016-286-AC1-supplement.pdf>

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

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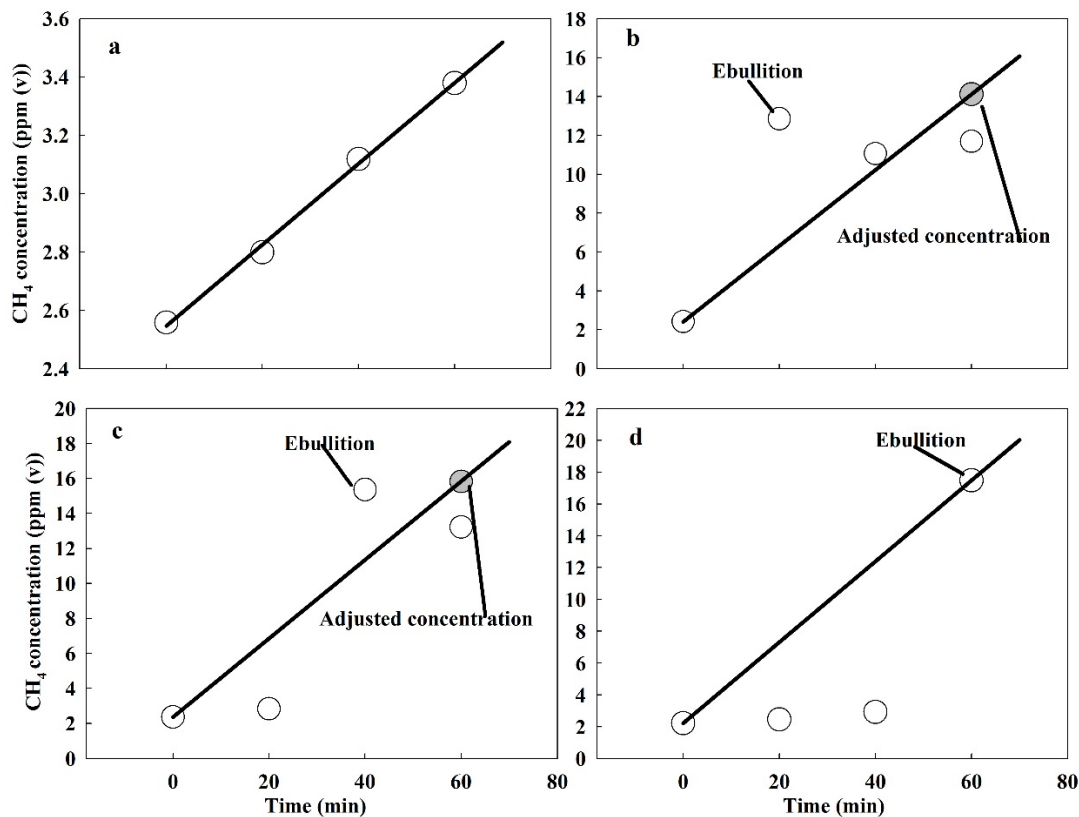
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**Fig. 1.** Location of sampling sites in Poyang Lake.

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

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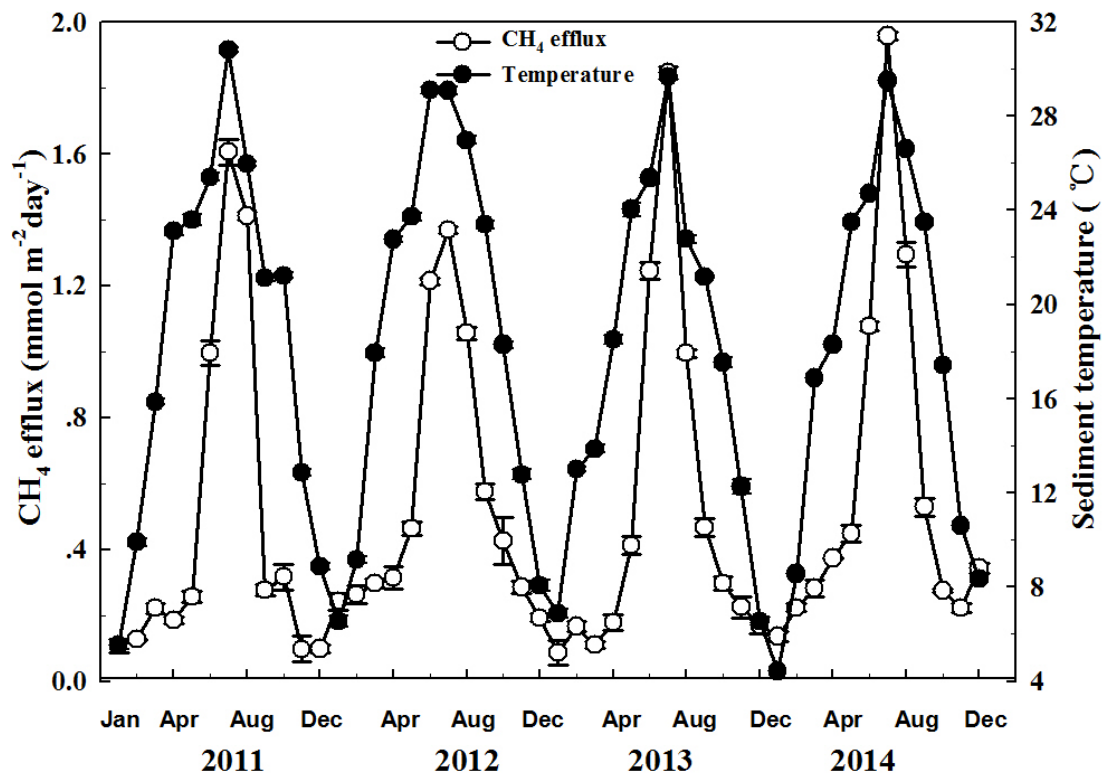
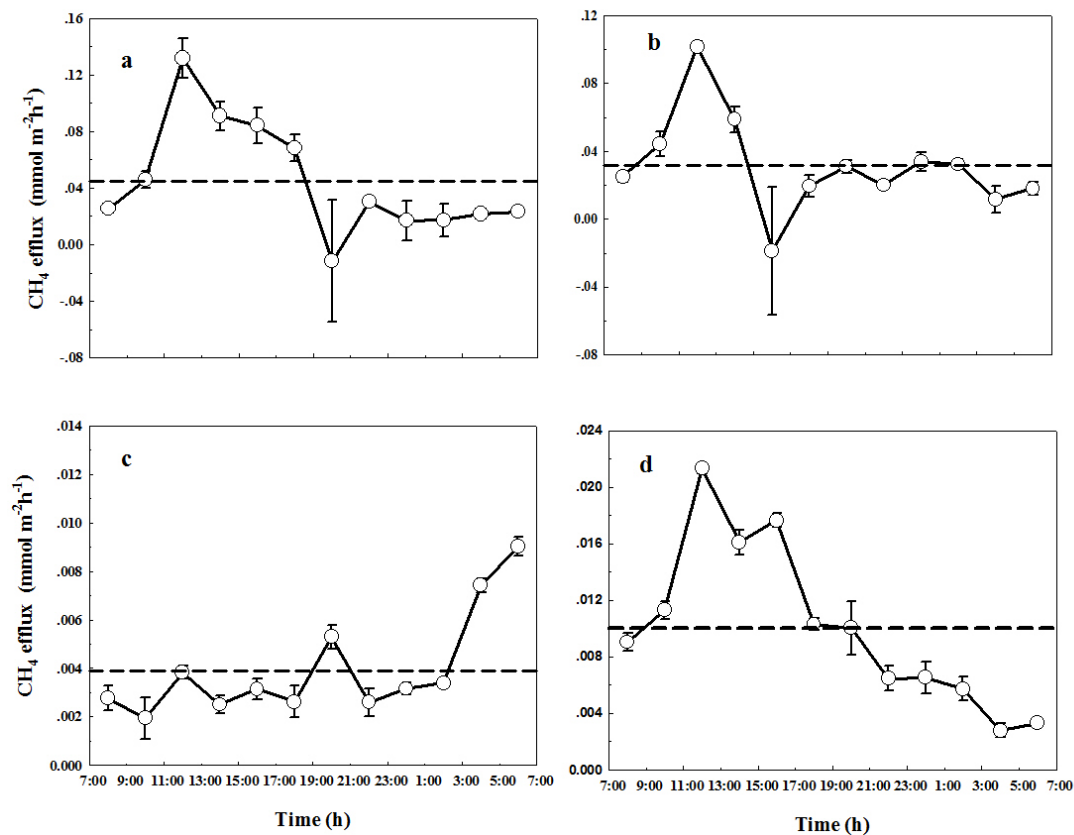


Fig. 3. Seasonal variations of CH<sub>4</sub> effluxes and sediment temperatures in Poyang Lake.

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**Fig. 4.** Diel variations of  $\text{CH}_4$  effluxes in Poyang Lake.

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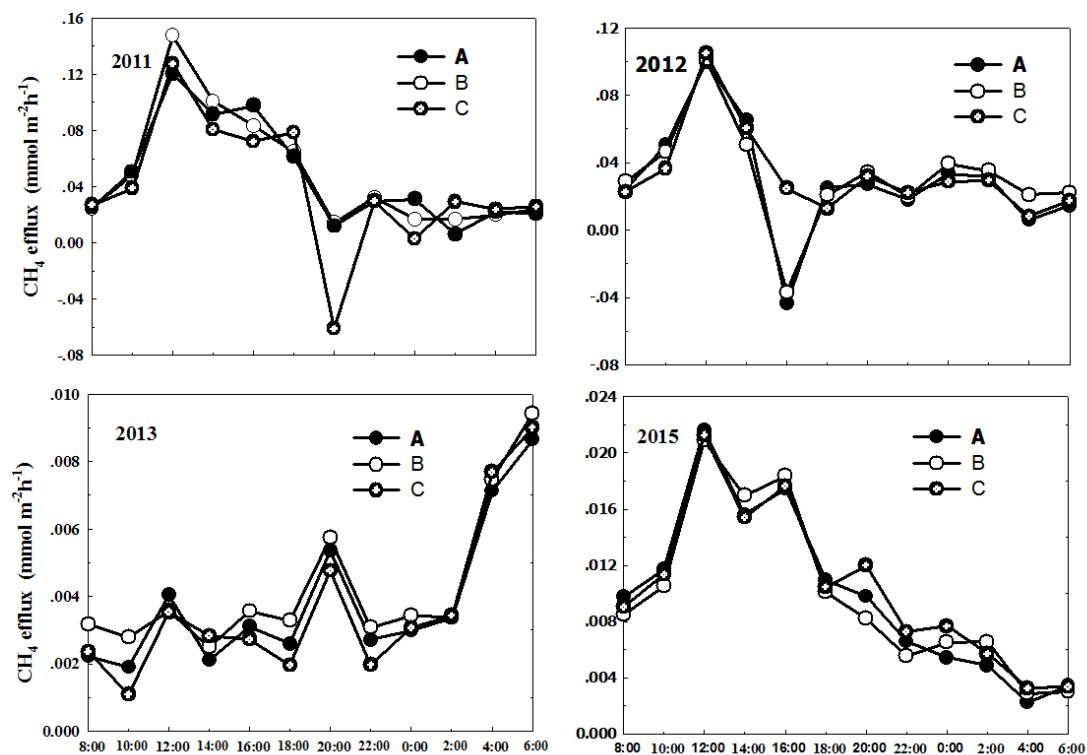
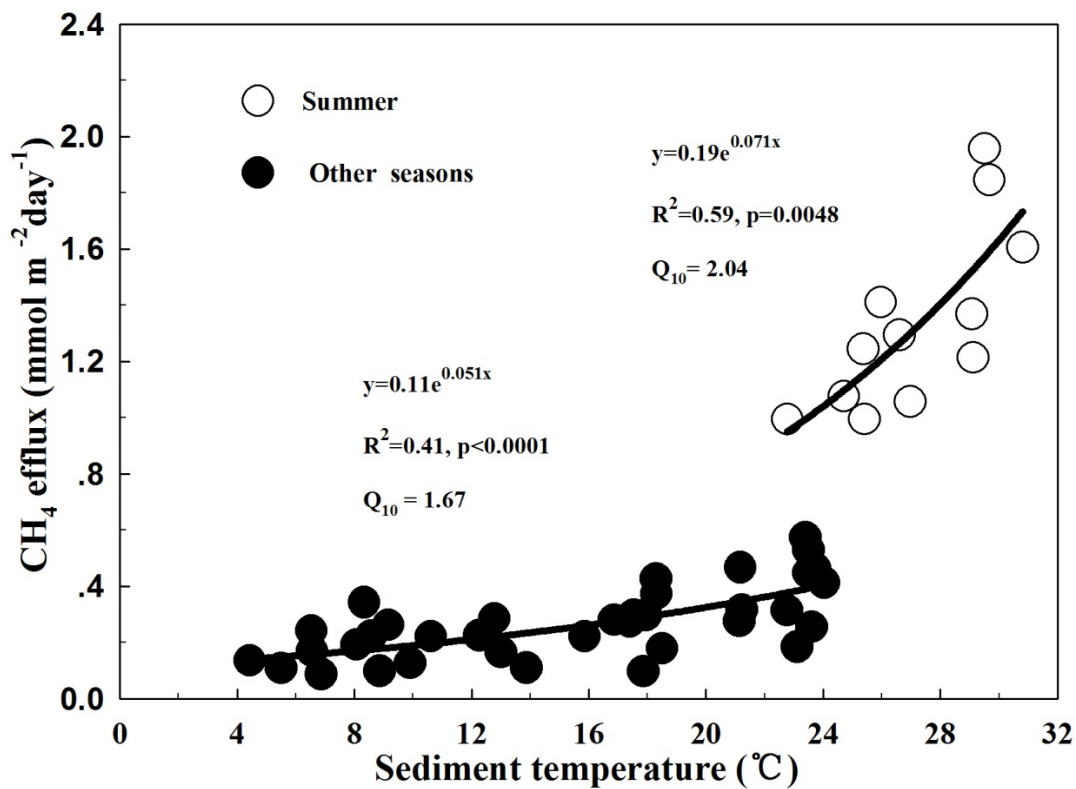


Fig. 5. Diel variations of CH<sub>4</sub> effluxes among three sites.

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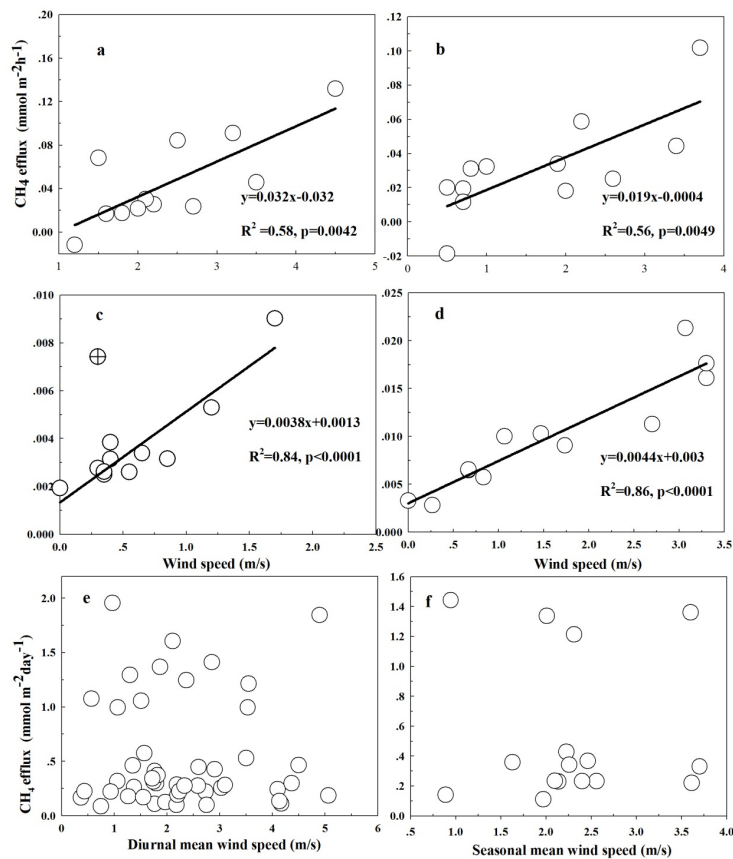


**Fig. 6.** Relationship between sediment temperature and CH<sub>4</sub> effluxes in Poyang Lake.

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**Fig. 7.** Relationships between CH<sub>4</sub> effluxes and wind speed in Poyang Lake.