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Biogeosciences
Discussions

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) Specific Comments: 1. Most of the results and discussions were built on the environmental variables and methane flux data. However, there are no data of biogeochemical related environmental variables shown in the figures and tables except Table 2. I would suggest to present the raw data of measured environmental variables in the supplementary material. Answer: Thank you for the suggestion. We added a table (Table 1) to the Supplementary Material section to present the raw data of measured environmental variables, such as sediment total nitrogen content, water level, DOC content in the water, and pH in the sediment , in the revised version. 2. Substrate availability (Line, 432), biological (e.g., microbial activities) and biochemical (e.g., sediment carbon and nitrogen contents processes) (Lines 454-455) are very important factors to link methane efflux to the biogeochemical

cycles and understand methane source and sink. Unfortunately, no comprehensive data or evidence to support the role of substrates and microbial activities on methane efflux in this manuscript which could be an important contribution to this journal. Answer: We agree with the Reviewer that substrates and microbial activities are important to understanding methane sources and sinks in lakes. In our earlier studies we found that sediment carbon and nitrogen ratio were highly correlated with microbial biomass and community structure (Liu et al. 2015) which was also highly associated with greenhouse gas (CO2, CH4, and N2O) fluxes in the Poyang Lake (Liu and Xu 2016). In the current study, we focus on examining the relationships environmental variables (e.g. climate) that may affect the temporal patterns and variations of CH4 effluxes in the Poyang Lake. We have added the related information and references to the discussion section in the revised version. Further investigation on the mechanisms of biological and biochemical controls on CH4 production and oxidation requires lab-based experiments with isotope and microbial DNA sequencing techniques which are beyond the scope of the current study. 3. It might be a risk to use the data from three sampling sites measured from one day (1 hr? Line 148) to represent methane efflux in that month. For example, it appears a contradiction between high methane efflux measured in July 2011 in Figure 3 and low methane efflux measured in July 2011 in Figure 4a. Answer: We measured CH4 effluxes at monthly interval to examine the seasonal dynamics of the efflux and the value does not necessarily represent the monthly average of CH4 efflux. We measured CH4 effluxes from early morning to late afternoon with about 6 cycles of measurements during the day (Pages 10-11/lines 213-219). The values of methane efflux measured in July 2011 in Figure 3 and Figure 4a are different because of different units. CH4 efflux in Figure 3 was measured on a daily scale, but CH4 efflux in Figure 4a was based on the hourly scale. So we used different units to present seasonal and diel patterns of CH4 effluxes. 4. How long and what time did the authors deploy the floating chambers in the three sampling sites within a day for the study at the large temporal scales (Fig. 3)? I feel 4-year measurements are not a very large temporal scale especially there are no continues measurements/monitering such as deploying floating chamber within a short interval (every week or every two to three days). Since high methane efflux was shown in the early mornings in Fig. 4a, b and d, were the floating chambers deployed at the same time at three different sites for the data shown in Fig. 3? Answer: We measured CH4 fluxes from early morning to late afternoon with about 6 cycles of measurements during the day for the 4-year study. For sampling frequency we measured every monthly. We agree with the Reviewer that 4 year is not "long-term" given the relatively low sampling frequency. So we deleted "long-term" and focused on the multi-seasonal investigations of CH4 effluxes as suggested by Reviewer 1 in the revised manuscript. We used three boats to monitor CH4 fluxes at the three sites, so the floating chambers were deployed at about the same time at the sites as shown in Fig. 3. 5. The area and water table of Poyang Lake fluctuate dramatically between the wet and dry seasons. The authors only have short but not clear descriptions of the effect of water level on methane efflux, e.g., in Lines 404-405 and Line 432. Methane efflux might be high in dry seasons instead of summer, since methane efflux is expected to be high under lower water level due to decreasing of the hydrostatic pressure (e.g. Chanton et al. 1989). Are there any difference in water level between three sampling sites in different seasons (The mean water depth at three sites should not be always 3m through the whole year; Line 186)? The authors might consider a simple calculation of methane solubility changes due to water level fluctuations to strength the role of water level on methane efflux, e.g., Line 432. Answer: It is true that the Poyang Lake features a large seasonal variation of water level, high water level in summer and low in winter. However, the water level at the 3 sites was very similar at a given time of the year. We agree that hydrostatic pressure affects CH4 efflux as reported in Chanton et al. (1989) but our data showed that CH4 efflux was positively correlated with water level. This is because the water level in the Poyang Lake co-varies with other factors, such as temperature and NH4+ content in the water, which also affect the CH4 efflux throughout the year. For example, we found that the CH4 efflux was highly correlated with sediment temperature at an annual scale. Our

results suggest that the CH4 efflux in the Poyang Lake was dominated by temperature rather than water level. The high CH4 efflux in summer was contributed to strong microbial activities induced by warmer temperature and high substrate availability from the flooding water in summer. Therefore, we think the positive correlation between CH4 efflux and water level in the Poyang Lake is a pseudo relation which does not reflect the hydrostatic pressure effect on CH4 efflux as evidenced by Chanton et al. (1989). It is possible to examine the water level effect by calculating CH4 solubility change due to water level fluctuation. However, given the large seasonal variation of temperature in the study area it is very difficult to separate the water level effect based on the CH4 efflux measurements on the water surface. In addition, water level induced CH4 solubility change may affect short-term (minutes to hours) CH4 diffusion gradient and thus CH4 efflux and it should have little impact on CH4 efflux as long as a new diffusion equilibrium has established. Thus, we did not calculate methane solubility changes to further investigate the water level effect on CH4 efflux in revising the manuscript. 6. As the authors stated in the introduction that methane is driven by three major mechanisms such as molecular diffusion, bubble ebullition and plant-mediated transportation, bubble ebullition is not the only pathway for methane to transport from water to the air. However, data for dissolved methane concentrations in lake water and sediments are lack in this study. No bubble ebullition doesn't mean no methane efflux. I would suggest to include diffusive methane flux to the air for comparison in the future by analyzing surface water methane concentrations and using the equation from the gas-transfer model e.g., Wanninkhof (1992). Answer: Great idea! We will take this suggestion in our future study. 7. Since many environmental factors and methane fluxes collected in October 2010 in Poyang Lake have been shown in Liu et al., (2013) for spatial studies, the authors may include Liu et al. (2013) in the introduction and discussions to emphasize why the three sampling sites were chosen in this timescale study and the relations between different environmental factors and methane effluxes in Autumn (October). Answer: Based on our previous study which examined the spatial variation of CH4 efflux in the Poyang Lake (Liu et al. 2013), we chose the 3 sites which gave CH4 effluxes close to the average efflux of the lake. We provided detailed information of Liu et al. (2013) in the introduction and discussion sections as suggested in the revised version. Minor Comments: 1. Lines 57-59: Please add references for the studies in high-latitude, tropical and subtropical lakes. Answer: We added references for the studies in high-latitude, tropical and subtropical lakes in the revised version (Page 4/lines 61-63). 2. Line 129: What fluxes did the floating chamber measured while inserting 20 cm above the water surface? Answer: The chamber measured the total CH4 efflux including diffusive and ebullitive fluxes as described in the method section. The plant-mediated CH4 transportation was negligible because no vascular plants grew above water surface at our study sites. 3. Line 150: the air samples ==> the gas samples Answer: Changed as suggested. 4. Line 159-160; Fig. 4: Since methane efflux was calculated by using a linear regression model to the methane concentration data, should the minimum value be zero instead of a negative value? There should be no negative methane value detected by GC. Answer: The negative efflux means CH4-uptake by the lake water due probably to the short-time change in air pressure. âĂČ Reference: Chanton, J. P.: Gas transport from methane-saturated, tidal freshwater and wetland sediments, Limnol.Oceanogr., 34, 807-819, 1989. 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. Liu, L. X., Xu, M., Qiu, S., Shen, R. C.: Spatial patterns of benthic bacteria communities in a large lake, Int. Rev. Hydrobiol., 100, 97-105, 2015. Liu, L. X., Xu, M.: Microbial biomass in sediments affects greenhouse gas effluxes in Poyang Lake in China, J. Freshw. Ecol., 31, 109-121, 2016.

Please also note the supplement to this comment:
http://www.biogeosciences-discuss.net/bg-2016-286/bg-2016-286-AC3-supplement.pdf

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

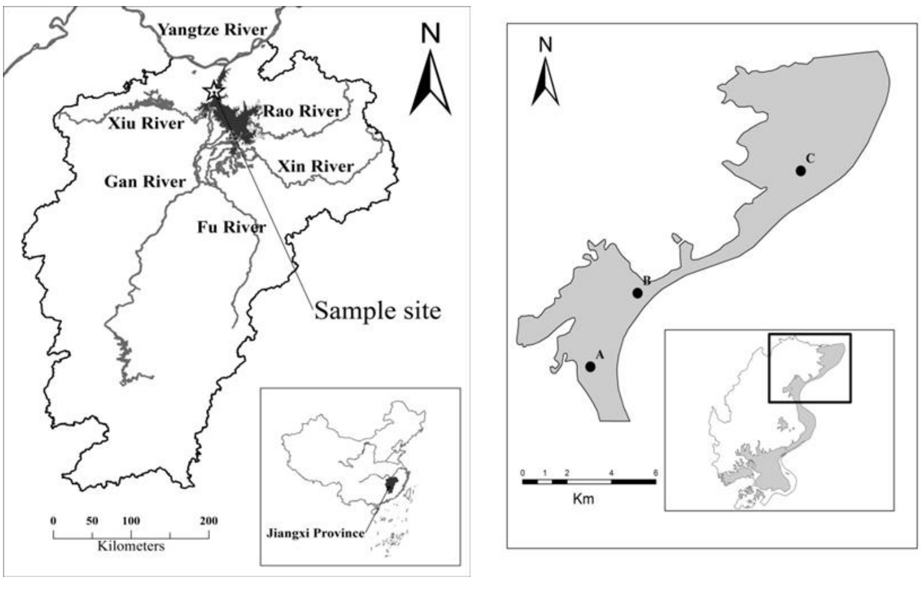

Fig. 1. Location of sampling sites in Poyang Lake.

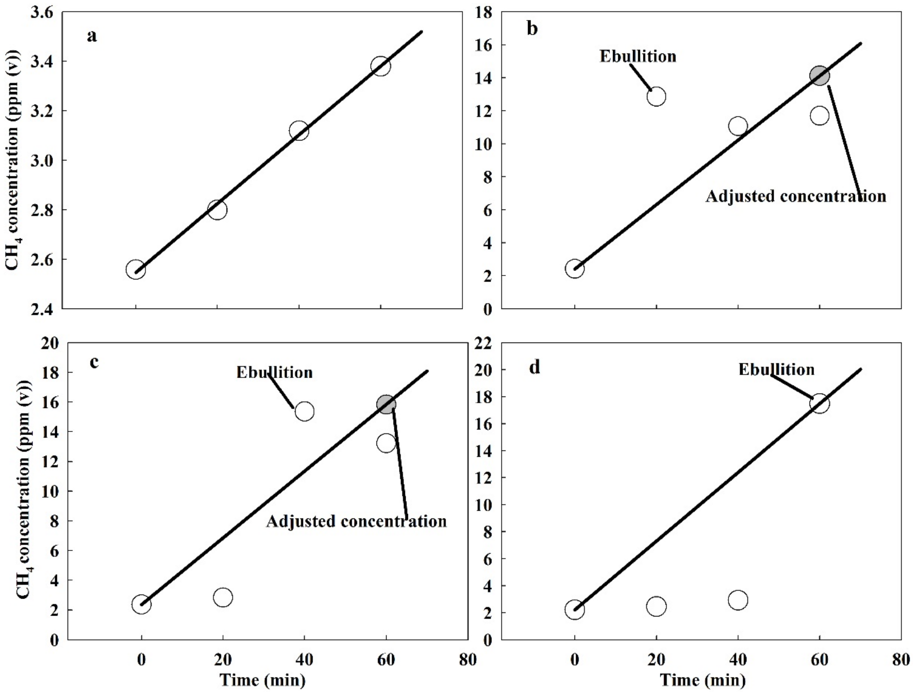

Fig. 2. Examples of calculating the slope of total effluxes, including diffusive and ebullitive effluxes.

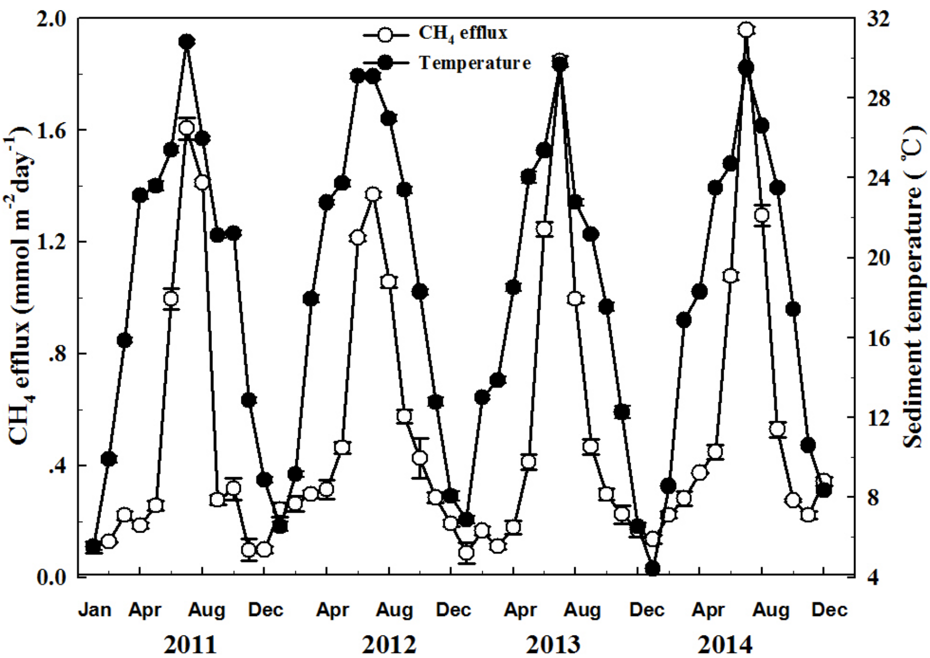

Fig. 3. Seasonal variations of CH4 effluxes and sediment temperatures in Poyang Lake.

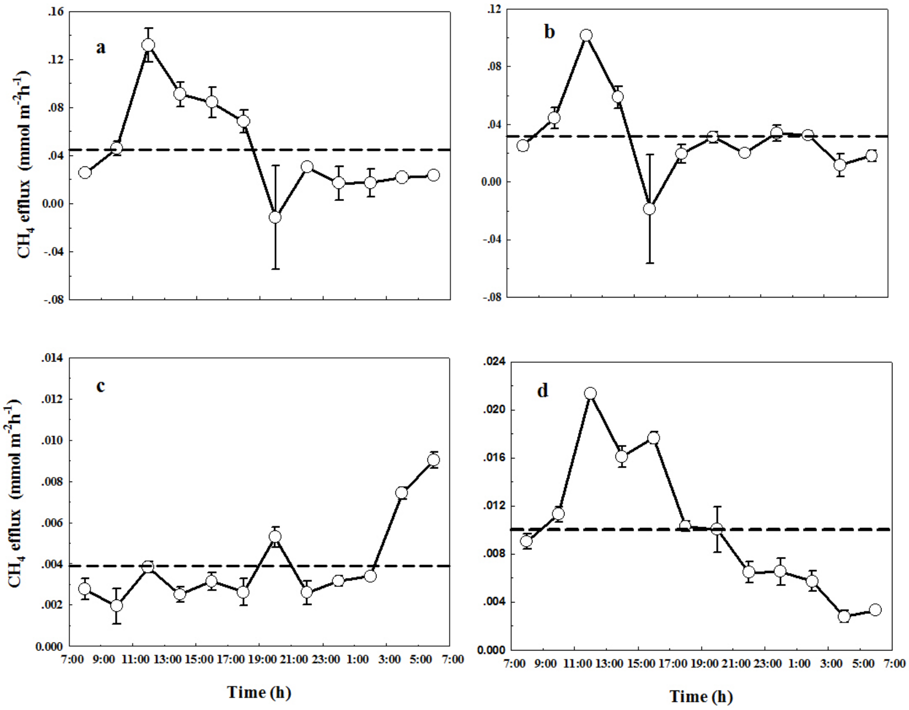

Fig. 4. Diel variations of CH4 effluxes in Poyang Lake.

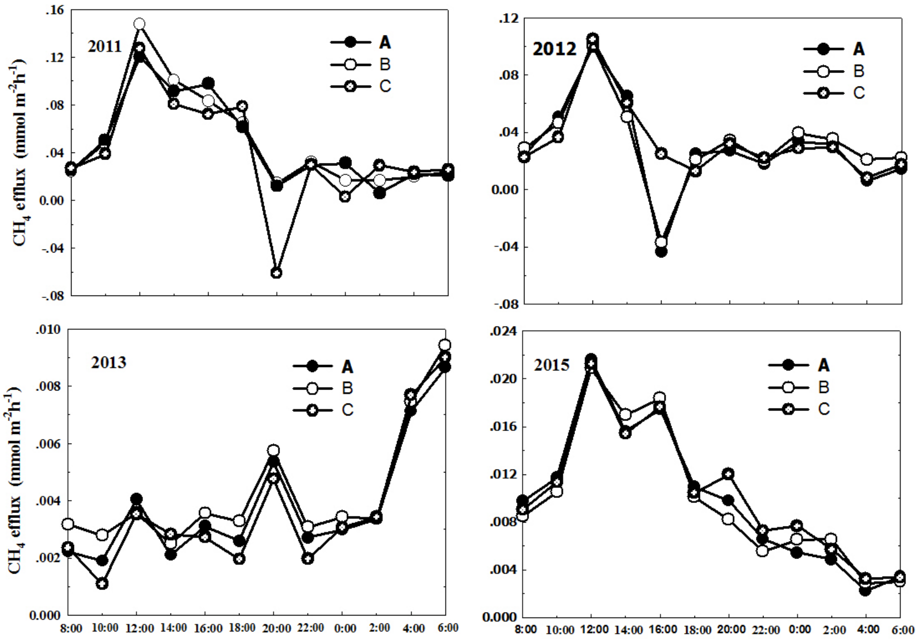

Fig. 5. Diel variations of CH4 effluxes among three sites.

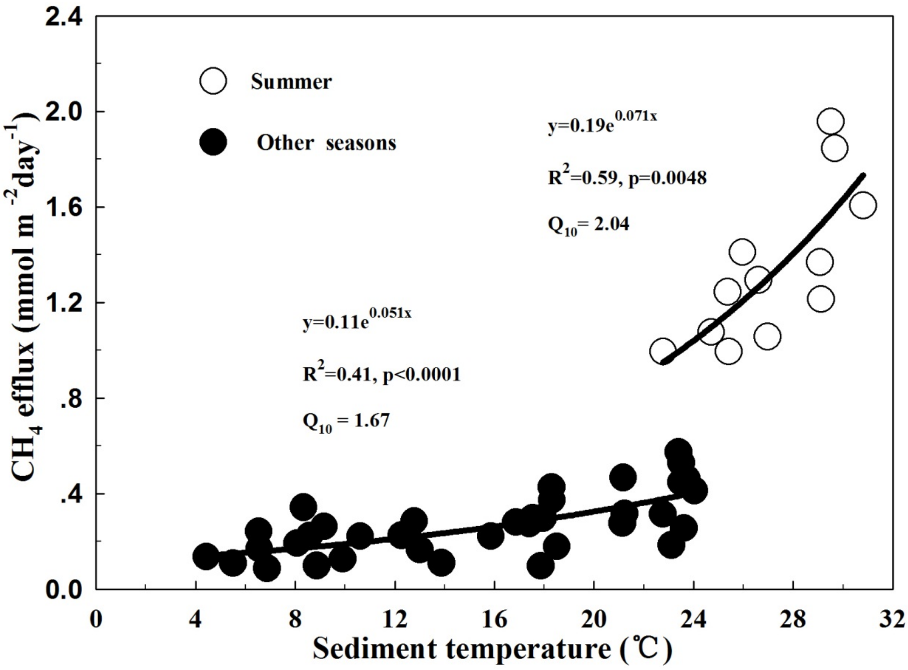

Fig. 6. Relationship between sediment temperature and CH_4 efïňĆuxes in Poyang Lake.

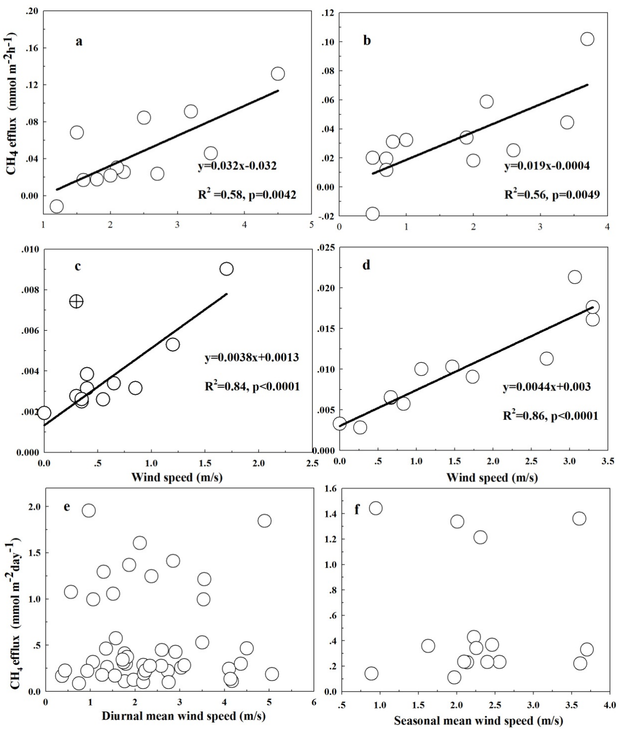

Fig. 7. Relationships between CH_4 effluxes and wind speed in Poyang Lake.