Biogeosciences Discuss.,
https://doi.org/10.5194/bg-2020-178-AC1, 2020

Interactive comment on "Diel and seasonal variability of methane emissions from a shallow and eutrophic pond" *by* Wenli Zhang et al.

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Received and published: 21 August 2020

Comment1: The focus of their study is an artificial pond, with a concrete bottom and water input from rain and street run-off. I do agree, that these anthropogenic structures also emit methane (in this case substantially), the importance of similar structures in China, Asia or worldwide should be discussed. (and not a comparison to beaver ponds in Canada)ïijŽ Response1ïijŽ We agree with the reviewer suggested. This type of pond with a concrete bottom is quite common in China. In the background of the revised manuscript, we will highlight the prevalence of this type of artificial pond in China. We will also add some methane studies from artificial ponds to the discussion to compare with our results in the revised manuscript. HoweverïijŇthe reviewer believed that our results were not comparable to those of a natural pond, which we did not agree with.

Because such ponds are common in China and are on the rise, little research has been done on methane emissions from such ponds. Our results, whether compared to a natural pond or an artificial pond, are to show the intensity of methane emissions from this type of pond. We think there should be no need to distinguish between artificial and natural ponds.

Comment2: The fact that methane production and methane fluxes are enhanced with increasing temperature is nothing new, and this study does not reveal any further insights here. - The same is rue for the influence of organic matter, for which phosphate content is taken as proxy in this study. The more organic material can be degraded, the higher is the methane production. Response2ïijŽ The reviewer is right and studies have shown that both temperature and organic matter affect CH_4 emissions from water bodies. Yet, those studies often relied on short term (30 min) measurements at monthly intervals. Meteorological variables such as temperature, air pressure, and solar radiation can change over timescales of minutes to seasons, which can affect the emissions. Our study, with high frequency flux measurements (Monitoring once every half an hour and continuously for 1 dayïijŇwhich is done once a month for one year), may have a higher probability of detecting direct temperature effects than studies using less frequent measurements, presumably being less influenced by seasonal primary productivity. In addition, our study not only analyzed the effects of temperature and eutrophication level on methane release, but also further explored the synergistic effects of temperature and eutrophication on methane release. The role of small ponds in the global carbon budget can be predicted to some extent under future climate change.

Comment3: Other aspects which from a ecologic point of view could have been more interesting have not been taken into account, such as the influence of precipitation or street run-off, absence of vegetation and fauna(?), or as it is a man-made construction which measure could be taken to reduce the methane emission? Response3ïijŽ The reviewer's Suggestions are very good. However, we did not consider rainfall and street runoff, and we chose sunny weather for in situ field monitoring every time. There are no large aquatic plants in the water we study, but there are microscopic algae and some aquatic animals in the water, and we don't really consider the influence of plants and animals. That's probably what we're going to focus on in the future. In addition, we did not consider analyzing what steps we could take to reduce methane emissions from artificial ponds. Instead, we would like to capture and utilize the methane released from ponds. Of course, this is only a vision of our future, but it hasn't been implemented as yet.

Comment4: L44 update?? Response4ïijŽ We will replace it with IPCC 2019 in the revised draft.

Comment4: L71 CH4 concentration of ponds ?? Response4ïijŽ Here pond CH4 is not only the concentration of CH4, but also the flux.

Comment5: L108 Please clarify: so each month you sampled on one day every hour?? L124 so you measured twice per hour? Response5ïijŽ Yes, indeed. We monitored once every half an hour and continuously for 1 dayïijŇwhich was done once a month for one year. We will redescribe it clearly in the revised draft.

Comment6: L109 Did the water depth vary over the season ?? Response6ïijŽ Yes, it varied. The water level in summer was slightly higher than that in winter. The description of water level in the paper didn't take into account seasonal changes, which was inaccurate. Thanks to the reviewer for reminding. We will re-describe this part in the revised manuscript.

Comment7: L110 A figure of photo would be helpful (may be in the supplements) to get an impression of this pond. Response7ïijŽ Good suggestions. We will provide photos of the pond in the supplements of revised draft.

Comment8: L112 one??. Response8ïijŽThanks. "One "is better than "a". And we will replace it in the revised draft.

Comment9: L167 Please clarify, how did you determine this delta? Tmax - Tmin ??

Response9ïijŽ Yes, it's the difference between the maximum and the minimum temperature throughout the day. We'll describe it clearly in the method of the revised draft.

Comment10: L209 this is a bit confusing, if I understand correctly, the maximum ebull. flux can be either in the early morning, the morning or the afternoon, thus anytime?? Response10ïijŽ When we looked at the pattern of daily bubble release, we found that not only was the bubble itself random, but the maximum daily bubble release was also random. We described it in this way to show the randomness of bubbling. That's the reason why we will try to find out the main factors affecting methane bubbling through various regression analyses in the next part of the article.

Comment11: L225 Which correlation analysis, please specify Response10ïijŽ We used Pearson correlation analysis. We'll specify it clearly in the revised draft.

Comment12: L298 But the point is how can you relate your anthropogenic pond to natural ones?? how widespread is such a type of pond in China or world wide? Response12: There hasn't been much research on methane emissions from concrete ponds at the bottom. Some artificial ponds have been studied, but they have no concrete at the bottom. So we didn't make a distinction between artificial ponds and natural ponds. As described earlier, our study shows the intensity of methane release from this type of pond and the contribution of different release pathways to the total methane flux. We think we can make no distinction between artificial and natural ponds. However, it is true that some research on artificial ponds is missing in this part of our discussion, which we will supplement in the revised draft. Besides, these concrete ponds at the bottom are very common in Chinese towns, especially in southern China, where there are two or three ponds per community.

Comment13: L342 I do not understand how air temperature should have any influence on CH4 fluxes ? Could it be a co-corelation between air temperature and water temperature?? Response13: It's known that air temperature and water temperature are interrelated and affect each other. Usually there are large diurnal variations in air temperature and small diurnal variations in water temperature. In the case of little change of water temperature, ∆T (the difference between water temperature and air temperature) is mainly affected by air temperature. Convective mixing caused by ∆T has been found to coincide with pulses of CH4 emissions. This is the main reason why we collect data every half an hour throughout the day. Besides, in order to analyze what are the major factors in the environment, researchers would collect large amounts of data and analyze them statistically. That's what we did.

Comment14: L343 yes, this has been known for a while, so I do not see what is new in your findings?? Response14: As described earlierïijŇour study, with high frequency flux measurements may have a higher probability of detecting direct temperature effects than studies using less frequent measurements, presumably being less influenced by seasonal primary productivity. In addition, our study not only analyzed the effect of temperature, but also analyzed the effect of daily temperature difference, daily water temperature difference and water temperature and temperature difference on methane emission.

Comment15: L371 to my knowledge the calculation of the methane flux and k600 only relates to the water temperature but not air temperature. Response15: Yes, the calculation of the methane and k600 only relates to the water temperature not air temperature. However, the causes which influence k600 are very complicated. Many efforts have been doing on this issue to quantify how environmental factors affect k600. These factors include wind speed, current velocity, water temperature, air temperature and so on. For examples:

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Upstill-Goddard, R.C., Watson, A.J., Lissi, P.S., et al., 1990. Gas transfer velocities in lakes measured with SF6. Tellus, 42B:364-377. [5] Beaulieu, J.J., Shuster, W.D., Rebholz, J.A., 2012. Controls on gas transfer velocities in a large river. Journal of Geophysical Research(Atmospheres), 117:G02007, doi:02010.01029/02011JG001794. [6] Vachon, D., Prairie, Y.T., 2013. The ecosystem size and shape dependence of gas transfer velocity versus wind speed relationships in lakes. Canadian Journal of Fisheries and Aquatic Sciences, 70(12):1757-1764. [7] Cole, J., Bade, D., Bastviken, D., et al., 2010. Multiple approaches to estimating air-water gas exchange in small lakes. Limnology & Oceanography Methods, 8:285-293. [8] Vachon, D., Prairie, Y.T., Cole, J.J., 2010. The relationship between near-surface turbulence and gas transfer velocity in freshwater systems and its implications for floating chamber measurements of gas exchange. Limnology and Oceanography, 55(4):1723-1732. [9] Jähne, B., Münnich, K.O., Bösinger, R., et al., 1987. On the parameters influencing air-water gas exchange. Journal of Geophysical Research: Oceans, 92(C2):1937-1949. [10] Wanninkhof, R., 1992. Relationship Between Wind Speed and Gas Exchange Over the Ocean. J. Geophys. Res., 97(C5):7373-7382. [11] Liss, P., Merlivat, L., 1986 Air-Sea Gas Exchange Rates: Introduction and Synthesis, in: P. Buat-Ménard, (Ed), The Role of Air-Sea Exchange in Geochemical Cycling, NATO ASI Series 185 Springer Netherlands, pp. 113-127. [12] Xiao, S., Yang, H., Liu, D., et al., 2014. Gas transfer velocities of methane and carbon dioxide in a subtropical shallow pond. Tellus B: Chemical and Physical Meteorology, 66(1):23795.

Please also note the supplement to this comment:
https://bg.copernicus.org/preprints/bg-2020-178/bg-2020-178-AC1-supplement.pdf

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