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Discussions

Interactive comment on "Greenhouse gas emissions from river riparian wetlands: An example from the Inner Mongolia grassland region in China" *by* Xinyu Liu et al.

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Dear Editors and ReviewersïijŽ

I very much appreciate your efforts and time in reviewing our manuscript. According to your precious advice and suggestions, we have revised this manuscript thoroughly. Response to each question from editors and reviewers were listed below. Thank you very much for your precious time and tremendous efforts in reviewing and supporting this manuscript.

Best Regards,

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Reviewers' comments: Reviewer #1: a)Table 1: please provide the number of the samples (n). Moreover, the grain size distributions (or the % age of sand, silt, clay) should be added. Additionally, the saturated volumetric water content and the residual volumetric water content of the soil should be determined. Reply: We have added the number of the samples (n), annual soil volumetric moisture content for the 0–10 cm and 10–20 soil depth in wet season and in dry season, and the saturated soil moisture content (SSM) in Table 1 and the grain size distributions added in Table 2. However, we don't add the residual volumetric water content, because we cannot measure the matrix suction and draw the pF curve. Residual volumetric water usually obtained by fitting the pF curve with the van genuchten formula. This is another research direction, and we do not have enough theory to study it. b)Fig. 3: It is not clear if the SMC(%) is based on volume or mass. Also in the text the numbers for SMC are not clear. I suppose, the values are gravitational SMCs. It is important that SMC is related to the soil water capacity and the pF curve of the soils. Therefore, relative saturation would be a better measure. Alternatively, the authors can define the field capacity and the saturation values of the different soils. Reply: SMC stands for soil mass moisture content, which has been indicated on line 144. We have rewritten the contents of the SMC, marking SMC10 and SMC20 as following: "The temporal and spatial variations in SMC10 in the following order: wet season > dry season and riparian wetlands > hill-slope grasslands (Fig. 3a, c, e). Similar variations were observed in SMC20 (Fig. 3b, d, f). The average SMC10 and SMC20 in the continuous river transects in the riparian zones (37.44% in wet season and 19.40% in dry season; 25.96% in wet season and

17.39% in dry season) were higher than those in the hillslope grasslands (9.12% in wet season and 4.15% in dry season; 6.51% in wet season and 5.96% in dry season). During the study period, both SMC10 and SMC20ÂăchangedÂăas the distance from the river increased, and the highest value was observed at the near-stream sites (L1 and R1). SMC10 fluctuations were low in the intermittent transect compared to the upstream transects, with a mean value of 11.79% in wet season and 3.72% in dry season in the riparian areas. The mean SMC10 in the hillslopes was 6.58% in wet season and 2.86% in dry season. SMC20 showed similar fluctuation, 7.22% in wet season and 2.98% in dry season in the riparian areas and 7.56% in wet season and 4.4% in dry season in the hillslopes. In transect T5, average SMC10 and SMC20 at the center of the lake (29.00% in wet season and 13.36% in dry season; 29.30% in wet season and 9.69% in dry season) were higher than those along the lake shore (4.90% in wet season and 3.13% in dry season; 3.34% in wet season and 5.22% in dry season)". c)Fig. 4) please integrate into the figures an improved legend. Then you can skip the lenghty text of fig.4. Reply: We have revised the legend in fig.4 and shortened the lengthy text of fig.4. d)Fig. 6) please indicate Riparian wetlands and hillslope grasslands directly in the figures. Then you can shorten the lengthy text of fig. 6. Reply: We have indicated "Riparian wetlands" and "Hillslope grasslands" in fig.6 and shortened the lengthy text of fig.6. e)line 292 and line 300/ line 301: SMC values of 40 to 60%... This must be related to the soil, because SMC is a function of suction (matrix potential). Reply: Yes, this is a very complex subject, and the soil's permeability is difficult to determine. This is another research direction, and we do not have enough theory to study it. So, we determined soil mass moisture content simply using experimental methods to illustrate the relationship between SMC and GHGs emissions. f)line 312: What means: "SMC was above the saturated water content"? This is not possible. Reply: Sorry for confusing you. "SMC was above the saturated water content" means that the soil reaches saturation. Thus, we have revised the sentence to "When SMC reaches or is close to saturation" , which has been indicated on line 344. g)Chapter 4.1.3: It would be beneficial for the understanding, if the

authors can calculate CO2 balances. Is the balance of photosynthesis and respiration / emission positive or negative? Reply: The paper uses the static dark chamber method to measure the ecosystem's respiration and discusses the "emission" part of greenhouse gases. The "absorption" is not measured, so the CO2 balance cannot be calculated. This is a very good suggestion that can be studied in the future. Generally, photosynthesis in healthy wetlands is more significant than respiration, conducive to the accumulation of organic matter. During the wetlands' degradation, the plant community and microbial composition change, the biomass is reduced, and photosynthesis is minor than respiration, causing carbon loss in the wetlands. After wetlands completely degraded, photosynthesis is more excellent than respiration, reaching a new balance. However, compared with a healthy wetland, the accumulation of organic matter is significantly reduced. h)The nitrification / denitrification description is too vague. Please insert the formulas of the nitrification / denitrification processes and determine its relation / quantification. Reply: We have added the formula and modified it in various parts of 4.1.1, 4.1.2, and 4.1.3. "The N2O fluxes showed a clear spatial pattern associated with the changes in SMC. The moisture content of wetland soils directly affects the aeration status of the soil. Besides, the aeration status affects the partial pressure of oxygen, which has an important impact on nitrifying/denitrifying bacteria's activity and ultimately affects soil N2O emissions (Zhang et al., 2005). Table 4 shows that N2O emissions are significantly positively correlated with SMC10 and SMC20 ($P < 0.01$). Generally, when SMC was below the saturated water content, the microorganisms were in an aerobic environment, and N2O mainly came from the nitrification reaction. N2O emissions increases with the increase of SMC (Niu et al., 2017; Yu et al., 2006). In our study, the sampling sites with higher SMC (riparian zones and some hillslope grassland zones in the upstream transects) have higher N2O emissions. When SMC increases to the saturated water content or is in a flooded state, the system was an anaerobic environment, and the Nos activity was higher due to excessively high SMC, which was conducive to denitrification and eventually produced N2 (Niu et al., 2017; Yu et al., 2006), such as site L1 in transect T3 in this study. Ulrike et al. (2004) showed that denitrification was the main process under flooded soil conditions in wetland soils, and the release of N2 exceeds N2O. These findings are consistent with those of Liu et al. (2003), who showed that SMC is an essential factor affecting N2O emissions". We have put the formula in the supplement. "Previous studies indicated that temperature is an important factor affecting N2O emissions (Sun et al., 2011) through primary mechanisms impacting the nitrifying and denitrifying bacteria in the soil. Table 4 shows that the correlations between N2O emissions and ST10 and ST20 are poor (P > 0.05). This can be attributed to the wide suitable temperature range for nitrification-denitrification and weak sensitivity to temperature. Malhi et al. (1982) found that the optimum temperature for nitrification was 20 âĎČ, and it will inhibit entirely at 30 âĎČ. However, Brady (1999) believed that the suitable temperature range for nitrification was 25ï¡đ35âĎČ, and the nitrification inhibits below 5 âĎČ or above 50 âĎČ. It showed that the temperature requirements of nitrifying microorganisms in wetland soils were different in different temperature belts. The suitable temperature range was the performance of the long-term adaptability of nitrifying microorganisms. Meanwhile, several studies revealed that denitrification could be carried out in a wide temperature range (5ï¡đ70 âĎČ), and it was positively related to temperature (Fan., 1995). However, the process will be inhibited when the temperature was too high or too low. The average ST in wet season was 27.4°C, conducive to the growth of denitrifying microorganisms, while that in dry season was 8.97°C, and the microbial activity was generally low (Sun et al., 2011). Furthermore, ST fluctuations were low both in wet season and dry season. Therefore, the effect of ST on N2O emissions was masked by other factors, such as moisture content". "Soil carbon source has an important influence on microbial activity. Nitrifying or denitrifying microorganisms need organic matter to provide carbon source during the assimilation of NH3 or NO3-. The high content of organic matter in the soil can promote the abundance of heterotrophic nitrifying bacteria increases, consume dissolved oxygen in the medium, and cause the soil to become more anaerobic, slowing down autotrophic growth nitrifying bacteria. This reduces the nitrification rate, ultimately promoting N2O release. Enwall et al. (2005) studied the effect of long-term fertilization on soil denitrification microbial action intensity. They found that the soil with long-term organic fertilizer application has a significant increase in organic matter content, and consequently, a significant increase in denitrification activity". "Moreover, incomplete denitrification leads to the accumulation of NO2-N, which is conducive to the N2O release. Meanwhile, due to the weak competitive ability of Nos to electrons, low C:N inhibits the synthesis of Nos, which is also a reason for N2O release". i)table 3: please add the number of samples (n). Reply: We have added the number of samples in table 5. j)line 464 and line 472: I would like to see the long term balance of CO2. Do we have a source or a sink in degraded wetlands considering a longer time span (several years)? Reply: Just like Question g, we cannot calculate the CO2 balance. However, according to the variation trend along the transects and in the longitudinal direction, the wetlands will gradually change into grasslands under the long-term degradation, and are carbon sinks. Meanwhile, theÂăgrasslands have aÂălowerÂăcarbonÂăfixationÂăcapacityÂăthanÂătheÂăwetlands, causing soil carbon loss.

Please also note the supplement to this comment:
https://bg.copernicus.org/preprints/bg-2020-184/bg-2020-184-AC1-supplement.pdf

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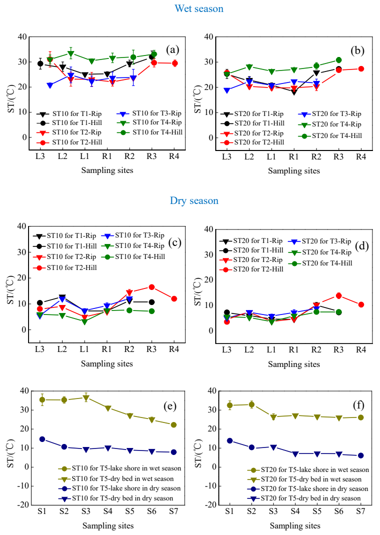

Fig. 4 Soil temperature (ST) at soil depths of 0–10 cm (ST10) and 10–20 cm (ST20) for transects T1–T5 in wet season and dry season. Error bars represent the SD about the mean.

Fig. 1.

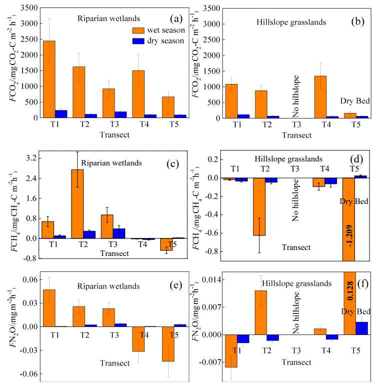

Fig. 6 Spatiotemporal patterns of CO$_2$ (first line), CH$_4$ (second line), and N$_2$O (third line) emissions (*F*) in the upstream (T1, T2, and T3) and downstream areas (T4 and T5). Bars are the mean values for each transect and error bars are the standard errors.

Fig. 2.