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Interactive comment on “Factors controlling *Carex brevicuspis* leaf litter decomposition and its contribution to surface soil organic carbon pool at different water levels” *by* Lianlian Zhu et al.

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Comment 2.1 Line 20 and 46: I recommend including (Cao et al. 2020), and references therein, that address aboveground litter decomposition on SOC pools. Response 2.1 Thank you for your recommendation, we had cited (Bowden et al., 2014; Cao et al., 2020) in the revised manuscript in line 46. Comment 2.2 Line 30: The SOC increase due to litter application (Figure 5d) appears to be calculated from Figure 5a, but I could not reconcile the value for -25 cm. While Figure 5 does seem to support that litter increases SOC, I have two concerns about this presentation. First, the differences in Figure 5a for the 0 cm water levels is labelled as significant, but the error bars clearly overlap. Please clarify. Second, and a potential fundamental flaw in the data presentation, is that the baseline SOC is not provided and there is no way to know if SOC changed throughout the course of the experiment. It appears based on Equation 4 you did measure baseline SOC for each core (_18 g kg-1)? Please clarify. In either case, a significant observation, which is not discussed, is that the no-litter treatments resulted in very large SOC increases and adding litter resulted in a small additional increase. Response 2.2 For the first concern, we are sorry for the mistake of the error bars. Figure 5a has been reconstructed. For the second concern, the soil cores were collected from the same site, and the baseline SOC was 63.32g kg-1. The aim of this study was to clarify the impact of litter addition on SOC, so we did not present the SOC baseline. The SOC differences among three water levels were caused by different soil mineralization in different environments. Soil mineralization in aerobic environment (-25 cm) was significantly higher than that in the flooded environment (0 cm, +25 cm) (Qiu et al., 2018), so the SOC at -25 cm water level was lower than the other two water levels. To avoid confusion, we have added the baseline SOC (63.32g kg-1) in section 2.2 in line 10. Comment 2.3 Line 40: References for this statement are inappropriate, or incorrectly cited. Means et al. 2016 does not discuss global carbon pools. Whiting and Chanton (2001) is an accurate source for the value you used for wetland carbon stocks, but they cite Schlesinger 1991 as their source, and there are more up-to-date carbon stock estimates, such as (Köchy, Hiederer, and Freibauer 2015). Cao et al., 2017, is a secondary reference, like Whiting and Chanton (2001), and neither reflect the range of wetland soil carbon (25– 63%) you provide. The value in Whiting and Chanton (2001) is 3 – 68% (secondary references) and the value in Cao et al. (2017) is 12 – 15% (also a secondary reference). Use of the most up-to-date sources and an accurate reflection of those sources adds value to the manuscript. I recommend adding a citation such as (Kayranli et al. 2010), which could also be useful in your discussion considering what happens to the SOC after it is leached from the litter into the soil. Response 2.3 We are sorry for the mistake and thank the reviewer very much for the commendation and suggestion. We have add the value into the manuscript, and cited the references (Kayranli et al., 2010;Kochy et al., 2015). The sentences have been rephrased as follows: Wetlands are important terrestrial carbon pools. They contain between 82 and 158 Pg SOC, which depending on the definition of "wetland" (Kayranli et al., 2010; Kochy et al., 2015). Please see Line40-41. Comment 2.4 Line 52: The Sun et al., 2019 study does not support the statement that litter decomposition stabilized the soil organic carbon pool. Litter decomposition made DOC more mobile and labile, which the authors suggested could lead to SOC stability after processing by soil microbes. Response 2.4 We are sorry for the mistake. The sentences have been rephrased as: In contrast, a recent study found that litter decomposition stabilized the soil carbon pool after processing by soil microbes in the Jiaozhou Bay wetland (Sun et al., 2019). Please see Line51-52. Comment 2.5 Lines 54-56: Aerts (1997) addresses litter decomposition in non-wetland sites where shredder invertebrates (detritovores) are important, but their role in wetland settings is more uncertain (Inkley, Wissinger, and Baros 2008). Shredding would be an important physio-chemical control on DOC leaching. Response 2.5 We thank the reviewer very much for the commendation and suggestion. The references have been changed, and the sentences have been rephrased as follows: Litter decomposition is a physicochemical processes that reduces litter to its elemental chemical constituents (Berg and McClaugherty, 2003). Litter decomposition rates are determined mainly by environmental factors (climatic and soil conditions), litter quality (litter composition such as C, N, and lignin content) and decomposer organisms (microorganisms and invertebrates) (Yu et al., 2020;Yan et al., 2018). Please see Line 53-57. Comment 2.6 Line 62: Zhang 2019 supports the statement that water levels affected microbial activity, but leaching and fragmentation were only discussed, not measured. Response 2.6 We are sorry for the ambiguity. The references have been changed to (Van de Moortel et al., 2012), which designed a leaching experiment to clarify the leaching process of litter decomposition. Please see Line 62.

Comment 2.7 Line 64: This is a mischaracterization of the Upton, 2018 study. Perhaps a better reference is (Hoyos-Santillan et al. 2015). However, clarification is needed because Hoyos-Santillan states that roots (not litter) are the main source of SOC in

peatlands, but litter strongly influences root decomposition rates, particularly near the surface. Response 2.7 We are sorry for our carelessness. The sentence has been rephrased as follows: Leaf litter contributes more to soil organic carbon than fine roots (Cao et al., 2020), litter also strongly influences root decomposition rates, particularly near the soil surface (Hoyos-Santillan et al., 2015). Please see Line 64-66.

Comment 2.8 Line 151. The Olson (1963) simple decay model assumes constant k, which you demonstrated is not a constant. Although use of this decay model is common in the literature, it is an oversimplification. This does not adversely affect your comparative analysis, but the paper would be strengthened with a more sophisticated analysis, such as a double exponential decay model (Berg 2014 or Wider and Lang 1982). Response 2.8 Thank you for the constructive suggestions. We have modified the model based on your suggestion to highlight the instantaneous rate variation of litter decomposition. The model is: M_(t_n)=M_(t_(n-1)) e^(ãĂŰ-kãĂŮ_n (t_n-t_(n-1))) Where M_(t_n) is the litter dry matter weight at nth sampling (g), M_(t_(n-1)) is the litter dry matter weight at (n-1)th sampling (g), t_n-t_(n-1)is the time between the nth and (n-1)th sampling, k_nis the instantaneous decomposition rate at the nth sampling. (Please see line 150-155) This model would be more accurate. The result was as following: The instantaneous litter decomposition rate was highest at initial and slowly decreased and stabilized at all three water levels. The maximum decomposition rates at the -25 cm, 0 cm, and +25 cm water levels were 0.00527 d-1, 0.00908 d-1, and 0.01307 d-1, respectively (Fig. 2b). (Please see line 189-192)

Based on the change of the instantaneous decomposition rate, we recalculated the multiple regression model which was used to analyze the intrinsic litter decomposition rate-limiting factor. The models are as follows (Table 1):

Water level (cm) Multiple regression model F R2 P -25 R=-0.715L-0.443C+0.033 5.738 0.727 0.006 0 R=-928LN-0.233CN+0.023 5.928 0.927 < 0.001 +25 R=-0.717LN+0.016 9.543 0.793 0.002

The multiple regression model of the instantaneous litter decomposition rate and the litter properties showed that at the -25 cm, the main decomposition rate-limiting factor was the lignin concentration, whilst at 0 cm and +25 cm water level, the main litter decomposition rate-limiting factor was the lignin/N ratio. Please see line 200-203. Comment 2.9 Line 266: Doesn't your argument imply C. brevicuspis, due to it's lower lignin content, would return less carbon to the soil compared to the other plants you cited? The manuscript may be strengthened, and have a wider inference, if you listed and compared decomposition rates and lignin contents of wetland plants including C. brevicuspis. Response 2.9 Thank you for the suggestion. But we just intended to clarify that the lignin content of C. brevicuspis leaf litter was lower than the other plants, so the C. brevicuspis leaf litter was more easily to be leached and then contributed more to the SOC pool. Due to the different environment, the litter decomposition rates were different, so we didn't compared decomposition rates. On the other hand, the aim of our study was to explore the contribution of litter decomposition to SOC pool, instead of the relationship between lignin content and litter decomposition rate. Taking all these into account, we didn't list and compare decomposition rates and lignin contents of wetland plants. Comment 2.10 Line 284: Your conclusion contains a significant amount of new and largely unsupported discussion material. Conclusions should stick to what you were able to show in your experiments. Response 2.10 Thank you very much for the comment. The conclusion part has been rephrased as follows: In this study, we quantified the contribution of leaf litter decomposition on soil surface organic carbon pools (S-SOCPs) under different water level conditions. Appropriate flooding (+25 cm water level treatment in our study) can significantly promote the decomposition of litters and contributed about 13.75% organic carbon to S-SOCPs. Under waterlogging condition (0 cm water level), litter decomposition, which mainly controlled by microbial activity, contributed 4.73% organic carbon to S-SOCP. However, under relatively drought condition (-25 cm water level treatment in our study), litter decomposition only contribute about 2.51% organic carbon to S-SOCP, which is largely ascribe to the slower decomposition rate and soil carbon lost by metabolism of the microbes (i.e. actinomycete).

We also found that lignin and/or lignin/N content were intrinsic factors controlling litter decomposition rate in Carex brevicuspis. In Dongting Lake floodplain, the groundwater decline which was caused by the climate change and human disturbance would slowdown the return rate of organic carbon from leaf litter to soil, and facilitate the S-SOCP loss. Please see line 291-302. We hope this modification can meet the requirements. Comment 2.11 Table 1: Is the lignin content (L) in the regression model the initial lignin content? Response 2.11 Sorry we didn't clearly define the model indictors. The regression model is used to analyse the intrinsic litter decomposition rate-limiting factor. We added "All indicators used to analyse the model was refered to the content at each time point" in line 450-451. Comment 2.12 Figure 3d (LRRI%) is nearly identical to Figure 2a (litter dry weight loss, %), which seems counter-intuitive unless lignin were the sole material being mineralized during the decomposition process. Did you measure lignin content at each time point? Response 2.12 We measured lignin content at each time point. In fact, the results of stepwise regression analysis showed that lignin content is the main intrinsic litter decomposition rate-limiting factor, which is consistent with the figure 3d. Technical corrections: Comment 2.13 Line 23: Carex brevicuspis may be ubiquitous to wetlands in China; however, is this true globally? Response 2.13 We are sorry for the ambiguity. This sentence has been rephrased as: The Carex genus is ubiquitous to global freshwater wetlands. Comment 2.14 Line 25: Is "mass loss" = "carbon release"? If so, one of these phrases is redundant. Response 2.14 Thank you for remind us. In our opinion, mass loss includes not only carbon release but also other elements release, such as N, P. but because of the high proportion of carbon release, the trend of mass loss and carbon release are similar. Mass loss reflected the whole process of litter decomposition, while carbon release reflected the process of carbon release. Comment 2.15 Line 82: The way you stated your hypotheses imply you have tested causal factors, which you did not. Specifically, leaching, fragmentation and infiltration. Response 2.15 Thank you for reminding us. We have rephrased the hypotheses as follows: First, water level has a significant effect on litter decomposition. Second, the intrinsic limiting factors may be different among three water levels. Third, the contribution of leaf decomposition to S-SOCP was relatively higher at the +25 cm water level. Comment 2.16 Line 102: Did the litter bags float? Did you need to pin them in contact with the soil surface? Response 2.16 We are sorry for the negligence. All litter bags were fixed to the soil surface with bamboo sticks. And the sentence has been added in section 2.2 in line 107-108. Comment 2.17 Line 105 - 107: Clarify how many soil cores were used in each pond for each purpose and how they were prepared (e.g. were soils blended prior to starting the experiment). The text is confusing. Response 2.17 We have clarified that all the soil cores were undisturbed soil. The experiment was conducted in nine cement ponds (2 m × 2 m × 1 m) (see Line 107-108 in revised manuscript). Three soil core sets were placed in each pond. One was designated the litter removal control (S), the second was distributed on the soil surface in 15 litter bags to observe the effects of leaf litter input on soil carbon pool (L), and the third was distributed on the soil surface in 15 litter bags to monitor the litter decomposition rate and process (D) in Line 113-116 in revised manuscript.

Comment 2.18 Line 183: You use capital letters (Fig 2A) in text references, but lower-case letters in the Figures. Response 2.18 We are sorry for the mistake. The capital letters in the text references have been changed into lower-case letters. Comment 2.19 Line 187/188 and Line 247: I would not interpret your data that decomposition rates "rapidly increased" – the decomposition rate at time t=0 is undefined. Response 2.19 We are sorry for our obscure writing. The sentences have been rephrased as: The instantaneous litter dry weight decomposition rate was highest at initial and slowly decreased and stabilized at all three water levels. Please see line 189-190. Comment 2.20 Figure 4: Are these figures reporting mass? The units are nmol g-1. Response 2.20 We are sorry for that we didn't clearly define the calculation method about microbial community structure. These figures were used to report the PLFA molar mass concentration. This is a common way to show the microbial content (Zhao et al., 2015). We calculated PLFA mass content first, PLFA (ng/g dry soil) = (Response of unkown PLFA/ Response of 19:0 internal standard)×concentration of 19:0 internal standard×(volume of sample/mass of soil). Concentration of 19:0 internal standard: 5 ug/ml, volume of sample: 200ulïijŇmass of soil: 8g dry soil. And then we calculated PLFA molar mass concentration, PLFA (nmol / g dry soil) = PLFA (ng/g dry soil)/ relative molecular mass. Please see line 165-169. The references in the responses were listed as follows: Cao, J. B., He, X. X., Chen, Y. Q., Chen, Y. P., Zhang, Y. J., Yu, S. Q., Zhou, L. X., Liu, Z. F., Zhang, C. L., and Fu, S. L.: Leaf litter contributes more to soil organic carbon than fine roots in two 10-year-old subtropical plantations, Science of the Total Environment, 704, 8, 10.1016/j.scitotenv.2019.135341, 2020. Hoyos-Santillan, J., Lomax, B. H., Large, D., Turner, B. L., Boom, A., Lopez, O. R., and Sjogersten, S.: Getting to the root of the problem: litter decomposition and peat formation in lowland Neotropical peatlands, Biogeochemistry, 126, 115-129, 10.1007/s10533-015-0147-7, 2015. Kayranli, B., Scholz, M., Mustafa, A., and Hedmark, A.: Carbon Storage and Fluxes within Freshwater Wetlands: a Critical Review, Wetlands, 30, 111-124, 10.1007/s13157-009-0003-4, 2010. Kochy, M., Hiederer, R., and Freibauer, A.: Global distribution of soil organic carbon - Part 1: Masses and frequency distributions of SOC stocks for the tropics, permafrost regions, wetlands, and the world, Soil, 1, 351-365, 10.5194/soil-1-351-2015, 2015. Qiu, H. S., Ge, T. D., Liu, J. Y., Chen, X. B., Hu, Y. J., Wu, J. S., Su, Y. R., and Kuzyakov, Y.: Effects of biotic and abiotic factors on soil organic matter mineralization: Experiments and structural modeling analysis, Eur. J. Soil Biol., 84, 27-34, 10.1016/j.ejsobi.2017.12.003, 2018. Yan, J. F., Wang, L., Hu, Y., Tsang, Y. F., Zhang, Y. N., Wu, J. H., Fu, X. H., and Sun, Y.: Plant litter composition selects different soil microbial structures and in turn drives different litter decomposition pattern and soil carbon sequestration capability, Geoderma, 319, 194-203, 10.1016/j.geoderma.2018.01.009, 2018. Yu, X. F., Ding, S. S., Lin, Q. X., Wang, G. P., Wang, C. L., Zheng, S. J., and Zou, Y. C.: Wetland plant litter decomposition occurring during the freeze season under disparate flooded conditions, Science of the Total Environment, 706, 9, 10.1016/j.scitotenv.2019.136091, 2020. Zhao, J., Zeng, Z. X., He, X. Y., Chen, H. S., and Wang, K. L.: Effects of monoculture and mixed culture of grass and legume forage species on soil microbial community structure under different levels of nitrogen fertilization, Eur. J. Soil Biol., 68,

61-68, 10.1016/j.ejsobi.2015.03.008, 2015.

Please also note the supplement to this comment:
https://bg.copernicus.org/preprints/bg-2020-266/bg-2020-266-AC2-supplement.pdf

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Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2020-266, 2020.

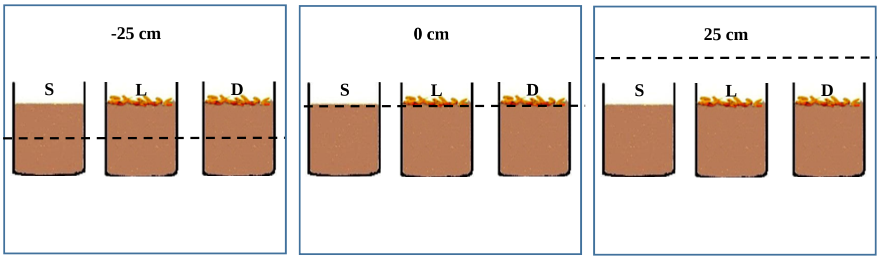

Fig. 1. Figure 1: Schematic diagram of the experimental setup. The dotted line represents the water level. L represents litter which was distributed on the soil surface in 15 litter bags to observe the effect

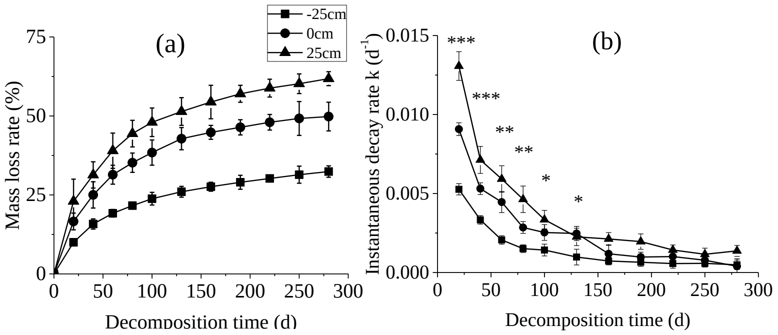

Fig. 2. Figure 2: Percentage litter dry weight loss and decomposition rate during C. brevicuspis decomposition at three water levels (-25 cm, 0 cm, and +25 cm). *, **, and *** represent significant difference

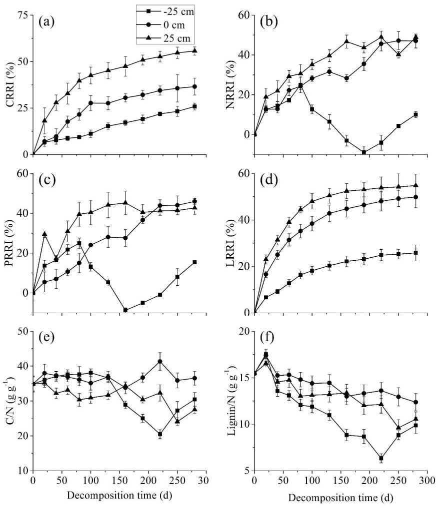

Fig. 3. Figure 3: Percentage (mean ± SE) of carbon relative release index (CRRI), nitrogen relative release index (NRRI), phosphorus relative release index (PRRI), lignin relative release index (LRRI), C/N ra

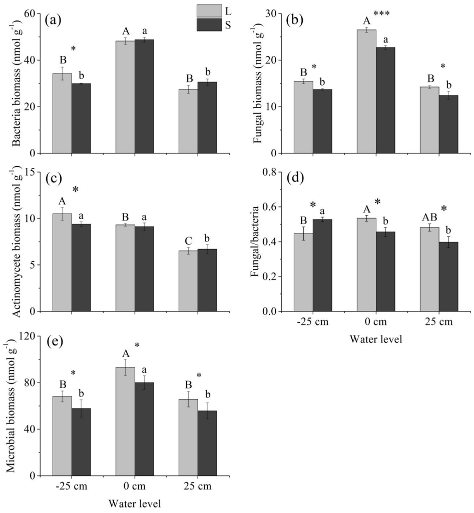

Fig. 4. Figure 4: Microbial community structure under litter input and litter removal at three water levels. Different uppercase letters among vertical bars indicate significant differences among the three wa

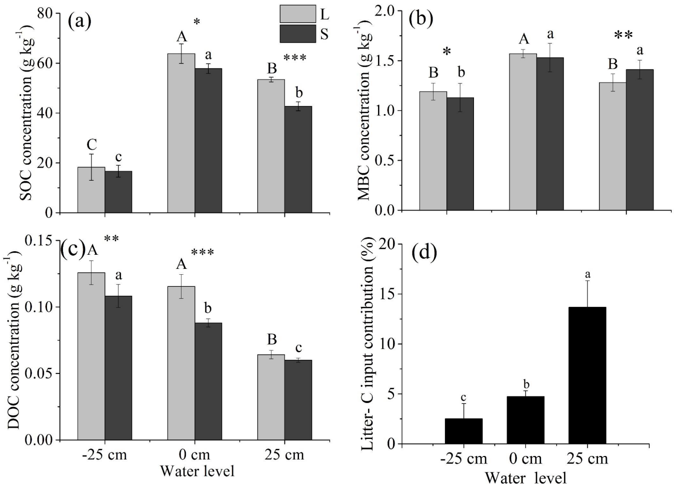

Fig. 5. Figure 5: Concentrations of SOC (A), MBC (B), DOC (C) between the litter input (L) and litter removal (S) groups and the litter-C input contribution (D) under three water levels at the end of the expe