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Interactive comment on "Response of soil respiration and soil microbial biomass carbon and nitrogen to grazing management in the Loess Plateau, China" *by* Zhen Wang et al.

Zhen Wang et al.

wangzh17@lzu.edu.cn

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Response to Anonymous Referee #2

General comments:

The authors investigated how grazing intensities and grazing patterns affect soil respiration as well as the potential underlying mechanisms. Their results are interesting and can be potentially published somewhere. But for the current MS, it was quite confusion and unclear (please see some of my specific comments below). Moreover, there were many grammar errors across the whole MS, I did not list all of these errors, it was quite time-consuming. I deeply understand the writing difficulties for the non-native English researchers, but this MS was quite immature for submission. I suggest that authors should well prepare their manuscript for the next submission.

Author's response: Dear Referee, first of all, we would like to thank you for the time you devoted to reviewing this manuscript. We explain how we have revised the manuscript by following the referee's comments one by one. We have made major revisions on the Abstract, Introduction, Discussion and Conclusions. The revised manuscript has been polished by native English speaker, Mr. Roger Lucien Daives.

Abstract The abstract should be rewritten, particularly for the description of your results. You should focus on what you are really want to let others know from this study.

Author's response: We truly appreciate your constructive suggestions. Changes were made following your advices. The revised part was colored in red in the revised manuscript and also listed as follows:

Grazing management affects grassland carbon dynamics and soil microbial biomass, yet how grazing management, including grazing intensity (GI) and grazing regime (GP), affects soil respiration (Rs) and soil microbial biomass carbon (SMBC) and nitrogen (SMBN) is not fully understood. To determine how GI (0, 2.7, 5.3, and 8.7 sheep ha−1) and GP (warm-season grazing, WG; cold-season grazing, CG) affect Rs, SMBC, and SMBN, an experiment was conducted in a semi-arid grassland that had been rotationally grazed for the previous 9 years. Results suggest that diurnal Rs in WG significantly decreased as stocking rate increased; however, in CG, diurnal Rs was significantly higher at the GIs of 2.7 and 5.3 sheep ha−1 than at 0 and 8.7 sheep ha−1. Although grazing (at the GIs of 2.7, 5.3, and 8.7 sheep ha-1) led to increased Rs in 2010 and decreased Rs in 2011, when compared with Rs in the non-grazing period (0 sheep ha-1), the negative indirect effect of GI on Rs offset its positive indirect effect on Rs over the whole experimental period. GP affected Rs both directly and indirectly through the positive effect it had on soil moisture, soil temperature, and aboveground biomass. Compared with WG, CG significantly stimulated an increase by 22% in annual Rs. A significant difference in the soil temperature sensitivity (Q10) values of Rs was observed at the four stocking rates for both WG and CG, although the Q10 of WG was significantly higher. Interactions between GI and GP had a significant effect on SMBC and SMBN, but GI alone did not affect SMBN. Regarding GP, compared with WG, CG caused a significant decrease of 11% in the mean concentration of SMBN. The monthly precipitation was significantly positively correlated with Rs, soil temperature, soil moisture, and SMBN, but was significantly negatively correlated with SMBC. The field experimental results indicated that the effects of grazing management on Rs processes in the grazing system mainly depend on GP, and the effects of grazing management on SMBC and SMBN mainly depend on the interactions between GI and GP. The results suggest that (1) In a long-term grazing grassland ecosystem, more attention should be paid the role of GP while determining the response of Rs to grazing management, and GP should be considered as an important factor in future evaluation models for studying the response of soil carbon dynamics to climate change; (2) the coupling of GI and GP should be taken into account in future studies on nutrient turnover in the soils of semi-arid grassland ecosystems. Please see L 15-L 42 .

You have a lot of information about your experiments design, is it too specific in the abstract section? Can you describe your experiment design in a much terser way?

Author's response: Thanks. We have rewritten the experiment design in the abstract section in the revised version and also listed as follows: "To determine how GI (0, 2.7, 5.3, and 8.7 sheep ha^{-1}) and GP (warm-season grazing, WG; cold-season grazing, CG) affect Rs, SMBC, and SMBN, an experiment was conducted in a semi-arid grassland that had been rotationally grazed for the previous 9 years." Please see P 1 L18-20.

P1 L16-18. Really? I think there are already many studies investigating these variables, even several meta-analysis. You should reorganize the sentence.

Author's response: Thanks. We have re-worded this sentence as "Grazing management affects grassland carbon dynamics and soil microbial biomass, yet how grazing management, including grazing intensity (GI) and grazing regime (GP), affects soil respiration (Rs) and soil microbial biomass carbon (SMBC) and nitrogen (SMBN) is not fully understood", see L 15-L18.

L 25. I think the word "affect" in your results section is very vague. Readers will not know whether grazing increase or decrease Rs in this way.

Author's response: Thanks for your constructive suggestions, we have revised this sentence as "Results suggest that diurnal Rs in WG significantly decreased as stocking rate increased; however, in CG, diurnal Rs was significantly higher at the GIs of 2.7 and 5.3 sheep ha−1 than at 0 and 8.7 sheep ha−1." Please see P 1 L25

P2 L4. Nothing new from the last sentence of your abstract. I think as a researcher in grazing ecology, one can easily hypothesized that grazing can affect C sequestration through both biotic and abiotic factors. Do you think your conclusion is very new and deserve to be published? One suggestion was that you should be very specific, then you will have your own conclusion.

Author's response: We appreciate the referee's suggestion. To make these sentences clear, we improved them as "The field experimental results indicated that the effects of grazing management on Rs processes in the grazing system mainly depend on GP, and the effects of grazing management on SMBC and SMBN mainly depend on the interactions between GI and GP. The results suggest that (1) In a long-term grazing grassland ecosystem, more attention should be paid the role of GP while determining the response of Rs to grazing management, and GP should be considered as an important factor in future evaluation models for studying the response of soil carbon dynamics to climate change; (2) the coupling of GI and GP should be taken into account in future studies on nutrient turnover in the soils of semi-arid grassland ecosystems", please see L 34-42.

Introduction At the beginning, I should highlight that there are many gramma errors in your whole manuscript; I will not list your errors one by one. I think this is your work, which should be finished before your submission.

Author's response: Sorry, our previous MS caused the misunderstanding by the referee. Roger L. Davies has assisted in editing this research paper.

You have too many abbreviations. It is quite difficult for me to remember so many abbreviations, I need to refresh these abbreviations frequently. Moreover, many abbreviations only appeared once or twice.

Author's response: Thanks for your comments. We have deleted some unnecessary abbreviations in the revised manuscript.

P2 L15. A repetition of the first sentences in your abstract

Author's response: Thanks, We have removed the first sentence in the abstract and changed this sentence as "Grassland covers about 41% of earth's terrestrial surface. . ." in the revised revision. Please see L45.

P2 L22. You have a good literature review. Then what are your research questions? The second paragraph of your introduction was very long, however, you changed your logical and focus for several times. It is very hard for readers to understand what you want to say. You should sharp your research questions and hypotheses. In your current version, you always present your hypotheses, questions and results in quite ambiguous ways. It is quite difficult for readers to find something interesting from your MS, if you determine present your results in this way.

Author's response: We appreciate the reviewer's comments that could help us improve our manuscript. We have rewritten the second paragraph in the revised manuscript as "Although a growing number of studies have shown that the health of grassland ecosystems strongly depends on grassland management strategies, such as grazing and grazing exclusion (Chen et al. 2015; Deng et al. 2017), the influence of grazing management on Rs is not well understood. This limits our understanding of how Rs responds to grazing management and our ability to predict carbon dynamic responses under continued climate change. Grasslands are widely distributed on the Loess Plateau, accounting for approximately 40% of the total area (Wang et al. 2017), and are subject to continuous and widespread stress. Most of the grasslands on the Loess Plateau have degenerated owing to their over-grazing and poor management (Fu et al. 2000). Efficient grassland management strategies have been considered to be an important way to promote soil carbon storage and to recover degraded grasslands (Conant et al. 2001; Ingram et al. 2008; Wang et al. 2011; Chen et al. 2015). Sustainable grazing intensity (GI) and a seasonal grazing regime (GP) with periodic resting are widely used grassland management practices (Cui et al. 2014; Chen et al. 2016; Wang et al. 2017, Wu et al. 2017). Grazing-induced soil respiration has been well studied; however, how the effects of different GIs on soil respiration vary through time remains unclear. For example, previous studies have reported that grazing had a positive effect on Rs (Cao et al. 2004), had no effect on Rs (Jia et al. 2007; Wang et al. 2007; Cui et al. 2014), and had a negative effect on Rs (Chen et al. 2016). Furthermore, in different types of grassland, Chen et al. (2015) found that warm-season grazing (WG) decreased Rs, while Wang et al. (2017) reported that cold-season grazing (CG) significantly increased Rs. These inconsistent results could be attributed to the complex processes induced by GP. Therefore, limited information is available on the effects of GP, especially seasonal grazing, on Rs under different levels of GI. Quantifying the effects of GI and grazing season on Rs is critical to accurately estimate the carbon balance of grassland ecosystems and to better understand how global changes affect grazing management practices on the Loess Plateau. ” Please see L 60-82.

Materials and methods P5 L10. Why do you only measure soil respiration in 2010 and 2011, considering you have conducted this experiment for nine years? Do you continue with the measurements from 2011-2018, since these experiments were conducted eight years ago? The description about your Rs measurements is unclear, even though you had some citations here.

Author's response: Thanks for your comments. The rotational grazing experiment began in 2001, and the Rs and soil microbial biomass C and N measurements were carried out from 2010 to 2011, the previous 9 years of field trials being used for other experimental purposes. We continue with the measurements from 2012-2018. Since 2012, we had set up another experimental on the original basis. For this reason, the data beyond 2012 is not shown in this manuscript. We have rewritten the description about Rs measurements as "For the field measurement of Rs, soil CO2 efflux chambers (six PVC collars permanently placed in each plot) were attached to each of the two gas analyzers (LI-COR 8150, Lincoln, NE, USA), which were rotated in a 2-h cycle around all plots in each GP group (WG and CG). The diurnal Rs flux in each plot was measured at 2h intervals between 6:00 am and 10:00 pm, on six fine days in mid-May (early growth stage of herbage), September (peak aboveground biomass), and December (dormancy) only in 2010 and 2011. Sampling sites were randomly selected at 30–40-m intervals along three 50-m long transects per plot, with two PVC collars (11 cm diameter $\times$ 5 cm height) per transect (i.e., six collars per plot). In preparation for Rs measurement, all aboveground vegetation in each PVC collar was clipped to ensure only Rs was measured. The measurement by gas analyzer took approximately 1.5 min to complete per chamber, connected to six soil efflux collars per plot for a total of 9 min. " in the revised manuscript. Please see L 148-157.

Why do you only measure Rs during the middle of May, September, and December?

Author's response: Thanks. The Loess Plateau belongs to temperate continental monsoon climate. The early stage of herbage growth begins in mid May; aboveground grassland biomass peaked in mid September; grassland dormancy occurs by mid December. For these reasons, Rs was only measured in mid May, September, and December. Please see L150-153.

Do you mean ST and SM measured for all treatments or only for the control? It was quite confusion.

Printer-friendly version

Discussion paper

Author's response: Thank you for pointing out that this was confusing. Soil temperature and soil moisture were measured for all treatments. We have revised this sentence as "Soil temperature at 10 cm depth was measured in real time using a thermocouple probe attached to every soil efflux collar during each Rs measurement. The soil moisture samples for gravimetric analysis were taken from the top 10 cm, close to every soil efflux collar, once daily in mid-morning (9:00–11:00 h) on the Rs sampling days, and were then oven dried at 105°C for 48 h. " Please see L160-L163.

Do you mean ST and SM only measure for the dates when RS was measured? How can you come true the random but adjacent the pots for Rs measurements? As soon as possible? How fast is it? Within several minutes, several hours or even several days?

Author's response: We are thankful for the reviewer's suggestion. Soil temperature at 10 cm depth was measured immediately using a thermocouple probe which attached to the gas analyzer adjacent to each PVC collar during the time of Rs measurement for all treatment. Soil moisture samples for gravimetric analysis were taken from the top 10.0 cm, close to every soil efflux collar, once a day in mid morning of Rs sampling days. The measurement by gas analyzer took approximately 1.5 min to complete per chamber, connected to six soil efflux collars per plot for a total of 9 min. Please see L 156 - L157.

Many variables were measured repeatedly across the seasons or years, so a repeated ANOVA analysis should be used for your statistical analysis

Author's response: Thanks. A repeated ANOVA analysis had been conducted in the revised manuscript. Please see L190 – L193.

You should have more information about the description of SEM analysis.

Author's response: Thanks. As you suggested, we have added detailed information for SEM analysis as "Structural equation modeling (SEM) was used to evaluate the pathways through which GP and GI affect Rs both directly and indirectly via biotic and abiotic factors. This was carried out according to the priori conceptual model to include all possible pathways (Supplementary Fig. 1), including (1) direct and indirect pathways of GP and GI influence on aboveground biomass, belowground biomass, soil temperature, and soil moisture; (2) direct and indirect pathways of GP and GI influence on soil microbial carbon and nitrogen; and (3) direct and indirect pathways of GP or GI influence on Rs via biotic or abiotic factors. Before constructing the SEM models, a correlation matrix was derived for all variables using least-squares. To differentiate the effects of grazing management on Rs, grazing management was divided into two sections. The first SEM was based on bivariate regressions to focus on the direct and indirect effects of GI on Rs, and included aboveground biomass, belowground biomass, soil moisture, soil temperature, SMBC, and SMBN. The second SEM focused on both direct and indirect effects of GP on Rs." Please see L204 – L205 , and Supplementary Figure 1.

Results Your whole results sections are quite confusion. I think there are many related studies published, you can read how they write their results section.

Author's response: We appreciate the reviewer's comments that could help us improve our manuscript. We have rewritten results sections in the new version of manuscript. Please see L221 – L297.

After the subtitle "SMBC and SMBN", you have a lot of description on ST, SM, AGB, BGB, or even the results from your data analysis. Do you need more subtitles?

Author's response: Thanks for your constructive suggestion. We added new subtitles as "3.3 Effects of grazing management on soil temperature, soil moisture, aboveground biomass, belowground biomass"; "3.4 Effect of grzaing management on temperature sensitivity of soil respiration"; "3.5 Structural equation models" in the revised manuscript. Please see L265, L281, and L288.

Discussion Sorry, I do not read your discussion. There are many gramma errors, confusion sentences or even very strange descriptions impeding my review. I will stop here. I think the authors should well prepare their manuscript for the next submission.

Author's response: We appreciate the referee's suggestion. In the new version, we rewrote the discussion section as: "4.1 Effect of grazing management on Rs The diurnal changes in Rs under different GPs (warm and cold season) with four GIs (0, 2.7, 5.3, and 8.7 sheep ha^{-1}) observed in our study were within the range of the daily Rs reported by several previous studies (Zhang et al. 2014; Wang et al. 2015; Rong et al. 2017). We found that GI significantly affected the diurnal changes of Rs in both WG ($P < 0.001$) and CG plots ($P < 0.001$), but the response was different. Since the diurnal changes in Rs followed a unimodal pattern through time, consistent with soil temperature, this could be due to the differences in sensitivity to temperature in grazing seasons or could be due to the spatial heterogeneity of Rs (Wang et al. 2013; Wang et al. 2017). Our study revealed that CG enhances the diurnal Rs rate. These results are consistent with those of a previous study that performed a meta-analysis of Tibetan grasslands (Wang et al. 2017). The GI had a significant effect on seasonal changes in Rs in both 2010 ($P = 0.007$) and 2011 ($P = 0.011$); however, the interaction between season and GI had no significant effect on Rs in 2010 ($P = 0.253$) and 2011 ($P = 0.153$). It was also found that both GI ($P = 0.826$) and the interaction between GI and year ($P = 0.070$) had no effect on Rs throughout the whole experimental period; this could be explained by both biotic and abiotic pathways (Fig. 6) in the following two ways: 1) The negative impact of GI on Rs was achieved indirectly by directly negatively affecting the aboveground biomass or by indirectly negatively affecting the microbial biomass; 2) At the same time, GI had a positive and indirect effect on Rs, which was achieved by directly negatively affecting the belowground biomass or by directly affecting soil moisture. Consequently, these two different types of pathways offset each other within a certain range. The results of this study indicate that GP ($P < 0.001$), year ($P < 0.001$), and their interaction ($P < 0.001$) have strong effects on Rs. Compared to WG, CG promoted soil respiration by 22%. These results were supported by the SEM analyses performed in this and previous studies (Jiang et al. 2010; Wang et al. 2013;

Chen et al. 2015; Xu et al. 2016). The response of Rs to GP can be explained by the following three mechanisms (Fig. 7): (1) The CG increased soil temperature by 3.1°C and increased soil moisture by 13.2%, and both soil temperature and soil moisture had direct positive effects on Rs. Soil temperature and water availability effect Rs by altering the activity of plant roots and soil microbes, and they also indirectly affect soil respiration by altering plant growth and substrate supply (Wan et al. 2007). In addition, the effect of soil temperature on Rs can be explained by the distribution of seasonal precipitation and interannual precipitation (Ru et al. 2017). This study found a significant correlation between monthly precipitation and Rs ($P < 0.001$); the precipitation of the semi-arid grassland peaked in September 2011, strongly influencing soil respiration. The significant interannual variations in Rs might be mainly caused by seasonal precipitation fluctuations; this could be proved by setting up a controlled field experiment. (2) Compared with WG, CG significantly increased the aboveground biomass ($P < 0.001$), which directly affected Rs. This might be due to the increased sensitivity of the aboveground biomass to low temperatures (Abdalla et al. 2010). On one hand, CG reduces litter and increases sunshine exposure, which is beneficial for plant growth in the subsequent year (Coughenour 1991; Altesor et al. 2005; Wang et al. 2017). On the other hand, grazing leads to a warm and dry microclimate by removing aboveground plants and compacting the soil (Rong et al. 2017). (3) GP has a negative effect on Rs through its negative effects on soil microbial biomass and microbial nitrogen. Since Rs is a process of converting organic carbon to inorganic carbon, the rate of Rs is ultimately controlled by the supply of carbon substrates (Xu et al. 2016; Bagchi et al. 2017). Soil microbial communities exhibit high substrate utilization rates at low temperatures (Monson et al. 2006); thus, a decrease in microbial biomass will reduce soil carbon emissions (Allison et al. 2010). Previous studies have reported that SMBC primarily determines microbial respiration (Zhang et al. 2014). Significant changes in SMBC and SMBN have significant effects on CO2 emissions under different land-use patterns (Iqbal et al. 2010). Previous studies have been conducted on the temperature sensitivity of Rs (Q10), both globally and in different ecosystems of China (Luo et al.

2001; Curiel et al. 2004; Davidson et al. 2006; Chen et al. 2015; Chen et al. 2016). In our study, under different grazing rates, the Q10 values ranged between 1.31 and 1.57 for the WG plots and between 1.21 and 1.36 for the CG plots, agreeing with the results of Chen et al. (2015). The Q10 values of the WG plots were higher than those of the CG plots. This might be due to soil water freezing at low temperatures, which inhibits soil microbial activity, and thus reduces Q10 in the CG seasons (Mahecha et al. 2010; Chen et al. 2016). The Q10 values for different ecosystems on a global scale are different, but the median is 1.4 (Mahecha et al. 2010). Our results are similar to this median, indicating that it is necessary to consider the impact of Rs on climate warming under different GIs and different grazing systems in order to accurately assess the carbon cycle of semi-arid grassland ecosystems. Overall, our results indicate that the mechanisms underlying the effects of grazing management on Rs mainly depend on GP, but not on GI. This indicates that the effects of GP, especially seasonal and long-term grazing, should be considered in future manipulation experiments and carbon models to accurately simulate soil carbon dynamics in semi-arid grassland ecosystems.

4.2 Effects of grazing management on SMBC and SMBN The results of our study revealed that SMBC was higher at the beginning (May) and in the middle (September) of the growing season than in the dormant period (December) (Fig. 4). These results are consistent with the findings of previous studies conducted in the grassland ecosystems of the trans-Himalaya (Bagchi et al. 2017) and the Tibetan Plateau (Fu et al. 2012). We found that SMBN in the WG plots was significantly higher than that in the CG plots ($P < 0.001$). The reason for this might be that the response of SMBN is more sensitive to grazing than that of SMBC (Fu et al. 2012). CG increased the soil temperature, which increased microbial biomass (Lu et al. 2013; Wang et al. 2017). Our results show that GI did not have an effect on SMBC ($P > 0.05$) and SMBN ($P > 0.05$), but the interactions between GI and GP significantly affected SMBC ($P < 0.001$) and SMBN ($P < 0.007$). These results indicate that the response of SMBC is coupled with GI and GP. On one hand, high GI increases bulk density and urine input and decreases soil porosity and aggregation, affecting microorganism metabolism (Prieto et al. 2011; Liu et al. 2012,). On the other hand, GI leads to a variation in SMBC as a direct result of the soil water content from higher precipitation and temperature. According to our SEM analysis, there are two pathways to explain the effects of GI (Fig. 6) and GP (Fig. 7) on SMBC and SMBN. (1) The effect of GI on SMBC and SMBN occurs mainly via its adverse effects on aboveground biomass, which directly stimulates SMBC. Recent studies have shown that the effects of grazing on soil microbial community size are largely dependent on GI via biotic factors (Zhao et al. 2017); grazing decreases the aboveground and belowground biomass (Koerner and Collins 2014). Our results support the theory that grazing management could change soil microbial activities by regulating the aboveground and belowground biomass, which in turn changes the microbial biomass in the soil (Stark et al. 2015; Xu et al. 2017). (2) GP positively affects soil temperature and soil moisture, both of which stimulate SMBC and SMBN. In our study, compared with WG, CG significantly increased soil moisture ($P = 0.005$) and soil temperature ($P = 0.020$), which might stimulate more efficient enzymes to catalyze the reactions of soil organic matter decomposition (Stark et al. 2015). Moreover, the dissolved organic carbon was metabolized only after rewetting, and the chemical signals released by the roots regulate the microbial communities, some of which have powerful feedbacks in carbon cycling (Schimel et al. 2013). Monthly precipitation events were significantly negatively related to SMBC ($P < 0.001$), but significantly positively related to SMBN in our study ($P < 0.001$). This agrees with the previous studies that found that the precipitation events stimulating microbial activity might shift the C-balance of grassland ecosystems (Curiel et al. 2007) and that grazing interacts with precipitation to affect the belowground biomass (Koerner and Collins 2014). Overall, our results indicate that the effects of grazing management on SMBC and SMBN mainly depend on the interactions between GI and GP. This suggests that integrated grazing management strategies should be taken into account in future studies on nutrient turnover in the soils of semi-arid grassland ecosystems." Roger L. Davies has assisted in editing this research paper. Please see L300- 399.

Figures and tables Table 1. Repeated ANOVA analysis should be conducted.

Author's response:Thanks. A repeated ANOVA analysis have been conducted in the revised manuscript. Please see L654 - L657.

Table 2. What do "WG" and "CG" stand for?

Author's response: Thanks. "WG" stand for warm-season grazing; "CG" stand for cold-season grazing. Please see L693-L694 in the revised manuscript.

Figure 1. Is this figure related to your study? You have legend for forest, grassland. . .If you want show a figure like this, I would suggest you show your experiments design since it was now very confusion.

Author's response: Thanks. We have deleted this figure and added a new figure about our experiments design. Please see L 706- L708.

Figure 3. Why did you only measure soil respiration from three months? Figures should be presented in a easier way depending on what you want to compare.

Author's response: We appreciate the referee's suggestion. The Loess Plateau belongs to temperate continental monsoon climate. The early stage of herbage growth begins in mid May; aboveground grassland biomass peaked in mid September; grassland dormancy occurs by mid December. For these reasons, Rs was only measured soil respiration in mid May, mid September, and mid December. To make better understand the figure, we merged Figures 3 and 4 into one figure, and then we made bar graph into thick color lines. Please see L740-L741.

Figure 5. Why do your determine to use line chart here? There are many overlaps. You symbols are not very similar. It was very hard for me to understand your figure.

Author's response: We apologize for the confusion from the chart. In order to show seasonal variations of soil microbial biomass carbon and nitrogen at 5 cm and 10 cm soil depth in the warm grazing and cold grazing grassland under different grazing intensity, for this reason, we used line chart here. To make better understand the chart, we made black lines into thick color lines and added more information in chart. Please see L 752-L755 and L761- L764.

Abbreviations were rarely used in the titles or in the first word of a sentence. How can you construct your SEM in this way? Was it based on your model comparison or randomly?

Author's response: We appreciate the referee's suggestion. We have made these points clear in the revised manuscript. SEM analysis was conducted according to a Priori conceptual model, to include all possible pathways (Supplementary Figure 1), including (1) both direct and indirect pathways of GP and GI on aboveground biomass, belowground biomass, soil temperature, soil moisture; (2) both direct and indirect pathways of GP and GI on soil microbial carbon and nitrogen; (3) both direct and indirect pathways of GP or GI on Rs via biotic or abiotic factors. To differentiate the effects of grazing management on Rs, grazing management was divided into two sections. The first SEM focuses on the direct or indirect effect of GI on Rs (Figure 6); the second SEM focuses on both direct and indirect effect of GP on Rs (Figure 7). Plesae See L 780-L782 and L793 –L795.

Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2018-531/bg-2018-531-AC6-supplement.pdf

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