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Biogeosciences Discussions

Interactive comment on "Soil carbon release responses to long-term versus short-term climatic warming in an arid ecosystem" *by* Hongying Yu et al.

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C: the original comments; R: the responses to the comments.

General Comments: C: This study addresses an important research topical at climate change impacts on dryland soil carbon dynamics. This article presents valuable data from a field manipulation study in which the authors examined how warming and watering regimes of varying intensity and duration impact soil respiration in a desert steppe. While the study methods appear sound and the results provide strong evidence for warming-driven reductions in soil respiration, many sections in the text are unclear and need to be improved to strengthen and clarify the manuscript. The authors could mod-

ify hypothesis two into a statement that could be tested in this study and contribute to new insight on the dynamics of soil respiration in water-limited ecosystems. R: Thank you for the positive comments. In the new version, we have revised the manuscript to strengthen and clarify the results as kindly suggested (please see detail below). The two hypotheses have been modified accordingly (Lines 105-109 of the new version, highlighted by red words).

C: There are key findings that are not clearly reported and challenge my interpretation as a reader. Specifically, the authors should address an apparent conflict: warming decreased Rs despite the positive relationship between Rs and soil temperature. The authors should explicitly highlight the important role of soil moisture as the dominant control on Rs rates and temperature sensitivity. R: Thank you for helpful comments. Actually, that is, the persistent warming treatments decreased Rs. The positive relationship between Rs and soil temperature occurs in each plot or each treatment. The two data sets are different, the former is warming treatment effect (comparison among the treatments: long-term warming, short-term warming, and ambient as a control), and the latter is the relationship between Rs and soil temperature. Yes, the important roles of soil moisture as the dominant control on Rs rates and temperature sensitivity were highlighted in many appropriate places of the newly revised version (e.g., lines, 22-23, 99-100, 374-376).

C: Lastly, the data availability statement does not appear to meet the journal's data policy requirements, and I suggest uploading data to a public repository, if possible. R: Thank you. the "Data availability" statement has been placed as at the end of the manuscript before the acknowledgements. Data availability: data can only be accessed in the form of Excel spreadsheets via the corresponding author. If necessary, we will upload it to a public repository.

Specific comments: Parts of this manuscript would benefit from additional explanation. Below I provide some specific examples. C: L 24-27. "This indicates that soil carbon release responses strongly depend on the duration and magnitude of climatic warming,

which may be driven by SWC and soil temperature." This is unclear. Please explain how SWC and soil temperature influence soil respiration, and then perhaps infer how those relationships have implications for climatic warming impacts on soil carbon dynamics. R: Thank you, we have revised it to "This indicates that climatic warming constrains soil carbon release, which is controlled mainly by decreased soil moisture, consequently influencing soil carbon dynamics" to be clearer and more concise (Lines 21-23 of the newly revised version).

C: L 55-59: An explanation of why low precipitation and biomass enhances vulnerability would strengthen the authors' claim that deserts are sensitive to climate change. R: Many thanks. We have made it to be clearer and concise accordingly, and the explanation was also added accordingly: "For instance, water deficit and heat waves during growing season can markedly decrease plant cover and productivity in this arid ecosystem" (Lines 58-62).

C: L 60-66: This section shows that temperature and moisture are well-known controls on Rs. However, this conflicts with the previous claim (L43-47) that Rs responses to biotic and abiotic factors are poorly understood. Can this apparent contradiction be addressed in a way that makes a stronger case for this study? E.g. whereas soil moisture and temperature are well-known controls on Rs, it is not well known how soil moisture modulates the response of Rs to changes in the duration and intensity of warming. R: we have changed the expressions in both sections to be clearer and more logical (Lines 44-48; 65-67). Many thanks.

C: L 84: Please elaborate on "undefined" since many studies have reported Rs pulses after water inputs (Huxman et al., 2004; Sponseller, 2007). Huxman, Travis E., et al. "Precipitation pulses and carbon fluxes in semiarid and arid ecosystems." Oecologia 141.2 (2004): 254-268. Sponseller, Ryan A. "Precipitation pulses and soil CO2 flux in a Sonoran Desert ecosystem." Global Change Biology 13.2 (2007): 426-436. R: Thank you for the useful advice, this part has been revised accordingly and cited the two references (Lines 88-92).

C: L 86-88. This argument would be stronger if the authors explained why a long-term study (4 years) might yield insights undetected in previous two-year studies. Why do the authors expect to find something new? R: Thank you, we have important findings in previous two-year which have been published (Liu et al. Plant Soil, 2016, 400:15–27). In the current study, we expect that the long-term (four-year) warming have different effects on Rs (i.e., more profound, even reverse effects relative to previous two-year short term); and the underlying mechanism under longer term warming condition, and the role of soil water status to Rs responses to climatic warming, are also uncertain (added this explanation in the new version, lines 96-100).

C: L 88-89: Unclear. Please elaborate. R: Thanks very much, we have re-edited it to "and the underlying mechanism under longer term warming condition, and the role of soil water status to Rs responses to climatic warming, are also uncertain" (also see above).

C: L 97-98: The introduction section already provides evidence in support of H2. In its current form, it is not clear why it is worth testing H2 in this study. How could H2 be modified into a hypothesis that could be tested in this study and contribute to new insight on the dynamics of soil respiration in water-limited ecosystems? R: This H2 has been modified to "the dynamics of Rs in the water-limited ecosystem can be driven mainly by the combination of soil temperature and soil moisture, and soil moisture can modulate the response of Rs to warming". Many thanks.

C: Results 3.1. Warming effects on soil features L 251-254: According to the Supplementary Table S1, belowground biomass is 11.5 units for the Acutely Warmed treatment. Is this a typo? It is considerably higher than the BB reported for other treatments. R: Thanks for your comments, this is a mistake, it should be 1.15, and we have corrected it (Supplementary Table S1).

C: 3.2: It is unclear why this is section is titled "Watering pulse effects on Rs." Does this section refer to data collected only after watering? Or does the section report findings

from all measurement dates? R: We have two experiments: one is the warming experiment which included three treatments: control, long-term moderate warming, and short-term acute warming. The other is the watering pulse treatments which included control and watering treatment. Yes, this section referred to data collected in the plots of watering treatments.

C: Figure 2: Please explain the data source – do the data represent the control or warmed treatments? Also, is it necessary to show the linear and quadratic fits? Are these pieces of information reported or used to make inferences? R: This section mainly focused on the relationship between Rs and soil water content. The data were collected in the plots of watering treatments (added in the figure 2 legend of the new version), and were used to determine the relationship between Rs and soil water content in dessert steppe. Here, we focused on the comparisons between the linear, quadratic, and Gompertz functional models. Thus, the information used could be useful. Many thanks for the kind comments.

C: Figure 3A. This figure presents information that is critical for the authors' conclusion. It provides evidence for why Rs was lower in warmed treatments, despite having a positive relationship with soil temperature. I suggest leading Section 3.2 or 3.3 with a strong statement describing the relationship between Rs, temperature, and moisture. For example, soil respiration increased exponentially with temperature in watered plots but was lower and insensitive to temperature in the control plots. R: Thanks for your useful advice, it has been revised accordingly in lines 287-289.

C: L 771: Unclear. What is the initial Rs response to SWC? What do the other points represent? R: It should be linear Rs response to SWC at low levels. This is Gompertz functional model features: for the all points, with SWC increasing, Rs linearly increased sharply, then reaching a maximum value, and levelling off. Thanks.

C: Section 3.3 Suggest leading with conclusive evidence. For example, "Warming regimes resulted in marked declines in Rs. Whereas no difference in Rs was ob-

served in July, during August average Rs values were x, y, z for the control, moderately warmed, and acutely warmed treatments, respectively." R: Thanks, it has been done in lines 278-281.

C: Section 3.4 needs a figure reference. R: The reference figure is figure 5, and was added (Line 296).

C: This section should explain why Rs decreased in warmed plots despite having a positive relationship with soil temperature. R: They are different two terms: Rs in warmed plots were the values averaged in the warming treatments, whereas Rs values used for the relationship with soil temperature are the data in each plots or each treatments; and particularly, the soil temperature data used for the relationship Rs and soil temperature are the values when the Rs were measured simultaneously. They two are matching values each other. Thus, long-term warming rather than temporary high temperature reduced Rs, despite having a positive relationship with soil temperature (added, lines 289-291).

C: L 319-322: Unclear how Rs can acclimate to warming but also decrease. Please explain the mechanism. Is the acclimation referring to changes in microbial respiration? Are net reductions in Rs driven by temperature-stress impacts on plant and root activity? R: Rs can acclimate to warming but also decrease, that may because the soil moisture levels differs: Rs can acclimate to warming at an ample soil moisture; whereas it decreases under water deficit (added lines 333-335). Yes, the Rs includes microbial respiration, but the microbial respiration is not separated from whole Rs in the current study. The net reductions in Rs could link to temperature-stress impacts on plant and root activity (e.g., Liu et al., 2016; Luo et al., 2001). Nevertheless, the underlying mechanism needs to be explored further. Many thanks for the valuable comments.

C: L358-362: Consider citing previous studies documenting that the temperature response of Rs is conditional on moisture (Roby et al., 2019; Conant et al., 2000). Roby,

M. C., Scott, R. L., Barron-Gafford, G. A., Hamerlynck, E. P., Moore, D. J. (2019). Environmental and Vegetative Controls on Soil CO2 Efflux in Three Semiarid Ecosystems. Soil Systems, 3(1), 6. Conant, Richard T., Jeffrey M. Klopatek, and Carole C. Klopatek. "Environmental factors controlling soil respiration in three semiarid ecosystems." Soil Science Society of America Journal 64.1 (2000): 383-390. R: Thank you, we have cited them already in lines 377-378, and added in the reference list.

TECHNICAL COMMENTS C: L22: Features is unclear. R: This has been changed it to “The belowground biomass, soil nutrition, and microbial biomass” to detail these soil variables in line 26 of the new revision.

C: L 143: What are the units of soil moisture? R: It has been added (a ratio: v/v).

C: L 227: Please provide depth of soil temperature measurements. R: We have provided it in line 237.

C: L 199: First mention of SWC; please define or introduce this acronym in section 2.3 R: the SWC whole name has been added in line 173 in the new version. Thanks.

C: L 126. Unclear. Is 1 m the wavelength of radiation or dimension of the heater? R: This indicates the dimension of the heater (1.0 m long); and we have revised it accordingly in line 136.

C: L117-119: Suggest using concise and consistent treatment names. E.g. control, long term moderate warming, short-term acute warming. R: It has been done in line 129, and throughout the entire text.

C: L 283: “Mode” typo. R: Sorry for this mistake, it should be “model”, and was corrected.

C: L 283: Please provide equation number. R: the equation number is 4, and was added.

C: L 238: Suggest different word for features R: We have changed to “belowground

characteristics” in line 248.

C: L 241-243: Suggest reporting an error estimate instead of range. R: This has been done in lines 252.

C: L 246: Define v/v R: it is defined as ratios of water volume and soil volume (added in the new revision, lines 255-256)

C: Throughout: Be consistent with significant figures (L264 : R2 = 0.31 vs. L284: R2 = 0.404 R: Thank you, we have revised R2 values with two 2 digits throughout the text.

Many thanks for the constructive comments and suggestions.

Please see the Manuscript-Revised-with supplement as Supplement (pdf).

Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2019-236/bg-2019-236-AC3-supplement.pdf

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