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

Anonymous Referee #3

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GENERAL COMMENTS

This study addresses an important research topicâĂŤclimate 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 modify hypothesis two into a statement that could be tested in this study and contribute to new insight on the dy-

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namics of soil respiration in water-limited ecosystems. 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. 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.

SPECIFIC COMMENTS Parts of this manuscript would benefit from additional explanation. Below I provide some specific examples.

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.

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.

L 60-66: This section shows that temperature and moisture are well-known controls on Rs. However, this conflicts with the previous claim (L 43-47) 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.

L 84: Please elaborate on "undefined" since many studies have reported Rs pulses after water inputs (Huxman et al., 2004; Sponseller, 2007).

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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.

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?

L 88-89: Unclear. Please elaborate.

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?

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.

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? 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?

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.

L 771: Unclear. What is the initial Rs response to SWC? What do the other points represent?

Section 3.3 Suggest leading with conclusive evidence. For example, “Warming regimes resulted in marked declines in Rs. Whereas no difference in Rs was observed in July, during August average Rs values were x, y, z for the control, moderately warmed, and acutely warmed treatments, respectively.”

Section 3.4 needs a figure reference.

Discussion

This section should explain why Rs decreased in warmed plots despite having a positive relationship with soil temperature.

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?

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.

TECHNICAL COMMENTS

L22: Features is unclear.

L 143: What are the units of soil moisture?

L 227: Please provide depth of soil temperature measurements.

L 199: First mention of SWC; please define or introduce this acronym in section 2.3

L 126. Unclear. Is 1 m the wavelength of radiation or dimension of the heater?

L117-119: Suggest using concise and consistent treatment names. E.g. control, long term moderate warming, short-term acute warming.

L 283: “Mode” typo.

L 283: Please provide equation number.

L 238: Suggest different word for features

L 241-243: Suggest reporting an error estimate instead of range

L 246: Define v/v

Throughout: Be consistent with significant figures (L 264 : R2 = 0.31 vs. L 284: R2 = 0.404

References

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.

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