

Title: Reviews and syntheses: Microbial Carbon Fixation in Dryland: A component of Global Carbon Cycle (egusphere-2026-2278)

This manuscript reviewed an overlooked but important carbon fixation process - the microbial carbon fixation in drylands. The topic is very interesting and meaningful. However, there are many problems with the manuscript. So, improvements are still needed.

To editor:

During the review process, I found that the manuscript contains an excessive number of paragraphs, but each with very limited content. Additionally, many viewpoints expressed are not supported by corresponding references. Meanwhile, the cited references have the problem of being unsearchable (or maybe fabricated). These characteristics (problems) are very common in AI-generated text. Therefore, it is recommended that the editor can conduct an AI detection check on this manuscript.

To authors:

Specific comments:

- [1] The manuscript contains an excessive number of paragraphs, but each with very limited content, resulting in the article being extremely fragmented. It is suggested to further integrate the entire text and merge relevant paragraphs. In addition, many viewpoints expressed are not supported by corresponding references, and some of the cited references have the problem of being unsearchable. Therefore, the overall presentation of this manuscript lacks sufficient rigor. A thorough revision of the entire text is recommended.
- [2] The title of Chapter 2 is not sufficiently precise. It should be clarified whether it refers to carbon sequestration in dryland ecosystems or specifically dryland soil carbon sequestration. Furthermore, the logic of this section is disorganized. The authors mention soil microbial carbon sequestration in drylands without clearly specifying which processes are included. Autotrophic microbial groups fixing atmospheric CO₂ constitute a net carbon sequestration process. Although heterotrophic microorganisms decompose organic carbon and release CO₂, if the organic carbon substrate originates from outside the soil itself, this also represents a carbon sequestration process from the soil's perspective. At the beginning of this chapter, the author failed to provide a clear definition of the above information.
- [3] L53 What specific carbon fixation rate do the authors refer to?
- [4] L75 what do the authors mean by "microbial GPP"? I have reviewed the cited reference, it did not provide a clear definition of this term. For an ecosystem, GPP refers to the total organic carbon fixed by organisms through photosynthesis per unit time. Does the "microbial GPP" mentioned here refer to the total organic carbon produced by photoautotrophic microorganisms using light energy? If so, what is the rationale for considering only photoautotrophic microorganisms? Why are chemoautotrophic and

heterotrophic microorganisms not considered?

- [5] L92-93 What do the authors want to express? Is it to say that heterotrophic microorganisms can also fix atmospheric CO₂? Although some heterotrophic microorganisms can perform dark carbon fixation during metabolic processes, the overall metabolic outcome should still be net CO₂ production.
- [6] L122 The cited reference pertains to desert ecosystems. However, drylands also include other types of ecosystems, such as farmlands. Please provide additional references to substantiate this claim.
- [7] L126-127 What evidence can support the claim that "the WL pathway can contribute significantly"? To my knowledge, compared with other carbon fixation pathways, the abundance of the WL cycle can be very low in dryland soils.
- [8] L132-134 What do the authors mean by "a network of complementary metabolic routes"? The cited reference merely correlated carbon fixation processes with microbial carbon fixation genes, without further analyzing how these pathways operate as a network. Therefore, the results of the cited reference do not support the inference of "a network of complementary metabolic routes." Moreover, from a genetic perspective, the operation of some pathways is not accomplished independently. For example, the rTCA cycle shares enzymes with the 3-HP cycle and the DC/4-HB cycle, and the pathways (rTCA, 3-HP, 3-HP/4-HB, and DC/4-HB) may inherently operate jointly. Whether these pathways operate in soil habitats under natural conditions, and in what network form, remain to be demonstrated and clarified. However, the authors provide no evidence for the issue.
- Additionally, I do not understand what is meant by "a single dominant pathway." In terms of abundance, the rTCA cycle is typically the dominant carbon fixation pathway in dryland soils, which highlights its potential dominant role. From a genetic perspective, the WL cycle and the Calvin cycle may be capable of operating independently; however, both pathways typically exhibit very low abundance in dryland soils.
- [9] L135 Please provide supporting evidence. I have not found any relevant reference that clearly substantiates this inference. Additionally, the reference of Huang et al., 2022 is unsearchable in Soil Biology and Biochemistry.
- [10] L148-151 The authors should provide specific examples of typical species present in dryland soils.
- [11] L155-156 This suggestion is too vague. The authors need to supplement the specific (or general) methods of integration to make it operational.
- [12] L161-163 This sentence is logically incoherent.

[13] L182-183 This section explores the carbon cycle dynamics in drylands. Why do the authors discuss energy sources here?

[14] L190-192 Similarly, the suggestion is too vague.

[15] L207 This is highly unrigorous.

[16] L211-213 The study of the cited reference is a short-term and plot-scale research, rather than long-term or ecosystem-scale investigations. Such simplistic scale extrapolation is scientifically unsound.

[17] L214-221 In this paragraph, the authors should discuss specific case studies of microbial inoculant application and its role in soil carbon fixation, rather than making vague prospective statements. Additionally, the sentences (Lines 216–219) lack supporting references.