

egusphere-2025-4088

Hysteresis and irreversibility in permafrost physical response to increase and decrease of CO₂ emissions

by Watanabe et al.

Reply to the comments by RC1

We thank the reviewer for carefully reading our manuscript again and providing technical comments. We addressed all issues raised by the review comments and revised the manuscript accordingly. Please see our point-by-point responses below.

The authors have appropriately addressed the minor corrections, and the new clarifications in lines 687-9 have sufficiently improved this important paragraph. The manuscript is now suitable for publication.

Thank you very much for the positive comment. We have revised the manuscript accordingly.

Line 656: Sanderson et al. (2023) should be corrected to Sanderson et al. 2024.

Figure S4 Panel (b): In colour bar label, “Moisturre” should be corrected to “Moisture”.

All corrected.

Figure S6: The version available to me does not include the updated description added by the authors in the latest round of reviewer comments.

I had forgotten to attach the new file. I've updated it.

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Reply to the comments by RC2

We thank the reviewer for carefully reading our manuscript again and providing constructive comments. We addressed all issues raised by the review comments and revised the manuscript accordingly. Please see our point-by-point responses below.

I still do not understand the contradiction between Fig.S2 and the text l.287. As expected, the simulated permafrost region (continuous permafrost) in Fig.S2 is smaller than the observations from Brown et al. (2002) (continuous+discontinuous). However, the text states that the simulated initial permafrost region covers $2.5 \cdot 10^7 \text{ km}^2$, which is larger than the observed permafrost region ($2.1 \cdot 10^7 \text{ km}^2$). This contradiction could be explained if the observed permafrost region was the actual area underlain by permafrost (i.e. the sum of the grid cell areas multiplied by the permafrost fraction). However, this does not seem to be the case, as the area underlain by permafrost is estimated to be between 1.4 and $1.6 \cdot 10^7 \text{ km}^2$ (Obu, 2021). If I understand correctly, the observed permafrost region of $2.1 \cdot 10^7 \text{ km}^2$ represents the entire area within the black boundaries of Fig.S2. As the simulated initial permafrost region is smaller than the observations (Fig.S2), I would expect it to be smaller than $2.1 \cdot 10^7 \text{ km}^2$.

However, this is a minor issue and does not impact the main results of the paper. Therefore, I consider that the manuscript can be published as is.

Thank you very much for the positive comment.

The black line represents the boundary obtained when continuous, discontinuous, sporadic, and isolated permafrost are all collectively treated as permafrost. As a result, the area it encloses is likely larger than that of what is typically considered the permafrost region, and we think this may be the cause of the discrepancy.

We have revised the manuscript accordingly.

Technical comments:

l.155 : Typo “Chiedung” → “Schiedung”

l.307 : Typo “afterwords” → “afterwards”

All corrected.