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RAPID REGIONAL ASSESSMENT OF ROCK GLACIER ACTIVITY BASED ON DINSAR WRAPPED PHASE SIGNAL

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AUTHOR COMMENTS IN RESPONSE TO ANONYMOUS REFEREE #2 (RC2)

Dear Referee,

We wish to thank you for your careful and constructive review of our manuscript, that we greatly appreciated. Here and in the manuscript, we have addressed all the issues raised by your review. Below you find detailed responses to your comments. We took the opportunity to do additional typo corrections and text improvements.

Best regards,
Federico Agliardi
(on behalf of all the authors)

General comment: The manuscript presents a novel and timely study that introduces a semi-automatic workflow for assessing the activity state of periglacial landforms, with a focus on rock glaciers, using wrapped interferometric phase signals (DInSAR). The proposed method includes the development of an 'Activity Index' that enables categorization of landforms based on their kinematic behavior. This methodology is applied to a pre-existing rock glacier inventory across a regional scale in the Italian Central Alps. The authors validate their findings against geomorphological field evidence and investigate potential environmental controls on rock glacier dynamics through multivariate statistical analysis.
Overall, this study contributes valuable methodological insights for improving the efficiency of rock glacier kinematic classification and supports the understanding of spatial variability in periglacial landform activity. The ability to assign kinematic attributes to large inventories using remotely sensed data, as demonstrated in this study, represents an advancement in regional-scale periglacial research. However, several key issues—particularly concerning the geomorphological interpretation and physical understanding of rock glacier dynamics—should be addressed before the manuscript is suitable for publication.

Reply: We thank the referee very much for recognizing the scientific contribution of our work.

Comment 1. The discussion of rock glacier dynamics in the manuscript, particularly in the Introduction and Discussion sections (e.g., Lines 49 and 302), places an unusual emphasis on basal frictional sliding. This is not widely recognized as the dominant process in rock glacier movement. Instead, the internal deformation and shearing within a distinct shear horizon, typically situated at depth in the permafrost core, is understood to be the principal mechanism of movement. This key concept, supported by numerous studies, is currently missing

from the manuscript and should be incorporated to strengthen the theoretical foundation of the study. The authors are encouraged to consult and reference the following publications, which provide comprehensive insights into the mechanics of rock glacier creep and kinematics:

Hu, Y., Arenson, L. U., Barboux, C., Bodin, X., Cicoira, A., Delaloye, R., Gärtner-Roer, I., Kääb, A., Kellerer-Pirklbauer, A., Lambiel, C., Liu, L., Pellet, C., Rouyet, L., Schoeneich, P., Seier, G., and Strozzi, T.: Rock Glacier Velocity: An Essential Climate Variable Quantity for Permafrost, Rev. Geophys., 63, https://doi.org/10.1029/2024rg000847, 2025.
RGIK: Guidelines for inventorying rock glaciers: baseline and practical concepts (version 1.0), IPA Action Group Rock Glacier Inventories and Kinematics, 25 pp., https://doi.org/10.51363/unifr.srr.2023.002, 2023.
Cicoira, A., Marcer, M., Gärtner-Roer, I., Bodin, X., Arenson, L. U., and Vieli, A.: A general theory of rock glacier creep based on in-situ and remote sensing observations, Permafrost Periglac, 32, 139–153, https://doi.org/10.1002/ppp.2090, 2021.

> **Reply:** We thank the referee for this comment. We totally agree and now we have explicitly included this important concept in the Introduction and in the Discussion. We also included the useful reference to Hu et al (2025), that was missing.

Comment 2. The background and motivation for the study, particularly in Lines 58–76, would benefit from a more comprehensive and up-to-date literature review. At present, the cited works are somewhat limited and do not fully capture the depth of recent advancements in remote sensing applications to permafrost research or rock glacier dynamics. To strengthen the Introduction, the authors should include additional relevant studies, especially those employing interferometric techniques or working toward standardizing inventory and classification methods in periglacial environments.

> **Reply:** We agree on these comments, that have been also made by Referee 1. We have updated/added references and moved them in more relevant locations when required. See also our replies to the Referee 1 comments.

Comment 3. The manuscript currently references an earlier version of the guidelines for rock glacier inventory and classification. The authors are strongly encouraged to adopt and explicitly reference the most recent guidelines provided by the RGIK (2023). These guidelines offer refined criteria for classifying rock glaciers based on kinematics and morphology and should be integrated consistently throughout the manuscript, including text, figure interpretations, and the reference list (e.g., revise Line 629 accordingly).

> **Reply:** Thank you for the comment. We have updated the reference to RGIK (2023a) throughout the manuscript.

Comment 4. RGIK (2023) states that active and transitional rock glaciers differ not only in velocity but also in the proportion of their surface area in motion. Active rock glaciers require movement across most of their surface. In this regard, the authors could enhance their analysis by leveraging the spatial information embedded in the DInSAR wrapped phase signals.

> **Reply:** Thank you for your comment. Please see our reply to the comment to Lines 311-314 made by Referee 1 above.