Response to Reviewer #1's comment on "**Temperature sensitivity of snow viscoplasticity: evidence from controlled creep experiments**"

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Reviewer #1:

General comments on the manuscript:

The manuscript by Védrine et al. presents an experimental investigation of the temperature dependence of snow viscoplasticity using a newly developed thermo-mechanical cell coupled with in situ X-ray tomography. The experimental protocol, in which temperature is systematically varied on the same snow sample while monitoring microstructural evolution, represents a clear improvement over previous approaches that rely on separate samples at different temperatures and initial bulk densities. The resulting measurements provide insight into the temperature sensitivity of snow deformation and have important implications for constitutive models of snow settlement and snowpack evolution.

Specific comments for the authors' consideration:

1. The identification of two activation-energy regimes is one of the central conclusions of the manuscript. While the data are certainly consistent with a bi-Arrhenius relationship, Section 4.3 also demonstrates that the observations can be explained by introducing a temperature-dependent stress exponent. I wonder whether the authors might consider framing the proposed transition near −13 °C somewhat more cautiously, emphasizing that the data are consistent with—but do not uniquely require—a distinct physical transition.

Response: We agree with the reviewer that the data are consistent with a two-regime Arrhenius relationship but do not uniquely require a distinct physical transition near -13 °C. As discussed in Section 4.3, the observations can also be described by introducing a temperature-dependent stress exponent, and we explicitly state that "this apparent similarity should be interpreted with caution" (Section 4.3). Accordingly, we have revised the Abstract and Conclusion to frame this result more cautiously.

2. I wonder whether the discussion in Section 4.3 could also briefly consider the possible contribution of grain-boundary sliding to the observed temperature sensitivity. While the authors discuss basal slip as the dominant deformation mechanism based on Védrine et al. (2024), it seems worthwhile acknowledging whether grain-boundary sliding might also contribute to the mechanical response, particularly given the fine-grained, porous nature of snow.

Response: We thank the reviewer for this suggestion. To the best of our knowledge, grain-boundary sliding has not been shown to contribute significantly to snow creep at low temperatures (below approximately −6 °C), and basal slip alone has been shown to reproduce creep experiments (Védrine et al., 2025).

However, as noted by Reviewer #2, grain-boundary processes are known to contribute to the strongly nonlinear temperature sensitivity of creep in polycrystalline ice near the melting point (Duval et al., 1979). They may therefore also become relevant to snow creep in this temperature range. We have added a short paragraph in Section 4.3 discussing grain-boundary sliding as a possible mechanism near the melting point, while leaving its experimental investigation in snow for future work.

Overall assessment:

Overall, the manuscript is well written, the experiments are well designed, and the conclusions are generally supported by the presented data. The manuscript presents a novel and technically strong experimental study that substantially improves our ability to isolate the influence of temperature on snow viscoplasticity. The newly developed thermo-mechanical cell and experimental protocol represent an important methodological advance, and the resulting observations provide useful constraints for the future development of constitutive models of snow deformation. Subject to minor revision, I believe this manuscript is well suited for publication in The Cryosphere.

We thank the reviewer#1 for his valuable comments and constructive suggestions that helped us to improve the quality of our paper. In the following, we provide detailed point-by-point answers to the comments from the reviewer.

Editorial comments keyed to line numbers:

- 282 – Change "a activation energy" to "an activation energy."

  Response: Corrected

- General – Several figure axis labels, legends, and mathematical symbols appear corrupted in the review PDF, likely due to a font-embedding or PDF rendering issue. I recommend verifying that the figures are exported with all fonts properly embedded before publication.

Response: Thank you for pointing this out. The font-rendering issue was introduced during the TC production process and was subsequently corrected by the TC editorial team on June 16.