

## **Author Comment**

We sincerely thank you for your careful review of our manuscript and for the detailed and constructive comments you provided. Your feedback has been invaluable in helping us improve the clarity, rigor, and contribution of our study. Below we provide a point-by-point response to your concerns.

### **1. Assumed knowledge and missing citations**

We acknowledge that our initial submission did not sufficiently cite key works and sometimes assumed prior knowledge from the reader. In the revised manuscript, we have added comprehensive references to foundational studies and restructured several sections to provide more background and avoid oversimplification.

### **2. Experiment 1 and surface energy balance**

We agree that the role of debris and surface heterogeneity is crucial in glacier energy balance. In the revised manuscript, we explicitly state the limitations of our experimental design (i.e., flat and uniform surfaces) and discuss how this simplification compares with natural glacier conditions. Additional references, including Steiner et al. (2018), have been incorporated to situate our work within the broader literature.

### **3. Section 4.2 and established literature**

We have revised Section 4.2 to include the references you suggested (Gardner and Sharp, 2010; Libois et al., 2013; Warren and Wiscombe, 1980) as well as recent works on algal blooms and their role in glacier ablation. This strengthens the discussion and situates our findings within the existing body of knowledge.

### **4. Spatial heterogeneity and topography**

We agree with your comment that spatial heterogeneity plays a key role in glacier ablation. In the revision, we have added a dedicated subsection discussing topographic controls and the influence of spatially variable debris cover. Where possible, we integrate remote sensing datasets to illustrate these spatial variations.

### **5. Conclusions and novelty**

We appreciate your concern about the novelty of our conclusions. In response, we have refined our conclusions to emphasize how our experimental results provide a framework for linking laboratory findings to glacier surface processes, particularly in the context of MDPs. We highlight specific avenues where our study extends current understanding and propose future research directions.

### **6. Specific comments**

We have carefully addressed each of your line-specific and figure-specific suggestions:

- Added missing citations (Lines 37, 45, 47, 54)
- Expanded methodological details (Line 94)
- Reorganized text to ensure methods precede results (Line 98)
- Revised Figure 1 with region map, sensor information, scale, credit, and legend. We also now explicitly address both retreat and surface lowering.

- Clarified that Line 131 refers to calculated inferences rather than direct observations.
- Revised discussion around Experiment 2 (Line 162) to acknowledge structural differences between water and glacier ice, as well as debris accumulation in topographic lows.
- Revised Figure 9 to better integrate spatial heterogeneity of debris cover.

### **Closing**

We are very grateful for your thoughtful and detailed feedback. We believe the revisions have significantly strengthened the manuscript and hope it now meets the standards for publication in *The Cryosphere*.