EGU24-1171, updated on 26 Jan 2025
https://doi.org/10.5194/egusphere-egu24-1171
EGU General Assembly 2024

Debris-covered area increased in the Central Andes of Argentina glaciers over the past four decades

Juan Cruz Ghilardi Truffa and Lucas Ruiz
Centro Científico Tecnológico - Mendoza, Glaciología e Hidroclimatología Andina, Argentina (juancruz.ghilardi@gmail.com)

In the Central Andes of Argentina, glaciers are crucial components of the mountain hydrological system, as they can provide up to 60% of river flow in the driest season. This region concentrates 82% of the debris-covered glaciers in the country. Most of them are small valley glaciers (< 2 km^2). Nevertheless, a few large debris-covered valley glaciers (>10 km^2) concentrated the most significant ice volume. Despite their abundance and regional importance, the processes underlying mass exchange and response to climate change in debris-covered glaciers have been little studied.

We process over 60,000 images from Landsat and Sentinel satellites through Google Earth Engine to study changes in the extent of the debris-covered area and Debris Emergence Elevation (DEE) for 128 valley glaciers of the Central Andes of Argentina (42.6% of the debris-covered glacier area). Using an automated classification algorithm, we identified the different surface facies (snow, ice, debris, and water) at each glacier between 1985 and 2022. We validated our classification against the National Glacier Inventory of Argentina, obtaining coincidence in the classifications in more than 94% of the cases.

Assuming there were no changes in glacier extent, we found a 27 ± 15% increase in debris cover along the studied glaciers. Between 1985 and 2009, the debris-covered area had a significant interannual variation, and from 2009 to 2022, there was a substantial increase in the debris-covered area. Indeed, almost 68% of the increase in debris-covered areas occurred in the last decade. During the last four decades, DEE showed a mean increase of 127 ± 109 meters for simple basin valley glaciers. These changes follow a similar pattern but with greater interannual variability than changes in debris-covered area.

The increase of debris-covered area and DEE in the last decade coincides with an extensive drought period and an increase in the glacier mass loss in the Central Andes. Nevertheless, the automated classification algorithm cannot differentiate between debris-covered ice and internal outcrops. Thus, the increase in the debris-covered area includes the expansion of internal rock outcrop due to a loss of ice mass. Furthermore, we hypothesized that hypsometry and glacier morphology control the extent and elevation debris can reach. We found that low-slope glaciers are the ones that increase their debris cover the most. Meanwhile, glaciers with a very steep accumulation area or a strong slope change around the Equilibrium Line Altitude do not significantly change the debris-covered area. Also, due to the expansion of internal rock, the

calculation of DEE at large compound or complex-basin glaciers shows more significant dispersion than at simple-basin glaciers. Improving the classification algorithm and assessing the influence of glacier morphology in the changes in debris-covered areas are crucial to better constrain the change in debris-covered glaciers.