

# GLACIER MONITORING SYSTEM IN COLOMBIA: INSIGHTS ON ONE OF THE LAST TROPICAL GLACIER ZONES

Rojas Heredia, Francisco<sup>1</sup> y López Moreno, Juan Ignacio<sup>2</sup>

<sup>1</sup> <sup>2</sup>Pyrenean Institute of Ecology IPE. 1. frojash@ipe.csic.es y 2. nlopez@ipe.csic.es

## ABSTRACT

The Institute of hydrology, meteorology and environment studies of Colombia IDEAM, has been leading the monitoring of Colombian glaciers using direct and indirect glaciology methods since 2006. The longest and the most important technique is the glaciological mass balance over two study areas (Conejeras and Ritacuba glaciers). There is also a hydro-meteorological network composed by 15 weather stations and 5 gauged river streams covering the main different mountain ecosystems between 2500 and 5000 m a.s.l.. Drone photogrammetry and remote sensing analyses are also applied to estimate glacier wastage and shrinkage for different ice bodies. Finally, the monitoring team has been implementing vegetation plots over glaciers boundaries since LIA to track first steps of plant communities after their retreat.

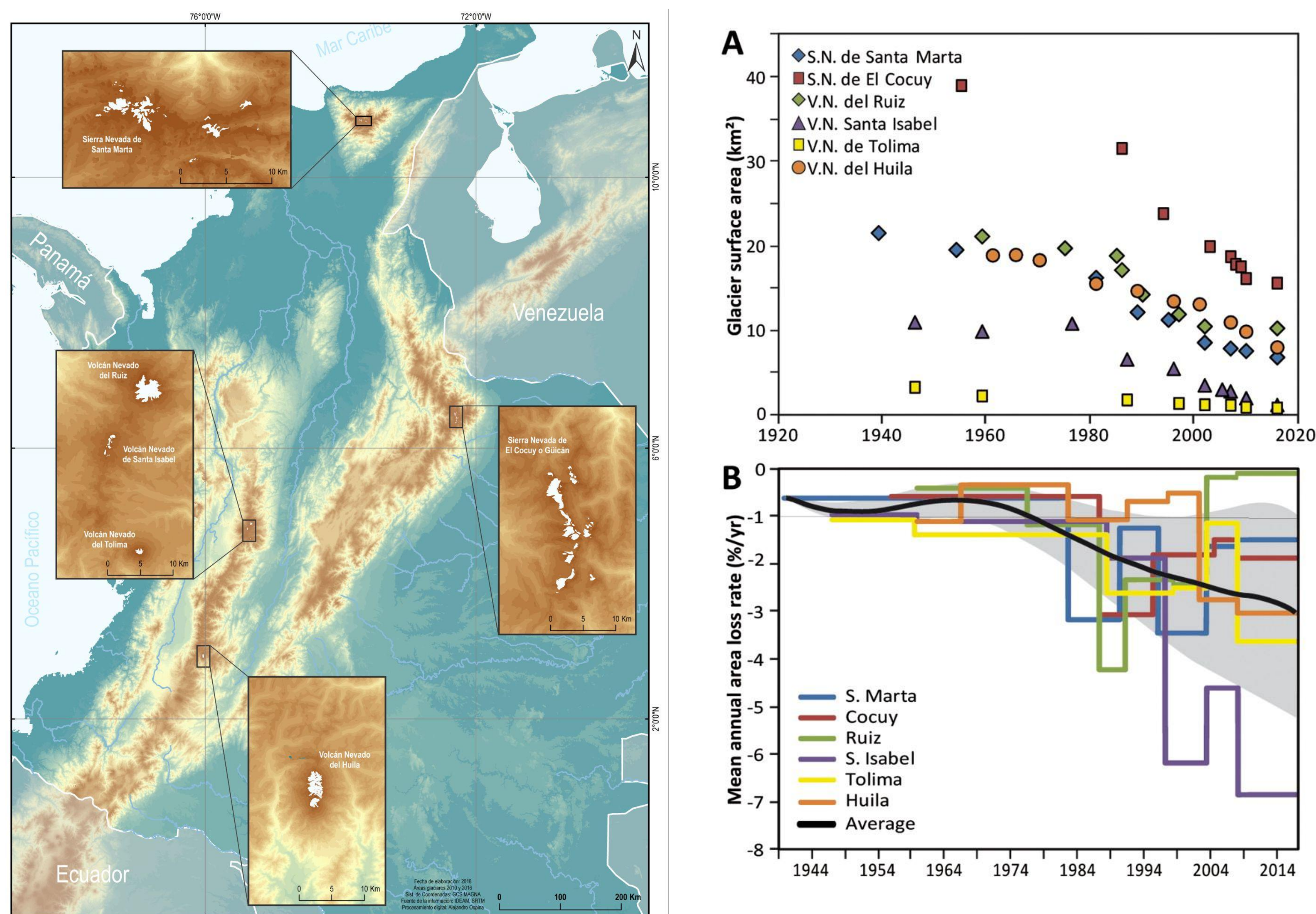


Figure 1. Overview of glacier areas in Colombia (IDEAM, 2022). Figure 2A. Glacier surface evolution and 2B. mean annual area of loss rate (Rabatel et al., 2018).

## WHY STUDY COLOMBIAN GLACIERS?

Andean glaciers represent around 99% of the all tropical glaciers in the world, being an important supply of meltwater during dry seasons and critical droughts events, an ecosystem services source to the closest population and cultural heritage symbols for mountain communities mainly. Colombia only has roughly 2% of this total, its glaciated area covered 35 km<sup>2</sup> in 2020 by 4 main mountain glacier areas and they are all protect by national parks. Unfortunately, Colombian glaciers are melting quite fast, following the current world trend of, making their study essential.

## HIGHLIGHTS FACTS

- 4 main glacier areas**
- 35 km<sup>2</sup> in 2020
- Average lower limit:** ±4800 msnm
- Largest glacier area:** SIERRA NEVADA EL COCUY O GÜICÁN 13,2 km<sup>2</sup>
- Smallest glacier area:** VOLCÁN NEVADO SANTA ISABEL 0,45 km<sup>2</sup>
- 49% - 33 km<sup>2</sup> melted glacier area in the last three decades**



Figure 3. Conejeras glacier changes between 2010 and 2020. IDEAM, 2022.

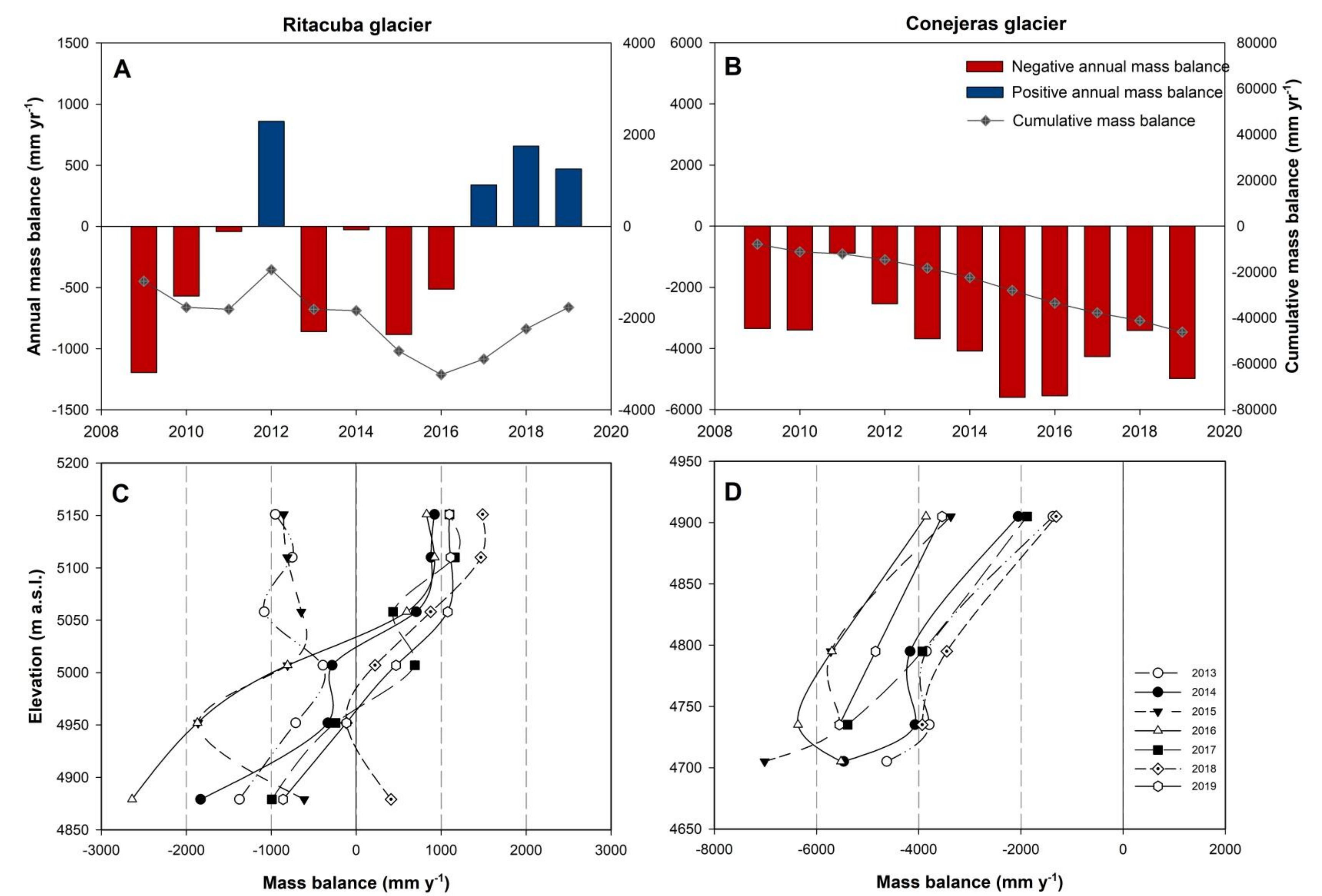


Figure 4A and 4B. Annual and cumulative Mass Balance in Conejeras and Ritacuba Glaciers. Figure 4C and 4D. Annual Mass Balance by Altitudinal Ranges. (Lopez Moreno et al., 2022).

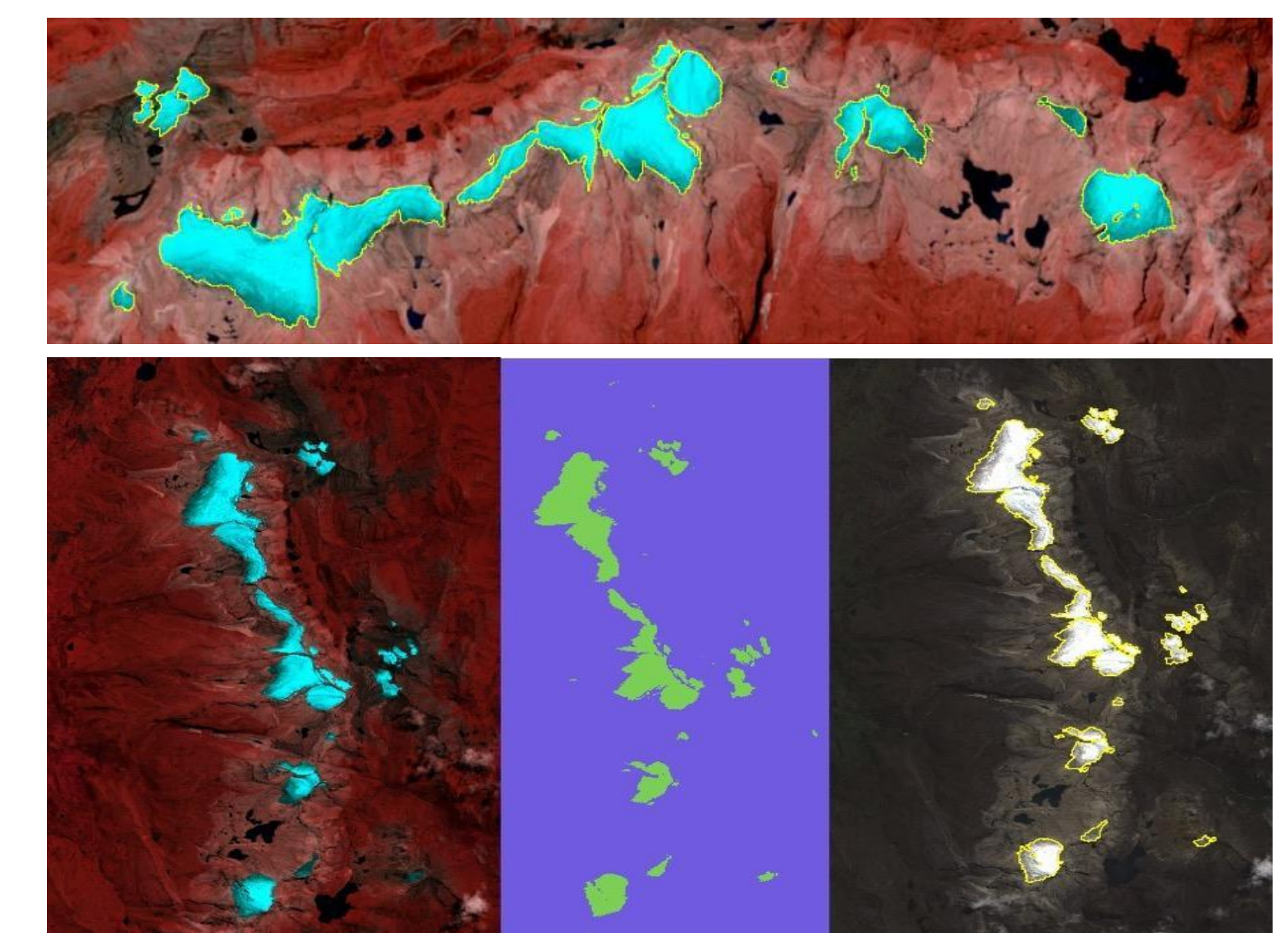
## GLACIOLOGICAL MASS BALANCE

The Glaciological Mass Balances have showed different evolution in the study areas. The Ritacuba Glacier (in the Cocuy-Güicán Mountains) alternated among positive, neutral and negative years, but the total cumulative loss was 1,9 m w.e. (Figure 6a) for the period 2009–2019. In the other hand, the Conejeras glacier (in the Santa Isabel Volcano) showed a negative recorded with 46 m w.e total losses for the same study period.

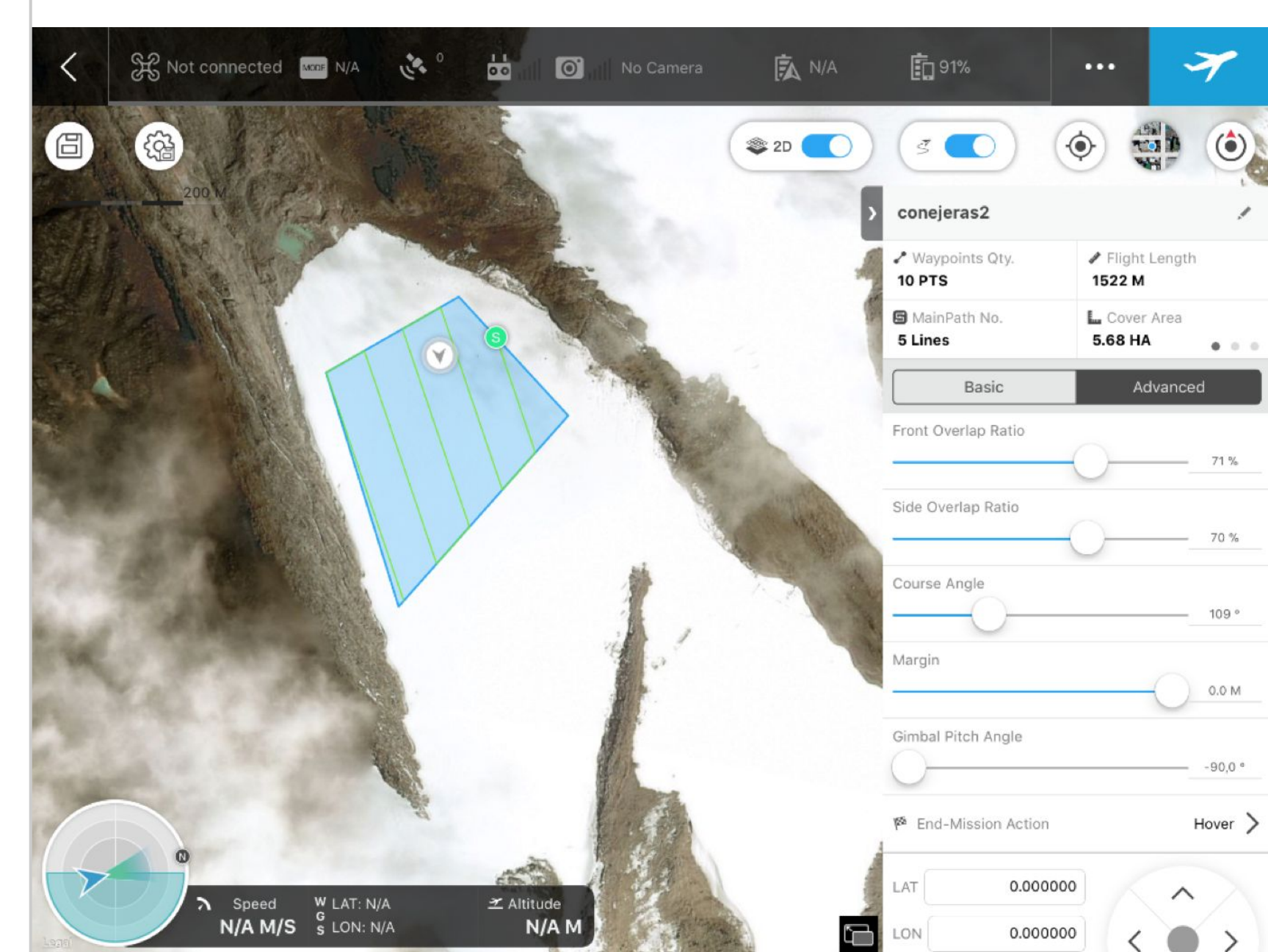
## WEATHER STATIONS NETWORK



## REMOTE SENSING AND GIS APPLICATIONS



## PHOTOGRAMMETRY AND SfM PROCESSES



## VEGETATION PLOTS OVER GLACIER RETREAT SURFACES



## WHAT'S NEXT?

It is one of the most unstudied glacier area in the world. There is still much research to be done:

- Update the national glacier inventory implementing different classification methods to set glacier outlines by remote sensing data.
- Explore through the hydrological, climatic and ecological implications of the glacier vanishing in other high mountain ecosystems (Páramo and Bosque Altoandino).
- Use and analyze the meteorological data obtained at the high mountain studies areas. Almost 15 weather stations are looking forward to be useful on research projects.

References:  
 IDEAM, 2022. Informe de los glaciares de Colombia 2022.  
 López-Moreno, J. I., et al. (2022). Recent evolution of glaciers in the Cocuy-Güicán Mountains (Colombian Andes) and the hydrological implications. *Land Degradation & Development*, 33( 14), 2606– 2618. <https://doi.org/10.1002/ldr.4336>  
 Rabatel, Antoine et al. (2018). Toward an imminent extinction of Colombian glaciers?. *Geografiska Annaler: Series A, Physical Geography*, 100:1, 75-95, DOI: 10.1080/04353676.2017.1383015