GEO Mountains Small Grants Programme 2023

Reanalyzing glacier mass balance along the Andes cordillera

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GEO MOUNTAINS
Observing Mountain Environments

UNIVERSIDAD YACHAY TECH

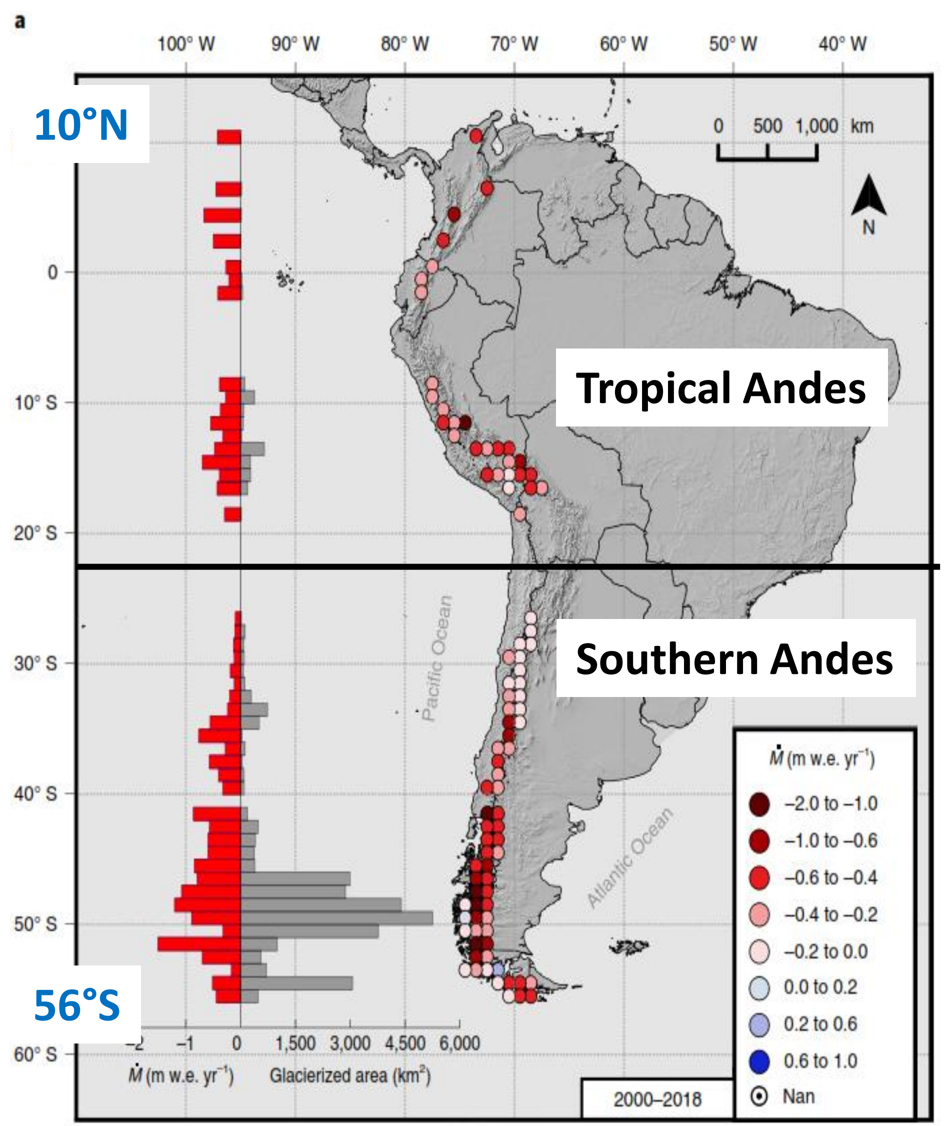
HydroCLIMA
GRUPO DE INVESTIGACIÓN

1. Motivation
2. Methods
3. Results
4. Achievements

1. Motivation

- Andean cordillera (7, 000 km). Andean glaciers are very diverse
- ~30,000 km² covered by glaciers
- Broadly glaciers are melting at a rate of **–0.72 m w.e. yr⁻¹** (2000-2020)
- Ice mass losses are less pronounced in the tropics **– 0.42 m w.e. yr⁻¹**
- Ice mass losses are less pronounced in the southern Andes **– 0.75 m w.e. yr⁻¹**

Regional glacier mass changes and their temporal evolution (2000-2020)



Dussaillant et al., 2021

1. **Motivation**

Objetives

1. To homogenize raw glaciological SMB time series in order to produce an accurate, spatially and temporally consistent, and comparable dataset.

2. A programming tool freely accessible for the scientific community

- Regional Project
  (8 Andean Institutes + 2 internacionales)
- Subvención GEO Small Grants MRI (~11,000 USD) + partners (~3,000 USD) + university (~3,000 USD)
  TOTAL ~17,000 USD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2. Methods

Problem: High spatial and temporal heterogeneity of the mass balance

The coordinates (X, Y, Z) of each stake
~3,800 point mass balance were processed.

Data cleaning involves correcting errors, removing inconsistent records, and standardizing the dataset.

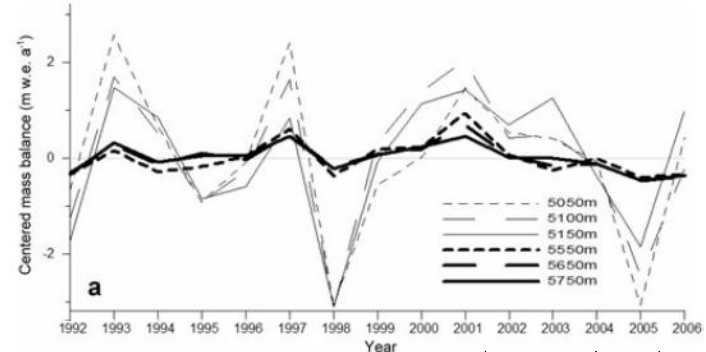
To capture nonlinearities in time and space the nonlinear model was applied

$$b_{i,t} = \alpha_i + \beta_t \gamma_i + \varepsilon_{i,t}$$

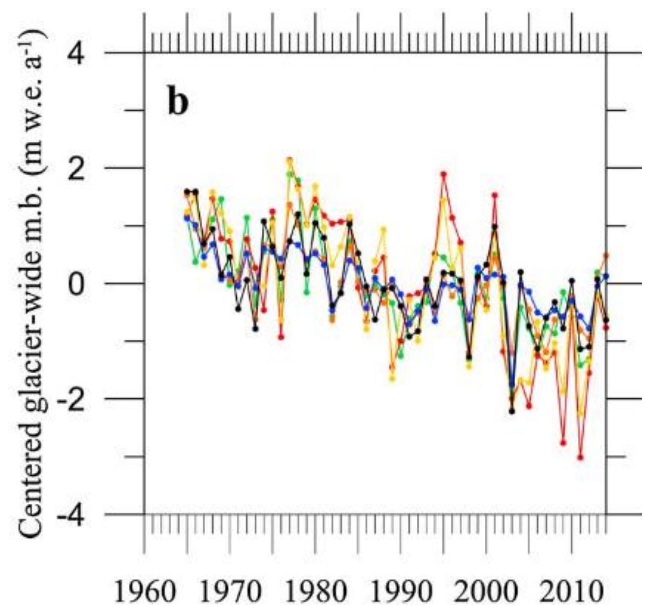
Spatial and temporal integration of the point mass balance over the glacier surface.

The geodetic mass balance was used independently to validate and calibrate, if necessary, glaciological mass balance estimates.

Discuss the results with research partners to reach agreement on the final interpretations and conclusions.



(Soruco et al.,2009)



(Lliboutry et al., 1974; Basantes et al., 2018; Vincent et al., 2018)

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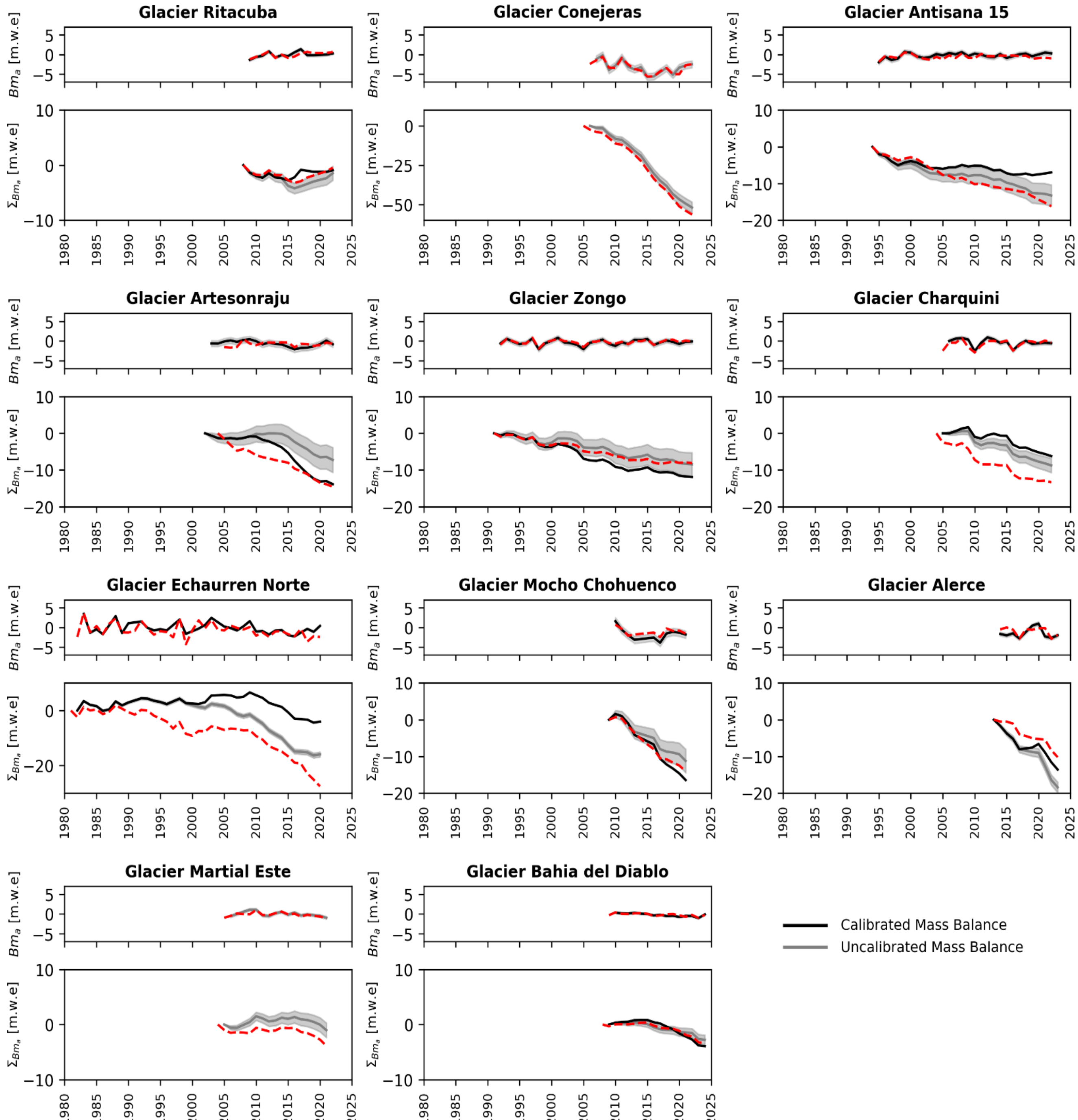
3. Results

All glaciers show a persistent negative cumulative mass balance

Moderate ice mass losses are observed in:
Glacier Ritacuba, Antisana 15, Martial Este, Bahía del Diablo

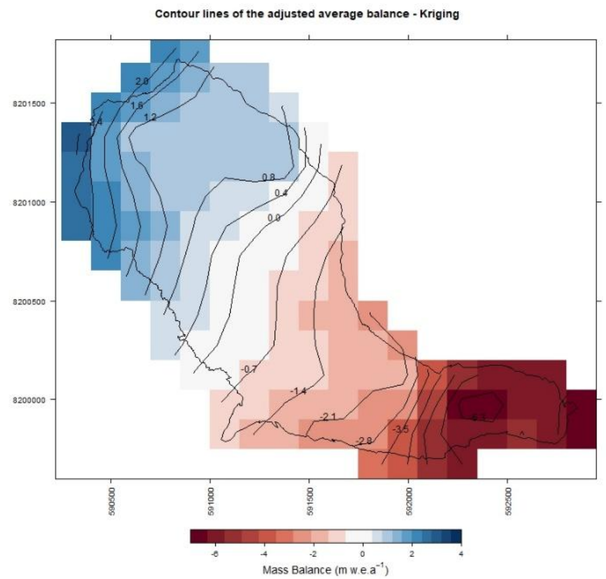
Calibration significantly modifies the cumulative magnitude in several glaciers: In Antisana 15, Charquini and Echaurren, the calibrated balance is less negative than the uncalibrated one.

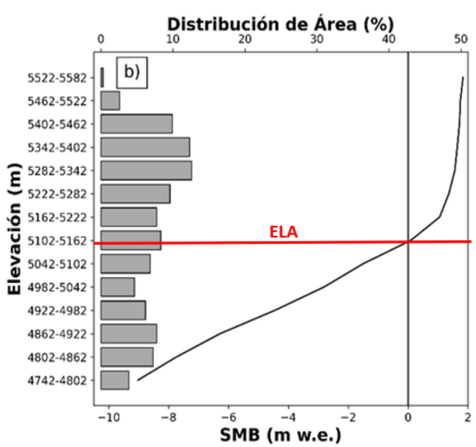
There was strong interest by the local partner in including Glacier Bahía del Diablo (ANT) in the study.



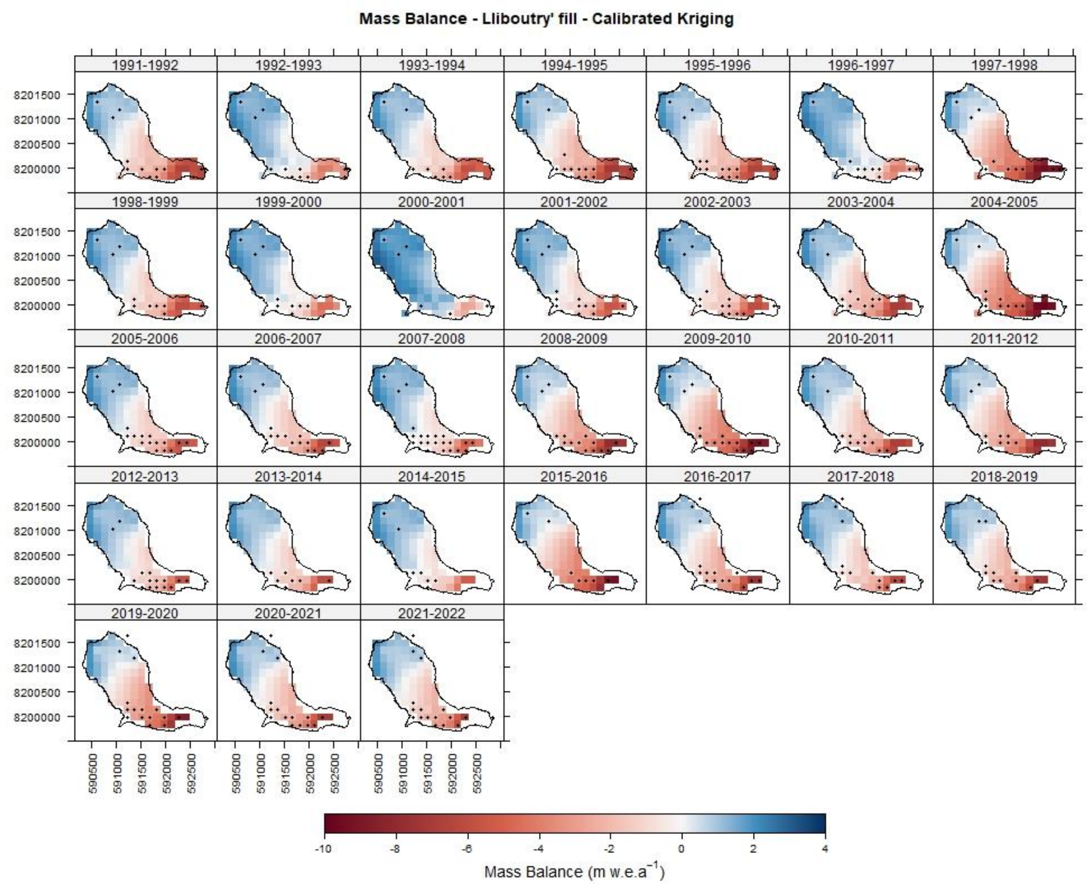
3. Results

By using the Ordinary Kriging (OK) interpolation method, it is possible to compute the distributed average glacier mass balance.





The spatially distributed annual mass balance is calculated while considering changes in glacier surface area.



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4. Achievements

1. The homogenized glacier mass balance time series were used in the TROPIPOLAR GLASCLIM project to reconstruct glacier mass balance from tropical to polar regions using machine learning and regional climate models. The project was funded by the Climat AmSud initiative and led by Universidade Federal do Rio Grande (paper in prep).

2. We develop a mass balance algorithm in *Beta* version

3. We develop some outreach and educational resources that are constantly updated and can be accessed by our *website*

4. We are working in developing a technical guidelines containing a set of recommendations for homogenizing observations and compute their corresponding uncertainties.

5. Presentation of this new dataset and an interpretation of the interannual response of Andean glaciers to the climate variability of recent decades. A scientific paper in preparation to be submitted in june

GRACIAS!

Levantamiento geodésico del casquete del volcán Cayambe (2021)

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