The Cryosphere Discussions

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Comment on tc-2022-70

Anonymous Referee #2

Referee comment on "New insights into the decadal variability in glacier volume of a tropical ice cap, Antisana (0°29′□S, 78°09′□W), explained by the morpho-topographic and climatic context" by Rubén Basantes-Serrano et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2022-70-RC2, 2022

Review of "New insights into the decadal variability in glacier volume of an iconic tropical ice-cap explained by the morpho-climatic context, Antisana, (0°29′ S, 78°09′ W)" by Basantes-Serrano et al., (2022).

General comments

This article describes the decadal changes in glacier volume in the Antisana ice cap located in the tropical Andes, Ecuador. The authors have used photogrammetric and remote sensing techniques to provide a long-term geodetic mass balance for the Antisana ice cap. Overall, there has been a lack of long-term glacier mass balances studies in this region. For this reason, additional information and novel insights into the past and current state of tropical glaciers are very welcome. In general, I think this is a well-presented and worthwhile piece of research and could help increase our knowledge about the spatiotemporal patterns of glacier volume changes. The topic is timely and highly relevant for various research branches including glaciology, hydrology, and climatology. I am very much in favor of seeing this manuscript published, and would like to make the following suggestions.

Methods

- The authors used state of- the art remote sensing and photogrammetric techniques to generate digital elevation models to estimate volume changes. The authors also applied state-of-the-art post-processing techniques (including co-registration, gap filling, outliers filtering, etc.) to provide a complete series of glacier elevation, volume, and area changes for the whole massif-volcano. However no information about the glacier area estimation.

- They also evaluate the effect of the morpho-topographic and climatic variables on glacier volume changes. However, in some sections, they mixed morpho-topographic-climate or vice-versa. In the title the use morpho-climatic. I suggest being consistent with the terms and clearly stating the variables evaluated.

Volume to mass changes conversion:

- The authors used one conversion factor (density) of ice volume change (850 kg m^{-3}). However, very little discussion is associated with the choice of this number. Why just this value? Are the uncertainty ranges sufficiently? (±60 kg m^{-3}). The authors also report that during the period 1965-1978 all the glaciers gain mass (moderate). Maybe it is possible to present density scenarios (e.g. Seehaus et al., 2019). For instance, a second scenario of two different conversion factors for areas below and above the ELA (e.g. Kääb et al. 2012).

Uncertainties:

- Overall, no details are mentioned about glacier area estimation or source. How did you obtain the glacier areas? How was the uncertainty of glacier mapping considered? No details about the uncertainty of the glacier area are included (not included in your error propagation equation).

Specific comments:

Title: I am not fully convinced with your title. I would suggest restructuring the title since this study signifies the first long-term geodetic mass balance /volume change, and also because Antisana ice cap more than “iconic” is a benchmark glacier for the inner tropics.

Abstract: Please provide numbers of volume or mass changes for this section. Strong and slight mass loss can sometimes be subjective.

21 -> what about the climatic variables

80 -> it seems that it was an important eruption in 1800.

115 -> did you scan the negatives? or how was the digitalization process for the aerial photographs?

135 -> did you apply any correction (GCP points) to the Pleiades image? Some of the images present some displacement.

212 - 216 -> Please check this, you have included the internal ablation due to the heat transfer in the subglacial interface layer and due to heat released due to glacier dynamics in your uncertainties. However, I think this is not necessary. To my knowledge, the geodetic mass balance is providing the total glacier mass balance including internal ablation (Cogley et al., 2011). Hence the uncertainty from the geodetic estimation should be enough.

214 -> include the area error/uncertainty into your propagation equation. No details about the uncertainty of the glacier area mapping are included.

280 -> what do you consider as morpho-topographic features just an elevation profile? Please provide clear detail about the morpho -topographic -climate variables. In the title of your study, you just included the morpho-climatic. Please be consistent throughout the text.

320 -> Table 4 -> the periods should be 1956-1965; 1965-1979, 1979-….etc…did you calculate the dhdt using these dates? You stated in line 237 that the time was not adjusted. I think that the results from â □period and 1956-2016 should be included in your uncertainty estimation as well (e.g. Brun et al., 2017; Menounos et al., 2019 -systematic errors-).

370 -> is there any signal of geothermal activity in the Antisana glacier? This could explains the surge event?, at least it is a factor that is should be considered since is an active volcano (although its last eruption was in 1800). Is there any fumarolic activity?

371 -> It is a confusing sentence. Ice flow dynamics are also a response of climate variations.

405 -> table 5 -> Just morpho-topographic? Please indicate what is Bm and ‘Bm

I missed a comparison of your results with those from Braun et al., (2019) and Dussaillant et al., (2019). Although they used RGI_V6 glacier outlines to estimate volume change over a limited period, it is a good opportunity to check their number with more high-resolution data as you have shown here.

Figures:

The figures are clearly meant to support the overall study, but they also present some issues for the reader

Figures 1 and 2 -> maybe both images can be merged, and the insert table can be inserted as a normal table.

Figure 3 -> It is difficult to follow the colors. Is it possible to change the brightness of the plot? it is not possible to identify the colors (opaque). In the period 1956-2016, there are data gaps mainly in glaciers from G4 to G7. I was wondering how you managed the samples in these accumulation areas (gray). The same for 2010-2106 period.

References

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