

## Comments for Julian Gelman Constantin et al.

This paper gives a thorough account of April (2016 and 2017) field measurements conducted on the Alerce Glacier in the Northern Patagonian Andes. Combined with an updated Snow, Ice, and Aerosol Radiative (SNICAR) model that accounts for partly cloudy conditions, the measurements are used to estimate the glacier's April 2016 – April 2017 surface mass balance. Representing the first particulate matter concentration, albedo, and grain size measurements conducted on the Alerce Glacier, these results are a valuable contribution to the community and therefore warrant consideration for publication in *The Cryosphere*. Before acceptance, however, there are specific concerns, provided below, followed by a list of technical corrections that I recommend the authors consider in a minor revision.

Throughout the manuscript, the authors refer to an average snow grain radius value that they claim (in Sect. 2.2) to be precise. Average radii values were obtained using two methods: from visual inspection against a crystal grid, which is outdated, and from ImageJ software, which, to my knowledge, is not a standard method for obtaining snow grain radius. Although these methods provide one estimate of snow grain size (e.g., the length of maximum dimension), they will not yield a precise optically equivalent snow grain radius (nor specific surface area) that is the relevant quantity in two-stream snow radiative transfer algorithms like the SNICAR model. To reduce a potential source of error regarding the SNICAR modeling results, I suggest placing a greater emphasis on the other measured quantities used as inputs into the SNICAR model, especially the light absorbing particle (LAP) concentrations.

Regarding the use of terminology, a reader would benefit from a brief description of the distinction, if any, between LAPs and particulate matter (PM). The abstract begins by stating the relevance of light absorbing impurities in snow studies, however, the results and discussion most frequently refer to PM. Because “LAP” is a well known acronym, I suggest either maintaining the convention used in the literature, or defining PM while also elucidating the reason for the use of “PM” to describe these particular measurements.

Although I found Sect. 3 to be well written, I recommend the following technical corrections regarding mostly the other sections and figures:

1. *Abstract (lines 1–4)*: Background could be refined, perhaps by moving one or two of the sentences into Sect. 1, to quickly introduce the present work.
2. *Abstract (line 6)*: “during ablation” → “during the ablation”
3. *Abstract (line 9)*: “from recent...eruption, with minor” → “from the recent...eruptions, with a minor”
4. *Abstract (lines 11–12)*: “SNICAR model has been updated to model snow albedo taking into account” → “We updated the SNICAR model to account for”

5. *Abstract (line 14)*: This part seems like an important component of this study, yet, it took me two or three times to understand the meaning of this sentence. Perhaps “which field measurements precision” can be rephrased to improve the readability.
6. *Abstract (line 17)*: “m we” → “m snow water equivalent (SWE)”
7. *Sect. 1 (line 20)*: I like this opening, but the first sentence needs to begin with “Since” or “Because.”
8. *Sect. 1 (line 29)*: It’s probably better to use the term “light-absorbing particles (LAP)” (Skiles et al., 2018).
9. *Sect. 1 (line 38)*: What is the distinction between LAP and atmospheric particulate matter?
10. *Sect. 1 (line 44)*: “there has been found” → “it has been shown”
11. *Sect. 2 (lines 88-89)*: “the hydrological year is defined from the 1-April to the 31-March of the next year. The accumulation season last from 1-April to 31-October and the ablation season from 31-October to the 31-March of the next year.” → “the hydrological year begins on April 1st with the accumulation season. The accumulation season lasts until October 31st, which marks the beginning of the ablation season.”
12. *Fig. 1 (caption)*: It might be good practice to include the term “true color” in the description to indicate that the image is intended to reproduce a natural color rendition.
13. *Fig. 2 (caption)*: It might be good practice to indicate that the grayscale used is logarithmic.
14. *Sect. 2.2 (line 125)*: Please provide additional details of the “in-house developed supports” in order to improve the reproducibility of results.
15. *Sect. 2.2 (line 127)*: “In the 2017 a” → “In the 2017 campaign, a”
16. *Sect. 2.2 (subsection headings)*: Are these subsection headings supposed to be numbered (i.e., 2.2.1, 2.2.2, and 2.2.3)?
17. *Sect. 2.2 (line 153)*: Equation (S1) has now been referred to twice. Should it be included in the main text?
18. *Sect. 2.3 (line 189)*: Is  $I_{glob} = I_{dir} + I_{diff}$ , or something else? Perhaps this can be more clearly described in Sect. 2.2.
19. *Fig. 4*: If the vertical axis represents a normalized, dimensionless quantity, please indicate so. Otherwise, please provide the meaning of the vertical dimension. Also, the right-most part of the figure (horizontal axis) appears clipped.
20. *Fig. 5*: The box-and-whisker plot demonstrates the distribution of measurements nicely when  $N > 2$ . Does this mean that boxes represent standard deviations even when  $N = 2$ ? If this is the case, perhaps a bar chart displaying the minimum and maximum values would be a more consistent portrayal of seasonal ranges, since standard deviations are better for estimating the variance of a distribution with a larger number of samples.

21. *Sect. 3.3 (line 368)*: Although Cuffey and Paterson (2010) have written a standard textbook for glaciology, it would be nice to include a more accessible, primary reference that demonstrates this phenomenon.
22. *Sect. 3.3 (line 403)*: “In the other hand” → “On the other hand”
23. *Sect. 3.4 (AAR)*: Definition of accumulation area ratio? If it is the accumulation area to ablation area ratio, why are the values in m?
24. *Fig. 9*: The prefix “glacier-wide” is technically redundant, as “surface mass balance” is considered a surface area-integrated quantity. When referring to it as a local quantity, however, it can be stated as “specific surface mass balance.” Also, the units on the axes labels should be in parentheses.
25. *Sect. 4 (line 510)* “observation and modeling activities to analysis” → “measurements and modeling to analyze”
26. *Sect. 4 (line 512)*: No need for a paragraph break here.
27. *Sect. 4 (line 526)*: “may difficult” → “may degrade”
28. *Sect. 4 (line 529)*: Remove the comma.
29. *Sect. 4 (line 534)*: “glacier-wide” → “surface” (see comment 24)