

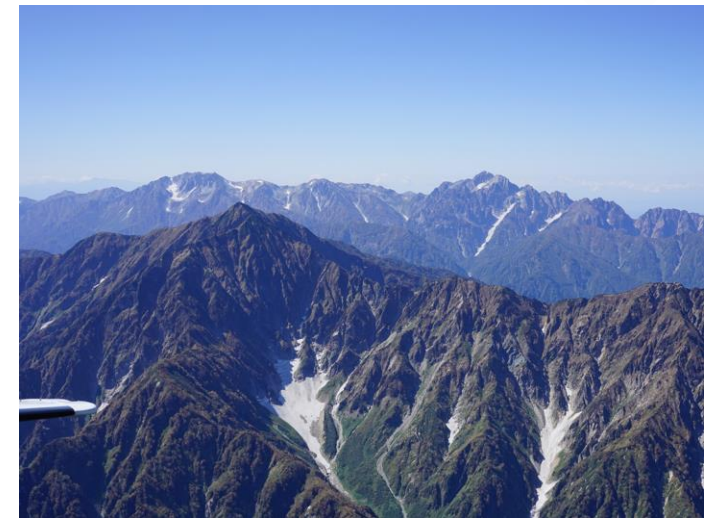
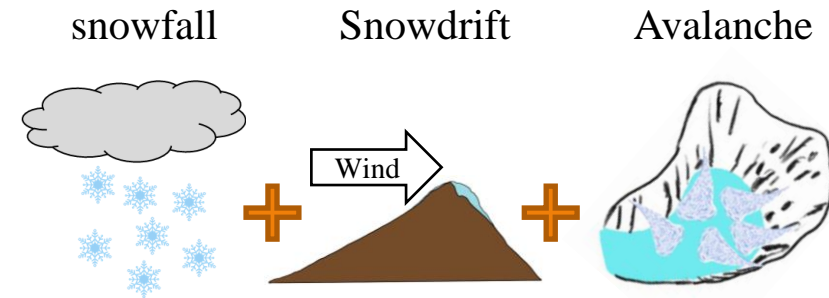
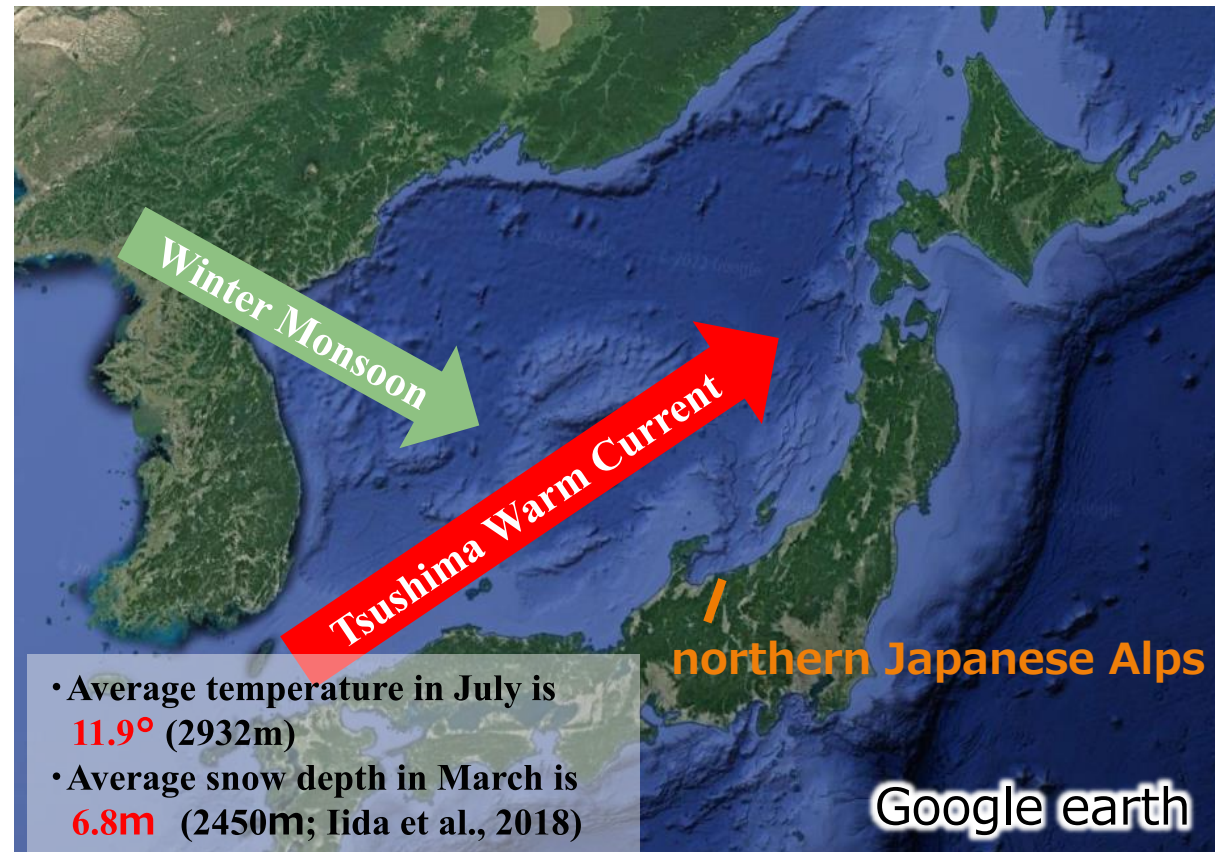
# Topographic conditions for the formation of glaciers and perennial snow patches in the northern Japanese Alps

Kenshiro Arie<sup>1</sup> and Chiyuki Narama<sup>2</sup>

<sup>1</sup> Niigata University, Graduate School of Science and Technology (Research Fellowship for Young Scientists of JSPS)

<sup>2</sup> Niigata University, Program of Field Research in the Environmental Sciences

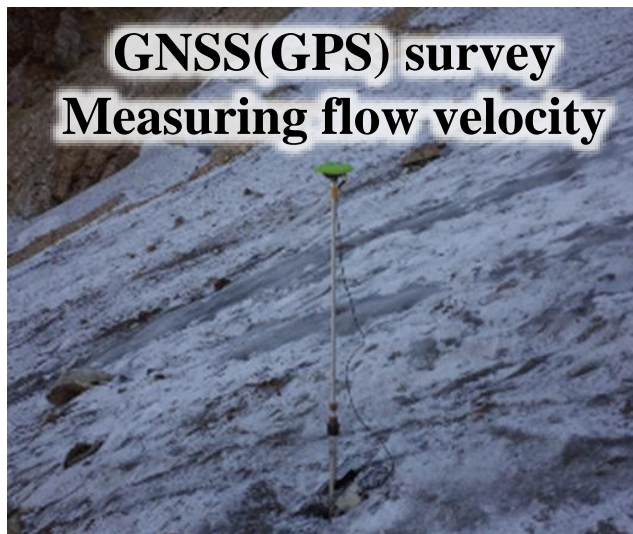




- The northern Japanese Alps is located along the Sea of Japan. The elevation of the main ridges is approximately 2500m-3200m.
- During the winter monsoon, a dry, cold air mass from the continent passes over the Tsushima warm current, gaining heat and water vapor, and then undergoes topographic updraft, producing the heaviest snowfall worldwide.
- In spite of a mid-latitude, mid-altitude, warm environment, and below the snow line altitude, due to heavy snowfall and topographic effect (avalanches and snowdrifts) there are more than 100 perennial snow patches. More than 80% of snow patches exist on the eastern slope because of the winter monsoon.



# Do you know very small glaciers (VSGs) exist in Japan ? <sup>3/11</sup>



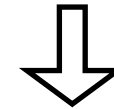
- Fukui et al (2012; 2021) and Arie et al. (2019) have confirmed seven perennial snow patches as VSGs in the northern Japanese Alps.



The Cryosphere, 16, 1091–1106, 2022  
<https://doi.org/10.5194/tc-16-1091-2022>  
© Author(s) 2022. This work is distributed under  
the Creative Commons Attribution 4.0 License.



The Cryosphere  
Open Access  
EGU



## Characteristics of mountain glaciers in the northern Japanese Alps

Kenshiro Arie<sup>1</sup>, Chiyuki Narama<sup>2</sup>, Ryohei Yamamoto<sup>1,3</sup>, Kotaro Fukui<sup>4</sup>, and Hajime Iida<sup>4</sup>

<sup>1</sup>Graduate School of Science and Technology, Niigata University, 8050 Ikarashi 2 no-cho, Nishi-ku, Niigata 950-2181, Japan

<sup>2</sup>Program of Field Research in the Environmental Sciences, Niigata University, 8050 Ikarashi 2 no-cho, Nishi-ku, Niigata 950-2181, Japan

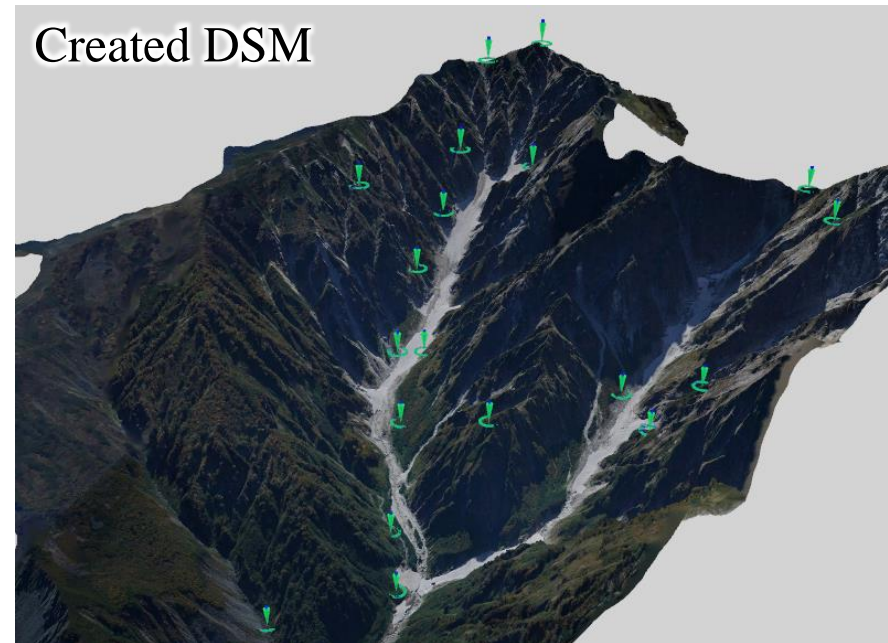
<sup>3</sup>Aero Asahi Corporation Spatial Information Business Headquarters, 3-14-4 Minamidai, Kawagoe, Saitama 350-1165, Japan

<sup>4</sup>Tateyama Caldera Sabo Museum, 68 Ashikuraji-bunazaka, Tateyama-machi, Toyama 930-1405, Japan

**Correspondence:** Kenshiro Arie ([kenshiroarie@gmail.com](mailto:kenshiroarie@gmail.com))

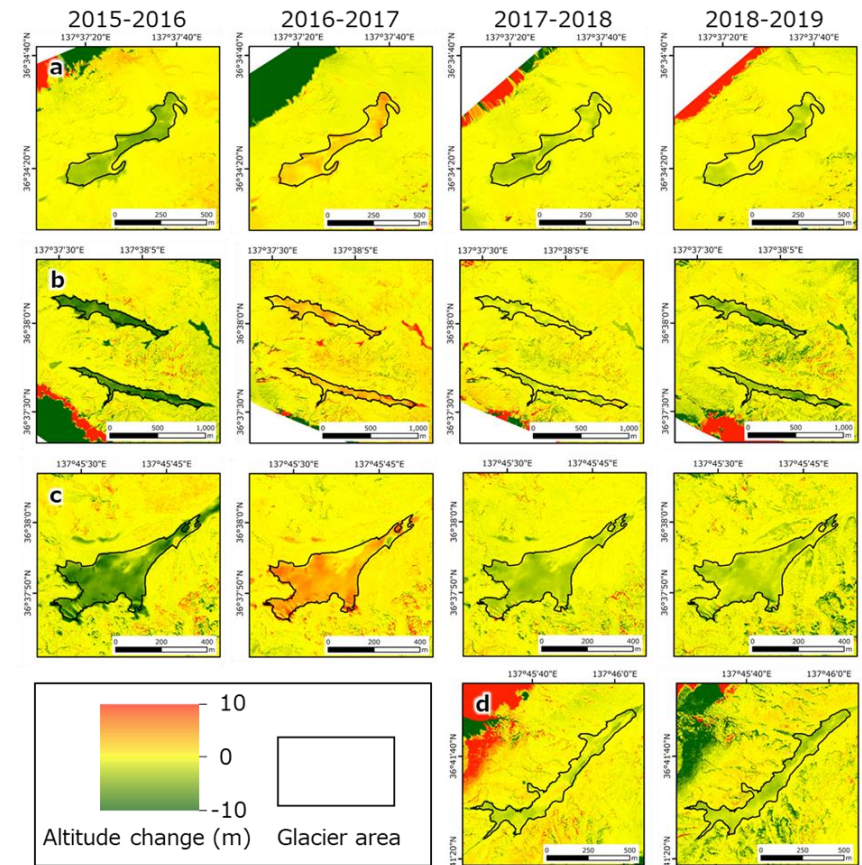
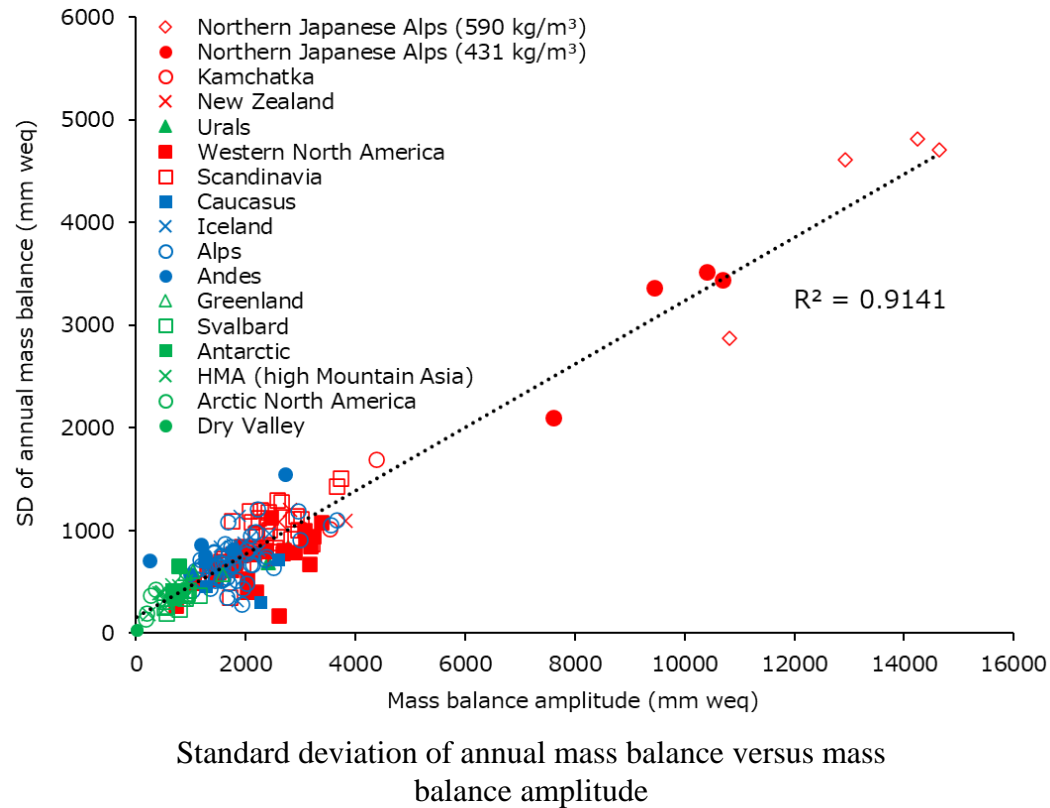
Received: 18 June 2021 – Discussion started: 1 July 2021

Revised: 25 November 2021 – Accepted: 30 November 2021 – Published: 30 March 2022



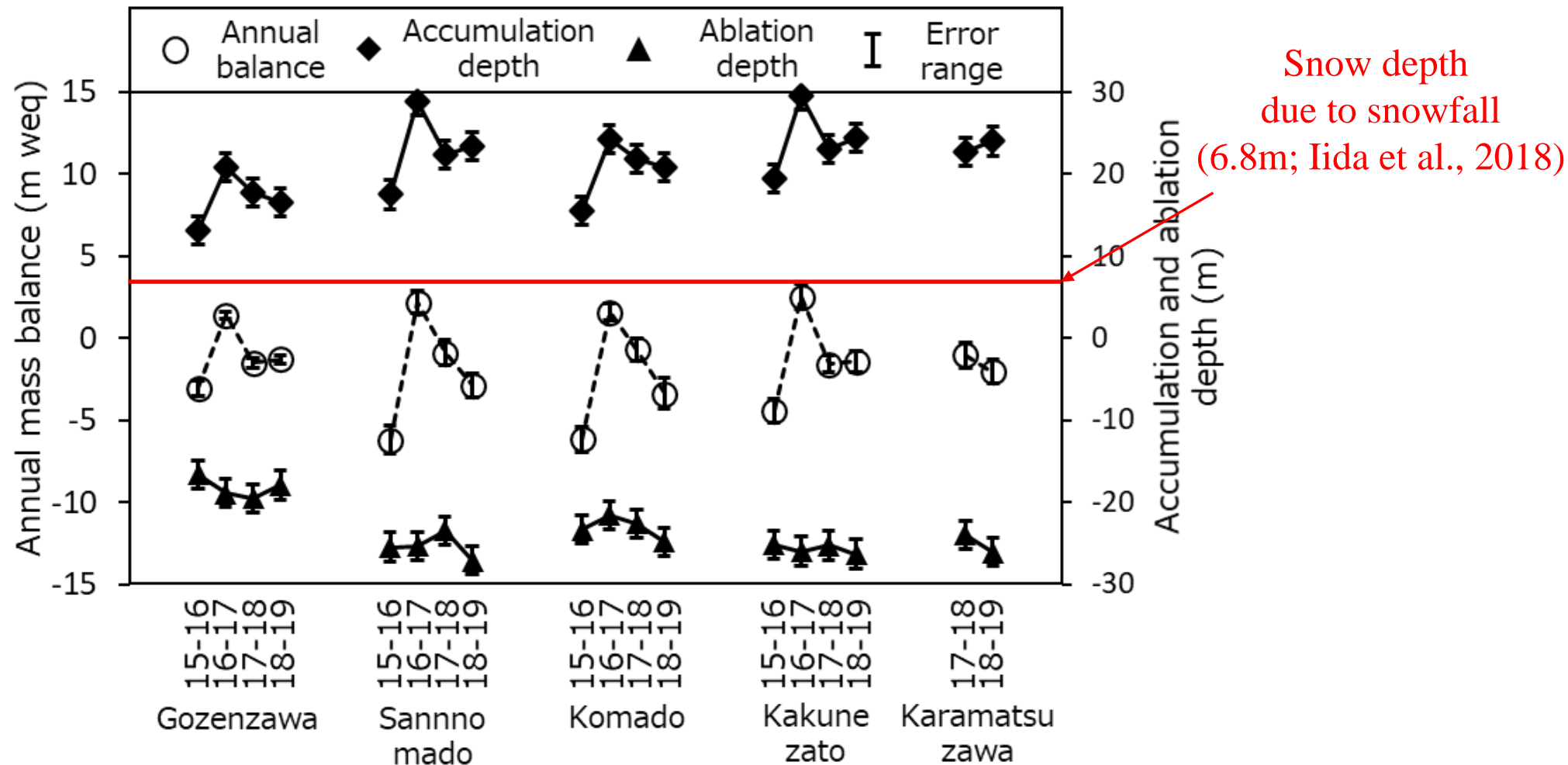
Created DSM

- We submitted a paper in March of this year on the geodetic mass balance of very small glaciers in the northern Japanese Alps observed by aerial photography and photogrammetry.



Annual altitude changes of each glacier and year. a) Gozenzawa. b) Sannomado (lower), Komado (upper). c) Kakunezato. d) Karamatsuzawa.

- In this paper, we showed that VSGs in the northern Japanese Alps have the largest mass balance amplitude and the largest yearly fluctuations in annual mass balance among the glaciers worldwide recorded in the WGMS.
- The annual mass balance with large yearly fluctuations showed accumulation throughout each glacier during heavy snow years and ablation throughout each glacier during light snow years.



Annual mass balance, accumulation depth, and ablation depth of each glacier in 2015-2019.

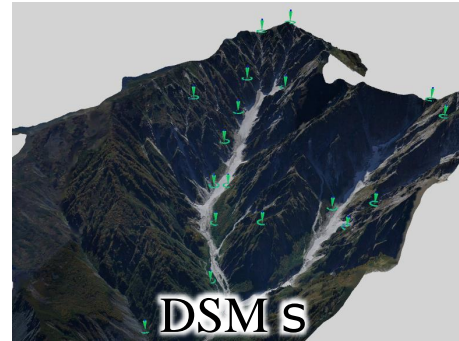
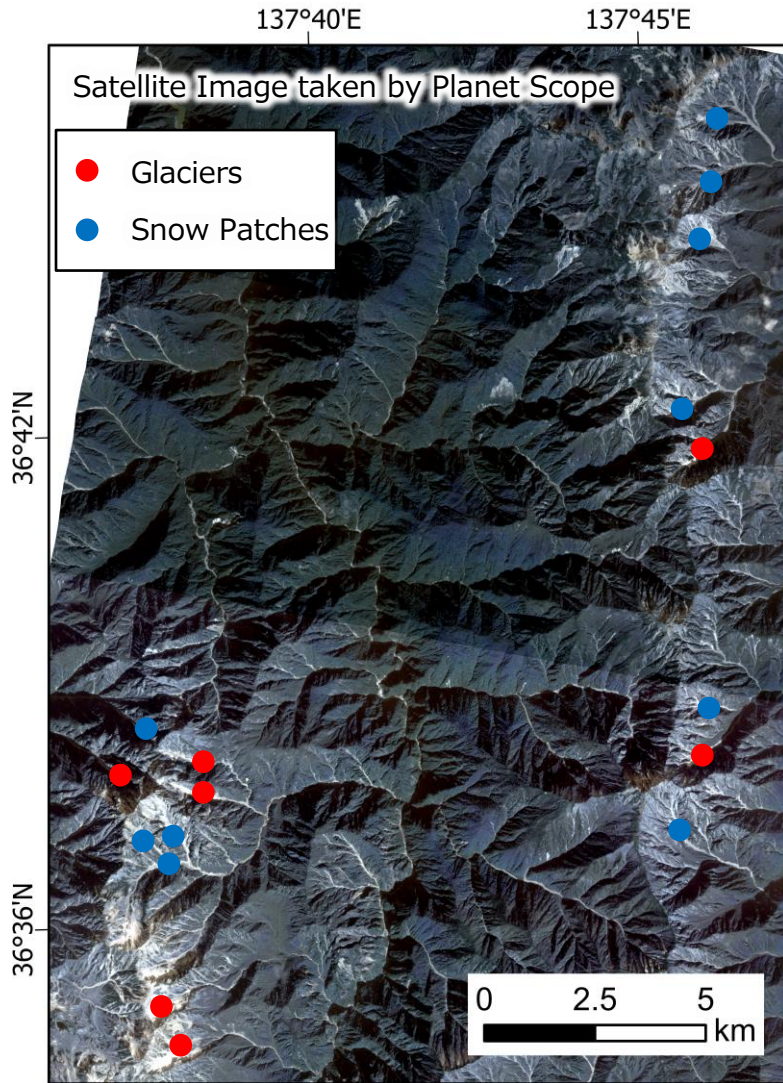
- Glaciers are accumulated more than double (over 20m) as much snowfall **due to the effects of avalanches and snowdrifts.**





- There are valleys where glaciers exist, perennial snow patches exist, and snow does not survive.
- In this study, we analyzed the topographic environment of glaciers and perennial snow patches ( $>0.01 \text{ km}^2$ ) to clarify topographic conditions where snowdrifts and avalanche contributions are significant and glaciers and perennial snow patches can exist.





+ GIS Analysis

## Drainage ratio

The ratio between the drainage area leading directly onto the total glacier surface area (drainage ratio) was used to provide an indication of the possible contribution of windblown and avalanching snow onto the glacier surface (Hughes, 2009).

## Altitude

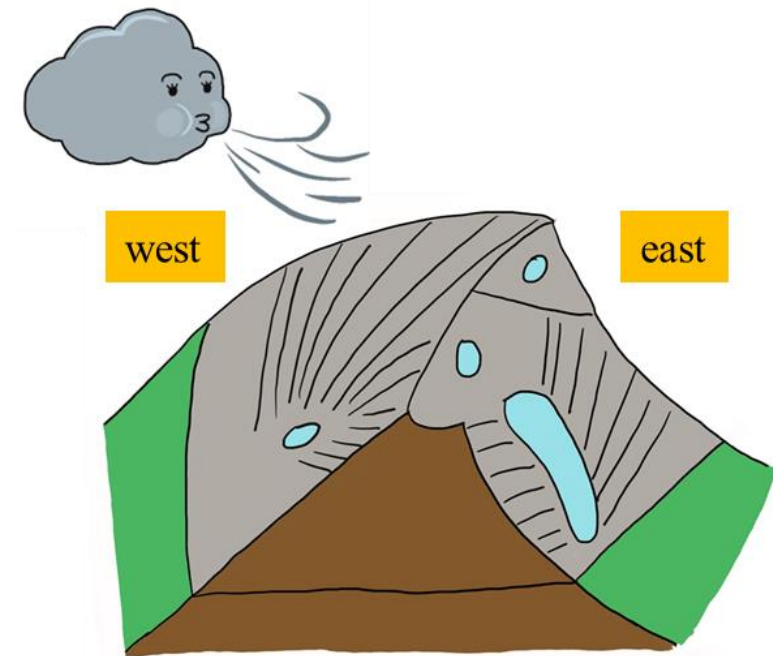
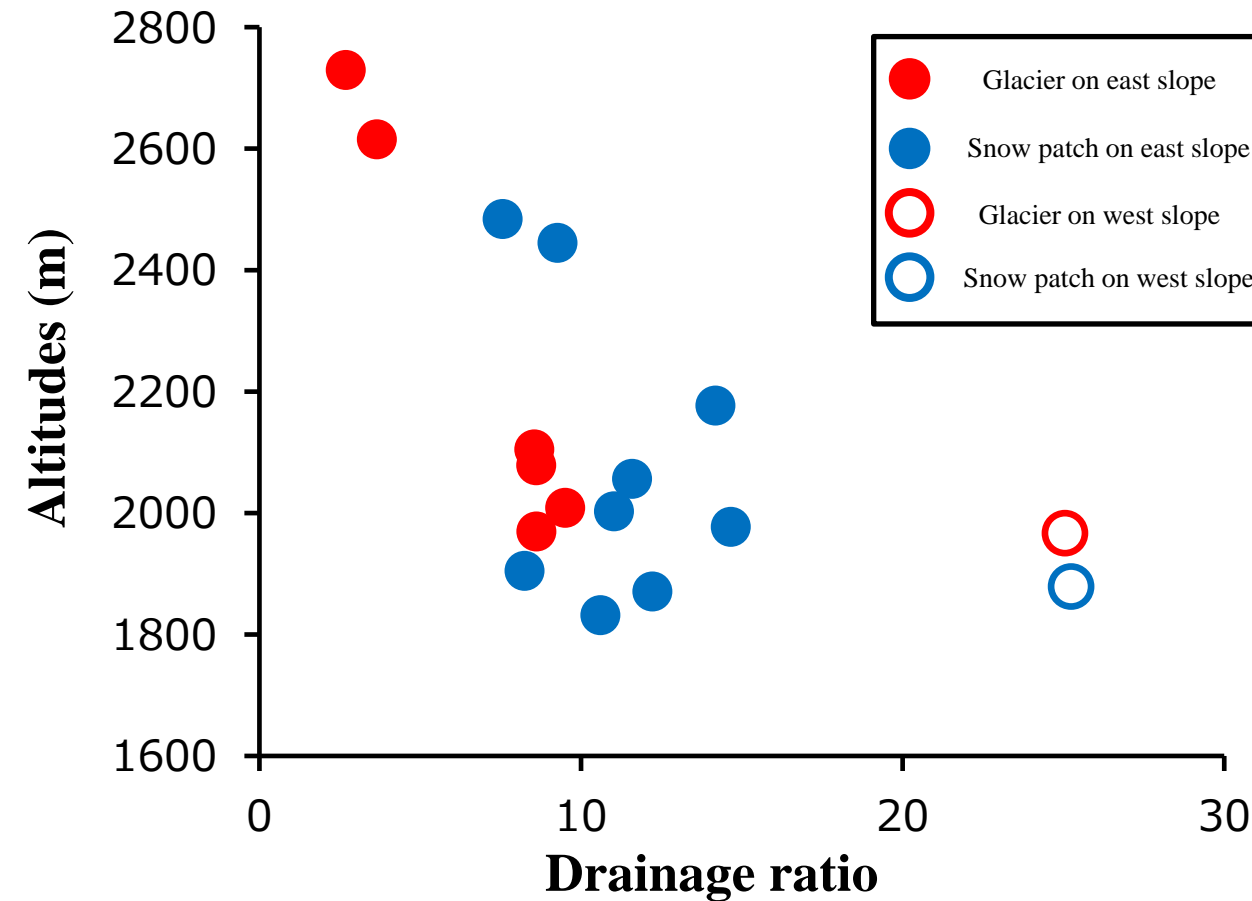
Temperatures are higher at lower altitudes and the amount of glacier melt is greater

- We compared the two topographical elements of **drainage ratio** and **altitudes** of 7 glaciers and 10 perennial snow patches ( $> 0.01\text{km}^2$ ).

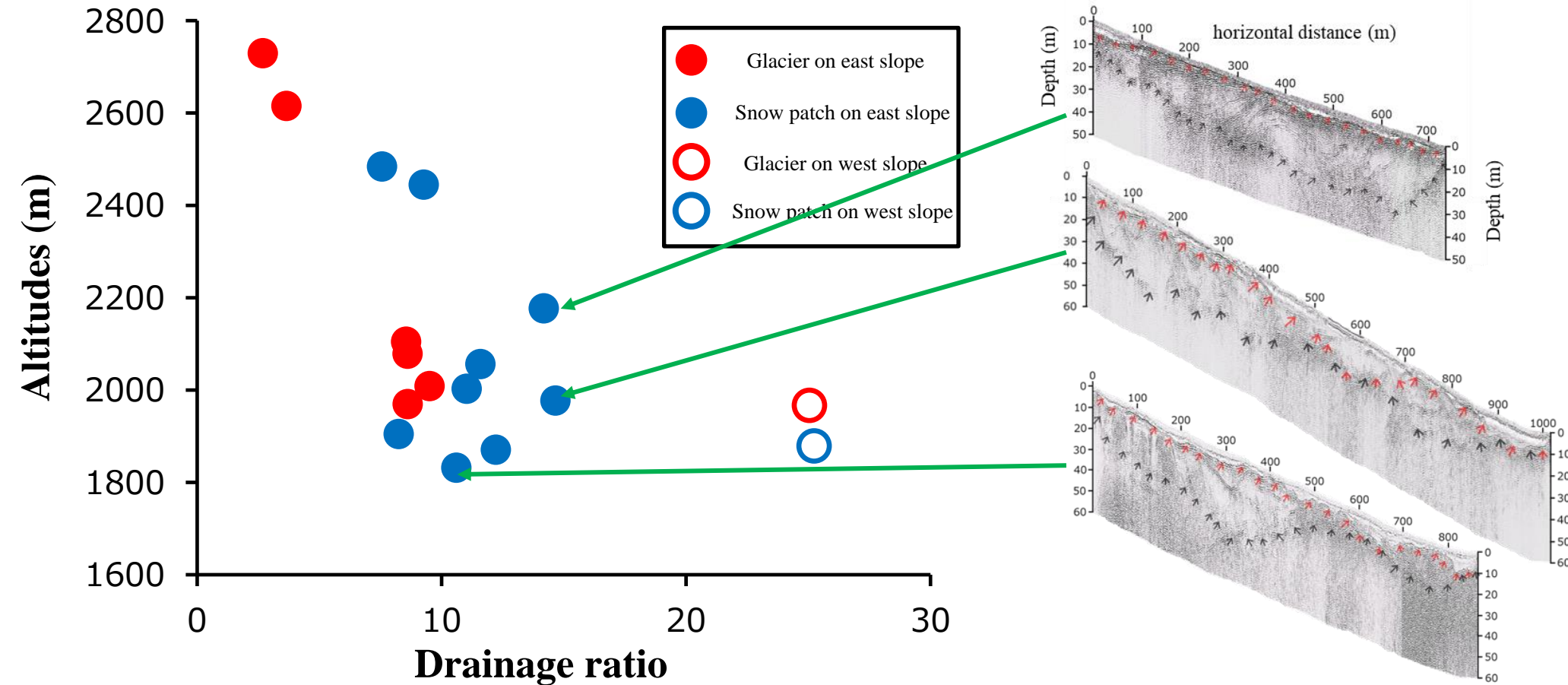


# Results (Topographic conditions for the formation of glaciers and perennial snow patches )

9/11



- A negative correlation was observed between drainage ratio and altitudes. **This suggests that large avalanche accumulation is necessary for the formation of glaciers and snow patches in a warm environment at low altitude.**
- In addition, the drainage ratio of glacier and snow patch on the west slope was very large. **This suggests that large avalanche accumulation is necessary for the formation of glaciers and snow patches on the windward slope where there is no snowdrifts accumulation.**



- No differences were found between glaciers and perennial snow patches in our analysis.
- In order to clarify the distribution of glaciers in the northern Japanese Alps, it is necessary to conduct a field survey to confirm whether perennial snow patches ( $> 0.01\text{km}^2$ ) are glaciers or not.
- We are currently conducting a GPR survey at three perennial snow patches.



# Thank you for your attention!

## References

- Arie, K., Narama, C., Fukui, K., Iida, H., and Takahashi, K.: Ice thickness and flow of the Karamatsuzawa perennial snow patch in the northern Japanese Alps, *Journal of the Japanese Society of Snow and Ice*, 81, 283–295, 2019 (in Japanese).
- Arie, K., Narama, C., Yamamoto, R., Fukui, K., and Iida, H.: Characteristics of mountain glaciers in the northern Japanese Alps, *The Cryosphere*, 16, 1091–1106, <https://doi.org/10.5194/tc-16-1091-2022>, 2022.
- Fukui, K. and Iida, H.: Identifying active glaciers in Mt. Tateyama and Mt. Tsurugi in the northern Japanese Alps, central Japan, *Journal of the Japanese Society of Snow and Ice*, 74, 213–222, 2012 (in Japanese).
- Fukui, K., Iida, H., and Kosaka, T.: Newly Identifying Active Glaciers in the Northern Japanese Alps and Their Characteristics, *Geographical Review of Japan Series B*, 94, 81–95, 2021.
- Hughes, P. D.: Twenty-first Century Glaciers and Climate in the Prokletije Mountains, Albania, *Arct. Antarct. Alp. Res.*, 41, 455–459, 2009.
- Iida, H., Fukui, K., and Osada, K.: Long-term Snow pit survey in Murodo-Daira, the Tateyama Mountains (II), *JSSI & JSSE Joint Conference – 2018 in Sapporo, Hokkaido, Japan*, 9–12 September 2018, 254, 2018 (in Japanese).



Arie et al. (2019)



Arie et al. (2022)



If any questions or comments, I am also available by e-mail

[kenshiroarie@gmail.com](mailto:kenshiroarie@gmail.com)