Estimation of mass balance of glaciers in the Northern Japanese Alps using SfM-MVS

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1. Introduction

Fukui and Iida (2012), Fukui et al. (2018), and Arie et al. (2019) measured ice thickness and flow in a perennial snow patches in the northern Japanese Alps, and confirmed seven perennial snow patches are extant glaciers.However, the characteristics of glaciers such as glacier mass balance and flow mechanism are not clear.

In this study, we calculated the mass balance, snow depth, and snowmelt depth of glaciers in the northern Japanese Alps for a total of four years from 2015 to 2019 using geodetic methods using SfM-MVS technology.

2. method

In this study, continuous aerial photographs of the glaciers area and topographic around the glacier area were taken from the Cessna during 2015-2019 at the end of snowmelt season (late September-early October) and during the maximum snowfall (late March-early April). Multi-period glacier DSM (digital surface model) was created using aerial photographs taken from Cessna and SfM-MVS software.The mass balance of a glacier can be obtained by calculating the relative volume change from a comparison of the two periods of DSM and integrating the snow volume with the relative volume change.We calculated the annual mass balance of five glaciers in the northern Japanese Alps from 2015/16 to 2018/19 by comparing the DSM at the end of snowmelt season in the year. In addition, the snow depth and melting depth of the glaciers from 2015/16 to 2018/19 were calculated from the comparison between DSM at the maximum snow season and DSM at the end of snowmelt season.

3. result

Fig. 1 shows the relative altitude change of glacier obtained from the difference of DSM at the end of snowmelt for each glacier and each year. In Fig. 1, the relative altitude change calculated from the DSM difference data is expressed in red as it is positive, green as it is negative, and yellow if there is almost no change.Furthermore, there is no partial difference in the relative altitude change on the glacier.Figure 2 shows the calculated annual mass balance, snow depth, and snowmelt depth for each glacier and each year. Figure 2 shows that there is a proportional relationship between the annual change of the annual mass balance and the annual change of the snow depth.Based on the above, the annual mass balance of glaciers in the northern Japanese Alps depends on the snow depth in that year, in heavy snowy years, the entire glacier is accumulation area, in light snowy years the entire glacier is ablation area.The mass balance characteristics of this Japanese glaciers are different from those of general mountain glaciers which have an accumulation area in upstream and an ablation area in downstream.

Keywords: Glacier, Mass-balance, SfM-MVS

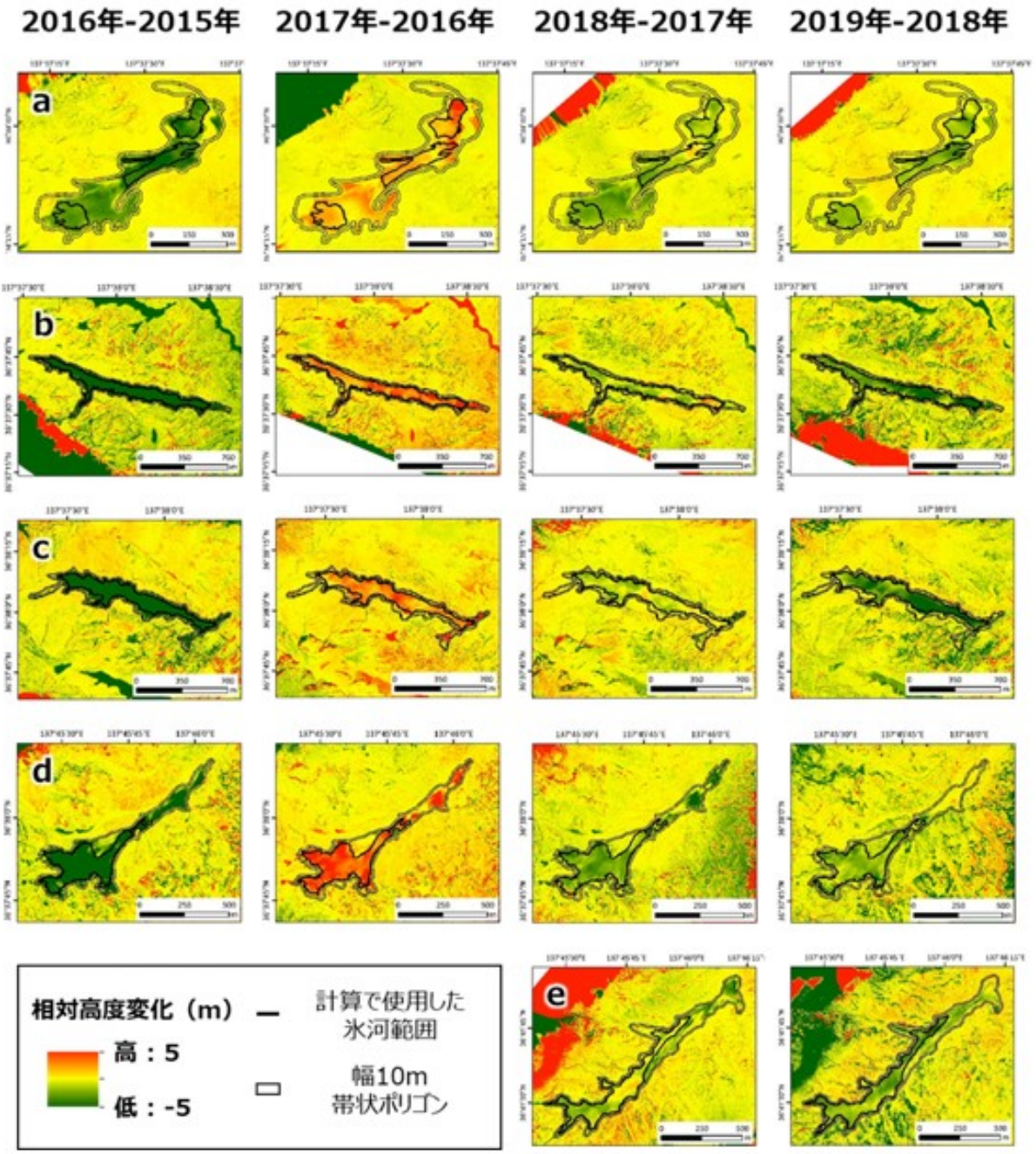

Fig. 1: Relative altitude change for each glacier and each year, obtained from the DSM difference at the end of snowmelt season. a: gozenzawa glacier b: sannnomado glacier c: Komado glacier d: Kakunesato glacier e: Karamatsuzawa glacier.