



Multiple crowd-sourced SfM-DEMs of an Alpine valley glacier: Validation by LIDAR and surface change detection 2012-2017

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In this study we compare recent multiple high resolution digital elevation models (DEMs) of the rapidly retreating distinct glacier tongue (3km²) of Pasterze (17 km², Hohe Tauern, Austria). The aims of this study are (1) to assess the accuracy of different ground-based crowd-sourced SfM-DEMs by comparing it to state of the art LIDAR DEMs and finally (2) to calculate glacier elevation changes and glacier retreat during different periods of time within the last decade.

The ground-based SfM-image acquisition surveys on Pasterze glacier took place in June and November 2015 and in August 2017. During those surveys three to four people made overlapping fotos of the glacier surface with different consumer grade cameras from various viewpoints that are accessible within several hours of walk. At the same time one person measured the exact position of 50-100 potentially visible points on the glacier surface using RTK-GPS. All three surveys are slightly different regarding the number and models of cameras and lenses, the exact position of the cameras and the GCPs, and the surface texture of the glacier. The distinct glacier tongue of Pasterze is 5.0 km long and covers an area of approximately 3.1 km².

Apart from the numerous ground control points, two LIDAR DEMs are available for SfM model validation, (1) a terrestrial Laser Scan carried out in August 2017 on the exact same day as one of the SfM image acquisitions took place and (2) an airborne Laser Scan from 2012, that covers the whole glacier and also its surroundings, especially a strip of stable terrain on each side of the valley glacier.

Between 2012 and 2017 the mean surface elevation change of the glacier tongue of Pasterze is 5.1 meters per year (m/a), varying from 2 m/a on debris covered areas to 10 m/a at the glacier snout and more than 15 m/a at certain areas where high basal ablation by means of meltwater channels is observed. The retreat of the frontal position of the debris free glacier part adds up to 600 meters within the last 5 years.