The Cryosphere Discussions

The Cryosphere Discuss., referee comment RC2
https://doi.org/10.5194/tc-2021-77-RC2, 2021

Reply on RC1

Anonymous Referee #2

Referee comment on "Multi-decadal (1953–2017) rock glacier kinematics analysed by high-resolution topographic data in the upper Kaunertal, Austria" by Fabian Fleischer et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2021-77-RC2, 2021

General comments

I highly agree with the opinion of the anonymous referee #1. Because of the high potential of the present paper I would like to add some personal comments helping the authors to improve their paper.

Permafrost studies are currently a hot topic in view of climate change. The authors focus on mountain permafrost, i.e., they want to understand the spatio-temporal change of rock glacier kinematics not only locally (single rock glacier) but on a more regional scale (several rock glacier, e.g., located in a valley or catchment area). The authors want to find out how nearby rock glaciers react (geometrically) to changing environmental conditions, i.e., MAAT, precipitation, snow cover, etc.

Change detection analysis is based on archival aerial photographs and ALS data. The proper processing of these data is not easy and requires a lot of knowledge and experience. I am confident that the data has been processed accordingly.

My mayor concern is on data analysis which has already been addressed by the anonymous referee #1. I'm referring to page 12 where the concept of 3D displacements on rock glaciers is outlined. The authors should clarify the term 3D displacement. To my understanding 3D displacement is a 3D vector describing the dislocation/movement of a point or distinct feature of an object/surface in space (and time). However, the authors of the paper interpret 3D displacement as a distance into a normal direction following the idea of Lague et. al. (2013). Commonly, this algorithm is called M3C2. This algorithm has same advantages, especially in interpreting surface change and its significance. The authors' quantitative analysis of the rock glacier kinematics is based on 2D/horizontal displacements and on volume change. The latter, however, has not been carried out in a fully correct way. Since volumetric change, as implemented in the paper, is based on

gridded ‘3D displacements’ (cp. P12L303-304) the obtained volumetric changes are inherently wrong. The authors would have derived a correct result if they had taken (0,0,1) = vertical axis as a reference direction. Due to the specific kinematics (e.g., extending creep internal mass transport) and the geometry (e.g., steep frontal slope) of rock glaciers the obtained volumetric changes are preferably/systematically negative (see Figue 8). I advise the authors to re-evaluate volumetric change. The authors may use M3C2 (properly modified) or a simple difference of digital elevation models (DoD).

In any case, the authors should include profound error analysis, i.e., significance analysis, for their velocity data (2D, horizontal) and their volumetric change results (1D, vertical, integral value obtained for an area).

The paper will benefit from a more formal structure, such as

Introduction (please clearly specify the research questions),

Study area,

Material (First: aerial photographs and ALS data; Question: What is the reason for not using recent aerial photographs? There is lots of data available at BEV! A comparative analysis would have boosted all results obtained. Second: Supplementary material, such as meteorological data, etc.

Methods (photogrammetric mapping, georeferencing, SfM; processing/georeferencing of ALS data; 2D-displacement measurements (orthophoto-orthophoto, orthophoto-hillshade, hillshade-hillshade; software used; precision/accuracy assessment). Question: What is the reason to use hillshades instead of original elevation data?; computation of volumetric change (method, precision/accuracy assessment); Supplementary material (explain data aggregation, etc.)

Results (present the results obtained. Maybe, you can find a good way to also aggregate the results)

Discussion (discuss the kinematics (movement, volumetric change) of the rock glaciers in a regional context. Is there a correlation in space and time? Interrelate the kinematic information with the supplementary data.)

Summary (optionally)

Specific comments

The title should reflect the content of the paper. Do you really want to address morphodynamics? Did you mean kinematics? Morphodynamics would imply process understanding.

The paper is too long and could benefit from shortening. Maybe, it is not important to discuss each rock glacier in detail. Is there a common response? If not, why?

Some of the figures are too small and too overloaded and thus they are not readable.

Figure 8: Mean annual volume change (m2) per 100m2 = mean surface height change (cm) !!!