Repeated Annual UAV-Based Measurement of the Surface Creep Velocity of Leibnitzkopf Rock Glacier (Austrian Alps) Without the Use of Geodetically Measured Ground Control Points (GCPs)

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The kinematic state of a rock glacier is best described by its surface velocity field. Rock glacier monitoring often includes annual measurements of the surface creep velocity. Due to time constraints and, in recent years, accessibility, in-situ geodetic measurements (total station, GNSS-based) are usually restricted to a limited number of observation points. In contrast, UAV-based rock glacier mapping allows the flow velocity field to be remotely derived, without stepping on the rock glacier's surface. Nowadays, the georeferencing of UAV-based aerial images is facilitated by measuring camera positions using RTK/PPK-GNSS techniques. However, UAV images taken with consumer-grade cameras generally require camera self-calibration during bundle block adjustment. Consequently, around 3-4 GCPs are commonly used to model systematic offsets and to eliminate strong correlations between unknowns. The present study is based on a field campaign planned for August 2021 and comparison with last year's UAV-based aerial survey of the highly active Leibnitzkopf rock glacier in the Austrian Alps. We will use a hexacopter twinFold Geo carrying a Sony Alpha ILCE-6000 and a PPK-GNSS module for data acquisition. However, this time we will not use any GCPs. Georeferencing of the 2021 UAV-based image data will be done using the PPK-GNSS-measured camera positions, and the UAV-based images from the 2020 aerial survey which have already been georeferenced. We intend to carry out a bi-temporal (2020-2021) joint bundle block adjustment, connecting both the reference and the follow-on image data using stable ground in the surroundings of the rock glacier. We are also investigating whether the 2021 image data can be georeferenced using plain co-registration and completely disregarding the 2021 PPK-GNSS-measured camera positions. The accuracy of the obtained creep velocities for 2020-2021 will be assessed using contemporary geodetic measurements. A further quality control will be to compare the digital orthophoto and digital elevation models with older ones obtained from previous aerial surveys, both conventional and UAV-based. This study emphasizes that annual (in-situ) geodetic measurements on highly active rock glaciers such as the Leibnitzkopf rock glacier can be replaced by UAV-based aerial surveys without the use of GCPs where high-quality UAV-based image reference is available.

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Internal Structure, Dynamic Behavior, and Hydrological Characteristics of a Rock Glacier in the Semiarid Andes of Argentina

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This work aims to present the analysis of the internal structure, dynamics, and hydrogeology of a large-sized, complex, multi-lobate and multi-root rock glacier located in the southwest of the San Juan province (31°52'59.75""S; 70°15'8.62""W), Central Andes of Argentina. The study was conducted combining electrical resistivity tomography (ERT), Differential Interferometry Synthetic Aperture Radar (DInSAR) and hydrochemical data. A total of eight ERT profiles have been carried out in the El Gigante rock glacier, which have been distributed to be representative for various lobes. ERT surveys show a marked irregular geometry for the upper sector of the permafrost with electrical resistivity values ranging from 7 to 142 kΩm. These low electrical resistivity values recorded could be influenced by the high metallic concentration present in the environment, reflecting ionic enrichment to varying degrees during water circulation and subsequent re-freezing.

The horizontal displacement from October 2014 to April 2017, exhibits its greatest magnitudes in the upper sector of both tongues, reaching speeds of up to 150 cm/year. The active frontal sector shows a displacement rate of 2 to 4.5 cm/year. The analysis of 28 interferograms shows minimal seasonal and inter-annual variability for the "The Giant" rock glacier. Part of this time span corresponds to a period of extreme drought in the Andes, which directly