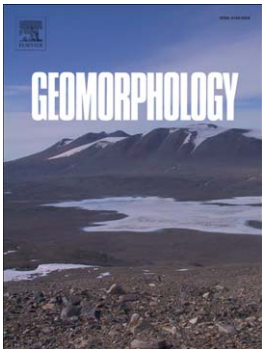

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Rapid melting dynamics of an alpine glacier with repeated UAV photogrammetry

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Abstract

Glacial retreat is a major problem in the Alps, especially over the past 40 years. Unmanned aerial vehicles (UAVs) can provide an unparalleled opportunity to track the spatiotemporal variations in rapidly changing glacial morphological features related to glacial dynamics.

The objective of this study is to evaluate the potential of commercial UAV platforms to detect the evolution of the surface topography and morphology of an alpine glacier over a short time scale through the repeated acquisition of high-resolution photogrammetric data.

Two high-resolution UAV surveys were performed on the ablation region of the Morteratsch Glacier (Swiss Alps) in July and September 2016. First, structure-from-motion (SfM) techniques were applied to create orthophotos and digital surface models (DSMs) of the glacial surface from multi-view UAV acquisitions. The geometric accuracy of DSMs and orthophotos was checked using differential global navigation satellite system (dGNSS) ground measurements, and an accuracy of approximately 17 cm was achieved for both models. High-resolution orthophotos and DSMs made it possible to provide a detailed characterization of rapidly changing glacial environments. Comparing the data from the first and the second campaigns, the evolution of the lower part of the glacier in response to summer ablation was evaluated. Two distinct processes were revealed and accurately