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Investigating software variation in creating detailed Digital Surface Models: Agisoft Photoscan applied on a high-alpine rock glacier

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Agisoft PhotoScan is a commonly used software to produce Digital Surface Models (DSMs) in geoscientific research. Based on the Structure-from-Motion (SfM) and Multi-View Stereo (MVS) principles, the software produces 3D environments from 2D imagery (often taken by Unmanned Aerial Vehicles (UAV)). However, random elements in the unpublished computer-vision algorithms used, can cause variation in the model outputs. To the best of our knowledge, the reproducibility of PhotoScan is not yet explicitly addressed by earlier research. However, it is known that the software processing algorithms directly influence model accuracy. Therefore, we explored the reproducibility of a 3D model of a complex alpine environment from multiple PhotoScan runs. This is done with exactly the same images, processing settings and Ground Control Points (GCPs) as these input parameters have been identified influencing accuracies by previous research. This way, ten model runs were performed on UAV imagery of a rock glacier to analyse the magnitude of the variation between the different model outputs. This variation was quantified calculating the standard deviation of each cell value in the respective DSMs and derivatives (curvature). Places with steep slope gradients have considerably more DSM variation (up to 10 cm) but stay within the range of the model's accuracy (10 vertical cm) for 88 – 96% of the area. The edges of the model also show a larger variability (0.10 – 3 m), related to a lower number of overlapping images. These results should be accounted for when performing a geomorphological research at centimetre scale using PhotoScan, especially in areas with a complex relief. We found that using medium-quality runs, additional oblique viewpoints and respecting a minimum of five overlapping images can minimize the software's variations.