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Application of terrestrial ‚structure-from-motion' photogrammetry on a medium-size Arctic valley glacier: potential, accuracy and limitations

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Terrestrial photogrammetry was the standard method for mapping high mountain terrain in the early days of mountain cartography, until it was replaced by aerial photogrammetry and airborne laser scanning. Modern low-price digital single-lens reflex (DSLR) cameras and highly automatic and cheap digital computer vision software with automatic image matching and multiview-stereo routines suggest the rebirth of terrestrial photogrammetry, especially in remote regions, where airborne surveying methods are expensive due to high flight costs. Terrestrial photogrammetry and modern automated image matching is widely used in geodesy, however, its application in glaciology is still rare, especially for surveying ice bodies at the scale of some km^2, which is typical for valley glaciers.

In August 2013 a terrestrial photogrammetric survey was carried out on Freya Glacier, a $6km^2$ valley glacier next to Zackenberg Research Station in NE-Greenland, where a detailed glacier mass balance monitoring was initiated during the last IPY. Photos with a consumer grade digital camera (Nikon D7100) were taken from the ridges surrounding the glacier. To create a digital elevation model, the photos were processed with the software photoscan. A set of $\sim$100 dGPS surveyed ground control points on the glacier surface was used to georeference and validate the final DEM.

Aim of this study was to produce a high resolution and high accuracy DEM of the actual surface topography of the Freya glacier catchment with a novel approach and to explore the potential of modern low-cost terrestrial photogrammetry combined with state-of-the-art automated image matching and multiview-stereo routines for glacier monitoring and to communicate this powerful and cheap method within the environmental research and glacier monitoring community.