# Reading ablation stakes with on-line cameras – automatically, remotely and cheap

Oder z.B. Automated ablation stake readings with on-line cameras?

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Glacier mass balance models are calibrated and validated using field data. Because measurements have to be acquired during extensive campaigns, most studies rely on annual or seasonal data sets. To provide an improved data basis, we aim at measuring glacier ablation remotely and with high temporal resolution.

On Findelengletscher (Valais, Switzerland), two ablation stakes are equipped to provide automated readings: an aluminum stake construction holds a solar-powered on-line camera at about 1m distance. The construction slides down the stake as the surface melts. Images of the bottom 50cm of the stake are taken at 20min intervals during daylight. Colored tape markers with a spacing of 2cm serve as a scale reference on the stake. The sequence of markers consists of 8 different colors and is shuffled to allow for a unique identification of sub-sequences.

By image processing, the distance of the stake top from the ice surface is obtained automatically: the stake is identified by finding collinear points of high color saturation, i.e. the tape markers. Because the base point at the ice surface has a fixed relative position to the camera its image coordinates are given. The markers are identified by their color while the sequence of colors provides their position on the stake. A scale is established for each image individually from the known marker tape width and spacing and takes into account the perspective skew of the stake. The distance of the stake top from the ice surface is then given by the known position of the identified marker sub-sequence and the distance of the lowermost marker from the ice surface. An uncertainty estimate of 2mm is derived from fitting of the scale and includes the quality of the detected marker bounds, image pixel size and the precision of the actual marker tape positions. Images with bad weather conditions are rejected by the processing scheme.

The time series provides ablation for each pair of images and is aggregated to daily values. The results show good agreement with manual validation data. Additionally, we discuss two alternative image processing approaches. By detecting the tape markers through template matching and tracking their location on the images over time they avoid the reconstruction of the stake top while being more sensitive to longer data gaps.

We conclude that the presented setup is well-suited to automatically and remotely determine near-realtime ablation rates at low cost. The program code and the specification of the camera construction will be made available upon completion and, until then, upon request.