EGU2020-11735
https://doi.org/10.5194/egusphere-egu2020-11735
EGU General Assembly 2020

UAV-derived change detection without ground control points, an example from the cliff coast of Rügen

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High resolution topographic models generated from repeat unmanned aerial vehicle (UAV) surveys and structure from motion (SfM) are increasingly being used to investigate landscape changes and geomorphic processes. Traditionally, accurate UAV surveys require the use of independently measured ground control points or highly accurate camera position measurements. However, in addition to accuracy in an absolute sense (how well modeled topography matches real topography), model quality can be expressed as accuracy in a comparative sense (the degree to which two models match each other). We present a simple SfM workflow for calculating pairs or sets of models with a high comparative accuracy, without the need for ground control points or a dGNSS equipped UAV. The method is based on the automated detection of common tie points in stable portions of the survey area and, compared to a standard SfM approach without ground control, reduces the level of change detection in our surveys from several meters to 10-15 cm. We apply this approach in a multi-year monitoring campaign of an 8 km stretch of coastal cliffs on the island of Rügen, Germany. We are able to detect numerous mass wasting events as well as bands of more diffuse erosion in chalk sections of the cliff. Both the cliff collapses and the diffuse erosion appear to be strongly influenced by antecedent precipitation over seasonal timescales, with much greater activity during the winter of 2017-2018, following an above average wet summer, than during the subsequent two winters, which both followed relatively dry summers. This points to the influence of subsurface water storage in modulating cliff erosion on Rügen.