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4D monitoring of actively failing rockslopes

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Assessing the conditions which promote rockfall to collapse relies upon detailed monitoring, ideally before, during and immediately after failure. With standard repeat surveys it is common that surveys do not coincide with or capture precursors, or that surveys are widely spaced relative to the timing and duration of driving forces such as storms. As a result gaining insight into the controls on failure and the timescales over which precursors operate remains difficult to establish with certainty, and establishing direct links between environmental conditions and rock-falls, or sequences of events prior to rockfall, remain difficult to define. To address this, we present analysis of a high-frequency 3D laser scan dataset captured using a new permanently installed system developed to constantly monitor actively failing rock slopes. The system is based around a time of flight laser scanner, integrated with and remotely controlled by dedicated controls and analysis software. The system is configured to capture data at 0.1 m spacing across > 22,000 m̂3 at up to 30 minute intervals. Here we present results captured with this system over a period of 9 months, spanning spring to winter 2015. Our analysis is focussed upon improving the understanding of the nature of small (< 1m̂3) rockfalls falling from near vertical rock cliffs.

We focus here on the development of a set of algorithms for differencing that trade-off the temporal resolution of frequent surveys (hourly) against high spatial resolution point clouds (< 0.05 m) to enhance the precision of change detection, allowing both deformation and detachments to be monitored through time. From this dataset we derive rockfall volume frequency distributions based upon short-interval surveys, and identify the presence and/or absence of precursors, in what we believe to be the first constant volumetric measurement of rock face erosion. The results hold implications for understanding of rockfall mechanics, but also for how actively eroding surfaces can be monitored at high temporal frequency. Whilst high frequency data is ideal for describing processes that evolve rapidly through time, the cumulative errors that accumulate when monitored changes are dominated by inverse power-law distributed volumes are significant. To conclude we consider the benefits of defining survey frequency on the basis of the changes being detected relative to the accumulation of errors that inevitably arises when comparing high numbers of sequential surveys.