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Insights from high frequency monitoring of coastal cliff erosion

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Much of our understanding of the drivers of coastal cliff erosion is derived from monitoring with a relatively low temporal resolution, at decadal, annual or monthly intervals. As a result, the erosion accrued during a single monitoring epoch can only be related to a summary of the conditions during that period. Whilst such approaches are successful in identifying broad seasonal variations in erosion, which can be attributed to longer-term fluctuations in marine and weather conditions, identifying the exact conditions that directly result in erosion remain more elusive to identify. Equally, it is commonly difficult to identify an adequate or ideal resurvey frequency or duration that provides a reliable insight into the patterns and changes in coastal cliff erosion. As a result, we are reliant on the validity of extrapolating the relationships that we identify from our monitoring data to both longer (millennial) and shorter (hourly) timescales. Where future changes might include local increases in storm frequency, such extrapolations need to be robust.

We present results from what we believe to be the first attempt at constant 3D cliff erosion monitoring, using a permanently installed automated laser scanning system. The system collects a high-resolution point cloud from across a 55 m high rock cliff at Whitby (North Yorkshire, UK), at hourly intervals. We report data collected over a period of 9 months, during which in excess of 150,000 individual rockfalls were observed, totalling c. 300 m3 of material loss. In parallel we collect a suit of environmental monitoring data, including weather, wave and tide information. We use this data here to assess of the drivers of erosion at time scales ranging from months to hours. We are able to consider the influence of changes in erosion in response to individual storms, but also during single hours within these storms. We identify, for example, that over 15% of all erosion during the 9-month monitoring period occurred during a single hour in a single storm. We compare the data derived from this system to longer-term monitoring using laser scanning at the site since 2003, to consider what less frequent monitoring can and cannot not capture, which holds implications for studies monitoring erosion in a variety of settings.