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The trembling of a disrupting Alpine peak – near real time seismic sensing of weather-driven rock failure initiation at the Hochvogel

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Failure of steep alpine peaks is prepared and driven by successive weakening of the rock mass. The long preparation phase and spatial distribution of the weakening processes, across a peak and also with depth makes it difficult to study their evolution and boundary conditions. A promising solution to this ambiguity can be a dense network of seismic sensors, able to continuously detect, locate, quantify and characterise the discrete pulses of seismic waves associated with rock crack expansion. Such high quality data allows linking the weakening processes to the environmental conditions affecting them, such as temperature, precipitation and snow melt.

Here, we make use of the excellent infrastructure deployed at one of the most active peaks of the Alps, the 2596 m high Hochvogel, where a series of quickly opening crevices prepares an overall rock volume of 260,000 m^3 compiled in several smaller units fail. The main crevice is now 3 m wide and can be traced tens of metres deep, opening at several mm per month. It is instrumented by crack meters, surveyed photogrammetrically, by LiDAR and with tachymeters. We installed an array of six 4.5 Hz geophones whose signals were telemetered in near real time to an analysis server. In addition, four seismic broad band stations were deployed along the runout zone of the unstable rock mass to survey smaller rock releases. We present results of the hot and dry summer of 2018, focusing on episodes of increased crack and slope activity. We report on the nature, location and released energy equivalent distribution of hundreds of crack events. We link these activity patterns to meteorological drivers and compare the seismic crack event density to the resulting crevice mobility as sensed by the independent methods. We explore to which extent activity of the Hochvogel peak is causing mass movements along the south facing slope. With the infrastructure of near real time seismic and auxiliary data transmission we discuss potential trajectories towards a robust early warning network for unstable alpine peaks.