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Seismic characterization of rock falls from detachment to propagation

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Characterizing rock falls parameters (localization, volume and propagation path) is a key point to improve the mitigation of the hazards associated and to better prevent them. However, due to a limited number of natural events observations particularly for events that provoke no damage on infrastructures and that are often missing in catalogs, these parameters stay poorly constrain. With the densification of seismometer networks, the seismic data analysis proved to be a powerful tool for a remote detection and characterization of gravitational events.
Here, we present the analysis of small (1-100m3) rock falls dynamics through the monitoring of the top and talus slope of the Mont Saint-Eynard limestone cliffs (French Alps) by a local seismological network composed by four seismic stations. Combine to this network, diachronic photogrammetric survey and a near-continuous survey (1 photography each 10 mn) are used to monitor the erosion of the cliff.
Seismic signals emitted by rock falls were compared to topographic data in order to identify the different phases of the rock falls (detachment, impact on the ground, propagation along the slope). First, by studying the seismic signal obtained, we identified different event types depending on their propagation modes (free fall, rolling/sliding, mixed). Secondly, for each type, we established scaling laws connecting the signal features (amplitude, duration, frequency) to the rock fall characteristics (volume, height of free fall, kinetic energy, propagation path).
These laws offer the possibility of a direct estimation of the mass and dynamic features of rock falls from the generated seismic signal and allow us to link rock falls seismic signals characteristics to their propagation mode.