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Grain size and roughness of talus slopes: implications for rockfall modelling and hazard assessment

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Talus slopes are common in mountain areas. Their morphology and fabric are mainly related to the long-term occurrence of rockfalls with different magnitude and frequency, and locally controlled by mass falls, snow avalanches, and granular flows. Nevertheless, talus properties strongly control subsequent rockfall dynamics, affecting slope roughness and the local deformability and interlocking of surface material. Accurate description of talus grain size distribution and roughness is also crucial in rockfall modelling, since it constrains block dynamics and the energy loss by impact and rolling. Thus, we performed a spatial assessment of grain size distribution and roughness of actual rockfall-dominated talus slopes by field measurements and DEM analysis. Particle size analysis has been performed at four talus slopes located south of the Presolana calcareous massif (Lombardia, Italy). For each slope, photo images have been taken at several areal sampling sites consisting of 1.6*1.6 m square parcels, regularly spaced along the longitudinal profile. Images have been processed by a specific software, able to detect and measure clasts. For each sample, grain-size distribution by clast number and weight has been obtained according to different shape assumptions, allowing different grain size and sorting parameters to be evaluated. Downslope dominant trends and local deviations have been outlined by plotting grain size and sorting versus horizontal distance from talus apex. In particular, an exponential grain size vs. distance relationship has been established by non linear regression, providing a quantitative description of downslope grain size variability in rockfall-dominated talus slopes. The results outlined the need for a spatially distributed description of slope roughness when performing rockfall modelling on natural slopes. Although high resolution LIDAR topographic models are able to explicitly include slope rough-

ness, they are not always available in practical applications. Thus, we performed a spatial characterization of slope roughness using DEMs generated by several techniques (e.g. aerial and ground-based LIDAR) at different spatial resolution. We tested roughness descriptors to establish and validate quantitative roughness-distance relationships. These could be useful to improve the reliability of numerical modelling, especially when very high-resolution DEM are not available. This is crucial in rockfall hazard assessment, since increased roughness at the talus slope toe is expected to result in enhanced variability and lateral dispersion of trajectories.