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Rock shape, restitution coefficients and rockfall trajectory modelling

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Restitution coefficients are used in rockfall trajectory modelling to describe the ratio between incident and rebound velocities during ground impact. They are central to the problem of rockfall hazard analysis as they link rock mass characteristics to terrain properties. Using laboratory experiments as a guide, we first show that restitution coefficients exhibit a wide range of scatter, although the material properties of the rock and ground are constant. This leads us to the conclusion that restitution coefficients are poor descriptors of rock-ground interaction. The primary problem is that "apparent" restitution coefficients are applied at the rock's centre-of-mass and do not account for rock shape. An accurate description of the rock-ground interaction requires the contact forces to be applied at the rock surface with consideration of the momentary rock position and spin. This leads to a variety of rock motions including bouncing, sliding, skipping and rolling. Depending on the impact configuration a wide range of motions is possible. This explains the large scatter of apparent restitution coefficients. We present a rockfall model based on newly developed hard-contact algorithms which includes the effects of rock shape and therefore is able to reproduce the results of different impact configurations. We simulate the laboratory experiments to show that it is possible to reproduce run-out and dispersion of different rock shapes using parameters obtained from independent tests. Although this is a step forward in rockfall trajectory modelling, the problem of parametersing real terrain remains.