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Natural Hazards and Earth System Sciences
Discussions

Interactive comment on "Simulation of Fragmental Rockfalls Detected Using Terrestrial Laser Scans from Rock Slopes in South-Central British Columbia, Canada" *by* Zac Sala et al.

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The manuscript is a very interesting contribution. It presents the simulation of the trajectories of fragmental rockfalls. The authors use a Unity3D game engine that works with polyhedra and takes into account the shape of the fragments and the collision between them. The procedure is promising and may have immediate practical application in rockfall risk management. The manuscript is well organized and presented. I have, however, a few comments:

1) From a formal point of view, the references must be checked (e.g. page 2: Jaboyedoff et al is 2010 or 2012?; page 2: Sala et al. 2018; page 5: Struik 1987; Monger and

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Nokelberg, 1996; among others, are not found in the reference list; Kramer et al. 2018 is not cited in the paper).

2) The discussion on the existing conventional rockfall models (page 2, lines 30-33) suggests that there are no codes able to model fragmental rockfalls, which is not correct. Nowadays some 3D rockfall runout models are able to simulate the disaggregation of the falling rock masses defined by pre-existing discontinuities (Cuervo et al. 2015) or by the breakage of the initial blocks upon impact on the ground surface (Wang and Tonon, 2011; Matas et al. 2017). This point should be clarified here andin the conclusions (page 37 lines 13-14).

Cuervo S, Daudon D, Richefeu V, Villard P, Lorentz J (2015) Discrete Element Modeling of a Rockfall in the South of the “Massif Central”, France. In: Lollino G. et al. (eds) XII IAEG Congress. Engineering Geology for Society and Territory - Volume 2: 1657-1661. Springer

Matas G, Lantada N, Corominas J, Gili JA, Ruiz-Carulla R, Prades A (2017) RockGIS: a GISbased model for the analysis of fragmentation in rockfalls. Landslides 14: 1565–1578

Wang Y, Tonon F (2011) Discrete element modeling of rock fragmentation upon impact in rock fall analysis. Rock Mech Rock Eng 44:23–35

3) Section 4. Runout simulation (page 17, lines 12-14). Despite the authors mention that the steps of the simulation are described in Sala 2018, a minimal description is required here. In particular: the parameters used to run the model; whether it works with a single block or with an In-Situ Block Size Distribution; and the criteria for generating the fragments and their size-distribution.

4) The performance of the model is tested by fitting the simulation to the studied events (section 4.1). As acknowledged by the authors the set of parameters used to fit the model may not be the one that reflects the conditions at any given site in the area. In

order to perform forward modeling and highlight the value of the work, a guidance on how to determine the initial fracture pattern of the rock mass and the material coefficients should be included in the paper.

5) The model simulates the disaggregation of the falling rock mass but (apparently) not the breakage of blocks. Please, discuss how it may affect the results.

6) Finally, the simulated runout does not consider the size of the fragments. However, the intensity of the impact and the efficacy of the rockfall mitigation measures is affected by the size the falling blocks. Please discuss this point and how it should be taken into account in risk management.

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