The Cryosphere Discussions

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Comment on tc-2020-368

Anonymous Referee #2

Referee comment on "Brief Communication: Initializing RAMMS with High Resolution LiDAR Data for Avalanche Simulations" by James Dillon and Kevin Hammonds, The Cryosphere Discuss., https://doi.org/10.5194/tc-2020-368-RC2, 2021

The Contribution "Brief Communication: Initializing RAMMS with High Resolution LiDAR Data for Avalanche Simulations" by James Dillon and Kevin Hammonds tackles a common problem of how input data influences modeling results in an operational avalanche simulation setting. The authors use a case study supported by LiDar data obtained at Yellowstone Club Ski Resort (YC), near Big Sky, MT, USA to demonstrate the variability of simulation results with respect to changes in the input data for four scenarios (ground DEM, snow covered DEM, snow covered DEM with variable release depth, snow covered DEM with variable release depth and LiDar supported vegetation delineation) and two test cases (~size D2 avalanches). The results show that certain simulation outcomes (e.g. flow depth and velocity) significantly change with respect to the different input scenarios – however the discussion on the source of these variations remains half-assessed.

Generally the paper is well written; some technical terms, description of methods (e.g. definition of runout, choice of parameter) as well as results and discussion require refinement.

All in all the study is interesting considering the aspect that it highlights the sensitivity of the simulation results and that a careful treatment of a simulation tool is required to distinguish different types of uncertainty sources - which is a valuable message for model users.

<u>Short / technical comments:</u>

- p1 l21: “common DEM” – what does common refer to?

- p1 l25: does the “snow-snow” interface automatically correspond to the sliding layer – what about different avalanche types?

- p2 l30: I am not sure you can refer to “more realistic” in that sense – it could be “more accurate” if a case study with documented observations would be available.

- p2 l38: what kind of “error”

- p3 l70: I very much appreciated the idea of data availability but was unable to open the corresponding link: “https://doi.org/10.5061/dryad.z8w9ghx9z”

- p3 Fig 1: could you indicate where the U and L test cases are located?

- p4 l 82 & 97: could you specify what “traditional” means in this context and which “automatically generated values” you refer to? Please comment on how vegetation is treated in terms of friction coefficients (scenario 4)?

- p4 l 82-95: The scenarios need to be more clearly defined. To me it remains unclear what impact on the simulation input the delineation of vegetation has (different friction parameters in this areas? Which ones?), see also major comments below.

- p5 l 106: How do you define and measure runout (please check more recent literature on model evaluation)? Which simulation results do you use? What is your reference and how is it measured?

- p6 l119: Is this due to the redistribution of the starting mass or due to changes in topography (or changes in friction coefficients (which ones?))? What are the differences between your test cases?

- pt Fig 3: What does “final” deposition height refer to – the flow depth at the last (which?) time step – to my knowledge the underlying flow model does not consider deposition?

- p7 l133: I think that it is only possible to show that change in input data implies a “dramatic change” in the simulation results. A dramatic “improvement” would only be possible if you compare to observation data.

Major comments:

- The fact that the outline of the LiDar DEM is insufficient to cover the whole avalanche path requires an ad hoc assumption, increasing the coulomb friction values by and arbitrary value of 0.4 to achieve “visible” runouts. This fact makes it impossible to properly interpret the simulation results with “automatic parameters” and very difficult to judge the “runout” results for the increased friction values (e.g. due to the fact that the avalanche may not even reach flatter terrain where “runout” differences may be way larger).

- I am not sure the authors succeed in identifying the source for the result variability (please see also recent publications on bayes methods for parameter / uncertainty handling in avalanche simulations for more information) for two major reasons:

1) the relation of changes in topography (or vegetation delineation) and friction coefficients with respect to result variability: Using “automated” friction coefficients infers a friction coefficient-dependence on the topography. Therefore not the topography directly (sliding surface from LiDAR) but the related friction coefficients may govern the result changes. These friction coefficients are optimized values and usually determined with respect to a specific spatial resolution and largely depend on the topography (usually something like 5m “winterly smoothed” terrain, the “automated” coefficients change not only with different topography (due to changes in curvature/slope etc) , but already with changing spatial resolution, since e.g. the magnitude of curvature is largely related to the spatial resolution). A similar question arises for the delineation of the vegetation: what does actually change in the delineated areas (friction coefficients?), to which degree does it change, and how do the manual and LiDAR delineations compare in terms of e.g. total area?

2) numerical rather than flow model based constraints: Changes observed between scenario 1-2 may either be related to the change in the sliding surface, the associates (automated) friction coefficient changes (see comment above) or even numerical reasons such as the utilized stopping criterion. For example Figure 3 refers to the final deposition height (or rather the spatial extend of flow height in the last time step?; see comment above). Usually this would refer to the time step where the stopping criterion is met (p. 4 l. 93: 5% or 10% momentum threshold respectively) and could therefore be different for each scenario/simulation (the differences in max. velocity and flow depth indicate that also the momentum threshold and therefore the final time step may be completely different for each scenario/simulation?). Thus the observed result changes would rather be a “numerical artifact” than an influence of the changes in release mass/topography/vegetation (or respective friction parameters). I therefore suspect that you are rather looking at a “numerical” variation rather then a “input data” or “flow model/input parameter” based one.

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Relevant Literature

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Valero, Cesar Vera, Wever, Nander, Bühler, Yves, Stoffel, Lukas, Margreth, Stefan, Bartelt, Perry: Modelling wet snow avalanche runout to assess road safety at a high-altitude mine in the central Andes , Natural Hazards and Earth System Sciences 16(11), Copernicus GmbH, 2303, 2016