Review of manuscript: *The importance of erosion for debris flow runout modelling from applications to the Swiss Alps*

The authors incorporate an empirical model for debris flow entrainment within the RAMMS debris flow model to investigate the importance of erosion and changes in debris flow volume on debris flow runout. While the model presented in this study is location-specific, the results are more generally useful for understanding a problem that has important implications for hazard assessment. This contribution is appropriate for *Natural Hazards and Earth System Sciences* and should be of general interest to its readers. However, I had a lot difficulty following key portions of the manuscript and think additional detail in those areas is necessary (see comments below).

General Comments:

It should be made clear at an early point in the manuscript whether or not this is a study that focuses on changes in bed topography (over the course of multiple events or one event) or changes in debris flow volume caused by entrainment throughout the course of a single event. I had difficulty following the modeling results section because I wasn't sure exactly what simulations were being performed and how they were being initialized (changes in initial topography if multiple debris flows were being modeled, assumptions about flow volume change).

Specific Comments:

Title: Reading the paper, I was confused about whether or not this study was going to focus on how changes to the bed influenced debris flow runout or focus on how changes in debris flow volume influenced runout. From reading the abstract and title, I thought the main focus of the article would be on understanding how temporal changes to the channel bed impacted debris flow runout. My suggestion would be to use the term 'entrainment' rather than 'erosion' in the title if it is really changes to the flow volume that are the focus here.

Abstract - Line 4-5: The terms 'debris flow' and 'granular flow' often refer to very different phenomena so it is confusing to say that the 'RAMMS debris-flow model' solves the equations for 'granular flow.' Do these equations approximate equations commonly used for debris flow modeling or are you using the terms 'granular flow' and 'debris flow' interchangably?

Abstract Line 5-6: What relationship? I'm guessing this is a relationship between maximum shear stress and erosion at your study site, but stating it this way makes it sound like there is a more general relationship between these variables.

Abstract Line 11-12: I had trouble following some of the results/discussion section (see comments below), but If I'm interpreting the results correctly then it seems like this study addresses the problem of debris flow entrainment and changes in debris flow volume (bulking). The model presented here can't address how changes in channel bed erosion influence runout (at least not for a single flow) since dynamic changes in topography are not accounted for.

Abstract Line 13: Same as above comment: 'channel bed erosion.' This makes it sound like dynamic changes in bed topography are important, but they are not included here.

2382 - Line 28 : 'Recent debris flow research...' Consider moving this paragraph to start before the paragraph beginning with 'Runout models are increasingly....'

2382 - Line 22: This paragraph could potentially be removed. I wasn't sure how it fit in with the rest of the introduction. Are these difficulties the reason for not using a process-based debris flow entrainment model?

2383 - Line 10-15: Previous models have included terms for debris flow mass change and investigated the effect of this term on flow runout. This study is different from those because of the strong connection to field data. Could emphasize the novel aspects of this study here.

2383 - Line 26: What is 'steep'? Please clarify.

2383 - Line 6: Was there any significant flooding during this time? Were significant water-dominated runoff events associated with the debris flow events?

2385 - Line 11: Is 'granular flow' the appropriate term?

2385 - Line 15: It is confusing to use subscripts to denote derivatives as well as direction (for flow velocity).

2386 - Line 11: '...dominates deceleration behavior.' This contradicts the next sentence. Do you mean it dominates when the flow is moving slowly?

2386 - Line 27: 'The RAMMS debris flow model....' This was already stated and could be removed.

2387 - Line 23: 'erosion algorithm is defined by'. Consider 'defined using' or 'a function of'

2388 Line 18 - 2389 Line 16: Most of this sounds like it would fit better in the discussion section.

2389 - Line 24: 'at a specified rate'

2390 - Line 9: 'main goal is to investigate the importance of erosion....' Over a single event? Multiple events? I've assumed up until this point that it would be for one event but if channel bed erosion isn't dynamic and only happens after the event then how is this possible? I assume (based on Lines 15-18 on page 2395) that changes in flow volume occur dynamically and maybe this is how erosion/entrainment become important in this model for a single event, but there is no source term for flow material in the continuity equation.

2391 - Line 1: I don't think this an adequate test for the model. Is it possible to predict values outside of that range given the limits imposed on erosion rate? Does the model predict negligible erosion for the smaller debris flow events as was observed?

2392 - Line 19: Are these choices (4 points, chosen time intervals) arbitrary? How do these choices for the initial condition influence the model-predicted erosion?

2393 - Line 13: 'diameter' should be 'deviation'

2393 - Line 1 and Line 25: One set of parameters is the best for the 'most realistic erosion result' and another set of parameters gives the 'most realistic spatial erosion pattern.' Please clarify.

2394 - Section 5.2: There were 2 flows mentioned earlier (2392 Line 17), but this section makes it sound like only one flow was modeled. Is this the case? Figures 4,5,6, and 7 also make it look as if only 1 flow was modeled. This is very confusing since changes in bed topography don't occur dynamically and changes in debris flow volume may/may not occur dynamically (I think they might but there is no source term for this in the flow equations). Please clarify exactly what event/events are being modeled and if changes in bed topography are accounted for between events (if multiple events were modeled).

2395 - Line 19: Does this mean that entrained material is added dynamically to the flow? If this is the case, it should be stated earlier. If changes in flow volume are not simulated, then how reasonable is it to start with a smaller flow volume initially (relative to the final flow volume)? Please Clarify.

2395 - Line 27: The term 'hydrograph' is used many times before this so if it is defined in the text it should come directly after the first time it is used.

2397 - Line 20: 'assess determine'

2398 Line 1: But it does require a pre-defined maximum erosion rate.

2398 Line 14 - 2399 Line 2: This material belongs in the results section.

2401 - Line 6: What was the most important factor in this case? Was it channel bed erosion or debris flow volume growth?