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Comment on nhess-2021-22

Anonymous Referee #1

Referee comment on "Optimizing and validating the Gravitational Process Path model for regional debris-flow runout modelling" by Jason Goetz et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2021-22-RC1, 2021

General Comments

Dear Editor, dear Authors,

this a well-written and interesting paper on the automatic calibration and validation of a framework for regional debris-flow modelling. Besides the modelling of debris-flow initiation sites with a GAM, the GPP model is used for debris-flow path and runout modelling in the upper Maipo river basin, Andes of central Chile. The authors develop and present a novel approach for model optimization and validation, including several aspects like uncertainty in parameter selection, spatial transferability, and the models's sensitivity to sample size. The results are well presented and discussed, including very nice and informative figures to illustrate the findings. Most parts of section 2 (material and methods) are also well written, but I think this is the section which could be improved most by adding some more detail on some of the aspects (see specific comments below). Apart from that I think the paper is well suited for publication in NHESS. It is also really nice to see that the tools developed for this paper (as well as the data) are also made available to the public.

With best regards.

Specific Comments

Section 2.1.2
Please use a different color for debris flows and roads in Fig. 1, they are both grey and can't be distinguished very well.

Section 2.1.3
Regarding the sampling of presence and absence of source points: how do you exactly determine the non-source points? Do you somehow guarantee that the samples are not "too close" to mapped source points? There are much more non-source than source points in your study area, how does this influence the results? This affects training as well as validation, please elaborate.

After denoising, you apply a sink filling algorithm to the DEM, which one?

Section 2.2.1
Regarding the rating of the random walk performance (line 160): performance was rated higher if observed debris-flow tracks were within the modelled paths. Please provide more details on how this was done exactly, e.g. did you also take the number of cells into consideration that were outside the mapped track? Otherwise you might get optimized parameters that overestimate the process area.

Regarding the random walk parameter optimization before the runout optimization (two-stage approach): in order to optimize the random walk parameters, wouldn't you also require to use some kind of friction model to limit the runout distance? This overlaps with the previous question, please explain.

Regarding runout distance optimization: here, you use a minimum area bounding box to measure length. What impact has the character of the derbis flow path on this concept? For example, take (1) a quite short, more or less straight debris-flow path versus a (2) very long path, which runs from a hillslope into a channel with a distinct change of direction, let's say 90°? Then you get (1) a bounding box matching the real length quite well and (2) a bounding box which is almost square, strongly underestimating the runout length.

Regarding the optimization of the 2 parameters of the PCM model (sliding friction coefficent "my" and mass-to-drag ratio "M/D"): a general problem with the PCM model calibration is, that there is some mathematical redundancy between the parameters. I.e., you can achieve the same runout length with different parameter combinations of my and M/D. How does your calibration approach handle this? Please add some information on this, because this may also have some impact on other sections of the paper, e.g. section 3.2 ("low sensitivity for a large range of parameter combinations"), section 3.5 ("no clear spatial pattern in optimal my and M/D parameter combinations across the study area"), section 4.1.2 ("we observed high variability in optimal PCM parameters").

Section 2.2.2
You assessed the transferability of optimized model parameters by 5-fold spatial cross-validation. In section 2.2.1 you state that you are using a random sample of 100 debris-

flow tracks for optimization. Is this the sample size you use here too? Or how is this related?

Section 2.2.4
To calculate the AUROC, you used 1000 samples of both debris-flow and non-debris-flow locations. How did you sample the non-debris-flow locations? Thematically similar to my question on the non-source point sampling.

Section 3.1
You write that areas with slightly concave profile curvature were modelled as more likely being source areas. So far plan (not profile) curvature was used, and it is also plan curvature that is shown in Fig. 5.

Section 3.2
I think it would improve the reading of Table 2 if you would name the "third" model component "Runout distance (spatially varying friction)" instead of only "Runout distance" (like the "second" model component).

Section 3.4
In line 294 you write "... the modelled runout paths failed to follow the flow direction ...": is this due to a general problem of the flow path model or is this caused by errors in the DEM?

In line 299 you write that "these cases were related to missclassifying stream erosion ...": was the runout lemgth over- or underestimated in these cases?

Section 4.1.2
This section (mostly) discusses the runout distance model, please also add a few sentences on the runout path model.

Technical corrections

p1, l5: fix typo in "Germany"

p1, l29: remove additional blank after "learning"; "source" instead of "sources"

p2, l30: remove additional blank after "and"

p2, l46/47: not sure if a comma should be used instead of a semicolon in the enumeration

p2, l55/56: add missing periods after "al" in three citations

p2, l56: remove additional blanks after "be"

p3, l73: "our" instead of "out"

p3, l77: add missing periods after "al" in three citations; Moreiras et al. 2012 and Serey et al. 2019 are missing in the references, please add

p3, l80: add missing period after "al" in the citation; Sepulveda et al. 2006 is missing in the references, please add

p3, l81: add missing period after "al" in the citation

p3, l83: add missing period after "al" in the citation

p4, l95: add period at the end of the table description

p5, l115: add missing "the" in "with ___ remaining set"

p6, l136: the PCM model was developed by three authors, so it isn't "Perla's" model, please rephrase

p9, l208: throughout the text you use a hypen in "debris-flow", here you write "non-debris flow"; should this be changed?

p9, l214: add the missing "a", the package is called "Rsagacmd"

p11, l243: "mass-to-drag ratio" not "mass-to-drag-ratio"

p14, l278: "towards a threshold of 0.5" instead of "thresholds"

p14, l279: There's quite a break between the two sentences, I had to read it twice to realize that "The resulting runout prediction map ..." was meant to be that with a threshold of 0.7. Maybe it would help to start a new paragraph here or to reformulate the sentence to something like "The runout prediction map resulting from the best threshold ..."

p18, l314, Figure 11: "... runout path (a), ..." "... relative error (b), actual runout length error (c), and ..."

p22, l264: "source conditions to spatially" instead of "source conditions spatially"

p22, l373: "parameters of the PCM model" instead of "parameters the PCM model"

p24, **References**: please add the missing references and also have a look at the formatting - there are many references in which the author's first names are not shortened to the initials