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Interactive comment on "Automated snow avalanche release area delineation – validation of existing algorithms and proposition of a new object-based approach for large scale hazard indication mapping" *by* Yves Bühler et al.

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Dear Reviewer

Thank you for your positive and encouraging review. Certainly, we keep on working on the spatial modelling. We apply the methodology in many different regions around the world in close collaboration with local avalanche experts. This testing and validation help us the further improve the algorithm and to stat to include more and more information on snow and weather conditions.

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Discussion paper

Specific reviewer comment 1: I would appreciate a very short discussion whether this approach is only usable for snow slab avalanches or – to a certain degree – also for glide avalanches? Al- though the processes leading to the release of the avalanches are different, predisposition concerning (1) terrain, (2) snow volume, (3) meteorological factors are partly overlapping...probably. This aspect is shortly addressed on page 2, lines 1-4 but should be revisited in the discussion section.

Answer 1: Thank you for this suggestion. We add the following sentence to the end of the discussion in the manuscript: In this research we present the processing chain for dry snow flowing avalanches. By incorporation information on snow temperature, snow erosion and free water content this approach could be extended with the scientific version of RAMMS (Bartelt et al., 2016;Bartelt and Buser, 2016) to simulate powder snow avalanches, wet snow avalanches, small skier triggered avalanches or glide snow avalanches. However, the validation of such simulations is very demanding in terms of valuable reference data but is planned for the future.

Specific reviewer comment 2: For the 'Input Parameter Setting' you have set one parameter to a 'Default Value' when changed systematically the other parameters. Why not changing all parameters for a specified range (using parameter sets instead of fixing numerous and changing one – as this could have interference effects). I assume that this was not done because of the enormous effort to implement parameter optimization routines (e.g. dream algorithm) and to link with the tested algorithms: but it should be addressed shortly in the discussion section if this could further improve your approach. Applying such types of adaptive Monte Carlo simulation could also lead to 'equifinality' of parameter sets and therefore this aspect, does not question the high quality of your approach and validation results but should be seen as another motivation to further work on the improvement of your approach. What were your criteria setting the default value? There might be some educated guess, but please state (this comment is to a great extent linked to the comment above, asking myself if a different fixed default value would influence parameter optimization routine.

Answer 2: The value ranges were set as educated guesses based on previous publications (Schweizer, 2003;Bühler et al., 2013;Veitinger et al., 2016). Initially, the default values were set in the centre of the respective value range. Based on this, it was iterated over all parameters and subsequently the optimal parameter setting (highest skill score, explained in Bühler et al. (2018)) obtained. Afterwards, it was reiterated with the optimum values from the previous iteration as default values. If the optimal parameter setting was equal to the previous iteration and the corresponding skill score compared to the previous iterations the highest, the optimal values were considered as confirmed. In short: Starting with default values based on previous knowledge and taking the optimal values of the previous iteration as default values for the next iteration, we elaborated optimal values with the highest skill score.

Another approach would be, as you suggest, to evaluate every possible combination. However as the example of the algorithm of Bühler et al. (2018) shows, the evaluation of every possible combination would be very demanding in time:

Number of possible settings: Min slope angle: 20 Max slope angle: 20 Moving Window Roughness: 7 Max Roughness: 19 Plan curvature: 19 Minimal release Area: 10 Number of Combinations: 10’108’000

There are over 10 Mio possible combinations. The computational execution for one run and its evaluation takes about 2 minutes for test site. To evaluate all combinations, a computation time of about 1403 days would be needed.

Random parameter settings created with the help of Monte Carlo simulations could possibly be used to find new combinations with high skill score at random. The Application of DREAM-algorithms (Vrugt and Ter Braak, 2011) could further improve the calibration process. Running several chains with different starting points, the parameter value space could be explored efficiently and local optima (high skill score) could be found. However, this approach would be too time consuming for this study but could maybe be explored in a future study.

We add the following to the manuscript: The default values are set based on previously published investigations (Schweizer et al., 2003;Bühler et al., 2013;Veitinger et al., 2016).

Specific reviewer comment 3: Conclusions and Outlook section, line 25: put ‘potential release areas (PRA)’ in the first sentence and come up with PRA only at this point. It is nice to have the abbrevia- tion PRA explained again this section, but at the very beginning.

Answer 3: We change this in the manuscript as suggested.

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