

Explicit treatment of uncertainties in operational avalanche simulation scenarios

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INTRO:

- Simulation input by guidelines and back calculations
- Investigation of multiple possible scenarios by using ranges as input
- Result variability

METHODS

- Parameter variations to evaluate the sensitivity of simulated run out lengths
- Variation of:
 - μ = friction
 - d_{rel} = release depth
- “Run out gradients” as indicator for run out length vs simulation input
- 3 operational scenarios:
 - Smaller release area
 - Reference (standard values)
 - Entrainment
- Mapping the uncertainties in run out lengths to parameter ranges
- Displaying the frequency and spatial distribution
- Identifying areas with large result variability or certainty

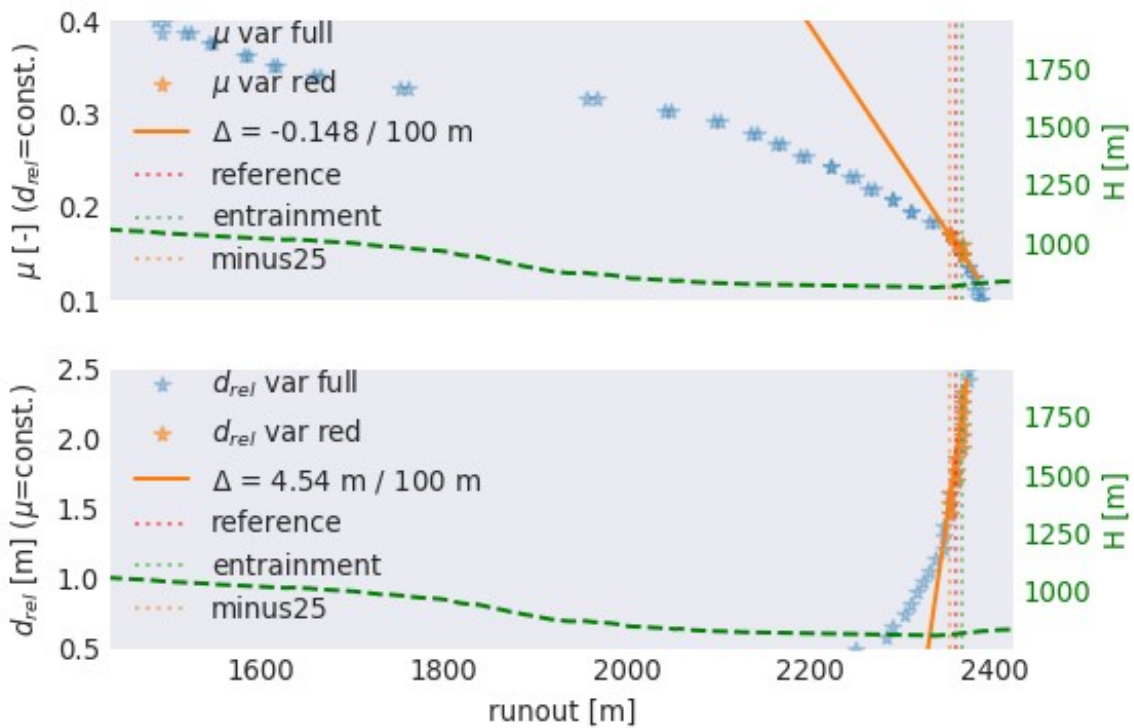
RESULTS

- Mean ranges for all investigated simulations:
 - $\mu = \mu_{ref} \pm 0.025$
 - $d_{rel} = d_{ref} \pm 0.5 \text{ m}$
- Next step is a forward calculation with this ranges, and to observe if the results fulfill what we expect

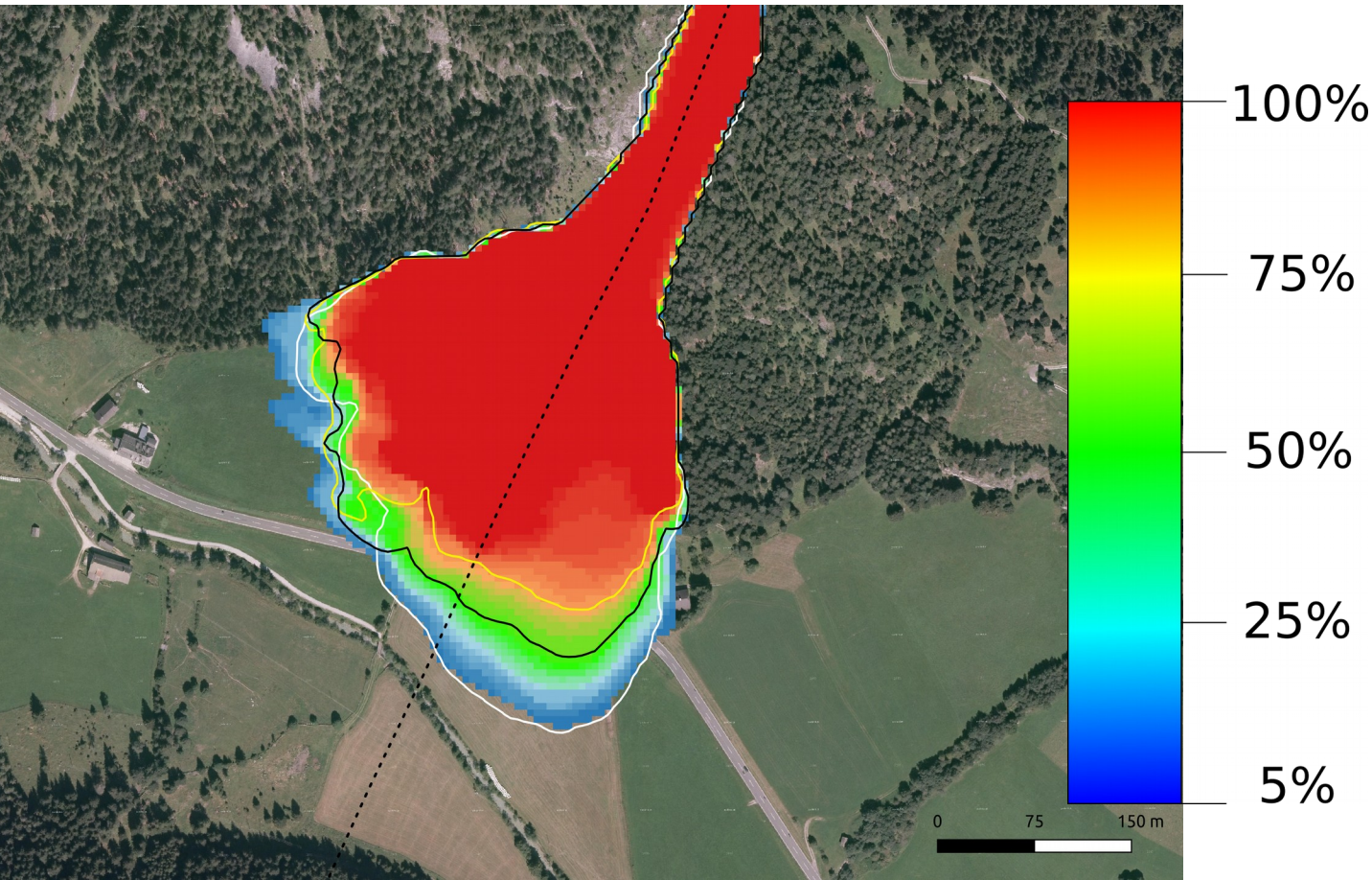
Identifying, Mapping & Displaying uncertainties in avalanche simulations



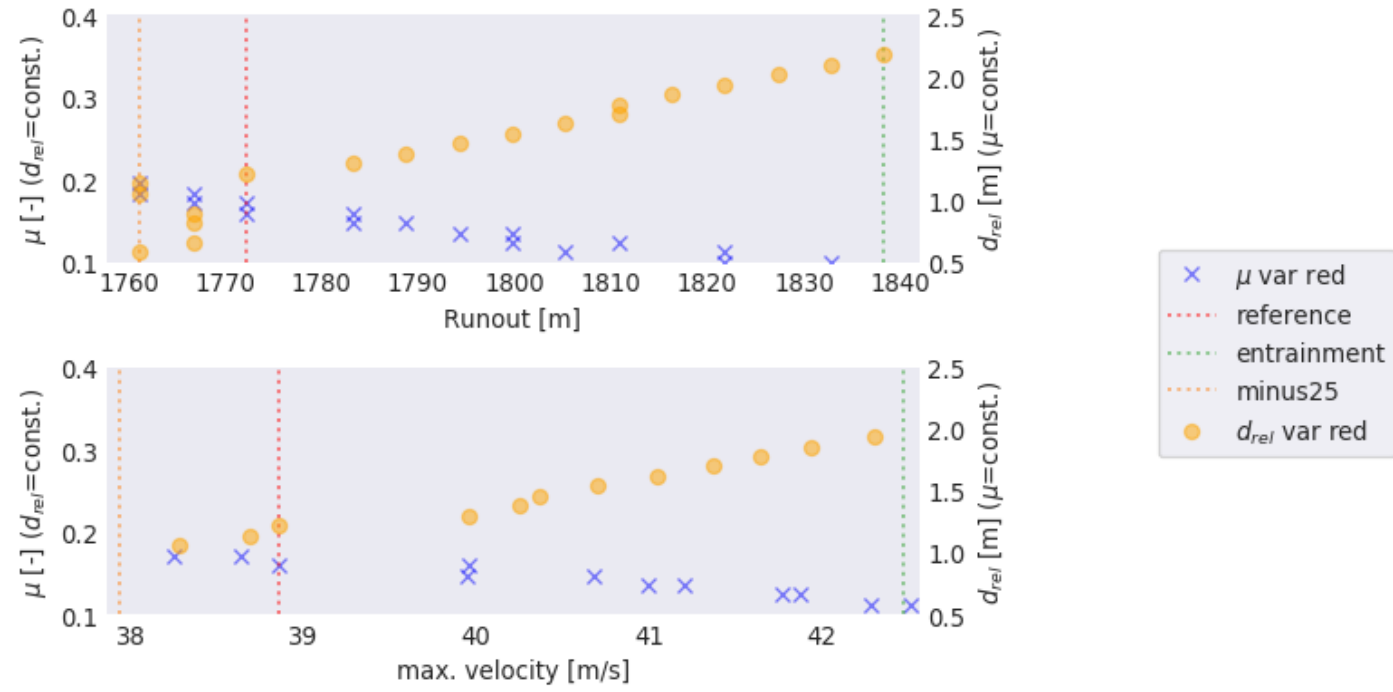
Wildbach- und Lawinenverbauung Forsttechnischer Dienst



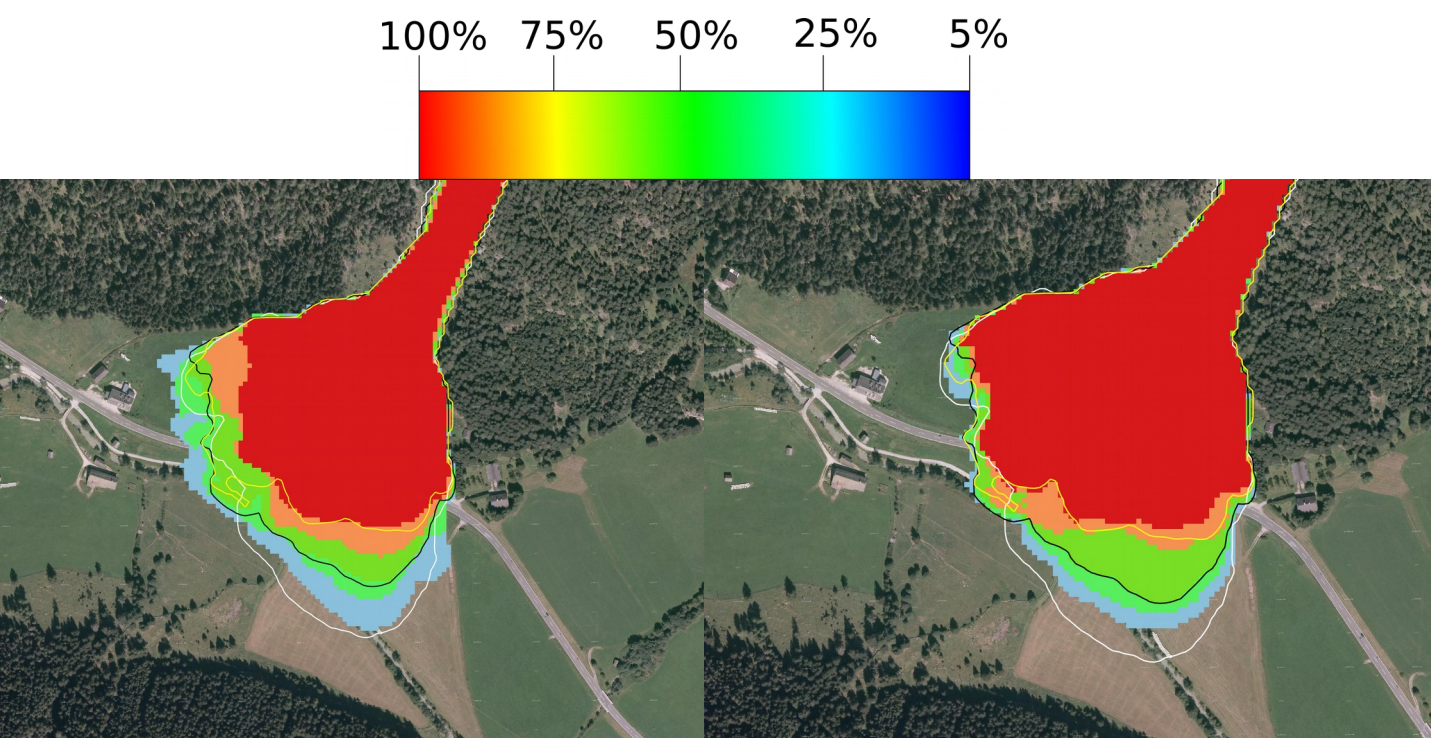
Mapping: Changes in run out due to the parameter variation of μ and d_{rel} . The run out distance is defined as the farthest point along the transformed avalanche track greater then 1 kPa. The gradient is calculated for the simulations between the two scenarios: [Entrainment, smaller release area].



Displaying: Spatial distribution for the Kerngraben avalanche with the 3 scenarios: black is reference, yellow is smaller release area and white equals Entrainment. The dotted line represents the avalanche path.



Identifying: Distribution of the max. velocity for the Kerngraben avalanche. The blue crosses indicate how the velocity evolves over the variation of μ , the orange circles indicate the same for the variation over d_{rel} .



Displaying: Forward Simulation for the Kerngraben avalanche. Left side depicts μ variation, right side d_{rel} variation, showing different influences on flow and spread in the run out zone.