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Abstract

Dynamic mass flow simulations provide multi-dimensional results of the spatio-temporal evolution of flow variables such as flow velocity, flow depth and derivatives thereof like impact pressure and associated run out. The analysis of simulation results is often reduced to final or peak states, e.g. comparing deposit outlines to flow depths of the last timestep, however, the dynamic aspects and the flow evolution over time are lost. This is reasonable from a historical perspective considering post event observation as damage or avalanche deposits are the main data source for model evaluation.

Recent studies using radar measurements acquire truly dynamic data of snow avalanche flows, offering the possibility to evaluate numerical simulation tools with respect to the temporal evolution of flow parameters. Radar data are typically displayed in a range-time diagram along the antenna line of sight and the distance to the approaching avalanche is shown for each time step. Converting the results of avalanche flow computation into simulated radar images using the radar coordinate system yields a synthetic range-time diagram that facilitates a direct comparison of radar measurements and modelling results.

This can be done not only from a radar's point of view, but also along the thalweg – a 1D representation of the avalanche path. The coordinate projection onto a regular non-uniformly spaced grid with curvelinear coordinates along the thalweg reduces the spatial complexity of the simulated flow variables and enables a comparison between different simulation scenarios and different models. Such a reduction is known from systematic approaches to objectively evaluate and compare simulation tools, which are implemented in the open-source AvaFrame simulation toolbox.

We present a new thalweg-time (TT) diagram to assess and visualize the temporal evolution of the simulated flow variables and at the same time provide information on overall runout distance and the frontal approach velocity. Both representations of the simulation results, the map-like snapshot at run-out and the radar-like range-time TT-diagram greatly complement themselves. The TT-diagram adds the temporal evolution to the established spatial extent in the visualization and analysis of a simulated mass-flow event and provides a reference system for systematic model evaluation and comparison.