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# Avalanche flow regime transitions in a changing climate

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In the near future, climate change will impact the snow cover in Alpine regions. Higher precipitations and warmer temperatures are expected at lower altitude, leading to larger gradients of snow temperature, snow water content and snow depth between the top and the bottom of slopes. As a consequence, climate change will also indirectly influence the behavior of snow avalanches.

The present work aims to investigate how changes in snow cover properties will affect snow avalanches dynamics. Experimental studies allowed to characterize different avalanche flow regimes which result from particular combinations of snow physical and mechanical properties. In particular, expected variations of snow temperatures with elevation will cause more frequent and more extreme flow regime transitions inside the same avalanche. For example, a fast avalanche characterized by cold and low-cohesive snow in the upper part of the avalanche track will transform more frequently into a slow flow made of wet and heavy snow when the avalanche will entrain warm snow along the slope. A better understanding of these flow regime transitions, which have already been largely reported, is crucial, because it affects both daily danger assessment (e.g. forecasting services, road controls) and hazard mapping of avalanches.

To date, most avalanche modeling methods are not considering temperature effects and are then unable to simulate flow regime transitions and unprecedented scenarios. Our goal is then to develop a model capable of simulating reported flow regimes, flow transitions and the interactions between the snow cover and the flow (erosion, entrainment). Since these elements are not yet fully understood, we firstly model these mesoscopic processes using a 2D Discrete Element Model (DEM) in which varying particle cohesion and friction mimic the effect of changes in snow temperature. Flow regimes are simulated by granular assemblies put into motion by gravity on an inclined slope, which interact with a granular and erodible bed surface. Simulations are calibrated using experimental data coming from the avalanche test site located in Vallée de la Sionne, which record avalanches since more than 20 years. This modeling will then be used as an input to improve slope-scale models and make them more appropriate for avalanche risk management in the context of climate change.