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Measuring snow properties relevant to slab avalanche release

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The release of a slab avalanche is preceded by a sequence of fractures. The main material properties relevant for the fracture processes are the specific fracture energy of the weak layer, as also the elastic modulus and the density of the overlying slab layers. The snow micro-penetrometer (SMP) is the method of choice for snow stratigraphy measurements in the field with high resolution. Recent advances in signal processing allow us to derive the most needed material properties to model the fracture behaviour of snow. On a smaller scale, the three dimensional structure of snow samples is obtained from snow micro-tomography (CT) providing snow density directly. By modelling the mechanical behaviour of the ice matrix the elastic properties of the snow sample can be calculated. At the macro-scale, fracture mechanical field tests with particle tracking velocimetry (PTV) allow observing the in-situ fracture behaviour. Specific fracture energy and slab stiffness are derived from PTV measurement by fitting an analytical beam equation to the observed deformation field. Over the past years we were able to generate two datasets of overlapping SMP and CT as well as SMP and PTV measurements. SMP measurements and micro-tomography of snow samples show that snow density is well reproduced with current SMP signal processing algorithms. Also the specific fracture energy as derived from the SMP signal is in agreement with PTV results. The effective modulus, however, being the most sensitive parameter in fracture covers three orders of magnitude depending on measurement method. The present work discusses observed similarities and differences arising from measurement methods, theoretical assumptions and process scales. Reliable methods to determine the parameters describing the fracture process are key to snow instability modelling based on either snow cover simulations or field measurements. Preliminary modelling results from ongoing spatial variability studies illustrate the practical relevance.