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A hydro-mechanical model to estimate wet-snow instability

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Infiltrating water changes wet-snow strength which consequently has an influence on the formation of wet-snow avalanches. Snow stratigraphy affects water movement which is thought to play a vital role in determining stability. In order to link water movement with the strength of wet snow we coupled a 1-D water infiltration model solving Richards' equation with a wet-snow shear strength formulation based on laboratory experiments. We assumed two different snow stratigraphies and applied 2 mm/h of rain for 8 h. One shallow snow profile included a melt-freeze crust; the second had a prominent weak layer. Simulation results suggest that only special conditions will promote wet-snow instability. If a weak layer is present and dry-snow stability is close to critical, instability is already results with a small increase in water content. In addition to their low strength, weak layers offer perfect conditions for the formation of capillary barriers: grain sizes are often large and differences in grain size to adjacent layers are large. Simulation runs produced always ponding of water at the transition to the weak layer due to this effect. Ponding on melt-freeze crusts caused a critical situation if the water content was high. However, results suggest that at the snow-soil interface instability will occur before the situation on the crust becomes critical. In a second approach, we coupled the physical based snow cover model SNOWPACK that also solves Richards' equation, with the above mentioned stability formulation for wet snow and recalculated the snow cover state during two major wet-snow avalanche cycles. The results are in line with former observations and assumptions on the formation of wet-snow instability. Results might be used to deduce general valid rules in order to support wet-snow avalanche forecasting programs.