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Revisiting snow settlement simulations performed with SNOWPACK

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Snow density is a fundamental parameter of snow on the ground. Snow-cover models thus need to simulate snow settlement as realistically as possible for very different types and states of snow. While the viscosity of older, already settled snow can be satisfactorily described with particle-based microstructural parameters, the behaviour of new snow is far more subtle and quite difficult to catch properly. Moreover, there appears to be an intermediate state to the two above that needs to be considered, too. Finally, snow does not respond linearly to stress and stress rates, further challenging modellers. To address these issues we revisited the implementation of snow settlement in the Swiss snow-cover model SNOWPACK. In particular, we added two terms to the overburden stress. One term mimics the relaxation behaviour of new and older snow to stress rates and the second deals with the initial settlement of new snow based on the rate of change of dendricity. In addition, the temperature dependence of viscosity was adapted both to the phase transition near the melting point as well as to temperatures well below -20 °C. Indeed, the new implementation should also be able to reproduce settlement in cold polar snowpacks.
To calibrate the model, we use settlement measurements performed in situ over four different winters. The specially designed sensors recorded settlement from the time they were snowed in until they melted out again. That way the model confronts quite different situations in an alpine seasonal snow cover and this constrains the possible set of fitting parameters. We will present the best possible set we found by visual comparison of measured with modelled settlement curves and will comment on the possibility to make such assessments more quantitative and less subjective.