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Relative influence of mechanical and meteorological factors on avalanche release depth distributions. Application to French Alps.

J. Gaume, G. Chambon, N. Eckert, and M. Naaim
CEMAGREF, France (johan.gaume@cemagref.fr)

This study sheds new lights on the properties of avalanche size distributions and discusses the universality sometimes postulated in the litterature. A full-scale mechanical model integrating weak layer heterogeneity and redistribution of stresses by elasticity of the overlying slab is developed. Considering that an avalanche can occur only if the snowfall depth exceeds the limit given by the mechanical criterion, release depth distributions obtained by the mechanical model are rigorously coupled with the distribution of 3-day extreme snowfalls. It is shown that this coupled mechanical-meteorological model is able to reproduce with excellent accuracy field data from 369 natural slab avalanches in La Plagne (France). Not only the power-law tail of the distribution, corresponding to large slab depths, but also the body of the distribution for lower slab depths, are well replicated. Small to intermediate size avalanches appear to be controled mainly by mechanics, whereas large avalanches and the associated power-law exponent, are influenced by a strong mechanical-meteorological coupling. Finally, using a rigorous interpolation formalism, this model is used to obtain release depth maps for given return periods, leading to a powerfull operational tool.