Geophysical Research Abstracts
Vol. 19, EGU2017-14820, 2017
EGU General Assembly 2017
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Regional-scale identification of forest stands with protective functionality

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In avalanche practice physical-based dynamical models are commonly utilized to estimate expected avalanche characteristics, such as runout lengths, velocities or impact pressures. These are of major interest for hazard zoning or planning and construction of mitigation measures and infrastructure in avalanche prone terrain. Physical-based models are commonly applied on a local scale for single avalanche tracks, where required model inputs are estimated based on local expertise and calculation times are not a limiting criterion. For regional scale studies on geophysical mass flows the area-wide availability of input parameters and required computational times present constraints on model applicability. Consequently, for studies encompassing larger areas, spatially distributed models with limited input parameter requirements have been developed and successfully applied in recent years. Published approaches often apply a combination of a one-dimensional physical or empirical runout model with different algorithms for flow propagation and spreading. Here, we describe a model for snow avalanche runout estimation based on an empirical runout criterion coupled with a simple propagation model. Avalanche runout lengths are obtained by a travel-angle and flow propagation is calculated based on hydrological flow directions derived from a raster digital elevation model. We compare model results to observed avalanche events and subsequently employ the model for a regional-scale identification of forest stands, which potentially provide direct protection for infrastructure objects. This comprises forested areas which are located in potential avalanche release areas and/or modeled avalanche tracks upslope of infrastructure objects. These are identified by back-tracing modeled flow paths from affected infrastructure objects to the respective release areas, which are delineated based on a combined thresholds for slope-angle and a proxy for seasonal snow cover. Results indicate that the model is largely able to reproduce flow paths and runouts of observed avalanches given prior parametrization. However, with added back-tracing functionality and for application over large areas, required computation time and choice of representative parameters still present a challenge.