Geophysical Research Abstracts
Vol. 12, EGU2010-13197, 2010
EGU General Assembly 2010
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Rockfall events in the European Alps: analysis of topography and permafrost conditions at the detachment zones

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The occurrence and changes of permafrost can influence the stability of high mountain rock walls among other factors such as topography, geology or hydrology. Knowledge of the connection between rock fall and permafrost is still limited, but several indications link past rock fall events and the warming of permafrost. For example, observation of numerous rock fall events in the unusually dry and hot summer 2003, the presence of ice in detachment zones, or the demonstrated reduction of shear-strength in ice-filled fractures with warming temperatures.

The main objective of the presented study is the analysis of past rock fall staring zones in the European Alps with focus on permafrost and topography in order to learn about the conditions under which such instabilities develop. An inventory of recent rock fall events in the European Alps (mainly the past 100 years) has been established and the collected data has been analysed. The work presented bases on and extends similar earlier studies of rock fall starting zones in permafrost areas.

In a first step, a descriptive statistical analysis of topographic and geological characteristics of the detachment zones was conducted and subsequently, the permafrost conditions in the detachment zones were investigated: a) the evaluation of the elevation and the aspect for each detachment zone and the relative comparison with two different permafrost boundary estimations from regional permafrost models, b) the relation of the mean annual air temperature and the potential solar radiation for each detachment zone, c) the assessment of the topographical situation of each detachment zone.

Despite uncertainties in the raw data, results corroborate findings from earlier studies that the majority of the rock fall events in the inventory originated from areas with potentially warm permafrost. Interestingly, a large proportion of events originates from areas below ridges and peaks.