Geophysical Research Abstracts
Vol. 15, EGU2013-613, 2013
EGU General Assembly 2013

Numerical modeling of the Mount Steller rock-ice avalanche and of the associated landquake

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Gravitational instabilities, such as landslides, avalanches or debris flows play a key role in erosion processes and represent one of the major natural hazards in mountainous, coastal or volcanic regions. Despite the great amount of field, experimental and numerical work devoted to this problem, the understanding of the physical processes at work in gravitational flows is still an open issue, in particular due to the lack of observations relevant to their dynamics. In this context, the seismic signal generated by gravitational flows (i. e. landquake) is a unique opportunity to get information on their dynamics. Indeed, as shown recently by Favreau et al. (2010), simulation of the seismic signal generated by landslides makes it possible to discriminate different flow scenarios and estimate the rheological parameters during the flow. However, the feasibility of this method was only proved for one landslide (i. e. the Thurwieser landslide) recorded by two seismic stations.
We simulate here the 2005 rock-ice avalanche occurring on the Mount Steller, Alaska, that has been recorded by more than ten seismic stations. This 40-60 million of cubic meters rock-ice avalanche traveled about 10 km and stopped on the Bering glacier. Field survey showed that a significant part of this mass result of ice eroded from the glacier by the flow (Huggel et al., 2008). By simulating the avalanche and the generated seismic signal, the aim is to constrain the flow dynamics and in particular, to assess the role of erosion processes on the avalanche behavior. As a result, simulation shows that the presence of the glacier as well as erosion processes have to be taken into account to reproduce the seismic signal generated by the avalanche. Comparison between simulated and observed seismic signals makes it possible to constrain the volume of eroded material and more generally to discriminate different landslide scenarios. Because gravitational instabilities are continuously recorded by global and regional seismic networks, this new method will help gathering new data on landslide behavior.

2D simulations of this landslide have also been performed to investigate how the 3D topography affect the seismic signal.

Favreau, P., Mangeney, A., Lucas, A., Crosta, G., and Bouchut, F., 2010. Numerical modeling of landquakes, Geophys. Res. Lett., 37, L15305.

Huggel, C. et al., 2008. Ninth International Conference on Permafrost.