Geophysical Research Abstracts
Vol. 15, EGU2013-13519, 2013
EGU General Assembly 2013

Permanent monitoring of alpine slope instabilities with L1-GPS

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Since winter 2010/2011, a network of permanent GPS stations is being set up in the Matter Valley (Swiss Alps). The aim is to monitor the time variable movement of potentially instable rock glaciers. The network has been established in the framework of the X-Sense project, currently totaling more than 20 stations. X-Sense is an interdisciplinary project for monitoring alpine mass movements at multiple scales, funded by the Swiss federal program Nano-Tera within the Swiss Science Foundation. The X-Sense stations consist of low-cost L1 GPS receivers coupled with inclinometers. A part of the stations allow for on-line data transmission. The data of the X-Sense L1 GPS network is operationally processed on a daily basis with Bernese GPS software, in a fully automated processing chain. In addition, real-time solutions are computed for the on-line stations.

The geodetic potential of low-cost GPS receivers for the precise monitoring of slope instabilities in mountain areas was previously investigated in a feasibility study. It is shown that low-cost GPS units are able to provide reliable and continuous time series of surface displacements at cm-level accuracy in harsh environment, using adequate differential processing techniques. Enhanced algorithms were developed to derive accurate time series of surface velocities based on the GPS displacements. It was shown that the low-cost GPS receivers allow to reliably observe surface velocities even below 1 cm/day, as well as to detect small and short-term velocity changes. In addition, the time series of more than 2 years obtained reveal the capability to detect seasonal velocity variations, as well as inter-annual variations of the velocity pattern. By providing continuous observations of surface motion, the GPS-based permanent monitoring contributes to the understanding of processes linked to permafrost-related slope instabilities.