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Integration and assimilation of remote and terrestrial data for monitoring rock glaciers deformations: the innovative experiences from the SloMove project

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We propose an innovative data integration methodology for monitoring landslides and slow moving processes such as rock glaciers. Within the Interreg project Slomove, we assimilated different sources of displacement data, such as GPS, terrestrial laserscans and DInSAR into a new field which integrates the information from all the measurement techniques.
The new displacements field is obtained using the well-know approach of 3DVAR used in atmospheric science to assimilated data in dynamical models. This approach produces the best observing field combining the information from different sources and minimizing the errors and the uncertainties associated to each native field (in our case GPS, laserscans and InSAR data).
The methodology was developed during the Interreg-funded research project SloMove, (www.SloMove.eu) which dealt with the monitoring of slow moving processes in high alpine environments. During the project duration (2012 - 2014), rock glacier movements and deformations in Switzerland and Italy were regularly monitored using satellite-based DInSAR, terrestrial laserscanning and differential GNSS. A major challenge of the project was to integrate terrestrial and remotely-sensed data sources and to investigate the benefits and limitations of the methods and their application in an alpine setting.
GPS campaigns were carried out one time in 2012 and three times a year in 2013 and 2014, terrestrial laserscans once a year. Artificial reflectors were installed on the test sites with the aim of improving the application of satellite-based DInSAR analyses. Radar data from the Cosmo SkyMed satellite was processed using the SBAS algorithm.
The study was carried out at two test-sites located in Grisons (Switzerland) and South Tyrol (Italy). The Swiss site is located above Pontresina in the Upper Engadin valley. The monitoring area includes three individual active rock glaciers in a West oriented mountain cirque called Foura da l'amd Ursina. The rock glaciers are henceforth referred to as Ursina I to III and are located between 2700 and 2900 m asl. The steep surrounding ridges and rock walls are over 3000 m high and are subject to intermittent rockfall activity.
The results of the assimilation analysis show a cumulative 3D displacement up to 50 cm in 2 years, and an average velocity of deformation up to 2 cm/y in the Swiss area. In particular, the collected data provide information about the trend of deformation of the three rock glaciers, identifying the faster zone in the front of Ursina I.
The presentation will focus on the data integration and the lessons learned in the SloMove project. Challenges of data integration, with a focus on the problems arising in rough alpine terrain will be highlighted and best-practice experiences will be shared with the scientific community.