REMOTE DETECTION OF SNOW AVALANCHES

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INTRODUCTION

Remote detection of snow avalanches is an appealing instrument for monitoring snow avalanche activity during periods of bad visibility. It supports local avalanche management professionals with information on avalanche activity in a specific avalanche track, supporting them in verifying the results of artificial avalanche releases. Additionally, it provides a regional avalanche activity index for avalanche danger assessment. During summer 2009, we instrumented several sites in the Swiss Alps with infrasound microphones, Doppler radars or geophones. For each site, a local observer reported and documented all avalanche events, which enabled verification and tuning of the detection algorithms. We report on the technical and organizational structure of the test sites and we show details on the acquired data and its post-processing. We discuss further improvements and optimizations required to make the systems ready for operational use.

INSTALLED SYSTEMS

Most systems were provided and installed by commercial suppliers, some of them being small start-up companies. For most of the locations, we chose avalanches paths which were regularly controlled by avalanche blasting in order to maximize the number of avalanche events. Another advantage of such a location is the presence of a local observer being able to check the terrain for new events on a regular basis. Observers were provided a notification form where they could put on record the estimated time of the event, sketch the avalanche path on a map and classify the events according to size of the avalanche, type (slab, loose snow, dry and wet) and whether the avalanche was triggered naturally or artificially by blasting or by a person.

INFRASONIC MONITORING

Arrays of four infrasound microphones spaced by a few ten meters were installed at different sites in Switzerland. They were connected to a computer recording the signals at a sampling rate of 80 Hz and performing an on-line analysis of the infrasonic spectrum. Another infrasonic monitoring system with different microphones and wireless data acquisition is installed in winter 2010/2011.

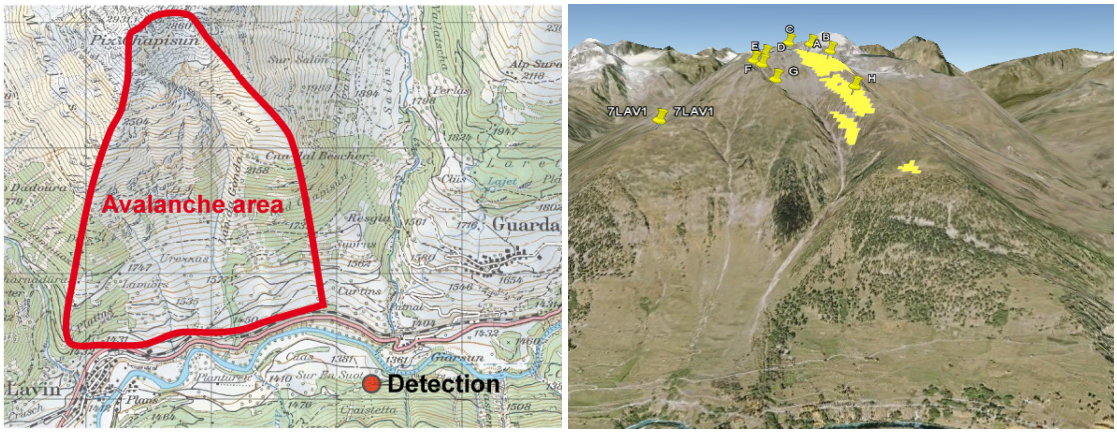

Fig. 1 Avalanche paths and detection system in Lavin (left), visualisation of an avalanche event (right).

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DOPPLER RADARS

Two different Radar systems from two suppliers have been installed in winter 2009/2010. Both systems are equipped with computers that perform a real-time analysis of the signal and could trigger an immediate alarm. Technical expertise from winter 2009/2010 is used to upgrade the systems for the winter 2010/2011. In Sedrun (Canton Graubünden) the radar observes an area of about 200 m in diameter (6 degrees antenna opening angle at a distance of 2 km).

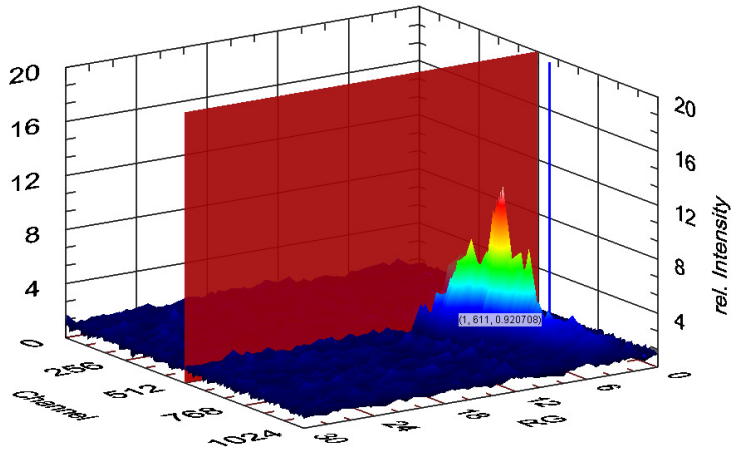

Fig. 2 Velocity spectrum of an avalanche (Radar)

GEOPHONES

An avalanche gully close to Liddes (canton Valais) was monitored by an alarm system which includes three geophones.

CONCLUSIONS

Snow avalanches emit signals that are detected by all systems. While the Infrasound System can monitor a large area, it is prone to noise, for example from wind. The Radar is less susceptible to such disturbing signals, but it can only observe a limited area. For both systems, the big challenge is to find the correct filters and triggers to eliminate false alarms. Another challenge is to bring the data to a form that can easily be interpreted by avalanche professionals.

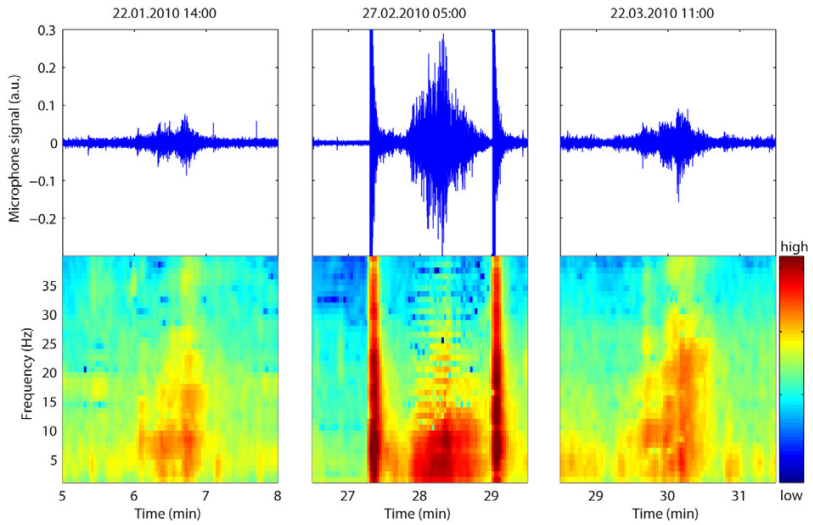

Fig. 3 Infrasonic snow avalanche signals

Keywords: snow avalanche detection, infrasonic monitoring, doppler radar, geophones