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A low cost wireless GNSS network to trace displacements

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Since 2008 Fondazione Montagna sicura is in charge of the monitoring system of the Grandes Jorasses's serac. It is an unbalanced hanging glacier standing above Ferret Valley, a famous and highly populated area. The glacier is subject to periodic icefalls which (especially in winter) can trigger snow and ice avalanches. Thankfully the serac dynamic was studied in 1997-98 by prof. M Funk (ETH Zurich) revealing an exponential acceleration the days before the collapse. Forecasting the breakdown is then possible by tracking the ice mass velocity. The current monitoring system consists of stakes with prisms placed on the surface of the serac and an automatic total station (theodolite plus distantiometer) sited on the valley floor. The major drawback of this system is that fog or bad weather could impair its operation, thus causing loss of information about the serac movement. This paper presents an alternative monitoring system developed and tested during the 2010. The idea is to use single channel GNSS receivers installed on the serac, transmit data with a wireless network and gain high accuracy exploiting permanent GNSS stations and the DGPS technique. The system must be characterized by low cost (throwaway sensors due to the environment), high precision (mean velocity is about 5 cm/day) self recovery and stand-alone electric supply. The solution was to adopt the Magellan AC12, a professional GNSS receiver, and develop the needed electronics to log and transmit data. The electronic board is able to start and configure the GNSS receiver and to recover possible failures. During the normal operation the system is optimized to reduce current consumption logging data and minimizing the transmission time to only once every 30 minutes. The developed network is composed by three slave nodes (GNSS receiver plus PCB) one relay station(the final installation is 4 km away from the valley floor) and one receiving station. The communication protocol in this first release is a single direction custom implementation of the "Listen before Talk" principle. The slave nodes probe the channel and if no one is transmitting the communication start. The receiving station logs the data in RINEX format closing one hourly file for each GNSS station. The high accuracy is than obtained by means of differential computation using local permanent GNSS stations. The whole system was tested in august 2010 during one field campaign in Val Veny (Courmayeur, Italy). The slave nodes were installed on a stake with a prism on its top and then moved for some centimetres and the movement recorded with a total station. In post processing was possible to compare the GNSS log with the total station measurements and appreciate an accordance lower than one centimetre.