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First approximations in avalanche model validations using seismic information

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Avalanche dynamics modelling is an essential tool for snow hazard management. Scenario based numerical modelling provides quantitative arguments for decision-making. The software tool RAMMS (WSL Institute for Snow and Avalanche Research SLF) is one such tool, often used by government authorities and geotechnical offices. As avalanche models improve, the quality of the numerical results will depend increasingly on user experience on the specification of input (e.g. release and entrainment volumes, secondary releases, snow temperature and quality). New model developments must continue to be validated using real phenomena data, for improving performance and reliability.

The avalanches group form University of Barcelona (RISKNAT - UB), has studied the seismic signals generated from avalanches since 1994. Presently, the group manages the seismic installation at SLF's Vallée de la Sionne experimental site (VDLS). At VDLS the recorded seismic signals can be correlated to other avalanche measurement techniques, including both advanced remote sensing methods (radars, videogrammetry) and obstacle based sensors (pressure, capacitance, optical sender-reflector barriers). This comparison between different measurement techniques allows the group to address the question if seismic analysis can be used alone, on more additional avalanche tracks, to gain insight and validate numerical avalanche dynamics models in different terrain conditions.

In this study, we aim to add the seismic data as an external record of the phenomena, able to validate RAMMS models. The seismic sensors are considerable easy and cheaper to install than other physical measuring tools, and are able to record data from the phenomena in every atmospheric conditions (e.g. bad weather, low light, freezing make photography, and other kind of sensors not usable). With seismic signals, we record the temporal evolution of the inner and denser parts of the avalanche. We are able to recognize the approximate position of the flow in the slope, and make observations of the internal flow dynamics, especially flow regimes transitions, which depend on the slope-perpendicular energy fluxes induced by collisions at the basal boundary.

The recorded data over several experimental seasons provide a catalogue of seismic data from different types and sizes of avalanches triggered at the VDLS experimental site. These avalanches are recorded also by the SLF instrumentation (FMCW radars, photography, photogrammetry, video, videogrammetry, pressure sensors). We select the best-quality avalanche data to model and establish comparisons. All this information allows us to calibrate parameters governing the internal energy fluxes, especially parameters governing the interaction of the avalanche with the incumbent snow cover.

For the comparison between the seismic signal and the RAMMS models, we are focusing at the temporal evolution of the flow, trying to find the same arrival times of the front at the seismic sensor location in the avalanche path. We make direct quantitative comparisons between measurements and model outputs, using modelled flow height, normal stress, velocity, and pressure values, compared with the seismic signal, its envelope and its running spectrogram. In all cases, the first comparisons between the seismic signal and RAMMS outputs are very promising.