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Development of events detector for monitoring cryoseisms in upper soils

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In some problems of solid Earth geophysics analysis of the huge amount of continuous seismic data is necessary. One of such problems is an investigation of so-called frost quakes or cryoseisms in the Arctic caused by extreme weather events. Weather extremes such as rapid temperature decrease in combination with thin snow cover can result in cracking of water-saturated soil and rock when the water has suddenly frozen and expanded. As cryoseisms can be hazardous for industrial and civil objects located in the near-field zone, their monitoring and analysis of weather conditions during which they occur, is necessary to access hazard caused by extreme weather events. One of the important tasks in studying cryoseisms is the development of efficient data processing routine capable to separate cryoseisms from other seismic events and noise in continuous seismic data. In our study, we present an algorithm for identification of cryoseisms that is based on classical STA/LTA algorithm for seismic event detection and neural network for their classification using selected characteristics of the records.

To access characteristics of cryoseisms, we used 3-component recordings of a swarm of strong cryoseismic events with similar waveforms that were registered on 06.06.2016 by seismic station OUL in northern Finland. The strongest event from the swarm produced a fracture on the road surface and damaged basements of buildings in the municipality of Oulu. Assuming that all events in the swarm were caused by the same mechanism (freezing of water-saturated soil), we used them as a learning sample for the neural network. Analysis of these events has shown that most of them have many similarities in selected records characteristics (central frequencies, duration etc.) with the strongest event and with each other. Application of this algorithm to the continuous seismic data recorded since the end of November 2015 to the end of February 2016, showed that the number of cryoseisms per day strongly correlates with variations of air temperature.