Geophysical Research Abstracts
Vol. 12, EGU2010-7899, 2010
EGU General Assembly 2010

Exupery volcano fast response system – The event detection and waveform classification system

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Volcanic eruptions are often preceded by seismic activity which can be used to quantify the volcanic activity since the number and the size of certain types of seismic events usually increase before periods of volcanic crisis. The implementation of an automatic detection and classification system for seismic signals of volcanic origin allows not only for the processing of large amounts of data in short time, but also provides consistent and time-invariant results. Here, we have developed a system based upon a combination of different methods. To enable a first robust event detection in the continuous data stream different modules are implemented in the real time system Earthworm which is widely distributed in active volcano monitoring observatories worldwide. Among those software modules are classical trigger algorithm like STA/LTA and cross-correlation master event matching which is also used to detect different classes of signals. Furthermore an additional module is implemented in the real time system to compute continuous activity parameters which are also used to quantify the volcanic activity.

Most automatic classification systems need a sufficiently large pre-classified data set for training the system. However in case of a volcanic crisis we are often confronted with a lack of training data due to insufficient prior observations because prior data acquisition might be carried out with different equipment at a low number of sites and due to the imminent crisis there might be no time for the time-consuming and tedious process of preparing a training data set. For this reason we have developed a novel seismic event spotting technique in order to be less dependent on the existence of previously acquired data bases of event classes. One main goal is therefore to provide observatory staff with a robust event classification based on a minimum number of reference waveforms. By using a "learning-while-recording" approach we are allowing for the fast build-up of a volcanic signal classification scheme as early as new events have been identified. For implementation issues we make use of the Hidden Markov Toolkit (HTK), a software package which is mainly intended for speech recognition. For the training procedure we first extract a valuable set of wave field parameters (here, polarization and spectral attributes) in a sliding window fashion from an unlabeled continuous data stream. In the following these parameters are used to extract a fixed number of clusters in the feature space. Based on this general multivariate description of the overall data set we start building particular event classifiers from a single waveform example based on the cluster description learned before.

We will present first results of the automatic classification process to show that the system is able to provide a robust event classification without previously existing training events and hence is a step forward for volcano fast response systems.