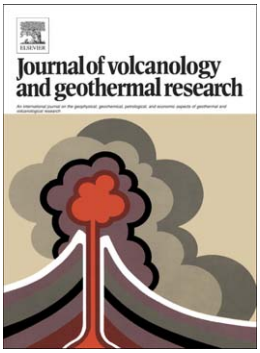

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Automatic identification of rockfalls and volcano-tectonic earthquakes at the Piton de la Fournaise volcano using a Random Forest algorithm.

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Abstract

Monitoring the endogenous seismicity of volcanoes helps to forecast eruptions and prevent their related risks, and also provides critical information on the eruptive processes. Due the high number of events recorded during pre-eruptive periods by the seismic monitoring networks, cataloging each event can be complex and time-consuming if done by human operators. Automatic seismic signal processing methods are thus essential to build consistent catalogs based on objective criteria. We evaluated the performance of the "Random Forests" (RF) machine-learning algorithm for classifying seismic signals recorded at the Piton de la Fournaise volcano, La Réunion Island (France). We focused on the discrimination of the dominant event types (rockfalls and volcano-tectonic earthquakes) using over 19,000 events covering two time periods: 2009-2011 and 2014-2015. We parameterized the seismic signals using 60 attributes that were then given to RF algorithm. When the RF classifier was given enough training samples, its sensitivity (rate of good identification) exceeded 99%, and its performance remained high (above 90%) even with few training samples. The sensitivity collapsed when using an RF classifier trained with data from 2009-2011 to classify data from 2014-2015 catalog, because the physical characteristics of the rockfalls and hence their seismic signals had evolved between the two time-periods. The main attribute families (waveform, spectrum, spectrogram or polarization) were all found to be useful for event discrimination. Our work validates the performance of the RF algorithm and suggests it could be implemented at other volcanic observatories to perform automatic, near real-time, classification of seismic events.

Keywords: Volcano seismology, Automatic identification, Random Forests,

1. Introduction

Volcanoes are among the most active geological structures on Earth and can pose significant threats to human societies. Assessing the potential occurrence