Classification of Seismic Signals at Vulcano, Italy, using Unsupervised Learning Techniques

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Abstract

We analyze the seismic signals recorded on the island of Vulcano (Italy) during a volcano unrest that started in 2021. From mid-September 2021 onwards, a high number of very long-period and long-period events occurred, accompanied by large emissions of CO_2 and the increased temperature of fumaroles at various sites of the island. The complexity of the seismic signals recorded during the unrest made standard amplitude-based monitoring techniques, such as RSAM, questionable, as part of the signals are not volcanogenic, such as the frequent close-by passage of ships. We therefore study the inventory of the recorded signals by exploiting machine learning procedures, in particular unsupervised classification techniques. Our studies aim at identifying varying classes of seismic events possibly related to volcanic dynamic as well as irrelevant signals, such as man-made noise. Self-Organizing Maps and Cluster Analysis were applied. As a result, we are able to visualize the development of signal characteristics efficiently. This can provide a useful contribution to volcanic surveillance purposes, which aim to identify changes heralding a "Vulcanian" eruption, an eruptive style with strong explosive characteristics.