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Principal Component Analysis for pattern recognition in volcano seismic spectra

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Variations in the spectral content of volcano seismicity can relate to changes in volcanic activity. Low-frequency seismic signals often precede or accompany volcanic eruptions. However, they are commonly manually identified in spectra or spectrograms, and their definition in spectral space differs from one volcanic setting to the next. Increasingly long time series of monitoring data at volcano observatories require automated tools to facilitate rapid processing and aid with pattern identification related to impending eruptions. Furthermore, knowledge transfer between volcanic settings is difficult if the methods to identify and analyze the characteristics of seismic signals differ.

To address these challenges we have developed a pattern recognition technique based on a combination of Principal Component Analysis and hierarchical clustering applied to volcano seismic spectra. This technique can be used to characterize the dominant spectral components of volcano seismicity without the need for any a priori knowledge of different signal classes. Preliminary results from applying our method to volcanic tremor from a range of volcanoes including Kīlauea, Okmok, Pavlof, and Redoubt suggest that spectral patterns from Kīlauea and Okmok are similar, whereas at Pavlof and Redoubt spectra have their own, distinct patterns.