Automating the Detection of Dynamically Triggered Earthquakes via a Deep Metric Learning Algorithm

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Abstract

Detecting subtle signals from small earthquakes triggered by transient stresses from the surface waves of large magnitude earthquakes can contribute to a more general understanding of how earthquakes nucleate and interact with each other. However, searching for signals from such small earthquakes in thousands of seismograms is overwhelming, and discriminating them from a miscellany of noise is challenging. Automating this process, even partially, could save thousands of hours of expert time. In our study, human experts identified triggered earthquakes on a dataset of near two thousand seismograms from eight large earthquakes from the Pacific and Indian Ocean rims. We explore how we can automate the detection of such dynamically triggered earthquakes using a simple, diagnostic signal-to-noise ratio (SNR) threshold as well as a convolutional deep metric learning network. Our analysis shows that the deep-learning network was more reliable at detecting small earthquakes than the SNR. Detecting and understanding dynamically triggered earthquakes are likely helpful means to detecting and understanding all types of earthquakes. Our way of automating such detections might likewise be helpful to automating the detection of other types of seismic events.