Multiple classes of non-tectonic emergent and impulsive seismic noise identified in continuous waveforms

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The proper classification of emergent and impulsive seismic noise is critical for detection of microearthquakes and developing a complete understanding of ongoing weak ground motions. Tectonic events occupy a small percentage of each day and seismic records contain numerous natural and anthropogenic signals. Recent studies have demonstrated that ongoing low-amplitude ground motion is dominated by various weak sources originating at the surface from anthropogenic and atmospheric interaction. Characterizing new classes of waveforms originating from wind generated ground motions, air-traffic, automobiles, and other non-tectonic signals can provide insightful information when designing a machine learning training data set. In 2014 a dense array (0.36 km^2) of 1,100 vertical geophones recorded ground motions on the San Jacinto fault for 30 days. The data provides detailed waveforms to detect microearthquakes and observe surface and atmospheric processes that manifest as impulsive and emergent signals. We apply a new methodology to label continuous records as random noise or non-tectonic signals, and develop a novel training data set with varying types of emergent and impulsive noise. Unsupervised learning is applied using engineered and autoencoder extracted data features from the non-tectonic signals to subdivide the waveforms into multiple classes of non-tectonic noise. Random noise and multiple classes of non-random noise waveforms are used to train a convolutional neural network that labels the continuous records for the entire array. The results identify tectonic events and different classes of non-tectonic waveforms as coherent signals in the array, with some originating at the surface within the study area. This effort to identify waveforms as new classes of non-tectonic signals provides insight to deformation in the shallow subsurface and surface generated ground motions that can potentially obscure microseismic events.

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