Using machine learning to improve earthquake catalogs for amphibious seismic networks: Application of EarthquakeTransformer to the Alaska Amphibious Community Seismic Experiment

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We use the deep learning earthquake detection and picking algorithm EarthquakeTransformer (EQT) to expand the existing catalog of earthquakes recorded during the Alaska Amphibious Community Seismic Experiment (AACSE) in 2018-19. AACSE included 30 onshore and 75 ocean-bottom seismometers (OBS) deployed along the Alaska-Aleutian Trench from Kodiak Island to the Shumagin Islands. Knowledge of offshore seismicity is key to understand subduction zone processes and seismic hazard, and machine learning methods may be able to detect substantially more small earthquakes using offshore seismic data. Yet, many machine learning methods to date are developed, trained, and tested with only onshore seismic data. EQT, for example, is trained on 1 million earthquake and 300 thousand noise waveforms, all recorded on land.

First, we test EQT against the existing AACSE earthquake catalog generated by the Alaska Earthquake Center. We apply the default EQT model to pick P and S waves in the AACSE seismic dataset, first applying a bandpass filter of 1-50Hz (land) or 5-20Hz (OBS). EQT finds 58% of P and 61% of S arrivals within 300 km epicentral distance, the max epicentral distance in the EQT training data. This relatively poor performance compared to EQT's test dataset (99% of P and 96% of S) suggests re-training with amphibious data may be necessary, a project that is currently underway. We are able to use EQT plus a grid association method to detect more small earthquakes in AACSE. In the region west of Kodiak Island, we find roughly 40% more events. Previously-observed along-strike variation in seismicity rate persists: in both the thrust zone and outer rise, the Semidi segment has relatively few earthquakes while the Shumagin segment has many. Quantifying spatial and temporal patterns of microseismicity in the region prior to the July 2020 M7.8 Simeonof and July 2021 M8.2 Chignik earthquakes may provide new insight into stress or rheological conditions in the thrust zone that prepare the plate interface for large-scale ruptures.