**Real-time Deep Earthquake Discriminator Using Radiated Energy flux features and Machine Learning Methods**

**Authors**: L. Barama, A.V. Newman

Rapid and robust identification of deep earthquakes is useful in the application of more accurate real-time analysis and location, particularly at teleseismic distances where real-time estimates of depth can differ from reviewed calculations by up to tens of kilometers. In Barama and Newman (2018), we developed a method using the first-derivative of the per-station energy time series of earthquakes to identify distinct double-peaks of energy associated with the direct-P phase followed by the energy of the depth phases (pP and sP). This was a promising result from automatic processing of initial energy pulses without any additional processing of the waveforms. With this we apply machine learning to deep earthquake detection using both a Convolution Neural Network (CNN) and a Deep Neural Net (DNN) trained on both physical features of the energy time series (prominence and peak density) as well as the original waveforms and energy curves. Initial results showed improved results on utilizing the time series and interestingly the peak-density per event time series over the first derivative per-station energy, despite the peak density curves having significantly less training data. In this work we continue testing of the conventional and ML methods for rapid depth determinations using data from a teleseismic network of stations as well as working on single station predictions. Using over 2000 earthquakes (> 70km depth) that occurred between 1989-2019 with moment magnitude greater than 5.5 from the Reviewed International Seismological Centre (ISC) bulletin, we calculated the per-station energy flux (of the P-wave group energy) in the time domain and smoothed and stacked energy rate determinations per event. We set a threshold for deep event detection based on time differential between energy peaks in the smoothed energy rate determinations as well as prominence of the direct P-arrival, and identify the usefulness of the derivative products over the event time series. We hope to implement these results in the real-time energy determinations operating at Georgia Tech (http://geophysics.eas.gatech.edu/anewman/research/RTerg/).