Title: Automatic picking of direct P, S seismic phases and fault zone head waves

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Session: Computational Seismology

Abstract

We develop a set of algorithms for automatic detection and picking of direct P and S waves, as well as fault zone head waves (FZHW), generated by earthquakes on faults that separate different lithologies and recorded by local seismic networks. The S-wave picks are performed using polarization analysis and related filters to remove P-wave energy from the seismograms, and utilize STA/LTA and kurtosis detectors in tandem to lock on the phase arrival. A quality metric is used to measure the degree by which the P and S waves have separated from each other in the waveforms, enabling large-scale automatic processing to be done. The early portions of P waveforms are processed with STA/LTA, kurtosis, and skewness detectors for possible first-arriving FZHW. Identification and picking of direct P and FZHW is performed by a multi-stage algorithm that accounts for basic characteristics (motion polarities, time difference, sharpness and amplitudes) of the two phases. The algorithm is shown to perform well on synthetic seismograms produced by a model with a velocity contrast across the fault, and observed data generated by earthquakes along the Parkfield section of the San Andreas fault and the Hayward fault. The developed techniques can be used for systematic processing of large seismic waveform data sets recorded near major fault zones.