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Automatic P - phase picking using skewness and kurtosis

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For near-real time event detection and localization, the automatic arrival time picking plays an important role and its picking uncertainty is essential to measure the accuracy of automatic phase picking. Characteristic functions calculated by STA/LTA algorithms are often used for automated detection of P-waves and the estimation of their arrival times. Here we present procedures for automatic picking of P-wave arrival times using characteristic functions, which are calculated by estimating the skewness and kurtosis in a moving window and compare with the characteristic functions of the conventional STA/LTA. When estimating the automatic arrival times, we take the picking uncertainty into account in order to control the quality of picking. In order to test the accuracy and robustness of these algorithms we apply these to broadband digital waveforms recorded by the German Regional Seismological Network (GRSN) stations from 1996 to 2006. The data set contains recordings from about 500 earthquakes in the region between 0°E and 90°E, and 20°N and 60°N. It includes recordings for earthquakes with magnitudes >= 4 occurring down to 100 km depth. This results in over 6000 vertical component broadband recordings. After estimation of the signal-to-noise ratio around the expected P-wave travel time and the rejection of noisy records the variance, skewness and kurtosis are calculated in moving windows. An automatic picker is applied to characteristic function obtained from kurtosis estimation in a moving window. These absolute arrival times are compared to travel times for the Earth reference model AK135 and to manual picks. Only automatic picks with an estimated uncertainty of less than 0.2 s are taken into account. The average of the differences is 0.30 s with a standard deviation of 0.44 s. Because of emergent onsets and the filtering applied to the waveforms the automatic picks tend to be slightly too late on average. Furthermore, the resulting characteristic functions of individual seismograms are corrected to a reference hypocentral depth and stacked in time and epicentral distance bins to obtain average seismogram sections of characteristic functions. The stacks show the P-wave arrival times clearly. These results show that the proposed algorithms are well suited for automated arrival time estimates and fast localization in the framework of an early warning system.