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A new catalog of earthquake rupture velocities inferred from the SCARDEC catalog of Apparent Source Time Functions

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Earthquakes rupture velocity is a key parameter to understand the physics of earthquakes. However, as opposed to other source parameters (e.g. stress drop or radiated energy), systematic analysis of the rupture velocity over a large number of earthquakes remains uncommon. This is essentially due to the fact that rupture propagation produces a second order effect on the waveforms, and is not easy to constrain. Basically, the effect of the rupture directivity on the waveforms is characterized by an apparent shape of the source at each station. The source is elongated at the stations in the direction away from the rupture propagation, and compacted at the stations in the direction of propagation. In the assumption of a simple unilateral rupture model (e.g. Haskell 1964), apparent duration of the source at each station is a function of rupture velocity, rupture direction (both considered constant), and the ray properties. Provided a good azimuthal coverage, the directivity pattern of dominant unilateral ruptures can be well resolved, and average propagation properties can be extracted. A recent method called SCARDEC (Vallée and Douet, 2016) retrieves the Apparent Source Time Functions (ASTFs), together with moment magnitude, focal mechanism and depth for most earthquakes with magnitude larger than 5.8. Using this wide catalogue of ASTFs, we here develop an automated method that extracts the average rupture propagation parameters in the assumption of unilateral rupture (Chounet et al, 2017). We specifically target the shallow and intermediate earthquakes (z<100 km) for which both direct waves of local surface reflections are merged in the signal. Because the direct waves goes down, and the reflection goes up, they carry inconsistent information on the vertical directivity, and only horizontal directivity can be detected in the ASTFs. We hence restrict our analysis to the sub-horizontal ruptures. Our method, based on a joint inversion of both P and SH ASTFs amplitudes and durations, retrieves 4 parameters : rupture velocity, propagation direction, rupture duration, STF asymmetry. It is successfully applied on 96 earthquakes for which rupture velocity and rupture direction are well constrained. This catalogue, together with STFs properties can offer a wide range of observations. Some of them are presented here, but we also highlight the potential of this catalogue for further analysis.