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Global Behaviors of Stress Drop, Radiated Energy and Rupture Velocity Extracted from an Exhaustive Catalog of Earthquake Source Time Functions.

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The SCARDEC method (Vallée et al, 2011) gives us access to the focal mechanism and the relative Source Time Functions (RSTFs) of the Mw > 5.8 earthquakes of the past 20 years, leading to a catalog of more than 2000 earthquakes.
This allows us to make an exhaustive analysis of two main rupture process properties : the static stress drop $\Delta\sigma$ and the apparent stress $\mu Er/Mo$. We have insights about the stress drop variations through the peak of the average STF, scaled to the seismic moment : $Fm^{scaled} \propto \Delta\sigma^{1/3}Vr$ (with Vr being the rupture velocity), and radiated energy is obtained through integration of STF squared first derivative. Our estimations indicate at the global scale an invariant stress drop with moment magnitude Mw, while Er/Mo slightly increases with Mw. A focus on thrust interplate subduction earthquakes (700 events) shows that, among normal and inverse shallow earthquakes (a subset of 1500 earthquakes, z<70 km), they are systematically lower in $\Delta\sigma$ and Er/Mo than the other earthquakes. This may be the effect of a specific friction law at the hydrated subduction interface; or, it can be the consequence of the well developed and mature plate boundaries that are subduction zones relative to other fault systems. Moreover, earthquakes properties do exhibit differences between subductions zones, which means that large scale plate convergence properties influence rupture behavior. We finally observe an interesting correlation between low stress drop earthquakes and low coupled zones of the subduction (e.g., Nicaragua, Northern Peru). These observations strongly suggest relations between tectonic settings and physical properties of earthquakes.
Our approach finds a limitation as Fm^{scaled} is a $\Delta\sigma$ analog through the important assumption, often used in stress drop systematic studies, of a constant Vr. However, a low Fm^{scaled} can result from the effect of a low $\Delta\sigma$ and/or a low Vr (see for instance, the low Vr tsunami earthquakes). This point, together with other intrinsic interests for the determination of the rupture velocity (rupture mechanics, wave amplification due to the directivity effects…) motivates an exhaustive analysis of this source property. RSTFs include the spatio-temporal effects of the source, which depend on rupture velocity and propagation. In a given rupture model (e.g. unilateral), we can constrain average rupture velocity and propagation of an earthquake. We here apply this method to the whole catalog of SCARDEC, in order to provide a consistent estimation of the rupture velocity on a large number of earthquakes.