



High-Frequency Radiation and Earthquake Rupture Complexities: From Back Projection to a Machine Learning Approach

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High-frequency (HF) seismic radiation is associated with abrupt changes of rupture velocity and slip-rate during earthquake faulting. Many studies have attempted to illuminate rupture heterogeneities of large earthquakes through the use of coherent imaging techniques such as the back-projection (BP) [e.g. Satriano et al. (2014), Lay et al. (2012)]. Fukhata et al. (2014) stated that, from a theoretical point of view, the BP image of the rupture is related to slip motion on the fault. However, the quantitative interpretation of the BP images in light of the physical properties of the earthquake rupture process remains still unclear.

In this work we aim at clarifying the influence that spatial heterogeneities in slip and rupture velocity have on the rupture process and its radiated wave field through the use of the BP technique. We simulate different rupture processes using a synthetic line source model. For each rupture model, we calculate synthetic seismograms at three teleseismic arrays and we apply the BP technique to identify HF radiation. This procedure permits to compare the BP images with the originating rupture model, and thus to interpret HF emissions in light of a priori-known kinematic parameters such as: rise time, final slip, slip-rate, rupture velocity.

Our results show that the HF peaks retrieved from BP analysis are better associated with space-time heterogeneity of slip acceleration. An outstanding question is therefore whether one can interpret the BP image of the earthquake to reconstruct the space-time pattern of slip acceleration on the fault. To move a first step in this analysis we apply supervised machine learning techniques to a large number of different synthetic rupture processes and their BP images, with the goal of apprehending the statistical link between HF radiation and rupture complexities.