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Rupture velocity inferred from near-field differential ground motion

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The velocity of the rupture propagation is a fundamental source parameter that strongly affects ground motion. It is commonly assessed from kinematic inversion of strong-motion or teleseismic data, sometimes combined with InSar and/or GPS data. The obtained rupture velocity remains inevitably affected by uncertainties, mainly due to imperfect knowledge of the earth structure and tradeoffs between different source parameters.

In this study we show how the analysis of differential ground-motion may help constraining the rupture velocity, without a priori information about the earth velocity structure. Our analysis is based on synthetic ground-motion simulations (0-2 Hz) for vertical strike-slip earthquakes propagating unilaterally at a fixed rupture velocity in a homogeneous elastic medium covered with a 1 km-thick low velocity layer (shear wave velocity equal to 1 km/s). We show that when the rupture reaches the bottom of the shallow layer, the phase velocity of transverse waves measured in the forward rupture direction up to a few rupture lengths is equal to the rupture velocity, for a large range of frequencies. The comparison with the phase velocity obtained for a point source then enables to retrieve the value of the rupture velocity. The phase velocity is simply computed from the ratio between the ground velocity and the shear strain or the rotation about a vertical axis.

This study points out the utility of setting up dense arrays at the vicinity of major faults to retrieve rupture features such as the rupture velocity.