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Limitation of slip-weakening distance estimation from near-fault seismograms

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Estimation of slip-weakening distance (Dc) is a very important issue to understand the breakdown process of the earthquake faulting. Ide and Takeo (1997, JGR) proposed a technique by reconstructing the stress distribution from the spatio-temporal distribution of slip and estimated the Dc of 0.5 -1 m for Mw6.9 Kobe earthquake. This method, however, requires very accurate slip time functions as demonstrated by Piatanesi et al. (2004, GRL). More recently, Mikumo et al. (2003, BSSA) proposed a method by using a slip-velocity function on the fault to estimate Dc. As Fukuyama et al. (2003, BSSA) noted, this method will not work properly when a very heterogeneous distribution of slip exists or the gradient of slip-weakening curve does not change sharply at its breakdown time. In addition, Dc tends to be overestimated by the band limited nature (Spudich and Guatteri, 2004, BSSA) or spatial smoothing effect (Yasuda et al., 2005 GRL). Thus there still exists a difficulty when applying this technique to the near-fault seismograms, which is a proxy of the observational fault motion. To examine the additional constraints when using near-fault seismograms, I investigated the near-fault wavefield due to 2D anit-plane / in-plane rupture propagation with constant sub-shear rupture velocity. The computation results show that the farther the station is located from the fault, the smoother the waveforms are. Thus the near-fault waveforms are the function of distance from the fault; more precisely, the pulse width is a linear function of distance from the fault. This pulse broadening effect is the main cause of the overestimation of Dc. According to Tinti et al. (2005, BSSA), Dc is mainly controlled by the ratio of the time to peak slip velocity (Tacc) to the rise time. Thus by comparing Tacc on the fault with the pulse broadening effect off the fault, we can introduce a constraint on the selection of near-fault records available for the estimation of Dc. I will present some examples of near-fault seismograms that satisfy the conditions introduced here.