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Constraining Rupture-Generator Scaling Using Measured Surface Offsets, Near-Fault Ground Motions and Rupture Dynamic Simulations

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This study shows evidence based on observations of near-fault ground motions and surface offset that regions with larger-than-average surface offset exhibit weaker ground motions for frequencies above 0.5 Hz. This negative correlation of surface offset and high-frequency ground motion is inconsistent with current scaling in kinematic rupture generators. Using rupture dynamic simulations with a linear slip-weakening rheology model combined with observed data enables us to define an input parameter space that is consistent with the observations. Given the multi-parameter nature of rupture dynamics, we focus on just two parameters: stress drop and the slip-weakening distance, D_c. Under this framework, the observed scaling can be explained if the stress drop is positively correlated with the slip-weakening distance. We explore the implications of our findings in kinematic source modeling constrained by our rupture dynamic simulations. We conclude that the ratio between the time of positive acceleration and the total rise time is negatively correlated with the total rise time, which contrasts with the current assumption of keeping this percentage fixed. Moreover, this study shows that regions with larger-than-average static stress drops tend to radiate weaker high-frequency energy and stronger low-frequency energy.