The physical basis for the source term in the non-ergodic ground motion model

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The ground motion prediction equation (GMPE) provides the intensity of ground shaking caused by a hypothetical earthquake. Traditionally, building GMPE uses the ergodic approach that assumes the statistical properties of the ground-motion parameters do not change in space. While the ergodic GMPE produces stable ground motion models globally, it suffers from significant aleatory uncertainty that can not be reduced by gaining data. This motivates the development of non-ergodic models: relaxing the ergodic assumption by considering site-, source- and path-relevant terms that used to be treated as epistemic uncertainties. Among these non-ergodic terms, the source term lacks a systematic physical explanation. In this study, we propose to associate such source terms with the dynamic stress drop. We adopt a dataset from Trugman and Shearer (2018) that contains 5297 earthquakes in the San Francisco Bay area from 2002 to 2016 with a magnitude range of M1-4. In this database, we have estimated stress drops of these earthquakes and observed peak ground accelerations (PGAs) within 100 km of those earthquakes. We develop a non-ergodic GM model using the Gaussian Process Regression(GPR) method, which is widely used for constructing non-ergodic ground motion models reflecting spatially variable source, path, and site terms. A similar algorithm is also adopted to get a non-ergodic stress drop model that considers a spatially variable mean stress-drop term to reflect the systematic stress drop variations. Our result shows that the source term of non-ergodic GMM and the stress-drop spatial term are highly correlated, implying that dynamic stress drop is the key factor in controlling the source term of the non-ergodic ground motion model. And it has the potential for further adjustment to the median ground motion in the base ergodic model by stress drop database.

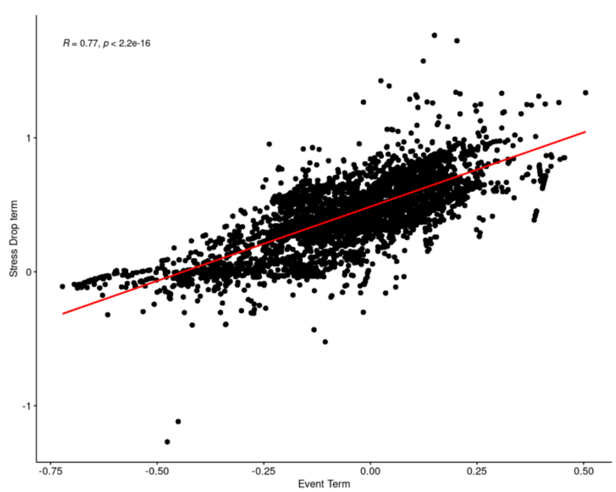

figure 1 Correlation between the source term of non-ergodic GMPE and stress-drop spatial term. The slope of the red line is 1.