Stochastic earthquake source model:

Analysis of the omega-square hypothesis

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Abstract. Recently A. Gusev suggested and numerically investigated the doubly stochastic earthquake source model. The model is supposed to demonstrate the following features for the far-field body waves:1) the omega-square high-frequency (HF) behavior of displacement spectra; 2) lack of the directivity effect in HF radiation; and 3) a stochastic nature of the HF signal component. The model involves two stochastic elements of the fractal type: the local stress drop (SD) on a fault and the rupture front (RF) with linear dominant component. The fractal property of a function is characterized by the index of fractional smoothness, $0<H<1$. We show that the omega-square behavior is achieved asymptotically in two cases: 1) RF fractal index is near to 1 and the SD index is any in the interval (0, 1). In other words, the rupture front is nearly regular (non-fractal); 2) the rupture front is linear and SD fractal index is close to zero, i.e., the local stress drop is a function of minimal smoothness. The situation with the directivity effect is more complicated: for different RF models with the same fractal index, the effect may or may not hold. The nature of the phenomenon is purely analytical and is due to the smoothness degree of 2-D distributions of the random RF function. For this reason the directivity effect in the framework of the doubly stochastic earthquake source model is unstable.