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Physical model of the omega-square model

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We investigate the physics of the "omega-square model" using realistic models.. First, we adopt a realistic slip velocity model by referring the model proposed by Miyatake (1998). Second, we consider locally variable rupture velocities, by introducing fluctuations from the average rupture time. Considering unilateral source models, we obtained the following results; 1) The amplitude spectra of the slip velocities are proportional to the inverses of frequencies up to fmax, and, 2) the amplitude spectra due to the integration on fault planes are proportional to the inverses of frequencies. Since the products of Results 1 and 2 give the source spectra, those spectra are omega-squares.

Recently, Herrero and Bernard (1994), and Bernard et.al.(1996) proposed the "k-square" model in order to explain the physics of the "omega-square model (Aki, 1967)". The conditions of the k-square model are as follows, under the assumptions that (a) the rupture velocities are constant, and (b) the slip distributions are proportional to square inverses of wave-numbers;

1. the amplitude spectra of slip velocity functions are constant with frequencies, and,
2. the amplitude spectra due to the integration on fault planes are proportional to the square inverses of frequencies,

To satisfy Condition 1, Herrero and Bernard (1994) used the step functions as slip functions, and later, Bernard et. al.(1996) adopted the slip functions with the scale-dependent rise times, where the rise times are assumed to be proportional to the inverses of frequencies. However, the ramp functions, they adopted, are not physically realistic, especially at high frequencies, because the amplitudes of their accelerations are infinite. In addition, the constant rupture velocities in Condition 2 are not realistic either. As shown in the barrier model (Das and Aki, 1977), locally variable rupture velocities are natural, and that is one of the most important parameters to explain the excitation of high-frequency waves (e.g., Hisada, 1998).

Therefore, we investigate the physics of the "omega-square model" using more realistic models in this study. First, we adopt a realistic slip velocity model by referring the model proposed by Miyatake (1998), which is based on the results from laboratory tests and dynamic source models. Second, we consider locally variable rupture velocities, by introducing fluctuations from the average rupture time. Considering unilateral source models, we obtained the following results;

1. The amplitude spectra of the slip velocities are proportional to the inverses of frequencies up to fmax, and,
2. the amplitude spectra due to the integration on fault planes are proportional to the inverses of frequencies.

Since the products of Results 1 and 2 give the source spectra, those spectra show omega-squares. In addition, the static slip distributions (k-square, and k-inverse) are less important to the source spectra than the fluctuations of rupture time, especially at high frequencies..