Introduction of forward scattering model into the Numerical Shake Prediction scheme

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A real-time ground motion prediction scheme based on a real-time monitoring of current wavefield (e.g., Hoshiba, 2013) is one of the promising approaches for an earthquake early warning (EEW) purpose. Hoshiba and Aoki (2015) implemented the idea and proposed the Numerical Shake Prediction scheme for the EEW. Hoshiba and Aoki (2015) adopted a radiative transfer theory in 2D space based on an isotropic scattering model for the prediction of future ground motion. The isotropic scattering model is suitable for the development of coda waves, however, it cannot represent an envelope broadening effect of the direct waves. The radiative transfer theory with non-isotropic (forward) scattering coefficients can model full seismogram envelopes (e.g., Wegler et al., 2006). In this study, we introduce a forward scattering model into the Numerical Shake Prediction scheme and investigate how the scattering model affects the ground motion prediction.

To introduce the forward scattering effect in the radiative transfer theory, we assume 2D exponential-type random media where the correlation distance is 1 km and the root-mean-square of the fractional random fluctuation is 0.05, then calculate non-isotropic scattering coefficients based on the Born approximation.

We compare the prediction results based on the non-isotropic scattering model with those based on the isotopic scattering model (Ogiso et al., 2018). Although the forward scattering model yields slightly larger residuals in maximum seismic intensity prediction than the isotropic scattering model, the forward scattering model results in smaller prediction residuals in whole seismogram envelope than the isotropic scattering model. The forward scattering model improves the prediction residuals, especially in the coda part. When we adopt momentum transfer scattering coefficient of the 2D random media as the scattering coefficient of isotropic scattering model, envelope prediction of the coda part is similar to that by the forward scattering model, however, residuals of maximum seismic intensity in isotropic scattering model become larger than the forward scattering model. Hence, we conclude that only the forward scattering model has a possibility to predict whole seismogram envelopes in the Numerical Shake Prediction scheme.

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