Numerical Shake Prediction for Earthquake Early Warning: Introduction of attenuation relation consistent with empirical GMPEs

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Numerical Shake Prediction proposed by Hoshiba and Aoki (2015) is a promising method for prediction of ground shaking. The method is different from conventional methods of Earthquake Early Warning, source information such as hypocenter location and magnitude is not required. Instead current wavefield of ground motion is estimated using data assimilation technique and then future wavefield is prediction using simulation of seismic wave propagation: the basic idea is the same as that used in Numerical Weather Prediction is meteorology.
Although Numerical Shake Prediction enabled more precise prediction than the conventional methods for near future (that is, near target location), it does not necessarily so for distant future (far location) because 2D space was used for simulation of seismic energy propagation in Hoshiba and Aoki (2015): attenuation of seismic energy (~amplitude^2) is proportional to (distance)$^{-1}$ in 2D, and (distance)$^{-2}$ in 3D. In many empirical Ground Motion Prediction Equations (GMPEs), the attenuation relation is between (distance)$^{-1}$ and (distance)$^{-2}$ for seismic energy propagation. For sample, -1.72 power is used for the Earthquake Early Warning of JMA. Introduction of 3D space into the simulation is not so difficult, but seismic observation is usually limited to the ground surface (2D) in which the data assimilation is applicable only at near ground surface.
To overcome the difference between 2D and 3D space, and realize virtually the arbitrary attenuation relation between (-1) and (-2), we introduce an adjust parameter in the seismic energy attenuation, which enables the prediction to be consistent with attention relation of the empirical GMPEs. It makes the prediction to be more precise even for distant future.
We will show results of predictions of the attenuation relation using crustal earthquakes such as the 2004 Mid-Niigata Earthquake and the 2016 Kumamoto earthquakes.

Keywords: prediction of seimic ground motion, earthquake early warning, GMPE

