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Real-time prediction of earthquake ground motion -application of data assimilation and its application to actual data-

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Aiming at improvement of prediction of seismic intensity in Earthquake Early Warning, we are investigating a new technique for real-time prediction of earthquake ground motion. We have proposed to use data assimilation technique for estimation of current wavefield of ground motion, and then predict future wavefield based on physics of wave propagation. In this presentation, we will show examples of application of the technique to the actual data, such as those from the 2011 Tohoku earthquake and the 2004 Mid-Niigata earthquake.

In the proposed technique, estimation of current wavefield is important. We correct site amplification factors using recursive filtering (Aoki and Hoshiba, 2014), apply band pass filter which is used for JMA seismic intensity (Kunugi et al., 2008), and then estimate envelope of 3-component vector summation of the filtered waveforms. We apply the data assimilation technique to the envelope and then estimate the spatial distribution of strength and propagation direction of ground motion.

The strength and the propagation direction are used as an initial condition, and then wave propagation is calculated. In this presentation, as the physics of wave propagation we will use Radiative Transfer Theory in which wave propagation is simulated by energy propagation based on high frequency approximation. The theory has been used for interpretation of seismogram envelope. We will indicate examples of predictions of 10 and 20s in this presentation.

For application to the 2011 Tohoku earthquake, this method reproduces the strong ground motion which were generated from multiple SMGA, and then propagated into many directions. Strong ground motion, generated at off Fukushima much later than the earthquake origin time, propagated into Kanto region, and then around Kofu and Nagoya. The prediction of 10 and 20s reflects the spatial distribution. In the conventional method based on hypocentral location and magnitude, it was not easy to predict the ground motion for the case of the late rupture.

For case of the 2004 Mid-Niigata earthquake, this method reproduces propagation of strong ground motion from repeated aftershocks. Especially at around epicenter region, strong ground motion repeatedly arrived even when the motion of earlier events still large. In the conventional method, the case of the repeated occurrence of aftershocks was not easy.

The proposed method is expected to be useful for improvement of prediction of seismic intensity in Earthquake Early Warning.

Keywords: Earthquake Early Warning, Data assimilation, Prediction of ground motion, Radiative transfer theory, 2011 Tohoku earthquake