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Real-time prediction of earthquake ground motion :application of data assimilation technique for estimation of wavefield

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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. In this presentation, I will explain the application of data assimilation technique for estimation of current wavefield of ground motion.

In the present EEW of JMA, at first hypocentral location and magnitude, M, are quickly estimated, and then seismic intensity is predicted from the hypocentral location and M. In this method, it is not easy to take into account the effect of extension of source region, and the error of hypocentral and M determination leads directly to the error of the prediction. When multiple earthquakes occurred simultaneously as is the case of aftershocks of the Tohoku Earthquake(M9.0), it is not easy to determine the hypocentral location correctly. For addressing these problems, new method for real-time prediction of ground motion is proposed, in which ground motion is predicted directly from the estimated current wavefield, skipping the process of hypocentral location and M. The boundary integral equation method (Kirchhoff integral) is applied. In the presentation, I will explain the application of data assimilation technique for estimation of current wavefield of ground motion.

Determination of detailed distribution of current wave motion is a key for the method, so that dense seismic observation network is required. Data assimilation is a technique to produce artificially denser network, which is widely used for numerical weather prediction and oceanography. Distribution of current wave motion is estimated from not only the current real observation of u(x, t), but also the prediction of one step before, P(u(x, t-delta_t)). Combination of them produces denser artificial network than the real one. Simulations of the case of large source extent, and the case where multiple earthquakes occurred simultaneously are performed to check the availability of the data assimilation technique.

Combination of the data assimilation technique with the boundary integral equation method and real time correction method of site amplification factors enables us to predict earthquake ground motion more precisely.

Keywords: Earthquake Early Warning, Real-time prediction of ground motion, data assimilation