The limits of effective earthquake early warning by estimating Mw: From viewpoint of real-time prediction of strong motion

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he subject of earthquake early warning, EEW, is to provide advance alert of impending strong motion, and real-time prediction of strong motion is a key technique in it. Many methods are based on a strategy of precise and rapid estimation of source information, such as hypocenter and radiation strength of seismic waves, and then strength of ground motion is predicted on GMPE. Many methods use moment magnitude (Mw) as an index as the radiation strength. Here a question arises: is Mw so effective for the real-time prediction of ground motion for EEW?

The frequency range which causes damage is usually between several Hz to several seconds, that is, about 1Hz, so that this relatively high frequency range is most important for EEW. On the other hand, Mw is estimated from lower frequency. Even if Mw of two earthquakes is the same, radiation strengths of high frequency may be different because of the different stress drop. This indicates that precise estimation of Mw does not necessarily means the precise estimation of radiation of the strong motion.

Analyses of the 2011 Tohoku earthquake and other recent M9 earthquakes indicated that large slip and strong motion generation areas were different. This means that estimation of source areas of low frequency does not necessarily means those of 1 Hz.

Recently Minson et al.(2018) showed that in the near-fault region strong motion arrivals are often earlier than the estimation of Mw even when growth of Mw can be monitored. Because growth of Mw monotonically increases with time, Mw becomes maximum at the end of rupture. Accordingly, prediction of strong ground motion also monotonically increases on GMPE and reaches the maximum at the end of rupture. On the other hand, strong motions generate before the end of rupture. Strong motions generation is earlier than the prediction on GMPE using Mw.

Mw is not a good parameter to represent the high frequency generation. Mw is regarded as an indirect evidence for real-time prediction of ground motion for EEW. For effective EEW, monitor of high frequency (~1Hz) gives more direct evidences for real-time prediction of strong motion.

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