Installed New Methods and Future Prospects of Earthquake Early Warning by Japan Meteorological Agency

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Japan Meteorological Agency (JMA) started Earthquake Early Warning (EEW) in October 2007. While JMA operates EEW, JMA has faced mainly two problems. The first problem is an overestimation caused by concurrent earthquakes being regarded as one big earthquake. In order to properly divide them, the integrated particle filter method (IPF method) (Tamaribuchi et al., 2014) was installed in EEW in December 2016. The IPF method is an advanced point-source-model approach which uses the Bayesian estimation framework to determine sources. The second problem is an underestimation in a large earthquake. In the 2011 off the Pacific coast of Tohoku Earthquake, the estimated magnitude of issued EEW was 8.1 that was smaller than the conclusive magnitude of 9.0, which caused the underestimation of seismic intensities. To solve the problem, propagation of local undamped motion method (PLUM method) (Kodera et al., 2018) started in March 2018. The PLUM method is a simple wavefield-estimation approach that predicts seismic intensities directly from observed real-time seismic intensities near target sites.

From March 2018 EEW combines these two methods, IPF method and PLUM method, by taking the maximum of both predictions. In the case of the earthquake in Osaka-Fu Hokubu on 18 June 2018 (M6.1), EEW was issued based on a prediction of the IPF method. The predicted seismic intensities were close to observed ones and the differences fell within the range of plus minus one seismic intensity scale. In the 2018 Hokkaido Eastern Iburi Earthquake (M6.7) the prediction of the PLUM method became a cause of issuing EEW. The predicted seismic intensities of point-source-model approach were smaller than those of the PLUM method. The PLUM method could estimate higher seismic intensities by using higher real-time seismic intensities observed in the western area of the source.

JMA will apply ocean bottom seismometers (OBS) for EEW, such as the Seafloor Observation Network for Earthquake and Tsunami along the Japan Trench (S-net) (Kanazawa, 2013) which has a dense observation network. When trying to utilize OBS, there is a problem that a magnitude calculated from data of OBS near a source tends to be overestimated. JMA plans to solve the problem by not using larger magnitudes of stations near a source. Although several OBS data are not used, the delay of EEW is shorter in a dense OBS network and the negative impact is smaller than not using stations on the ground.