How to improve earthquake early warning for multiple simultaneous earthquakes: example of January 5 2018 event

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Earthquake early warning (EEW) has been provided to public since 2007 October in Japan. In December 2016, a new algorithm was implemented by the Japan meteorological agency (JMA) to avoid false alarms due to multiple simultaneous earthquakes: integrated particle filter (IPF) method. The method was designed for detecting multiple simultaneous aftershocks properly after the 2011 off the Pacific coast of Tohoku earthquake which caused more than 40 false alarms in 2 months.

On January 5, 2018, the EEW issued an inappropriate warning to Ibaraki Prefecture, for the first time after the new algorithm was implemented. There was a non-damaging earthquake in Toyama prefecture (Mj 4.0) and 3 seconds later, another earthquake occurred off the Ibaraki prefecture (Mj 4.5). The earthquake early warning could not classify these two events, and estimated a large magnitude (Mj 6.4) from the amplitudes of the seismic station in Ibaraki and source location in Toyama.

We performed the simulation of EEW by using Hi-net (775 stations) and JMA strong motion data (308 stations) with IPF method. We found that the two events are far enough in time and space to be separated by the method. The simplest solution to avoid the inappropriate warning is to use amplitude of near-source stations. Another issues of these events are the location estimate was poor for the Ibaraki event, since it was offshore event. It is more critical if we use only JMA data, as done in the current JMA EEW system. If we merge two networks and process them in a single method, a more accurate and faster warning can be provided.

The condition to separate two events was also reevaluated. An EEW algorithm should classify two different events if they are far enough in time and space, but it should not split a single earthquake, even the uncertainty of the location estimation is large. We are using variance of P-wave arrival time and displacement amplitude for the splitting condition. We re-evaluated these parameters and the source estimates became better in the severe conditions such as offshore earthquakes and deep earthquakes.

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