Application of the Japanese Earthquake Early Warning Method (IPF method) to the 2018 Hualien earthquake in Taiwan

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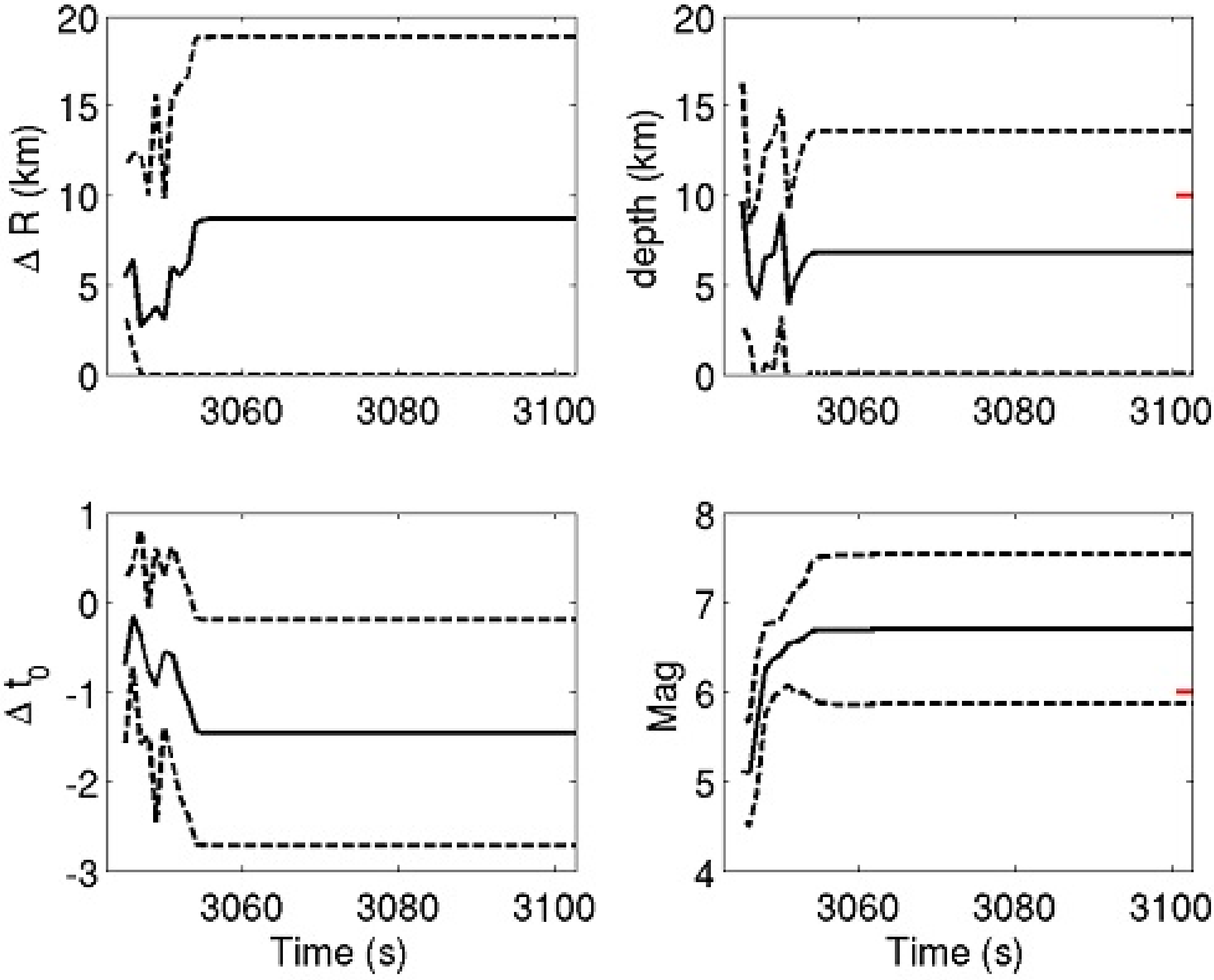
In Japan, earthquake early warning has been issued to public people since 2007 October. During the 2011 Tohoku earthquake, 44 false warnings (i.e., the largest expected seismic intensities were overestimated by at least two intensities or larger) were issued in a month, due to a large number of aftershocks (Sagiya et al., 2011).

The IPF method was developed in order to classify multiple earthquakes occurred at the same time (Liu and Yamada, 2014; Tamaribuchi et al., 2014; Yamada et al., 2014; Wu et al., 2015). Classical hypocenter determination method treats the P-wave arrivals of multiple stations within a certain short period of time as a single earthquake. Therefore, it becomes unreliable in the case of multi-event, because of the mixed waveforms from different sources. The IPF method uses Bayesian formulation that considers the possibility of having more than one event present at any given time, by using a likelihood function including the information of amplitude and non-triggered stations. The method has an advantage to determine the source location of multiple earthquakes occurred simultaneously. The method is effective especially right after a large earthquake, when many aftershocks occur closely in time and space.

We applied the IPF method used for the Japanese earthquake early warning system to the dataset of the 2018 Hualien earthquake in Taiwan. Figure shows the time series of the estimated source parameters (location error, depth, origin time, and magnitude). Note that the left side of the horizontal axis is the occurrence time of the earthquake. We assume there is no data transmission latency. At 3 s after the earthquake occurrence, the three stations were triggered and the event was detected. The location error is less than 10 km, but the magnitude was estimated as 5.1. The magnitude increased as the rupture propagated and the amplitude of the seismic signal became larger. The estimation was converged at 13 s after the origin time.

The offline simulation shows that we can detect the mainshock at 3 s after the origin time, and the magnitude is estimated as 6.3 at 7s after the origin time. The largest foreshock was detected at 4 s after the origin time, but the following M_l5.2 earthquake was not detected, since the P-was arrival was contaminated by the coda of the first event. The result shows that the IPF method can be applicable for the Taiwanese seismic network.



Time series of the estimated source parameters.
Origin time is 15:00 on February 6