拡張IPF法(IPFx法)を利用した2018年台湾花蓮地震の自動即時震源決定

Automatic Hypocenter Determination with the IPFx method for the 2018 Hualien earthquake sequence

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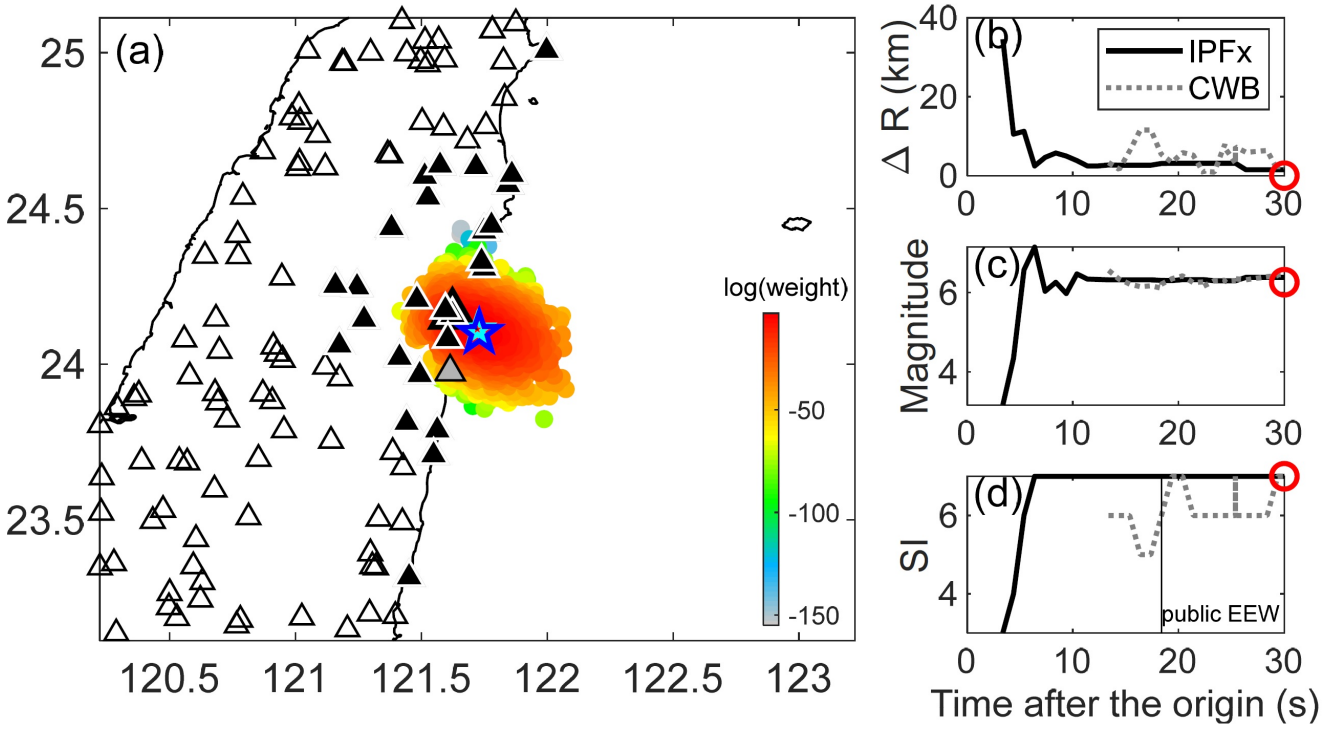
The extended integrated particle filter (IPFx) method is an automatic source determination algorithm designed for the Japanese earthquake early warning (EEW) system. The method improved earthquake source determination during active seismicity by incorporating the smart phase association scheme. We applied this method to the 2018 Hualien earthquake sequence and evaluated its performance by comparing it to the manual catalog.

We used 1-month continuous waveforms from February 2018 at 170 stations. Owing to the higher noise level, we improved the phase association algorithm to avoid noise contamination. The IPFx method detected the Hualien mainshock 9 s faster than the CWB EEW system and would have provided the warning 12 s earlier (Figure 1).

The detectability of the IPFx method was sufficient for use in EEW. Out of 127 earthquakes with a seismic intensity 4, 105 were successfully detected in one month, of which 103 had good accuracy with a location error of <30 km. Earthquakes in the manual catalog with magnitude 5 were mostly detected, while earthquakes with a magnitude between 2 and 5 were missed if they occurred immediately after large earthquakes. Except for the earthquakes with an interval <5 s, the detectability of the IPFx method agrees with the CWB manual catalog. The method was also applied to the 1-day continuous data on April 18, 2021, and detected 14 earthquakes with a magnitude ~2 that were not on the manual catalog.

Currently, the Central Weather Bureau in Taiwan uses the effective epicenter method to locate earthquakes for the EEW system. However, source determination for offshore events is difficult as most of the stations are on land. We expect the IPFx method to provide better location estimates for offshore earthquakes and during the period of active seismicity. It also provides an earlier warning as it sends the first message when three stations are triggered. This new method can potentially improve the speed and accuracy of the Taiwanese EEW system.


(a)
25
24.5
24
23.5
120.5
121
121.5
122
122.5
123
log(weight)
-50
-100
-150
(b)
IPFx
CWB
Δ R (km)
40
20
0
0
10
20
30
(c)
Magnitude
6
4
(d)
SI
public EEW
Time after the origin (s)