Automatic hypocenter location for REIS in cases of more than two earthquakes occurrence at the same time (2)

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We are engaging in the study developing REIS (Real-Time Earthquake Information System), which detects the occurrence of large earthquakes and determines source parameters within 3-5 seconds from P-wave arrivals to the closest station by using real-time seismic data of High Sensitivity Seismograph Network (Hi-net) and Kanto-Tokai observation network in Japan. Although it can determine reliable hypocenters for most events, there are a few % of un-correctly processed events mainly owing to the occurrence of some small events. We revised the software so that it can process correctly even at the time of two events occurrence.

Firstly, we search for erroneous readings as follow. Assuming the P wave travel time to be approximated by that of the plane wave, we calculate travel time residuals for all readings by determining apparent velocity and arrival direction of the plane wave, which can be easily calculated without the knowledge of the hypocenter location, at each station with using it nearby stations but not using it. We removed readings having large residuals. Next we carried out the calculation of the ordinary hypocenter location. When no converged solution is obtained, we think that two events occur simultaneously and determine the station closest to one of the hypocenter by searching for stations with minimum P-wave arrival times. Then, we calculate the hypocenter by using only its nearby stations. Next we add arrival time readings consistent with the calculated hypocenter. The hypocenter for the other event is calculated by using readings not used in the first hypocenter location.

A numerical test of the new method was conducted by generating artificial travel time data for 100 sets of two events. We put one hypocenter at (36.0N, 140.0E, 10 km) and 10 x 10 locations around it for the other event with 0.5 degrees intervals. Two sets of hypocenters are correctly determined except for five events, whose hypocenters are beneath the sea and their arrival times become nearly same with the other,

Next, we generate two events simultaneously by using actual waveform data for two events and tested the method. First test was for the foreshock-mainshock type. We use waveform data for an event at Southern Ibaraki at depths of 45 km. Foreshock of M2.0 is generated 15 sec before the main shock of M5.5. The new method determined two events separately. Second test was for the two simultaneous occurrences of two earthquakes at distant places. Two events are at Aomori and Hiroshima and magnitude of 3.0 for each. The new method could calculate two events simultaneously. These results show the new method to be very effective.