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Improvement of MT/CMT analyses in the AQUA (Accurate and QUick Analysis System for Source Parameters) system

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Quick determination of hypocentral parameters and its transmission to the public are very valuable in the viewoint of disaster mitigation. We have operated an automatic system called the Accurate and QUick Analysis System for Source Parameters (AQUA system) since 2005 (Matsumura et al., 2006). In this system, the moment tensor (MT) and centroind moment tensor (CMT) solutions have been automatically estimated after determination of an initial hypocenter. However, after the 2011 Off the Pacific coast of Tohoku Earthquake, several limitations have been recognized. So, we improved the AQUA system to solve these problems.

The AQUA system could not determine the MT/CMT solutions of the 2011 Off the Pacific coast of Tohoku Earthquake. This is because NIED F-net broadband seismometers were saturated due to large amplitude excited from this earthquake. Furthremore, size of the initial hypocenter was underestimated at the initial stage of rupture process due to short processing time. On the other hand, numerous aftershocks occurred around the outer rise far from the inland seismographic network. Their initial hypocentral depths have large uncertainties and their MT/CMT solutions were not determined accurately.

To solve these problems, we used records from NIED F-net velocity type strong motion seismograph. These types of seismographs provide unsaturated records not only for the mainshock, but also for M>7 earthquakes at closer stations. In the AQUA system, proper parameters are selected according to event size and MT/CMT analyses are repeated at larger stage when larger size is estimated at some stage. We increased maximum number of this repetition of analysis from 1 to 10. We modified parameters such as search range of centroid time, to analyze M9-class earthquake accurately. We used 0.005-0.02 Hz records for M>8 earthquakes, in contrast to 0.01-0.05 Hz records in the original system. We broadened search range of centroid depth for earthquakes far from the seismographic network to process aftershocks around the outer rise.

After above improvement, we re-analyzed the mainshock with the M5-class initial hypocenter and obtained result with moment magnitude Mw of 8.6 after repetition of analyses at each stage. We also re-analyzed M>7 aftershocks. Comparing these results with GlobalCMT (Global CMT Web Page), focal mechanisms, sizes, and centroid depths show good coincidence. Sizes are consistent with those of GlobalCMT within Mw difference of 0.1 except the mainshock. However, difference is large for the mainshock compared to Mw9.1 of GlobalCMT. This might be because a passband of analysis is not adequate for an M9-class earthquake. So, we used 0.0025-0.01 Hz records and obtained result of Mw8.9. This result shows good coincidence with GlobalCMT (Mw9.1) and other results (e.g., Ozawa et al., 2011; Suzuki et al., 2011; Mw9.0). Further improvement is necessary to shorten analyzing time.

Keywords: Centroid moment tensor, Earthquake Early Warning, the 2011 Off the Pacific coast of Tohoku earthquake, outer rise earthquake