Real-Time GNSS Positioning System REGARD for Rapid Earthquake Moment Estimates

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Key words: GNSS/GPS; Earthquake; Tsunami; Early warning

SUMMARY

Recent rapid advances in earthquake early warning (EEW) have been achieving great improvements in promptness and reliability of EEW. The further improvements involve a prevention of a saturation problem in estimating moment magnitudes (Mw) for large earthquakes, especially those of Mw larger than eight. The saturation can also result in an underestimation of following tsunami forecasts. GNSS real-time kinematic positioning technique has enabled rapid detection of coseismic crustal deformation and estimation of a finite fault model for a large earthquake without any saturation. Such advantage of finite fault modeling can resolve the weakness of current EEW system, which experienced the saturation at the 2011 off the Pacific coast of Tohoku Earthquake.

A new real-time fault modeling system based on GNSS Earth Observation Network (GEONET) is collaboratively developed by Geospatial Information Authority of Japan (GSI) and Tohoku University. The new system consists of real-time GNSS positioning, automatic detection of earthquake events, and quasi real-time finite fault model inversion routines. The tests of the system for past three large earthquakes with Mw larger than eight, which includes the 2011 off the Pacific coast of Tohoku Earthquake, demonstrate that the system stably estimates appropriate moment magnitudes within three minutes. Furthermore, the Mw estimates are not saturated for all the cases. Therefore, the Mw estimate with GNSS augmentation employed in such a system should be utilized for improving an initial Mw estimate for better tsunami forecasts. The authors believe that the system would be one of the realizations of the 2015 International Union of Geodesy and Geophysics (IUGG) resolution No. 4.