Real-time Earthquake Magnitude Estimation by Real-time GNSS positioning: the development of GEONET real-time processing system, REGARD

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The displacement data produced by GNSS observations never saturate for large earthquakes in contrast to seismometer data that has a limitation of instrument saturation. Recently, many researches recommends to utilize GNSS real-time kinematic analysis for rapid real-time earthquake magnitude estimations that improve tsunami forecasts (e.g., Blewitt et al., 2009; Ohta et al., 2012). This fact actively forward GNSS real-time analysis for disaster preventions after the 2011 Tohoku Earthquake. For example, READI project has started in western U.S. by a team of several universities and agencies which operate GNSS network to advance tsunami forecasts. The International Union of Geodesy and Geophysics 2015 resolved to engage with IUGG member states to promote a GNSS augmentation to the tsunami warning systems. Geospatial Information Authority of Japan, which operates Japan's national GNSS network GEONET including ~1300 sites, has also launched a project to develop a system that estimates earthquake fault model rapidly using GNSS data in collaboration with the Tohoku University. The system is named REGARD: Real-time GEONET Analysis system for Rapid Deformation monitoring.
In this paper, we show the overview of REGARD and assess the performance of REGARD for the previous large earthquakes. We used the data of four previous large earthquakes occurred on plate boundaries around Japan: 2003 Tokachi-oki earthquake, 2011 Tohoku earthquake and the largest after shock, Ibaraki-oki earthquake. The simulation data of the 1707 Hoei type Nankai trough earthquake (Todoriki, 2013) was also used. The Mw estimates with high variance reductions > 90 % were derived for all the earthquakes within 3 minutes. It is noteworthy that the Mw 8.83 was estimated for the 2011 Tohoku earthquake by 3 minutes without saturations. The performance assessment of REGARD confirmed that the real-time GNSS analysis is very powerful to estimate reliable Mw for large earthquakes with M > 8 rapidly. Future work will involve the improvement of GNSS analysis with multi-GNSS, PPP, etc. to provide more stable fault models.

Keywords: RTK GNSS, Real-time fault model estimation, GNSS seismology

