REGARD: GNSS-based rapid finite fault modeling system

*Satoshi Kawamoto[1], Yohei Hiyama[1], Satoshi Abe[1], Naofumi Takamatsu[1], Yusaku Ohta[2], Takuya NISHIMURA[3], Masaru Todoriki[4]

1. Geospatial Information Authority of Japan, 2. Graduate School of Science, Tohoku University, 3. Disaster Prevention Research Institute Kyoto University, 4. Fujitsu Laboratories LTD.

We present a newly developed real-time GNSS system REGARD (the Real-time GEONET Analysis system for Rapid Deformation monitoring), which estimates single rectangular fault and slip distribution models within 3 minutes. The new system is part of the GNSS Earth Observation Network (GEONET) operated by Geospatial Information Authority of Japan, and it was developed in collaboration with Graduate School of Science, Tohoku University.

The REGARD system consists of real-time GNSS positioning, automatic detection of coseismic displacements by seismic events, and quasi real-time finite fault model inversion. The real-time data from the GEONET stations are processed by the RTKLIB (Takasu, 2013) and GSILIB (GSI, 2015) softwares. Then, the displacement time-series are monitored by RAPiD algorithm (Ohta et al., 2012) to detect earthquake events. If an early earthquake warning with $M > 7$ is issued and/or the displacement more than 10 cm occurred at neighboring 3 stations, the finite fault models are estimated from the coseismic displacement field.

The performance of the automatic inversions of the finite fault models is examined by using real raw GNSS data of the past large earthquakes : the 2003 Tokachi-oki earthquake (moment magnitude (M_w) 8.3), the 2011 Tohoku earthquake (M_w 9.0), and the 2011 off Ibaraki earthquake (M_w 7.7). A simulated 1707 Hoei-type Nankai Trough earthquake (M_w 8.7) is also tested. The Mw estimates with high variance reductions > 90 % were derived for all the earthquakes within 3 minutes. It is noteworthy that the M_w 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.

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