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Real-time Earthquake Magnitude Estimation by the GEONET real-time processing system: REGARD

KAWAMOTO, Satoshi[1*] ; MIYAGAWA, Kohei[1] ; SATO, Yudai[1] ; NISHIMURA, Takuya[2] ; OHTA, Yusaku[3] ; HINO, Ryota[3] ; MIURA, Satoshi[3] ; TODORIKI, Masaru[4]

[1]Geospatial Information Authority of Japan, [2]Disaster Prevention Research Institute Kyoto University, [3]Graduate School of Science, Tohoku University, [4]The University of Tokyo Interfaculty Initiative in Information Studies

The recent development of Global Navigation Satellite Systems (GNSS) and communication infrastructures provides real-time displacement data. The data enables the real-time estimation of coseismic fault model for large earthquake, which is free from the saturation problem found for seismic data. The obtained moment magnitude (Mw) constrains the size of a subsequent tsunami, thus it potentially improves tsunami warning systems that rely only on the seismic data.

Geospatial Information Authority of Japan (GSI) and Tohoku University have jointly developed a real-time analysis system in the Japan's national GNSS network, GEONET: the Real-time GEONET Analysis system for Rapid Deformation monitoring (REGARD). The goal is to estimate the magnitude and finite fault models for large earthquake in real-time. Currently the system involves about 1300 GNSS stations, RAPiD algorithm (Ohta et al., 2012) for automatic event detections, and two real-time fault modeling routines: a single rectangular fault modeling routine and a slip distribution fault modeling routine.

We evaluate the two fault modeling procedures for the 2003 Tokachi-oki earthquake, the 2011 Tohoku earthquake and the 1707 Hoei type Nankai trough earthquake in the real-time situations. The real-time waveform data for the Nankai trough earthquake are based on the simulation (Todoriki et al., 2013). Furthermore, we also evaluate the past large earthquakes using the published finite fault models (Sato et al., 1989) and the maximum class tsunamigenic earthquake models used to predict the potential tsunami inundation area in each prefecture.

Both routines gave magnitudes with high variance reduction for the 2003 Tokachi-oki earthquake and the 2011 Tohoku earthquake within 3 minutes. However, only the slip distribution model provided reasonable magnitude for the simulated Nankai trough earthquake. On the other hand, the single rectangular fault modeling routine was unstable to model the Nankai trough earthquakes. This implies the fault rupture is too heterogenic to approximate with a single rectangular fault for the future Nankai trough earthquake, and should adopt the slip distribution for the robustness.

Keywords: GEONET, Real-time analysis, RTK-GPS, Fault model inversion