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Real-time coseismic fault model estimation based on RTK-GNSS analysis for rapid tsunami simulations

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Displacement data produced by GNSS observations never saturate for large tsunamigenic earthquakes in contrast to seismometer data that has a limitation of instrument saturation. Geospatial Information Authority of Japan has launched a real-time GNSS analysis system named "REGARD" which estimates finite fault models based on the Japanese nationwide GNSS network GEONET. The REGARD system is designed to provide finite fault models including single rectangular fault and slip distribution models in a few minutes.

The system is comprised of three subsystems: (1) Real-time positioning subsystem, (2) Event detection subsystem, and (3) Fault model inversion subsystem. The real-time 1 Hz data from the GEONET stations are analyzed by Real-time positioning subsystem using RTKLIB 2.4.2 software (Takasu, 2013) as the positioning engine. The processed time-series data are monitored by Event detection subsystem to detect earthquake events. EEW messages are also checked for complement of much noisier GNSS data. Once an earthquake event is detected, Fault model inversion subsystem is launched and finite fault models are estimated automatically. The finite fault models include single rectangular fault model, which is applicable to both inland and subduction zone earthquakes, and slip distribution model, which is particularly suitable for large subduction zone earthquakes.
The REGARD system has been in operation since April, 2016. The REGARD system is processing ∼1,200 stations of GEONET. In this presentation, we introduce an overview of the system design and show the test results for the cases of the 2011 Tohoku earthquake (Mw 9.0) and a simulated Nankai Trough earthquake (Mw 8.7). Furthermore, an operational real-time result for the 2016 Kumamoto earthquake (Mj 7.3) is also shown.

The test results showed that reliable finite fault models for the earthquakes could be provided within 3 mintues for rapid tsunami simulations. The result for the 2016 Kumamoto earthquake (Mj 7.3) showed single rectangular fault models with VR of 96.2%, demonstrating the capability for modeling inland earthquakes. These results imply the possibility of improvements in tsunami simulations or hazard information using rapid finite fault models.