REGARD: Real-time Crustal Deformation Monitoring based on GNSS data in Japan and its Performance for 2024 Noto Earthquake

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GNSS continuous observation enables us to rapidly estimate a finite fault model for a large earthquake without magnitude saturation. Geospatial Information Authority of Japan (GSI) operates a dense and nationwide GNSS continuous observation network named GEONET, which can provide 1Hz displacement time series in real-time. After the gigantic 2011 Tohoku-Oki earthquake, GSI, in collaboration with Tohoku University, launched REGARD (REal-time GEONET Analysis system for Rapid Deformation monitoring), which offers a finite fault model based on the real-time displacement data observed by GEONET. The REGARD system has successfully provided information on the coseismic displacement and finite fault model for recent M~7 or larger earthquakes. These results are provided to relevant agencies within a few minutes of an earthquake and are utilized for their initial response and tsunami prediction.

In the M7.6 earthquake that hit the Noto peninsula, the central part of Japan, on January 1st, 2024, REGARD successfully estimated crustal deformation over a wide area in and around the Noto peninsula. The information was automatically provided to relevant agencies approximately 10 minutes after the origin time. Moreover, the system successfully estimated a single rectangular fault model, the reverse type of fault model with a northeast-southwest strike direction four minutes after the origin time. The obtained model is roughly consistent with the post-processed model except for dip angle, and the model was provided to the relevant agencies successfully.

Two significant updates are ongoing to increase the capability and reliability of REGARD: the utilization of real-time PPP (Precise point positioning) and MCMC-based single rectangular fault model estimation. The PPP can improve the robustness of real-time positioning in REGARD due to the nature of positioning without a reference station. Meanwhile, MCMC-based fault model estimation offers more realistic uncertainty information on the fault model, which widens the capability of subsequent applications such as tsunami prediction. We will continue to provide more reliable information for the large earthquake through these improvements.