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Development of prototype to estimate a fault model using real-time GPS data

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Real-time GPS can detect coseismic eternal-persisting displacement (i.e. crustal deformation) just after the earthquake occurrence. Several authors proposed that it was useful for accurate estimation of earthquake magnitude for giant or tsunami earthquakes. It must be also useful to estimate the focal area ruptured by an earthquake. Because many earthquakes of reverse-fault type occur in inland of Japan, the focal area often corresponds to a heavily damaged area. In order to evaluate an application of real-time GPS to an early assessment of an earthquake hazard, we developed prototype to estimate a fault model using real-time GEONET data.

The data of the most GEONET stations with 1 second sampling are transmitted to GSI in real time. The prototype has a capacity to estimate instantaneous coordinates of 60 GEONET stations using RTD software, simultaneously. At the present, it monitors the GEONET stations selected in the southern Kanto area. Sidereal filtering for the instantaneous coordinates can be applied. When the Earthquake Early Warning is issued by the Japan Meteorological Agency, the prototype automatically calculates coordinate offsets before and after the earthquake. And then it estimates parameters of a rectangular fault buried in an elastic half-space. The estimation is finished within 20 minutes after the earthquake occurrence. The result of the coseismic displacement and the fault model can be viewed by a web browser in the institution. There is no chance to certify a practical usefulness because no earthquake that is large enough to cause significant crustal deformation. However, post-processing analyses for the past earthquake data including the 2007 M6.8 Niigataken Chuetsu-oki, the 2008 M7.2 Iwate-Miyagi Inland earthquakes (Fig. 1) suggest that it is useful for M~7 earthquakes which cause several centimeters of the coseismic displacement.

Several problems were raised during operations of the prototype. One is a large noise of real-time GPS in summer. The repeatability of instantaneous coordinates is typically 1-2 cm in horizontal components. It becomes several times larger in summer (Fig. 2).

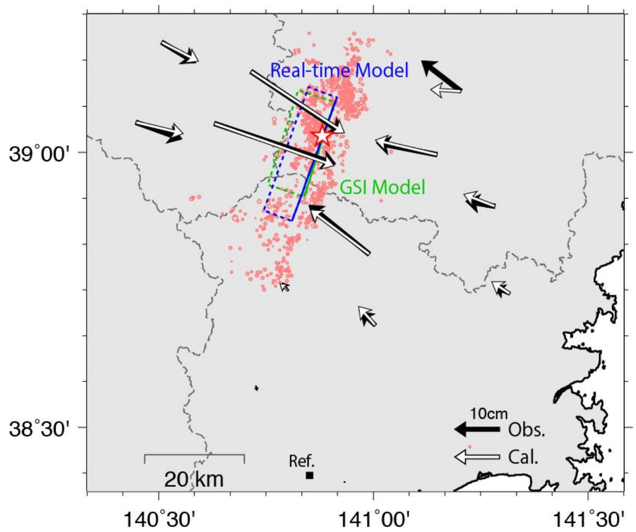

Fig. 1 Coseismic displacement and fault model for the 2008 M7.2 Iwate-Miyagi Inland earthquake using post-processing analysis of 1-second sampling GPS data. The real-time model is based on the post-processing instantaneous coordinates under the same condition of the real-time analysis. The observed displacement is calculated from the difference of 2-minutes averages before and after the earthquake. The GSI Model using routine daily GPS coordinates was announced 4 days after the earthquake. Location and magnitudes are similar in both models.

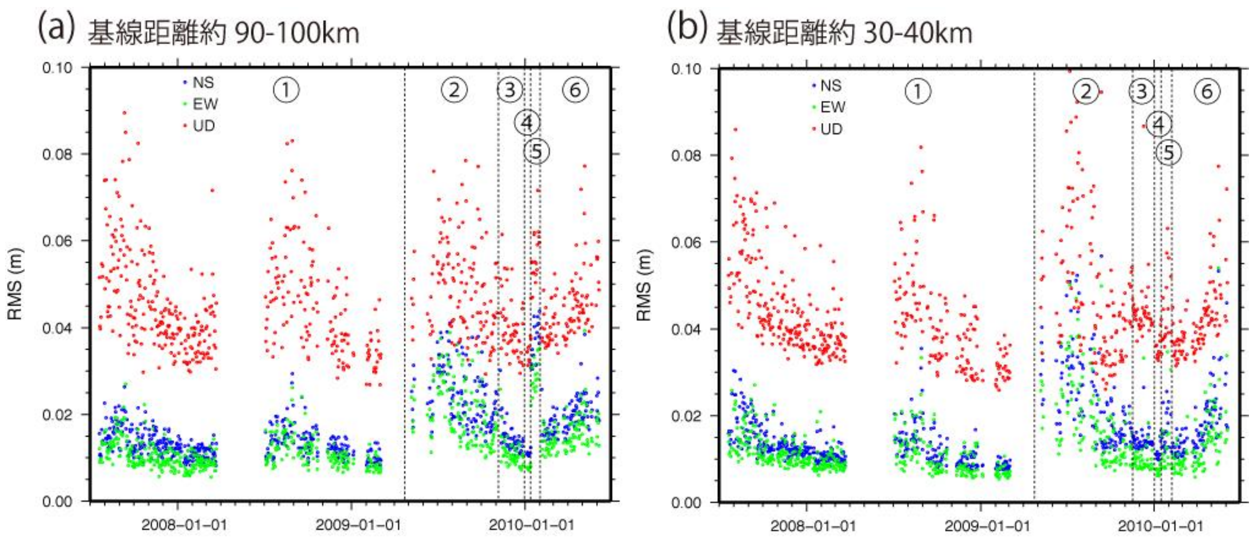

Fig. 2 Daily repeatability of site coordinates estimated from real-time GPS analysis. The repeatability is the root-mean-squares for a daily average of 1-second instantaneous coordinates. Different strategies of GPS baseline analysis were used for periods (1) to (6). (a) An example for a baseline length of 90-100 km. (b) Another example for a baseline length of 30-40 km.