Co- and post-seismic deformation of the 2011 off Pacific coast of Tohoku earthquake, Japan

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The 11 March 2011 off the Pacific coast of Tohoku earthquake (M9.0, hereafter 2011 Tohoku earthquake) occurred at the subduction zone of Japan Trench, which is a plate boundary between the Pacific plate and the Okhotsk (or North American) plate. This huge earthquake generated a large tsunami, which caused a devastating disaster including the loss of more than 12,200 lives up to April 7. The Geospatial Information Authority of Japan (GSI) established GEONET, a nation wide GPS network composed of more than 1,300 stations (e.g. Hatanaka, 2003). There are, however, not so many GEONET sites near the coastline and some small offshore islands because of the area's accessibility problem. Since 1994, Tohoku University (TU) established new continuous GPS stations in Tohoku region to complement GEONET and improve detectability of the interplate slip expected during the predicted Miyagi-oki earthquake (Miura et al., 2004, 2006).

In order to investigate the co- and post-seismic crustal deformation, we estimated daily coordinates at 741 GPS sites, which include TU, GSI, Japan Nuclear Energy Safety Organization (JNES), National Astronomical Observatory (NAO), and International GNSS Service (IGS). We used Bernese GPS Software version 5.0 (Dach *et al.*, 2007) with precise ephemerides and earth rotation parameters distributed by IGS. Coordinates are referred to the ITRF2008 (Altamimi *et al.*, 2011) by constraining daily coordinate of four IGS sites (aira, daej, khaj, and yssk).

During the co-seismic displacement, two nearest GPS sites from the epicenter (knk, and en3, Kinkasan and Enoshima islands) recorded 5.6m of horizontal displacement directing ESE, and 1.2m of subsidence. It is the largest value among whole onshore GPS sites including GEONET site. Co-seismic horizontal displacement shows E~ESE directing in whole Tohoku region. On the other hand, significant subsidence appears along the Pacific coast. The simple rectangular fault model on the plate interface approximately explains observed co-seismic displacement field. For more detail, Iinuma *et al.* (2011) estimated variable slip distribution using same GPS data set, and its principal slip region is consistent with location of our estimated fault.

Post-seismic deformation is also revealed at extended region in and around Tohoku region. As of middle of May 2011 (two months after the mainshock), daily coordinate time series are well fitted with logarithmic function, assuming frictional afterslip (e.g., Morone et al., 1991). It is thought that afterslip is dominant in the early post-seismic period rather than viscoelastic relaxation. Thus this fitted logarithmic pattern is reasonable to explain the coordinate time evolution. The post-seismic deformation caused by such a huge earthquake, however, will expect during the several decades. In addition, effect of viscoelastic relaxation will be significant in later period (e.g., 1964 Alaska earthquake, discussed in Suito *and* Freymueller, 2009). It is important to continue monitoring post-seismic deformation by dense GPS network and estimate its mechanism, as a future works.