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Characteristic strain distribution following the 2011 Tohoku earthquake based on the kinematic PPP analysis

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The 2011 off the Pacific coast of Tohoku Earthquake (March 11, 2011, M 9.0) generated widespread coseismic deformation. The slip on the plate boundary is larger than the 10 m in widely (e.g. [1]). Ohzono et al [2] found inhomogeneous strain distribution caused by the coseismic step of the 2011 Tohoku earthquake. They extracted the residual strain distribution, which is estimated by comparison between the expected coseismic displacement by a simple rectangular faults model and the observed coseismic displacement in the Tohoku area. Ozawa and Fujita [3] found the local deformation around the Akita-Komagatake, Kurikoma, Zao, Azuma, and Nasu volcanoes caused by the 2011 Tohoku earthquake based on the ALOS/PALSAR and GPS data. They suggested that the coseismic extensional deformation concentrates in the soft medium under a volcano and that this deformation has caused local deformation with subsidence based on the FEM modeling. These previous studies , however, used the daily coordinates time series of the GPS observation. Thus, these previous studies result might be contained early postseismic displacement following the 2011 Tohoku earthquake. Based on these backgrounds, we tried to extract the pure coseismic deformation by the kinematic Precise Point Positioning (kPPP) approach.

We estimated every 1 seconds coordinates time series of the 1,208 GEONET by the GIPSY-OASIS II software version 6.1.2. We defined the " pure " coseismic displacement, which is coordinate difference between just before the origin time and 600 seconds after the event. We averaged from 500 to 700 seconds after the event for eliminating short-term fluctuation of the time series. Based on the estimated " pure " coseismic displacement, we estimate the dilatation strain distribution by method of the [4]. We also estimated strain distribution in the early time period after the 2011 Tohoku earthquake, which estimated coordinate difference between coseismic displacement by the daily coordinate (e.g. difference between 10 to 12th March, 2011) and " pure " coseismic displacement by the kPPP analysis.

As a result, we found the characteristic local expansion in and around the Mt. Gassan, which located in Yamagata prefecture. We also found the characteristic contraction in and around Mt. Zao even though this obtained strain amount is smaller than the noise level determined by the kPPP time series. We also estimated strain distribution of early postseismic between mainshock and 15th March for the understanding the spatiotemporal development of strain distribution. The area of the expansion is clearly larger than the 12th March in and around the Mt. Gassan. Furthermore, the contraction area around the Mt. Zao clearly changed to expansion between just after the mainshock and 15th March.

In the presentation, we will discuss more detail characteristics and its interpretation of the obtained strain distribution.

[1] Iinuma et al., (JGR, 2012), [2] Ohzono et al., (EPS, 2012), [3] Ozawa and Fujita, (JGR, 2013), [4] Shen et al., (JGR, 1996)

Keywords: strain, 2011 Tohoku earthquake, postseismic deformation, kinematic PPP