Verification of accelerated vertical crustal movements in the Tohoku region prior to the 2011 Tohoku-Oki earthquake by reanalysis of GEONET data using Precise Point Positioning

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Homogeneous coordinate time series data over a decade from GNSS analysis is essential for investigation of various phenomena preceding massive earthquakes such as the Tohoku-Oki earthquake. Kurokawa (2016) found a significant difference between vertical velocities obtained from GNSS and those from tidal record during 2003~2011. This suggests that the long-term homogeneity of the GNSS result is questioned. Routine processing of GEONET, the GNSS continuous observation network in Japan, currently adopts the network analysis strategy (F3 solution). However, such strategy may generate bias in analysis result because the combination of baselines has changed in response to the increase of the number of stations. In this study, we reanalyze the daily coordinate of 30 GEONET stations along the coast of Tohoku region for the last 20 years by using Precise Point Positioning method (PPP) in order to get rid of bias due to network analysis. We compare the velocities obtained from the F3 solution and our PPP result. In the horizontal components, the differences are about 1~1.5 mm/yr before the Tohoku-Oki earthquake. In the vertical component, large differences of about 2~3 mm/yr are found before 2003, and gradually decrease to smaller than 0.5 mm/yr just before the Tohoku-Oki earthquake. Even if the difference is small, there exist systematic differences in many cases. We estimate the vertical acceleration before the Tohoku-Oki earthquake. Our PPP result shows no significant change along the Japan Sea coast, and accelerated subsidence along the Pacific coast (about -0.3 mm/yr^2). This result is consistent with the horizontal acceleration indicated by Mavrommatis et al. (2014) and the accelerated subsidence by Kurosawa (2016). Furthermore, this suggests that the construction of a network for the F3 solution is one of the causes of the common mode error, because Mavrommatis et al. (2014) and Kurokawa (2016) eliminated such errors by using spatial filtering technique.

Keywords: Precise Point Positioning, accelerated vertical crustal movements, GEONET

