Surface movements immediately before and after the 2011 Tohoku-oki earthquake from kinematic solution of GNSS and thermal expansion of the pillars

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The Tohoku-Oki earthquake (Mw9.0) occurred on March 11, 2011, and fault dislocation at the Japan Trench caused large eastward surface displacement of the Japanese Islands. Ohta et al. (2012) reported displacement of GNSS stations in NE Japan with the time resolution of three hours just before the Tohoku-Oki earthquake. Hino et al. (2014) reported high time-resolution vertical movements of the seafloor close to the epicenter using ocean bottom pressure gauge. Hirose (2011) analyzed the Hi-net tiltmeter data just before the Tohoku-oki earthquake. All these observations showed clear signatures of the afterslip of the foreshock that occurred two days before the main shock, but did not show any anomalous movement immediately before the earthquake.
For time periods just after the earthquake, Munekane (2012) reported kinematic analysis results of GNSS stations in NE Japan, and identified signatures of crustal deformation associated with several large foreshocks and the afterslip of the main shock fault. Mitsui & Heki (2012) analyzed periodic surface movements caused by the Earth's free oscillation. In addition to these “real” crustal movements, Munekane (2012) identified uniform horizontal displacement signatures, and inferred that they originate from differential thermal expansion of GNSS pillars due to direct sunlight.
In our study, we try to investigate spatial and temporal correlation between the sunshine and thermal-expansion origin horizontal displacements (see the attached figure). Here we used the 30-second position data of the GEONET station in NE Japan obtained using the RTnet software package by Dr. T. Iwabuchi, UNAVCO. This is the same data set that Mitsui and Heki (2012) used. We also use the weather data available from the website of Japan Meteorological Agancy (http://www.data.jma.go.jp/risk/obsdl/index.php).

Description about the attached figure

[A]:Position change of the GNSS station (JST 12:00-13:00) by kinematic solution.
[B]:The sunlight hour (JST 12:00-13:00) by AMEDAS.
[C]:Solar Azimuth at every each hour.

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