

# Possible anomalous changes in solar quiet-daily geomagnetic variation $S_q$ related to the 2011 off the Pacific coast of Tohoku earthquake (Mw 9.0)

\*Xiaocan Liu<sup>1</sup>, Katsumi Hattori<sup>2,3</sup>, Peng Han<sup>4</sup>, Huaran Chen<sup>1</sup>

1. Institute of geophysics China Earthquake Administration, 2. Graduate School of Science, Chiba University, Chiba, Japan, 3. Center for Environmental Remote Sensing, Chiba University, Chiba, Japan, 4. Department of Earth and Space Sciences, Southern University of Science and Technology, Shenzhen, China

Seismo-electromagnetic researches have been studied for decades (e.g. Hayakawa and Fujinawa, 1994; Hayakawa and Molchanov, 2002, 2008, 2013; Hattori, 2004, Hattori, et al., 2004a, 2004b; Hayakawa et al., 2007; Hattori et al., 2013; Han et al., 2011, 2014, 2015, 2016, 2017; Huang QH et al., 2011, 2015; Du A, Huang Q et al., 2002, Rong YM et al., 2012, Yuan G.P., Zhang X.M. et al. 2015), and the geomagnetic diurnal variation (GDV) is a stable variation of the geomagnetic field that can be used to detect possible anomalous changes associated with large earthquakes.

We investigated data observed at 20 geomagnetic observatories at longitudes of 130°E to 150°E between 2009 and 2012 to detect possible anomalous changes in the geomagnetic solar quiet daily variation ( $S_q$ ) related to the 2011 off the Pacific coast of Tohoku earthquake (Mw 9.0) occurred on March 11, 2011 in Japan. We selected the 5 quiet days every month and analyzed three component magnetic data with 1 min resolution using the natural orthogonal component (NOC) method to identify  $S_q$  variations from observations, and performed the spherical harmonic analysis (SHA) to separate the internal and the external equivalent  $S_q$  current systems of  $J_e$  and  $J_i$ . We obtained that,  $J_e$  and  $J_i$  are distorted near the epicenter area on two geomagnetic quiet days of January 23 and 27, 2011. They are about two months before the earthquake. Then, we made backward computation on the external and internal parts of the SHA model geomagnetic fields,  $B_e$  and  $B_i$ , to determine the possible anomalous magnetic field variations at each station. Results show significant differences in daily variation for all components on January 23 and 27, 2011. The other days, we could not recognize any apparent anomalous behaviors, except known secular, seasonal, and solar activity dependences. A possible connection between this anomaly and the very strong Tohoku earthquake, which followed only one and half month after the geomagnetic anomaly is of highest interest for the research on earthquake precursors.

Keywords: geomagnetic solar quiet daily variation ( $S_q$ ), natural orthogonal component (NOC) method, spherical harmonic analysis (SHA), the 2011 off the Pacific coast of Tohoku earthquake