Research report for the ERI visit from April 15 to June 17, 2018

Dr. Lucile BRUHAT (Visitor), Dr. Junichi FUKUDA (Host)

July 31, 2018

I visited ERI from April 15 to June 17, 2018. The original plan was to apply the methodology I developed during my PhD to the Japan Trench megathrust, in particular the region affected by the 2011 Tōhoku earthquake. Following recent study that Dr. Fukuda had done about slow slip events in the Bōsō Peninsula area, he suggested that I analyze interseismic rates in the same regions. This is the project I focused on during my stay at ERI. I also took advantage of my visit to give a seminar at ERI on Friday, May 11, to participate to the weekly *Blue Earth Seismology Seminar* organized by Prof. Kawakatsu, to present my research at the JpGU annual meeting, and to visit JAMSTEC at the Yokohama Institute for Earth Sciences.

Research Project: Temporal evolution of fault coupling associated with the occurrence of slow slip events in central Japan

Background

Although interseismic coupling has often been considered to be stationary in time, there is increasing evidence that fault locking can vary both spatially and temporally during the interseismic period. The detection of transient slip behavior in the proximity of locked regions, such as slow slip events or decadal-scale uncoupling events, suggests in fact that the notion of a characteristic interseismic coupling distribution might not be appropriate.

This study focuses on interseismic deformation rates in the southeastern part of the Kantō area in Japan. This region lies at junction of two subduction zones, leading to a particularly complicated tectonic setting. On the Eastern side, the Pacific plate subducts under the Okhotsk Plate at the Japan Trench, while the Sagami Trough to the south evidences the subduction of the Philippine Sea Plate under the Okhotsk Plate. The Philippine Sea Plate interface has hosted M8 megathrust earthquakes in the vicinity of Tokyo metropolitan area, such as the 1923 Great Kantō earthquake. Studies of interseismic deformation rates (*Sagiya*, 2004; *Nishimura et al.*, 2007) have shown that these megathrust events are consistent with the presence of a strongly locked asperity on the western extent of the Philippine Sea Plate interface at depths above 15-20km. Meanwhile, offshore the Bōsō Peninsula, i.e. on the eastern side of the interface, recurrent slow slip events have been detected in 1996, 2002, 2007, 2011, 2013-2014, and 2018. These events of magnitude 6.4–6.7 last between 14 to 43 days and are associated to transient slip located at the downdip transition between the locked region and the deep freely creeping zone (e.g., *Fukuda*, 2018; *Hirose et al.*, 2012, 2014).

Data analysis

In this study, we analyze deformation rates from GEONET GPS measurements at stations in the southern Kantō region (see Figure 1).

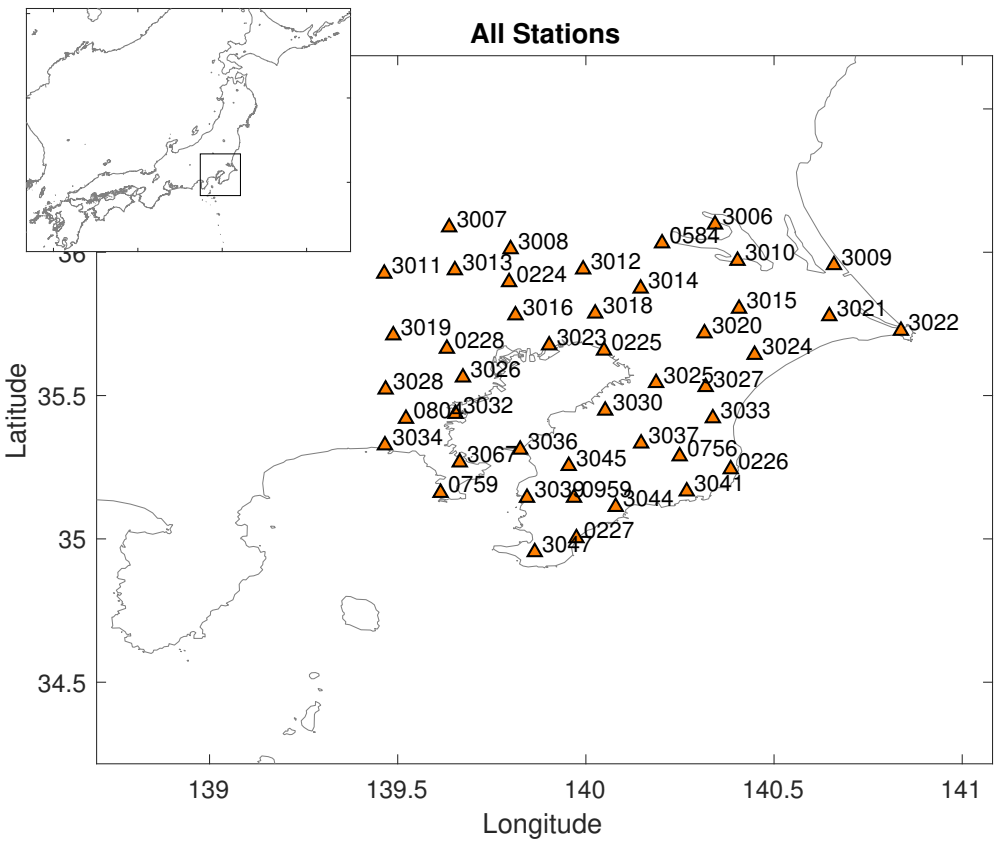

Figure 1: GPS stations used in this study

Time series are corrected for offsets due to antenna changes, for the 2000 volcano-seismological event in Izu Islands, and for co- and post-seismic deformation due to local earthquakes (e.g., the series of magnitude 6-6.9 which occurred on May 8th, 2008, off the coast of Ibaraki Prefecture). Time series are also filtered from seasonal variations and from common-mode errors following a procedure developed by *Mavrommatis et al.* (2014). Figure 2 presents an example of corrected time series.

We estimate horizontal and vertical interseismic rates at four different inter-SSE periods from 1994 to 2011. We notice changes in the linear trend, between inter-SSE periods for both horizontal and vertical components, which may be associated to changes in fault coupling.

Preliminary results and perspectives

Deformation rates are then inverted to produce coupling maps at the considered inter-SSE periods. We finally investigate possible relationships between the characteristics of the slow slip events and the inferred changes in interseismic fault coupling.

This work will be presented at the 19th General Assembly of WEGENER in Grenoble (France) in September 2018, and at the 2018 AGU Fall meeting in Washington, D.C. (USA).

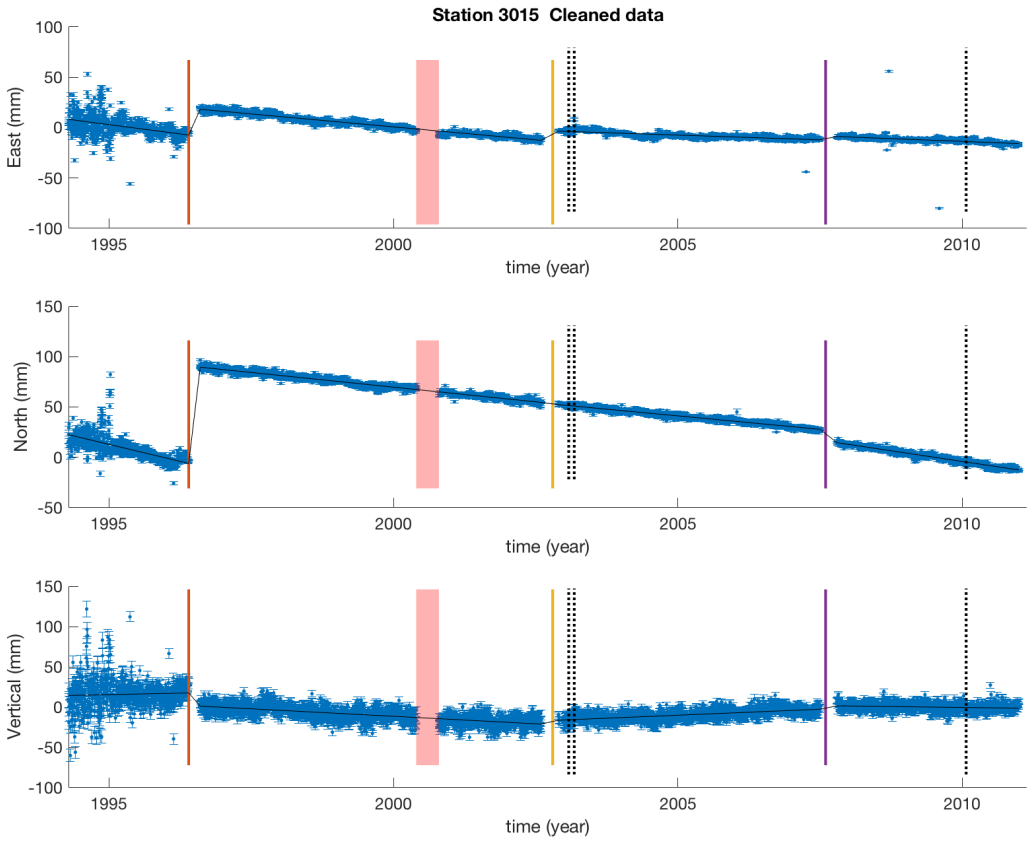

Figure 2: Displacement at the station 3015. Corrected from seasonal variations, antenna changes and earthquake deformation. During considered time period, three slow slip events (SSEs) occurred: May 11th - 24th, 1996; October 2nd - November 13th, 2002; and August 12th - 25th, 2007. SSEs are indicated by thin solid colored lines in the time series.

Acknowledgement

I would like to thank Dr. Fukuda for hosting me during these two months at ERI. I would also thank Prof. Kawakatsu for welcoming me in his weekly seminar. Finally, thank you to all the students and researchers I have interacted with, and all the staff at the ERI International Office for making my visit so enjoyable.

References

Fukuda, J. (2018), Variability of the Space-Time Evolution of Slow Slip Events Off the Boso Peninsula, Central Japan, From 1996 to 2014, *Journal of Geophysical Research: Solid Earth*, *123*(1), 732–760, doi:10.1002/2017JB014709.

Hirose, H., H. Kimura, B. Enescu, and S. Aoi (2012), Recurrent slow slip event likely hastened

by the 2011 Tohoku earthquake, *Proceedings of the National Academy of Sciences*, *109*(38), 15,157–15,161, doi:10.1073/pnas.1202709109.

Hirose, H., T. Matsuzawa, T. Kimura, and H. Kimura (2014), The Boso slow slip events in 2007 and 2011 as a driving process for the accompanying earthquake swarm, *Geophysical Research Letters*, *41*(8), 2778–2785, doi:10.1002/2014GL059791.

Mavrommatis, A. P., P. Segall, and K. M. Johnson (2014), A decadal-scale deformation transient prior to the 2011 M w 9.0 Tohoku-oki earthquake, *Geophysical Research Letters*, *41*(13), 4486–4494, doi:10.1002/2014GL060139.

Nishimura, T., T. Sagiya, and R. S. Stein (2007), Crustal block kinematics and seismic potential of the northernmost Philippine Sea plate and Izu microplate, central Japan, inferred from GPS and leveling data, *Journal of Geophysical Research*, *112*(B5), B05,414, doi:10.1029/2005JB004102.

Sagiya, T. (2004), A decade of GEONET: 1994–2003 —The continuous GPS observation in Japan and its impact on earthquake studies—, *Earth, Planets and Space*, *56*(8), xxix–xli, doi:10.1186/BF03353077.