The moment release rate of short-term slow slip events in the northern Kii Peninsula from 2002 to 2015 based on NIED Hi-net tilt data

*Naoya Chujo[1], Hitoshi Hirose[2,1,3], Takeshi Kimura[3]

1. Department of Planetology, Graduate School of Science, Kobe University, 2. Research Center for Urban Safety and Security, Kobe University, 3. National Research Institute for Earth Science and Disaster Resilience

In the southwest Japan subduction zone, short-term slow slip events (S-SSEs) with nonvolcanic tremor (Episodic Tremor and Slip: ETS, Rogers and Dragert, 2003) which last for several days to weeks occur repeatedly (e.g., Obara et al., 2004). Because the S-SSEs occur at the downdip extension of a megathrust earthquake rupture zone, the SSEs are one of the key factors for stress buildup processes of the megathrust earthquakes (e.g., Obara and Kato, 2016). Therefore, detailed slip distributions of S-SSEs are important for understanding the strain accumulation and release at the ETS zone. In the northern Kii Peninsula, S-SSEs have been detected (e.g., Hirose and Obara, 2006). In addition, previous studies examine the moment release rate by S-SSEs in this area (Sekine et al., 2010; Nishimura et al., 2013). For example, Nishimura et al. (2013) show the long-term moment release rate is roughly constant for nearly 16 years (1996-2012). Since we obtained more recent data, it is important to explore longer-term moment release history as S-SSEs.

Here we apply an inversion method (Hirose and Kimura, 2020) which can express a spatial slip distribution to tilt offset measurements in the northern Kii Peninsula and estimate detailed slip distributions of 52 S-SSEs from March 2002 to October 2015. We also calculate the long-term moment release rate of S-SSEs over a more recent period than the previous studies, and discuss regional differences of S-SSEs activity in the northern Kii Peninsula.

We used time-series records of a high-sensitivity accelerometer (tiltmeter) installed at NIED Hi-net stations located in the Kii Peninsula and Tokai areas. We applied the BAYTAP-G (Tamura et al., 1991) program together with atmospheric pressure records observed at the Tsu Local Meteorological Observatory to the tilt records in order to remove tidal components and an atmospheric pressure response. First, we checked the tremor activity in the northern Kii Peninsula based on the NIED tremor catalog (Maeda and Obara, 2009; Obara et al., 2010) to find out “active episodes”. Next, We try to identify a corresponding tilt transient to an active episode of tremor, then we define the event duration of the SSE from the tilt transient if it is identified. We measured a tilt offset due to an SSE from a detrended tilt record as a difference in tilt just before and after the SSE. We estimated a slip distribution that explains the tilt offset dataset for an SSE by a conventional inversion method by Hirose and Kimura (2020).

We successfully identified and estimated 52 S-SSEs in the study area in 13 years. The estimated moment magnitudes of the 52 SSEs range from 5.4 to 6.2. The cumulative seismic moment in the entire modeled region (the rectangle with the solid line in Fig.) indicates the moment release rate is mostly constant (~ 4E+18 Nm/year) through the study period. Then, we divide the modeled region into three segments (southern, central, northern; separated by dashed lines in Fig.) based on the slip distributions of S-SSEs. We find that the long-term moment release rate in the central and northern segments (corresponding to the Shima Peninsula and Ise Bay part of the ETS zone) is higher than that in the southern segment (corresponding to the southern Nara Prefecture in the ETS zone), indicating the regionality of S-SSEs activity in the northern Kii Peninsula. In addition, in the central and northern segments, the moment release rate decreases around 2011, suggesting a possible effect of the crustal deformations caused by the 2011 Tohoku earthquake.

Acknowledgments: This work was supported by JSPS KAKENHI Grant Number JP16H06474.

Meteorological data were provided by Japan Meteorological Agency.