Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SCG62-09 会場:303 時間:5 月 27 日 16:30-16:45

深部低周波微動の潮汐応答性
Tidal sensitivity of tectonic tremors in subduction zones

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Tectonic tremor, which is one of slow earthquakes occurring in subduction zones, have been known to be triggered by small stress perturbation such as passing surface wave from distant earthquake and tidal stress. Tidal sensitivity of tremors can be detected by investigating the frequency of tremor catalog, but more quantitative comparison gives us useful information. By comparing tremor activity with calculated tidal stress on the plate interface, some previous studies estimate frictional property on the plate interface, such as frictional parameter in rate and state friction (Tanaka et al., 2008), friction coefficient (Thomas et al., 2012; Houston, 2015). Furthermore, recent studies reveal the relation between tremor rate and tidal stress is exponential (Ide and Tanaka, 2014, Houston, 2015), which would represent the frictional property of plate interface. However, the analyses of previous studies are limited to specific places in subduction zones. Hence in this study, we try to estimate the spatial variation of tidal sensitivity in Nankai, Cascadia and Mexican subduction zones.

Tidal stress calculation includes both body tide and ocean tide. Tidal stress is converted to normal stress and shear stress on the plate interface based on the local plate model and plate movement.

Tremor catalog is from Yabe and Ide (2014). We calculate tremor rate at each tidal stress level following Ide and Tanaka (2014) and Houston (2015). Tidal sensitivity is calculated from this data using maximum likelihood method. The uncertainty of estimated parameter is assessed as well.

In this study, we categorize tremors in the catalog into four types. Tremors occurring between major ETS episodes are categorized into inter-ETS events. Tremors in ETS events are categorized into three categories (“early”, “front”, and “later” as Houston, 2015). Spatial variations of tidal sensitivity for each type of tremors are estimated. Nankai and Cascadia subduction zones have both ETS tremors and inter-ETS tremors, while tremors in Mexican subduction zone do not show significant along-strike migration, and all tremors are categorized into inter-ETS tremors.

As for tremors in ETS, early tremor and later tremor show high sensitivity in Nankai subduction zone, while front tremor does not. In Cascadia, only after tremor does show tidal sensitivity. The absence of tidal sensitivity in early tremor in Cascadia is considered to be due to the smaller amplitude of tidal stress and/or stronger coupling of slow earthquake region. In the front period, stress perturbation due to SSE slip would be larger than tidal stress, and tidal sensitivity disappears. After the SSE front passes, plate interface get weakened, and strong tidal sensitivity will appear. Comparing with the amplitude of tremors estimated by Yabe and Ide (2014), tidal sensitivity tends to increase from early tremors to later tremors where the amplitude of front tremors is large. Because the amplitude of tremors is proportional to moment rate (Ide and Yabe, 2014), this observation is consistent with the interpretation presented above. Tidal sensitivity also tends to be higher in shorter duration tremors, which is defined as the half value width of tremor envelope. Considering the tremor model by Ando et al. (2010, 2012) and Nakata et al. (2011), shorter duration might imply smaller tremor patch, which would not endure higher strain accumulation than larger tremor patch, resulting in higher tidal sensitivity.

キーワード: 深部低周波微動, スロー地震, 沈み込み帯, 潮汐応答性, 速度状態依存摩擦則
Keywords: Tectonic Tremor, Slow Earthquake, Subduction Zone, Tidal Sensitivity, Rate and State Friction Law