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Monitoring of Short-term Slow Slip Event by GPS data in Tokai Region

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In the south-western part of Japan, there occur episodic tremor and slip beneath Nankai trough. These short-term slow slip events (S-SSEs) especially in Tokai region are known to be very small and hard to detect by GPS. Our study is a trial for monitoring these S-SSEs by GPS data.

The S-SSEs in Tokai region have been detected by strain meters and Hi-net tilt meters (Hirose and Obara, 2006), and the fault parameters were estimated from these data. Though the tilt- and strain-meters are very sensitive to short term variation, the records by tilt meter and strain meters are not so stable for weeks or months because of local movements of ground water around sensors affect them. For example, Hirose and Obara [2006] clipped the time series of tilt-meter corresponding to the time of tremors, and then they estimated the fault parameter from the clipped tilt records.

On the other hands, Satomura et al.,[2008;JPGU] successfully detected surface deformation accompanying deep low frequency tremors and estimated the amount of the slip by forward modeling using the fault parameter obtained by tilt-meter analysis. Although the amount of the slip was not equated with that estimated by tilt-meter, the pattern of the displacement matched very well between observed and calculated one.

One of the advantages of GPS data is its small middle- or long-term variations comparing to tilt- and strain-meters. The records of GPS antennae during the term without S-SSE or far from the sources are quiet. GPS record should be a powerful tool for automatic temporal and spatial detection of S-SSEs without any assumptions like coherences between several stations or correspondence with tremors.

We conducted feasibility study for the automatic detection of the S-SSEs using GPS. The aimed event was the S-SSE occurred in January 2006 beneath western Mikawa. The moment magnitude of it was estimated to be Mw 5.5 by JMA. We confirmed that the GPS data covering Tokai region were successfully inverted to the slip just around the source of the tremor at the corresponding time.

The used data were obtained at 69 stations of GEONET and 35 stations by GPS university consortium of Japan from December 1, 2005 to December 31, 2006. Positioning was done by GAMIT ver.10.35 software. The calculated positions were processed by the method by Satomura et al.,[2008;JPGU] to reduce fluctuation and then inverted by a method based on theory by Yabuki and Matsuura.,[1992;GJI]. The maximum slip of about 1 cm was detected around the focal area of the tremor.

The next step is to extend the temporal and spatial expansion of the GPS data eastward to Suruga Trough, westward to Bungo Channel, back to 2002 and forward to 2010. We will try to detect the spatio-temporal distribution of the SSEs beneath south-west Japan automatically.

Keywords: deep low-frequency slight tremor, short-term slow slip, GPS, inversion