Shallow slow slip event inferred from GNSS-A seafloor geodesy

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In the subduction zone where mega thrust earthquakes occurs, many kind of slow earthquakes in deep plate boundary have been detected by terrestrial dense seismometer and GNSS monitoring networks. On the other hand, in the shallow part of the plate boundary, the investigation of slow earthquakes is limited because of the difficulty of observation at the ocean area. Due to recent development of observation technology, shallow slow earthquakes, such as LFE, VLFE and short-term SSE, have been detected by seafloor seismometers, ocean bottom pressure gauges and submarine borehole strainmeters (e.g., Yamashita et al.,2015; Wallace et al., 2016; Araki et al., 2017, Science).

Deep long-term SSE with duration over a few months is detected by terrestrial GNSS observation which is sensitive to long-term deformation. In this analogy, shallow long-term SSE can be detected by seafloor GNSS-A observation. However it was difficult to detect SSE with the capability of GNSS-A so far. Recently, we have been developing the GNSS-A technology to improve an observation frequency and precision (Yokota et al., 2017; Yokota et al., 2018). Then, the GNSS-A monitoring has a capability to reveals the occurrence situation of undersea SSE which could not be observed by the terrestrial GNSS.

However, because the accuracy is yet poor compared with GNSS, we have been investigating a method for detecting SSE from varying time series data. Nishimura et al. (2013) attempted to detect deep short-term SSE from GNSS data using AIC testing. We modified this method for GNSS-A data and attempted to detect shallow SSE. Then, we detected SSE signals from the GNSS-A data at off the Kii channel, Hyuga-nada and Kumano-nada which locate shallow side around the Nankai Trough historical seismogenic zone and strong coupling regions. There are various statistical method to detect transient variation from time series, and AIC is one example. It is necessary to consider further application of other statistical methods.

We also estimate the rectangle fault model using grid search that can explain displacements obtained from AIC method. Since the current observation sites are installed at 80 to 100 km intervals, displacements are detected only at 1 to 2 sites. Therefore, the estimated fault model has large uncertainty.

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