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Slip deficit at the Nankai subduction zone inferred from seafloor geodetic observations (second thought)

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The Philippine Sea plate (PH) subducts beneath the southwest Japan along the Nankai Trough with a rate of about 4-6 cm/yr, where megathrust earthquakes have repeatedly occurred every 100-150 years. The probability of earthquake occurrence within 30 years from January 1st, 2011 are estimated to be 87 %, 70 %, and 60 % for the next Tokai, Tonankai, and Nankai earthquakes, respectively. We are concerned about the expansion of earthquake damage because these earthquakes have possibilities of interlocking with adjacent segments according to the historical record. Thus, it is important to know the spatio-temporal variation of crustal deformation accompanied with plate interaction. For this issue, we have conducted seafloor geodetic observation at the Nankai Trough using a GPS/Acoustic technique since 2004. In this system, we estimate the position of a surveying vessel by Kinematic GPS analysis and measure the distance between the vessel and the benchmark on the seafloor by Acoustic measurements. Next we determine the location of the benchmark. For the repeatability of this observation, the location of benchmark is determined within a precision of 2-3 cm at horizontal components. Recently, a number of research institutes have conducted seafloor geodetic observation using this technique before and after earthquakes occurred in offshore area, and then they have provided significant achievement to understand inter-, co-, and post-seismic crustal deformation. Several seafloor benchmarks are located at the Nankai subduction zone, which are individually operated by Japan Coast Guard, Tohoku University, and Nagoya University. In the Kumano Basin, we have three seafloor benchmarks located about 60-80 km away from the deformation front of the Nankai Trough. The observations from 2005 to 2010 have illustrated that those benchmarks are moving at rates of about 3-4 cm/yr toward west-northwest with velocity uncertainties of about 2 cm/yr relative to the Amurian plate (AM). In this study, we investigate interplate coupling at the Nankai Trough using onshore GPS velocities derived from Geophysical Survey Institute of Japan and offshore GPS site velocities derived from seafloor geodetic observation. We assume that observed GPS velocities are represented by the superposition of elastic deformation associated with subduction of the PH, rigid block motion of the overriding plate, and error. The plate interface along the Nankai Trough is represented by multiple rectangular faults. Moreover relative plate motion of the PH-AM (Sella et al., 2002) is assigned to the plate interface as a priori constraint.

Keywords: Seafloor geodetic observation, Nankai Trough, Slip deficit rate, GPS, Interlocking