

Shallow episodic tremor and slip near the Japan Trench before the 2011 Tohoku-Oki earthquake

Yoshihiro Ito^{1*}, Ryota Hino¹, Syuichi Suzuki¹, Yoshiyuki Kaneda²

¹Tohoku University, ²JAMSTEC

Instances of episodic tremor and slip (ETS) have been discovered in several subduction zones in the past decade. Most ETSS have been found in the deep regions of subduction zones, such as those of the Nankai, Cascadia, and Mexico subduction zones. We report on a shallow ETS (<20 km depth) event that occurred prior to the 2011 Tohoku-Oki earthquake. Two transient slow slip events accompanied by long duration seismic signals, or tremors exceeding 1 h, were observed by ocean-bottom seismic and pressure sensors near the Japan Trench. The first ETS, which occurred over the period of a week in November 2008, was recorded simultaneously by ocean-bottom pressure gauges, and an on-shore volumetric strainmeter. Tremor signals were also observed at ocean bottom seismometers near the trench. This observed deformation was interpreted as being an M6.8 episodic slow slip event. The second ETS was observed from the end of January 2011 until just before the 2011 Tohoku-Oki earthquake; the moment magnitude of this event was 7.0. The ETS in 2011 preceded the interplate earthquake of M7.3 (March 9, 2011), which was the largest foreshock of the 2011 Tohoku-Oki earthquake. An anomalous tremor exceeding 24 hours duration was observed only at a seismometer located 20 km away from the trench, in the updip extension from the hypocenter of the largest foreshock. No obvious tremors were observed at the seismic stations just above the epicenter and coseismic slip area of the largest foreshock. The observed bottom pressure data also indicated a slight shift of the updip tip of the slow slip fault to the trenchward direction just before the largest foreshock. Our findings reveal that the slow slip events mainly occurred at the updip extension of the coseismic slip area of the largest foreshock. There was no obvious slow slip, or pre-slip near the hypocenter.

Keywords: slow slip, tectonic tremor, The 2011 Tohoku-Oki earthquake, subduction zone