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Episodic slow slip events in the Japan subduction zone before the 2011 Tohoku-Oki earthquake

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We describe two transient slow-slip events that occurred before the 2011 Tohoku-Oki earthquake that occurred near the high coseismic slip region near the Japan Trench. A transient crustal deformation, which occurred over 7 days in November 2008, was measured using ocean-bottom pressure gauges and an on-shore volumetric strainmeter simultaneously; this deformation has been interpreted as an Mw 6.8 slow-slip event with a slip magnitude of 0.4 m at most. The other transient crustal deformation was observed in mid-February 2011, just before the 2011 Tohoku-Oki earthquake: the source model of this deformation is probably almost the same as that of the 2008 transient slow slip. The two transient slow deformations preceded interplate earthquakes of magnitudes M 6.1 and M 5.8 in December 2008 and February 2011, respectively. The hypocenters are located at the down-dip ends of the slow-slip area. Our findings indicate that the slow-slip events induced an increase in shear stress, which in turn triggered the interplate earthquakes. The slow-slip area is also located within the large coseismic slip area of the 2011 earthquake; in particular, the slow-slip area is mainly located in the down-dip end of the high coseismic slip region near the Japan Trench. The result suggests that a fault segment where velocity strengthening occurs at low slip velocity and velocity weakening occurs at high slip velocity probably exists in the down-dip portion of the high coseismic slip area of the 2011 Tohoku-Oki earthquake.

Keywords: Slow slip event, The 2011 Tohoku-Oki earthquake, Ocean-bottom pressure observation