

The 2011 Tohoku-Oki Earthquake:

Cross Correlation of Bathymetric Data model Horizontal Displacement Reaching the Japan Trench Axis.

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We studied the bathymetric data acquired before and after the 11 March 2011 Tohoku-Oki Earthquake [moment magnitude (M_w) 9.0]. In 1999 and 2004, multibeam bathymetric data were acquired during active source seismic surveys along the same track across the Japan Trench Axis using a SeaBeam 2112 swath mapping sonar with a 12 kHz frequency and a $2^\circ \times 2^\circ$ beam width. We estimated the horizontal and vertical displacement by cross correlating data from the 1999, 2004 and 2011 survey, revealing that the displacement extended out to the axis of the Japan Trench, suggesting that the fault rupture reached the trench axis and caused the sea floor on the outermost landward region to moved approximately 50 meters horizontally east-southeast and about 10 meters upward. Our data also revealed the large horizontal displacement lifted the sea floor up to 16 meters on the landward slope in addition to the vertical displacement. This uplift was an important factor in the generation of tsunami waves. The effect of horizontal displacement is usually neglected, however, when the tsunami source is on a steep slope and the horizontal displacement is large relative to the vertical displacement, as in the Tohoku-Oki Earthquake, the effect becomes significant and the horizontal displacement becomes an important source to the tsunami wave generation.