Earthquake source parameter study using micro-tsunamis recorded with ocean-bottom pressure gauges

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Micro-tsunami waves with a maximum amplitude of 4 to 6 mm were detected with two ocean-bottom pressure gauges, following the January 28, 2000 earthquake (Mw 6.8). The two pressure gauges, deployed at 2,283 m and 2,248 m depth on the continental shelf off Hokkaido, Japan in the southern Kuril subduction zone, are equipped on a cabled seafloor observatory developed by the Japan Marine Science and Technology Center (JAMSTEC) in 1999. The relative resolution of pressure measurements is approximately 3 Pa, which is approximately equivalent to 0.3 mm in sea-surface level change. Amplitudes of the observed micro-tsunamis are more than 10 times of the resolution limit, indicating a large enough signal-to-noise ratio to extract earthquake source information.

To determine earthquake source parameters for this event, we initially prescribe a rectangular fault co-located with the previously determined aftershock distribution. Then, we model the observed micro-tsunamis and estimate the focal depth and other source parameters such as fault length and slip amount using a grid searching algorithm together with the least squares minimization. From these parameters, we calculate the corresponding seismic moment and stress drop. The focal depth and stress drop for the January 28, 2000 earthquake is estimated to be 50 km and 7 MPa, respectively, with possible ranges of 45 - 55 km and 4 -13 MPa. The fault length is estimated to be 15 km, with possible ranges of 10 - 20 km, which is the same as that from the aftershock distribution. The corresponding estimate for seismic moment is 2.7 x 10^19 Nm with possible ranges of 2.3 x 10^19 - 3.2 x 10^19 Nm. The focal depth and stress drop strongly suggest that the earthquake was an intra-slab event within the subducting Pacific plate. Standard tide gauges along the nearby coast did not record any tsunami signal. The high-precision tsunami measurements with ocean-bottom pressure gauges offshore as well as sensitivity of micro-tsunami waveforms on earthquake source parameters thus make it possible to determine fault parameters of moderate-sized earthquakes in subduction zones