

The Central Kuril Earthquakes and Tsunamis of 15 November 2006 and 13 January 2007: Two Predicted Events

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Two major earthquakes have recently occurred within two months of one another seaward of Simushir Island (Central Kuril Islands, NW Pacific). The $M_w = 8.3$ earthquake of 15 November 2006 generated a trans-oceanic tsunami, the strongest tele-tsunami in the Pacific Ocean in the last 42 years (since the 1964 Alaska tsunami). Waves recorded around the rim of the Pacific Ocean reveal the global reach of the tsunami. Wave heights exceeding 1 m were recorded as far as the Hawaiian Islands, Oregon, California and Chile. Significant damage took place in the port of Crescent City (California) located roughly 6600 km from the source; maximum recorded wave heights at this site were 177 cm. Marked tsunami signals were identified in records from Japan, Alaska, Canada, Peru, New Zealand and the Pacific Islands. Significant waves were recorded at Malokurilsk, Shikotan I. (156 cm), Yuzhno-Kurilsk, Kunashir Is. (50 cm), Magadan, NW part of the Sea of Okhotsk (63 cm) and other Russian sites. The second earthquake ($M_w = 8.2$) occurred on 13 January 2007 with a source area located slightly seaward from the source area of the 2006 earthquake. Although weaker than the 2006 tsunami, the 2007 tsunami was clearly recorded in the Kuril, Aleutian and Hawaiian Islands and Japan and the Aleutian Islands. A unique feature of these earthquakes and tsunamis is that they were predicted. Following the catastrophic 2004 Sumatra tsunami, seismic zones around the Pacific Ocean were thoroughly examined in the context of the seismic-gap theory and some potential areas of major earthquakes were selected. The Central Kuril zone was defined as the zone of highest risk for a catastrophic event for the coast of Russia. To examine the Central Kuril seismic gap, two detailed marine geophysical expeditions were undertaken on the R/V “Michail Lavrentiev” in 2005 and 2006 by the Russian Academy of Sciences. The main purposes of these expeditions were examination of the tectonic structure of the seismic gap, identification of cross-shelf fault areas, detection of a possible source region, and determination of the expected magnitude of a major earthquake and associated tsunami. A detailed pre-event investigation of this zone also included numerical modeling of several scenarios of a possible major tsunami. The region of primary concern was the northeastern shelf of Sakhalin Island in the Sea of Okhotsk, the area of the active oil and gas exploration.

The earthquakes of 15.11.2006 and 13.01.2007 occurred very close to the expected source region. Parameters of the actual tsunami were also similar to those predicted, except that fortunately the NW coast of Sakhalin Island was sheltered from the arriving waves by the Simushir coast. Simulated tsunami wave forms were found to agree closely with the offshore island and deep-ocean DART records. The energy flux of the waves was mainly directed southeastward toward the Hawaiian Islands and Chile.