

# Paleoseismological information from remote historic documents

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Effects of earthquakes were recorded in historical documents at remote place. Such remote documents can be used to study earthquake recurrence without near-field historical data. Here I show two examples: use of historical records in Japan to study an earthquake along Cascadia subduction zone in North America, and use of records in Honshu to study earthquakes along the Kuril trench.

Japanese records of tsunami damage have helped estimate the date and size of the 1700 Cascadia earthquake. The origin time was estimated as around 9 pm January 26 (local time) from the earliest arrival time to Japan. The size attained moment magnitude 9, according to new estimates based on effects of its tsunami in Japan, computed coseismic seafloor deformation for hypothetical ruptures in Cascadia, and tsunami modeling in the Pacific Ocean. Three sets of estimated heights express uncertainty about location and depth of reported flooding, landward decline in tsunami heights from shorelines, and post-1700 land-level changes. Reports of damage and flooding show that the 1700 tsunami reached 1-5 m heights at seven shoreline sites in Japan. We compare each set with tsunami heights computed from six Cascadia sources. Each source is vertical seafloor displacement calculated with a 3-D elastic dislocation model. To compute tsunami waveforms, we use a linear long-wave approximation with a finite-difference method, and we employ modern bathymetry. The various combinations of Japanese tsunami heights and Cascadia sources give seismic moment of  $1-9 \times 10^{22}$  Nm, equivalent to moment magnitude 8.7-9.2.

Earthquakes before AD 1800 along the southern Kuril trench, before the start of written history on nearby Hokkaido, probably account for some of the earthquakes noted by local records in Honshu, hundreds of kilometers to the southwest. Since 1926, Tokyo has had a yearly average of 15 felt earthquakes with seismic intensity 2 or more on the Japan Meteorological Agency scale. For Tohoku the average annual frequency is about 4, of which 0.6 also reached intensity 2 in Tokyo. About one quarter of these events occurred in the southern Kuril trench. Earthquake historians have identified about 4800 felt earthquakes in Edo (present Tokyo) and about 3000 felt reports in selected local government records in Tohoku, northern Honshu, for the years AD 1656-1867. On the average, 19 earthquakes per year were felt in Edo. Of the Tohoku records, about two events per year were felt at multiple locations; 0.4 per year were also felt in Edo. If the seismicity is temporally constant, about 80 of the earthquakes recorded in 1656-1867 probably had a Kuril origin.