Validation for tsunami source model of large earthquakes occurred in the Sea of Japan

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For the 1964 off Oga Peninsula (Mjma 6.9), 1971 West off Sakhalin (Mjma 6.9), 1983 West off Aomori (Mjma 7.1) earthquakes occurred in the Sea of Japan, tsunami waveforms are computed and compared with the recorded ones on tide gauges for the heterogeneous slip models obtained by the teleseismic waveform inversion and tsunami source models compiled by MLIT (Ministry of Land, Infrastructure, Transport and Tourism), CAO (Cabinet Office), and MEXT (Ministry of Education, Culture, Sports, Science and Technology) (hereinafter referred to as “MLIT model”) (Murotani et al., 2015, JpGU; 2015, SSJ). As the results, the calculated tsunami waveforms were almost the same whether the dispersion term is included or not in the simulation, and whether the slip on faults is heterogeneous or uniform. In this study, we quantitatively compare the observed tsunami waveforms with the calculated tsunami waveforms to examine the validity of those fault models. It is difficult to compare the entire waveforms of M7 class tsunami, because the later part of waveforms may have an influence due to a bay or a shelf where tide gauge stations locate. In this study, we used factors K and k by Aida (1978, JPE). K is the geometrical mean value of K*i*, where K*i* is the ratio of the observed and the calculated amplitudes for the first wave and the second one of *i* th stations, and log k is the logarithmic standard deviation of K*i*.
For the 1964 earthquake, we estimated K and k for six fault models which are the teleseismic waveform inversion model and some modified MLIT models, etc. k was the smallest (1.65) for a rectangular fault with uniform slip of 0.4 m, that is larger than the average slip 0.2 m of the heterogeneous slip distribution (fault size: 50 km x 40 km, M_0: 1.5 x 10^{19} Nm, maximum slip: 1.4 m) obtained by the teleseismic waveform inversion. This uniform slip 0.4 m best reproduced the amplitudes of the observations (K = 1.11). For the 1971 earthquake, we estimated K and k for five fault models which are the teleseismic waveform inversion model and modified uniform slip models. k was relatively small (2.42) for both the first and the second waves from the heterogeneous slip distribution (fault size: 50 km x 30 km, M_0: 1.3 x 10^{19} Nm, maximum slip: 1.2 m, average slip: 0.2 m) obtained by the teleseismic waveform inversion. However, the amplitudes of the calculated waveforms was so small (K = 2.41). The amplitudes of the observations were reproduced (K = 1.13) when we assumed the rectangular fault with uniform slip 0.5m, although k was a little larger (2.80). If only the first wave is used, k was the smallest (2.01) from two rectangular faults (fault size: 30 km x20 km and 30 km x20 km) with uniform slip 0.2 m and 1.5 m, respectively. The strike 21° of this model was changed from the strike 329° obtained by the teleseismic waveform inversion. However, k values of this earthquake are still large, hence further examination is necessary. For the 1983 earthquake, we estimated K and k for six fault models which are the teleseismic waveform inversion model and some modified MLIT models, etc. k was the smallest (1.64) from the heterogeneous slip distribution (fault size: 50 km x 30 km, M_0: 3.1 x 10^{19} Nm, maximum slip: 2.2 m, average slip: 0.5 m) obtained by the teleseismic waveform inversion. This model best reproduced the amplitudes of the observations (K = 1.33) as well.

Keywords: eastern margin of the Sea of Japan, tsunami waveform analysis, fault parameters