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Tsunami generation near Japan by Earthquakes Along-strike Single Segmentation and Along-dip Double Segmentation

Junji Koyama and Motohiro Tsuzuki
Natural History Sciences, Hokkaido University, Sapporo, Japan (koyama@mail.sci.hokudai.ac.jp)

After the 2011 Tohoku-oki megathrust earthquake of Mw9.0, we have proposed a hypothesis that megathrust earthquakes worldwide occur Along-dip Double Segmentation (ADDS) or Along-strike Single Segmentation (ASSS). The former is characterized by the apparent absence of earthquakes in the aligned seismic segments along the Japan trench as opposed to those along the Japan Islands that generate repeated smaller earthquakes (ADDS), where the 2011 Tohoku-oki megathrust occurred. Meanwhile, the latter is by a weak seismic activity before the main event all over the subduction zone, where we find aligned seismic segments along the subduction zone from the trench to the island-arc (ASSS). A typical example of ASSS is the Nankai trough, Japan, where future great earthquakes are expected. The 1960 and 2010 Chile megathrusts occurred in ASSS. In and near Japan, ADDS earthquake activity is restrictively found along the Pacific side of Hokkaido and Tohoku regions and the Hyuganada, Kyushu. The rest of seismic activity near Japan is classified into ASSS. Comparing tsunami magnitude m from local tsunami-wave heights and seismic moment Mo from long-period surface-waves of 61 earthquakes from 1923 in and near Japan, we found that tsunami-wave heights of ASSS earthquakes are almost two times larger than those of ADDS's. This is also confirmed by studying tsunami magnitude Mt evaluated from teleseismic tsunami-wave heights. The reason of this different excitation between ADDS and ASSS is considered to be due to either (1) shallower focal depths for ASSS give rise to larger ocean bottom deformation, resulting in larger tsunami excitation, (2) larger dip-angles of fault planes for ASSS, (3) three dimensional ocean-bottom structures, such as troughs, trenches and continental shelves, or (4) ocean bottom topography nearby causes the focusing of tsunami waves. (1) is the conclusion that we would like to derive. (2) Speaking about the effect of dip angles to the maximum ocean bottom deformations, the difference is about 30% in cases of reverse faults with dip angles of 30 and 60 degrees. (3) Both of earthquakes along the passive margin of the back-arc basin of the Japan sea and along the Nankai trough are classified into ASSS. (4) Both of local and teleseismic tsunami-wave heights do suggest the similar result, rejecting the local tsunami focusing. Therefore, we conclude that the larger tsunami excitation for ASSS earthquakes is due to larger amount of ocean bottom deformations than those for ADDS earthquakes or by the reason of (1) or by both the effects. Asperity for ADDS locates in the shallow part of the subduction zone along the trench, and it ruptures only in the case of megathrust events like as the 2011 Tohoku-oki earthquake. In estimating tsunami wave heights for future earthquakes, we have to take into account of this difference in tsunami excitations in the ADDS or ASSS zone.