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Uncertainties of tsunami wave height in the tsunami simulation due to dynamic fault rupture effects

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In 2011, the Great East Japan Earthquake generated tsunami that exceeded their expectations and caused massive damage in the Northeast coast of Japan. One of the methods to avoid such unexpected event is to understand cyclopaedically the uncertainties of tsunami wave height as an output of a tsunami simulation. There are two categories of fault parameters in a tsunami simulation: static parameters and dynamic parameters. Static parameters are such as dip, slip, strike angle. Dynamic parameters are risetime and rupture velocity. So far, uncertainties of tsunami wave height due to static parameters has been studying by many previous studies. However, the effect of dynamic parameters are still unclear. In this study, we focused on the dynamic parameters. We quantitatively assessed how dynamic parameters in the tsunami simulation effect on tsunami height. In case of such a great earthquake in 2011 Great East Japan Earthquake, it seemed that the effect of dynamic parameters on uncertainties of tsunami wave height is not negligible.

Firstly, five unit faults were set. Risetime was given and generated for 100 cases using monte-carlo simulation based on probabilistic distribution (log normal distribution) gatherd from past seismic data. The generated risetime applied to each small faults and tsunami simulation was perfomed. Tsunami wave height data was collected at 12 fixed virtual observation points and calculated the variability (standard deviation) from median value of tsunami wave heights. Rupture velocity was also generated for 100 cases using monte-carlo simulation. Rupture starting point applied to each unit fault (5 cases). In a way that rupture spread radially, tsunami simulation was performed. Tsunami wave height data was collected at the same 12 fixed points and calculated the variability from median value of tsunami wave heights.

Throughout the statistical analysis of the above simulation cases, we found that the effect of risetime and rupture velocity on uncertainties of tsunami wave height is not negligible compared with the effect of static parameters. Standard deviation of tsunami wave heights due to risetime and rupture velocity is about 0.01-0.14 and 0.001-0.01 respectively. In the future, we will also investigate the standard deviation change depending on strike angle and distance from fault center.

These results are supposed to be taken into account in the probabilistic tsunami hazard analysis (PTHA) as the aleatory uncertainty. the PTHA might be improved for the future work.

Keywords: tsunami hazard assessment, probabilistic approach, rupture velocity