Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS26-02 Room:103 Time:May 26 09:15-09:30

Tsunami observation inside the source region: a simulation and a theory

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A tsunami observation network is being constructed offshore northeastern Japan, where ˜150 ocean-bottom seismometers and pressure gauges are to be deployed across the source area of huge earthquakes that could possibly occur in future. Since tsunami records inside the source region are seriously contaminated by ocean-acoustic and seismic waves, we cannot correctly estimate the tsunami size if conventional methods are directly used in analyzing these records. It is fundamentally important to know the contributions of the acoustic wave and sea-bottom movements on the tsunami records. By numerically simulating the tsunami generation from the earthquake rupture including the interactions between fluid ocean and elastic earth medium (e.g. Maeda and Furumura 2013 PAGEOPH), we investigated the relation between the sea-bottom pressure and the sea-bottom motion. Past studies employed a simple relation p = rho a h for interpreting ocean-bottom pressure records (e.g. Filloux 1982 GRL), where p is the pressure generated by dynamic sea-bottom deformation, a is the acceleration of the sea bottom, rho is the water density, and h is the sea depth. However, our simulations indicated that this relation failed when a steep sea-bottom deformation occurred. It was necessary to extend the relation by using an analytical solution of an incompressible fluid theory (Saito 2013 EPS). We confirmed that a spatial filtering of tanh (kh)/ kh in the wavenumber domain k reproduced our simulation results better than the simple relation in the past studies.

Keywords: tsunami, earthquake fault, seismic wave, ocean acoustic wave