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Integrated simulation of plate subduction, earthquake dynamic rupture and seismic wave propagation

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We have conducted a joint simulation from the plate subduction to the generation of seismic waves through the earthquake dynamic rupture process. In the simulation of dynamic rupture, we employed shear stress distribution and slip-weakening constitutive relation computed by the quasi-static simulation of earthquake cycles due to the plate subduction [Hashimoto et al., 2004 PAGEOPH] based on slip- and time-dependent constitutive relation [Aochi and Matsu'ura, 2002 PAGEOPH]. The plate boundary model is used for the simulation of earthquake cycles, which is based on the ISC hypocenter catalog, and was qualified by examining the strain distribution caused by the subduction of plates [Hashimoto et al., 2004 PAGEOPH]. In the dynamic rupture simulation, the boundary integral equation method is used that allows us to model non-planar fault geometry [Tada et al., 2000 Comp. Mech; Tada, 2006 GJI]. Using the obtained slip function on the fault, we computed seismic wave propagation using the finite difference method assuming a 3-D heterogeneous velocity structure in this region [Aoi and Fujiwara, 1999, BSSA].

In this presentation, we focus on the 2003 Tokachi-oki earthquake (M8.0). We used a shear stress distribution and slip-weakening constitutive law for the Tokachi-oki-like earthquake obtained by the simulation of plate subduction with non-uniform strength distribution along the plate boundary. We first detect the region where the shear stress is the closest to the strength, initiate the dynamic rupture in this region, and then the rupture starts to propagate. After this computation, we obtain the spatio-temporal distribution of slip on the fault, which becomes the input for the simulation of seismic wave propagation. In the computation, we employed realistic velocity structure model in this area to take into account the propagation path and local site effects as mush as possible. Finally, we obtained the distribution of ground motions caused by the Tokachi-oki like earthquake.