Modeling of the 2003 Tokachi-oki, Japan, Earthquake: Stress Accumulation, Dynamic Rupture and Ground Motions

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We demonstrate that integrated modeling of subduction earthquake is important, introducing several physical constraints. We modeled the 2003 Tokachi-oki, Japan, earthquake (Mw8.3) taking into account the stress accumulation due to tectonic loading, dynamic rupture propagation, and generation of strong ground motions. The Tokachi-oki earthquake is one of the largest subduction earthquakes that occurred after the construction of nation wide seismological network in Japan, and it provided us with plenty of strong motion waveforms. Thus we compared the synthetic seismograms with observed ones to confirm that a simple but physically reasonable modeling can obtain an optimum estimate of ground motions of large earthquakes. Stress accumulation and evolution of constitutive relation are computed to fit the current plate motion assuming the precise geometry of subducting Pacific plate [Hashimoto and Matsu'ura, 2006]. Then using the shear stress distribution and constitutive relation just before the earthquake, dynamic rupture propagation is computed based on boundary integral equation method [Fukuyama et al., 2002; Tada et al., 2000; Tada, 2006]. Finally, using the slip time function in space and time on the fault, we compute the wave propagation assuming realistic 3D velocity structure in this region by finite differences [Aoi and Fujiwara, 1998]. In this series of simulation, nucleation process of the earthquake is one of the major uncertainties, but we still did not have enough information to reproduce this process. Therefore, for the hypocenter locations, we computed for several possible hypocenter locations and compared the resultant strong grand motions. We found that the variation in amplitudes due to different hypocenter locations ranges between factor of 2 and 4 in the period of 3-25s. And within this variation, the synthetic ground motions fit the observation quite reasonably. The above procedure is quite important to construct physics-based earthquake generation model, which might be useful for the prediction and mitigation of disasters due to future large earthquakes. Of course, this simulation still includes certain amount of uncertain parameters, but the parameter searching experiment itself will help us construct useful scenarios of possible disasters we will suffer in the future.