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陸海地形モデルを用いた地震波伝播シミュレーションの並列GPUによる高速化
Multi-GPU-accelerated simulation of seismic wave propagation for models with land-ocean topography

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Accurate simulations of seismic wave propagation using the heterogeneous Earth model is essential in evaluating the strong ground motions due to earthquakes. Recent study with realistic models of land topography and oceanic layer have been revealing their effects on the seismic ground motions (e.g., Nakamura et al., AGU Fall Meeting, 2009). Thus the effects of the land-ocean topography need be incorporated in the simulations and be studied further for better understanding of the ground motions. In order to include those effects, we have recently proposed a unified approach (Takenaka, SEGJ 2009) to model structures with both the irregular free-surface (i.e., land topography) and the irregular water-solid interface (e.g., ocean bottom) in 3D seismic modeling with the finite-difference method (FDM). The approach allows to incorporate the effect of land-ocean topography with sufficient accuracy.

Thus, we implement the unified approach into multi-GPU finite-difference method (FDM) program. The GPUs are adopted to accelerate the simulations because, not only the accuracy, but also the efficiency (performance) of the numerical method is important for the simulation of the seismic wave propagation. GPU (Graphics Processing Unit) is a remarkable device for its many core architecture and for its high memory bandwidth. Recent GPU delivers extremely high computing performance (more than one TFlops in single-precision arithmetic) at a reduced power and cost compared to conventional CPUs.

In this talk we present examples of the simulations by using the new TSUBAME-2.0 grid cluster in the Global Scientific Information and Computing Center, Tokyo Institute of Technology. TSUBAME-2.0 is equipped with 4,224 NVIDIA M2050 GPUs and is ranked as world fourth fastest supercomputer in the recent TOP-500 list. Our MPI-parallel FDM program with the three-dimensional domain decomposition have achieved a performance of about 42.7 TFlops by using 1,200 GPUs so far. The weak scaling was nearly proportional to the number of the GPUs. We will also present some examples of visualization of the wave propagation for realistic land-ocean model.

キーワード: GPU, 地震波伝播, 差分法, 地形, 海底地形
Keywords: GPU, seismic wave propagation, finite-difference method, topography, ocean bottom topography