# Extremely Large-scale earthquake cycle simulations using lattice H-matrices

*So Ozawa[1], Akihiro Ida[2], Ryosuke Ando[3], Tetsuya Hoshino[1]

1. Graduate School of Science, the University of Tokyo, 2. Japan Agency for Marine-Earth Science and Technology, 3. Information Technology Center, the University of Tokyo

Large-scale earthquake sequence simulations using the boundary element method (BEM) incur extreme computational costs through multiplying a dense matrix with a slip rate vector. Recently, hierarchical matrices (H-matrices) have often been used to accelerate this multiplication. However, the complexity of the structures of the H-matrices and the communication costs between processors limit their scalability, and they therefore cannot be used efficiently in distributed memory computer systems. Lattice H-matrices have recently been proposed as a tool to improve the parallel scalability of H-matrices.

In this study, we develop a method for earthquake sequence simulations applicable to 3D nonplanar faults with lattice H-matrices. We present a simulation example and verify the accuracy of our method for a 3D nonplanar thrust fault. We also performed performance and scalability analyses of our code. Our simulations, using over 100,000 degrees of freedom, demonstrated a parallel acceleration beyond MPI processors and a >10-fold acceleration over the best performance when the normal H-matrices are used. Using this code, we can perform unprecedented large-scale earthquake sequence simulations on geometrically complex faults with supercomputers.

Keywords: HPC, Boundary element method, Earthquake cycle Simulation

 