Large-scale earthquake sequence simulations on 3D geometrically complex faults with lattice H matrices

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Large-scale earthquake sequence simulations with boundary element method (BEM) require huge computational costs in multiplication of a dense matrix and a slip rate vector. Recently, Hierarchical matrices (H-matrices) are often used to accelerate the multiplication. However, because of the complex matrix structure of the H matrices and communication costs between processors, it is not highly scalable and cannot be efficiently used on distributed memory computer systems. Recently, lattice H matrices are proposed as a way to improve the parallel scalability of H matrices. Here, we implement lattice H matrices in earthquake sequence simulations on 3D nonplanar faults. Our simulations using over 10^5 degree of freedom show parallel speed-up beyond 10^4 MPI processors and achieve >10-fold speedup compared to the best performance when the normal H matrices are used. By using this code, we can run unprecedented large-scale earthquake sequence simulations on geometrically complex faults with supercomputers.