Earthquake Dynamic Rupture Simulation using Triangular Elements -Second Report -

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Fukuyama et al. (2001, SSJ fall meeting P126) showed a possibility to compute dynamic rupture process on fully non-planar faults using a boundary integral equation method with triangular elements (hereafter we call this code FTS01). They compared the result for a planar fault simulation with that of Fukuyama and Madariaga (1998, BSSA) code (hereafter we call it FM98), which was developed for a dynamic rupture simulation on a planar fault. They found that both results are consistent with each other and confirmed that the computation with FTS01 was made with sufficient accuracy.

In FM98, since all integration kernels are common for all elements on the fault, these kernels are pre-computed and stored their Fourier components. At each time step, convolution is made in Fourier domain to reduce the computation time. However, in FTS01, in order to compute on a non-planar fault, all kernels at all fault elements become different. Thus at each time step kernels are computed and convolutions are made in time domain. Thus FTS01 needed the computation time about three hundred times longer than that for FM98 for a computation we compared as an example. But it should be noted that in FTS01 computation time is independent of the fault geometry (planar or non-planar).

There is a problem that FTS01 requires more computation time than FM98 (N^2 vs. NlogN) although it consumes less memory space (N vs. N^2). This problem is overcome by using parallel code with MPI library. Parallel computation is made under the SCore environment on the RedHat Linux. Only the integration kernel computation and convolution are parallelized and speedup rate, which is defined as the ratio of elapse time of single CPU to that of n CPUs, becomes 0.9n. We could achieve a very good performance.

Aochi and Fukuyama (2002, JGR) simulated the Landers earthquake whose fault trace is very complicated. This code enables us to model a subduction earthquake whose geometry changes along both strike and dip directions.

Using FTS01, we modeled the earthquake along the Tokachi-Oki subduction zone. Initial stress distribution is assumed by taking into account the plate subduction and spatially variable constitutive relation is introduced. The preliminary result shows that fault geometry controls the stress distribution on the fault and this stress heterogeneity affects the dynamic rupture process.