Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SSS30-P13 Room:Convention Hall Time:May 25 18:15-19:30

Development of the quasi-dynamic cycle simulation code including both great and small earthquakes

TAKASAKI, Keisuke[1*] ; HIRAHARA, Kazuro[1] ; OHTANI, Makiko[1]

[1]Graduate School of Science,Kyoto University

The magnitude-frequency relation of earthquakes is formulated as Gutenberg-Richter law (GR law). The b values in the GR law take different ones depending on the regions and also show temporal changes. If the b value increases,the number of large earthquakes relatively decreases,and vise versa.

Nanjo et al.(2012) reported that the b value had decreased during a period of ten years before great earthquakes,such as 2011 Tohoku and 2004 Sumatra earthquakes. They suggested that the decrease of the b value can be phenomenon before the occurrences of great earthquakes.

Tormann et al.(2015) reported that the b value,which increase after the 2011 Tohoku earthquake,decreased to the value nearly equal to that before the earthquake.

Although the physical mechanism of the temporal change in the b value has remained unclear,small but many earthquakes may give some effect on the occurrence of great earthquakes or at least the change in the b value can be an indicator of stress state in the focal regions of great earthquakes. It may lead to forcasting great earthquakes that we understand the physical mechanism of the temporal change in the b value. One of ways for clarifying the physical mechanism is to simulate earthquake cycles,which include not only great earthquakes but also small ones,and reproduce the spatio-temporal change in b value for a variety of rate-and state friction models.

Since interseismic period is much longer than coseismic one,the adaptive time-step control Runge-Kutta method is usually used in the present simulations. While the time-steps take small values around the coseismic period with large slip rates,the time-steps take larger ones in the interseismic period with smaller slip rates. Most of present simulations reproduce only great earthquakes,not including many earthquakes with different magnitudes.

If the small earthquakes whose magnitude-frequency relation obeys the GR laws are simulated in addition to great ones,the earthquakes always occur and requires small time-steps in the whole period,leading to the huge computational costs. Thus,we have to reduce the costs for small earthquake simulations in particular to realize the realistic cycle simulations of earthquakes with a variety of sizes.

As noted above,it is the key issue to reduce the computational costs in order to simulate the spatio-temporal change in the b value in the focal region during great earthquake cycles. In our simulations,we use the boundary element method and the quasi-dynamic approximation(Rice,1993).

In addition to the problem of time-steps,the time consuming part is the product calculation of the slip response function matrix and the slip velocity vector. When plate interface is divided into the N small subfaults, the computational cost is O($N*N$). N become much larger when including small earthquakes. We apply H-matrices method to the product part in cycle simulations,which reduces the memory size and the CPU time to O(N)-O($N\log N$)(Ohtani et al.,2011).

As described above,we have to use small time-steps in cycle simulations including also cycles of many small earthquakes,and the computational costs become huge. For this reason,RSQSim(Dieterich and Richards-Dinger,2010) code has been developed. In this study,however,we try to develop another code which performs the same quasi-dynamic cycle simulations for large earthquakes as in the usual ones and the simplified ones for small earthquakes. Namely,when the stress at a patch of small earthquake reaches a certain value,the stress is released and the slip and slip velocity are given in proportion to the stress drop.

In the talk,we give some details of the computation and evaluate our model. Furthermore,we add discussion on the current problems and th future perspectives of our approach.

Keywords: earthquake cycle, numerical simulation, Gutenberg-Richter law, fast computation