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Accumulation of earthquake scenarios towards the construction of simulation database

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In recent years, earthquake cycle simulations based on plate motions and rock friction laws have been utilized for studies on the earthquake preparation process and repetition pattern of the earthquake which occurs in the plate boundary near the Japanese Islands (e.g., Hori et al., 2004, Nakata et al., 2012, etc.). In these studies, the target earthquakes are mainly events occurred in the past. Through the trial-and-error correction in the distribution of frictional property on faults, many forward simulations are carried out until the basic repetition patterns or magnitudes of target earthquake is reproduced. Then, for expecting the future repetition of target earthquakes, the extension of simulations for some tuned parameters might be utilized. However, an natural earthquake is a highly nonlinear problem with huge degrees of freedom, and the modeling error of forward simulations of earthquake cycles is generally large due to the simplicity. For this reason, ”deterministic future prediction” is theoretically impossible through the above strategy based on the reproduction of old events.

That is, for the purpose of practical earthquake prediction, we need the prediction framework which can reflect the real-time observation data (such as crustal deformation) without large time lag, and can perform sequentially with increasing data. In order to realize such prediction, we propose the construction of a simulation database consisted of a large number of simulation results (scenarios) with various simulation models or model parameters. If such database is established, with the increase of realtime observation data, simulation results in the database are sequentially accessed and utilized to compare with observed data by likelihood evaluation. Then, the extrapolation of scenarios with higher likelihood values is regarded as the tentative prediction based on the last observation data. The large advantage of this prediction concept is that the resultant predictions have high flexibility according the real-time observation data.

Due to the recent development of domestic High Performance Computing Infrastructures(HPCI), such as K (RIKEN) or ES2 (JAMSTEC), within several days, we can calculate 100-1000 scenarios of quasi-dynamic earthquake cycle simulations, with moderate discretization (about 1km cell) of the plate interface (about 300kmx800km area). Now, for the Nankai Trough region where the next earthquake occurrence is anticipated, many earthquake scenarios with various frictional parameters are tried, and simulation database is under construction towards the establishment of earthquake prediction system.

In the presentation, we will introduce the more details of simulation database and the concept of our prediction system.

Keywords: High Performance Computing, earthquake cycle simulation, database, prediction system, realtime data