A Proposal of Monitoring and Forecasting Method for Crustal Activity in and Around Japan with 3D Heterogeneous Medium Using a Large-Scale High-Fidelity Finite Element Simulation

*Takane Hori[1]

1. R&D Center for Earthquake and Tsunami, Japan Agency for Marine-Earth Science and Technology

Recently, we can obtain continuous dense surface deformation data on land and partly on the sea floor. The obtained data are not fully utilized for monitoring and forecasting of crustal activity, such as spatio-temporal variation in slip velocity on the plate interface including earthquakes, seismic wave propagation, and crustal deformation. For construct a system for monitoring and forecasting, it is necessary to develop a physics-based data analysis system including (1) a structural model with the 3D geometry of the plate interface and the material property such as elasticity and viscosity, (2) calculation code for crustal deformation and seismic wave propagation using (1), (3) inverse analysis or data assimilation code both for structure and fault slip using (1) & (2). To accomplish this, it is at least necessary to develop highly reliable large-scale simulation code to calculate crustal deformation and seismic wave propagation for 3D heterogeneous structure. Unstructured FE non-linear seismic wave simulation code has been developed. This achieved physics-based urban earthquake simulation enhanced by 1.08 T DOF x 6.6 K time-step. A high fidelity FEM simulation code with mesh generator has also been developed to calculate crustal deformation in and around Japan with complicated surface topography and subducting plate geometry for 1km mesh. This code has been improved the code for crustal deformation and achieved 2.05 T-DOF with 45m resolution on the plate interface. This high-resolution analysis enables computation of change of stress acting on the plate interface. Further, for inverse analyses, waveform inversion code for modeling 3D crustal structure has been developed, and the high-fidelity FEM code has been improved to apply an adjoint method for estimating fault slip and asthenosphere viscosity. Hence, we have large-scale simulation and analysis tools for monitoring. We are developing the methods for forecasting the slip velocity variation on the plate interface. Although the prototype is for elastic half space model, we are applying it for 3D heterogeneous structure with the high-fidelity FE model. Furthermore, large-scale simulation codes for monitoring are being implemented on the GPU clusters and analysis tools are developing to include other functions such as examination in model errors.

Keywords: Earthuake Forecasting , 3D Heterogeneous Medium, High-Fidelity

