A proposal of monitoring and forecasting system for crustal activity in and around Japan using a large-scale high-fidelity finite element simulation codes

*Takane Hori[1], tsuyoshi ichimura[2], Narumi Takahashi[3,1], Katsuhiko Shiomi[3], Yoshiyuki Kaneda[1,4]

1.Japan Agency for Marine-Earth Science and Technology, 2.Earthquake Research Institute, University of Tokyo, 3.National Research Institute for Earth Science and Disaster Prevention, 4.Kagawa University

Here we propose a system for monitoring and forecasting of crustal activity, especially great interplate earthquake generation and its preparation processes in subduction zone. Basically, we model great earthquake generation as frictional instability on the subjecting plate boundary. So, spatio-temporal variation in slip velocity on the plate interface should be monitored and forecasted. Although, we can obtain continuous dense surface deformation data on land and partly at the sea bottom, the data obtained are not fully utilized 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. Actually, Ichimura et al. (2014, SC14) has developed unstructured FE non-linear seismic wave simulation code, which achieved physics-based urban earthquake simulation enhanced by 10.7 BlnDOF x 30 K time-step. Ichimura et al. (2013, GJI) has developed high fidelity FEM simulation code with mesh generator to calculate crustal deformation in and around Japan with complicated surface topography and subducting plate geometry for 1km mesh. Further, for inverse analyses, Errol et al. (2012, BSSA) has developed waveform inversion code for modeling 3D crustal structure, and Agata et al. (2015, this meeting) has improved the high fidelity FEM code to apply an adjoint method for estimating fault slip and asthenosphere viscosity. Hence, we have large-scale simulation and analysis tools for monitoring. Furthermore, we are developing the methods for forecasting the slip velocity variation on the plate interface. Basic concept is given in Hori et al. (2014, Oceanography) introducing ensemble based sequential data assimilation procedure. Although the prototype described there is for elastic half space model, we will apply it for 3D heterogeneous structure with the high fidelity FE model.

