Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

SSS30-P09 Room:Poster Time:April 29 18:15-19:30

Large-scale simulation of coseismic and postseismic crustal deformation using a high-fidelity finite element model

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Postseismic crustal deformation of a subduction zone earthquake is an essential factor in such studies as interseismic slip deficit rates and stress-field change of the focal area of inland earthquakes. The viscoelastic behavior of the asthenosphere largely affects postseismic crustal deformation. Several studies have used analytical models or three-dimensional (3D) finite element (FE) method to simulate postseismic crustal deformation, considering the viscoelasticity. Yet because of the large computational cost, simulations using a realistic model of crustal structure have not been carried out, despite that detailed crustal data are available. Based on the technique of high performance computing, we performed large-scale finite element simulations using 3D FE models of higher-fidelity (High-fidelity model: HFM) to available crustal data. We used the data of JTOPO30, which was constructed in a 900 m resolution by MIRC (JTOPO30, 2003), for modeling the ground surface and CAMP standard model (Hashimoto et al. 2004) for the interplate boundaries. By using this data, we constructed a one-kilo-meter-resolution HFM with the size of 1700 x 2600 x 400 km, which includes the whole of the Japanese Islands. The model has 30km thick crust and the underlying viscoelastic mantle wedge, where the Philippine Sea and the Pacific plates are subducting beneath the Eurasian and the North American plates. Because the target area was large, we also took into consideration the curvature of the earth. We expect a large degrees-of-freedom in our HFM. Therefore, to compute the time history of the crustal deformation with such a large-scale model, we used the K computer, the fastest supercomputer in Japan.

In the session, we will show the simulation of the 200-year time history of postseismic crustal deformation using the HFM. In addition, by comparing the results of various sizes of temporal and spatial discretization, we will demonstrate that our method can compute the solution with discretization fine enough for numerical convergence.

Keywords: postseismic crustal deformation, high-fidelity finite element model of crustal structure, large-scale simulation