# Evaluation of long-period ground motions from megathrust earthquakes along the Kuril Trench using the supercomputer Fugaku

*Masashi Nishimoto[1], Yu Yamamoto[1], Ryoichiro Agata[2], Takane Hori[2]

1. Taisei Advanced Center of Technology, 2. Japan Agency for Marine-Earth Science and Technology

There are concerns about extensive damage caused by megathrust earthquakes along the Kuril Trench, and damage estimates were presented by the Cabinet Office (2021). In particular, long-period ground motions generated by these earthquakes may have a significant impact on buildings with long natural period, such as tall buildings and seismically isolated buildings in Sapporo and oil tanks in Tomakomai. Therefore, the evaluation of long-period ground motions caused by multi-segment earthquakes in the region is important. On the other hand, the seismic-source characteristics have uncertainty, and the ground motion prediction results may vary greatly depending on the selection of them. Therefore, long-period ground motions are evaluated using a variety of source models, such as the study of the earthquakes in the Sagami Trough by the Cabinet Office (2016). We analyzed the effect of uncertainty in seismic-source characteristics on long-period ground motions for the foreshock of the 2016 Kumamoto earthquake.

In this paper, we evaluated the long-period ground motions caused by the megathrust earthquakes from off Tokachi to off Etorofu Island by using the three-dimensional finite element method (3D-FEM). In addition, we evaluated the influence of the seismic-source characteristics on the long-period ground motions.

The evaluation of ground motions was carried out by using a large-scale 3D-FEM calculation program "E-wave FEM" for seismic motion calculation, and supercomputer "Fugaku" and "Oakforest-PACS" were used as calculation resources. The modeled area is 1,000 km long, 420 km wide, and 150 km deep, including the sea areas in eastern and southern Hokkaido, and the subsurface structure is based on the Japan Integrated Velocity Structure Model of the Headquarters for Earthquake Research Promotion (HERP). The subsurface structure was extrapolated along the trench axis of the Kuril Trench for the area east of 147 degrees east longitude. The model was divided into tetrahedral quadratic elements with a period of more than 3.3 seconds and a size of five elements per wavelength. It had 1.473 billion nodes and 1.078 billion elements. The Earth Simulator was used for mesh generation. We set up 28 cases of seismic-source models considering the uncertainty of seismic-source characteristics in asperity sizes, locations, and rupture initiation point locations based on the models of the Cabinet Office (2020). The other seismic-source characteristics were in accordance with the Recipe for Predicting Strong Ground Motions of the HERP.

We calculated the long-period ground motions using the above analysis method, subsurface model, and seismic-source models. We found that the long-period ground motions at some K-NET and KiK-net stations exceeded those of the 2003 Tokachi-oki earthquake. We will report the results of analysis of seismic-source characteristics that have a significant influence on seismic intensity.

Acknowledgements : This work was supported by MEXT as “Program for Promoting Researches on the Supercomputer Fugaku” (Large-scale numerical simulation of earthquake generation, wave propagation and soil amplification, JPMXP1020200203) and used computational resources of the supercomputer Fugaku provided by the RIKEN Center for Computational Science and the Oakforest-PACS provided by

 

Joint Center for Advanced High Performance Computing (Project ID: hp210171). This work also used the Earth Simulator provided by Japan Agency for Marine-Earth Science and Technology. The results of this analysis were obtained from the code developed by the Earthquake Research Institute, the University of Tokyo, which was provided by the Fugaku Project and modified and operated by JAMSTEC. We are grateful for the provision of the code. We used strong-motion records from K-net and KiK-net of the National Research Institute for Earth Science and Disaster Prevention, and the Japan Integrated Velocity Structure Model of the Headquarters for Earthquake Research Promotion.

Keywords: Long-period ground motion, Three-dimensional finite element method, Megathrust earthquakes along the Kuril Trench, Seismic-source uncertainties

 