

Large numerical simulations for modeling and forecast in the Science of Slow-to-Fast Earthquakes

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Slow earthquakes have a seismic moment of more than 10 orders of magnitude, and fast earthquakes (i.e., regular earthquakes) have a larger range of seismic moment than slow earthquakes. In addition, slow and fast earthquakes obey different scaling relationships over both temporal and spatial scales. To understand the slow and fast earthquakes and the transition between the slow and fast processes, a research project, which is entitled as "The Science of Slow-to-Fast Earthquakes", was adapted in September, 2021, as a Grant-in-Aid for Scientific Research Project [Grant-in-Aid for Transformative Research Areas (A)] of MEXT, Japan. This project will end in March 2026. A planned research subgroup of this project, entitled as "Spatio-temporal multiscale modeling and forecast of slow and fast earthquakes" (hereafter, modeling and forecast group), aim to model and forecast the occurrence of slow and fast earthquakes and the transition between them. In this talk, we introduce the modeling and forecast group.

The modeling and forecast group consists of three subgroups: modeling, forecast, and data analysis for large-scale calculations. In terms of modeling, we will model slow and fast earthquakes, especially making large-scale numerical simulations that maintain hierarchy of slip distribution and multi-scale complexity. We develop numerical codes for large computing, using GPGPU (e.g., Matsuzawa, 2022, this meeting), and H-matrix method. We also aim to integrate stochastic and statistic models with physical models. In terms of forecast, we will conduct earthquake forecasting based on a various approaches based on new perspectives, in addition to an HPC-based approach. We also aim to incorporate real-time information in a further study. Regarding data analysis for large-scale calculations, we will conduct research to quantify model errors (uncertainty quantification) by applying HPC and to extend the spatio-temporal range of the catalogs of slow and fast earthquakes through the analysis of past data.

In addition, we also aim to develop a research area linked to the field of HPC. For example, the modeling and forecast group are planning to use the result obtained from the Fugaku project of Riken, Japan. The modeling and forecast group also intend to submit a proposal of a research theme to the Fugaku project.

Keywords: slow earthquakes, numerical modeling, forecast