Prediction of Strong Ground Motion with “Recipe”

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Summary

A recipe for estimating strong ground motions from specific earthquakes is proposed based on source characteristics from the waveform inversion using strong motion data. Main features of the source model are characterized by two kinds of parameters, which we call: outer and inner fault parameters. The outer fault parameters are to outline the overall pictures of the target earthquakes such as entire source area and seismic moment The inner fault parameters are parameters characterizing fault heterogeneity inside the fault area. Further, other fault parameters are considered to complete the source model such as the starting point and propagation pattern of the rupture. The seismic hazard maps for future large earthquakes with high probability of occurrence potential are made following the idea of the recipe proposed here by two governmental organizations, the Head Quarter of Earthquake Research Center and Central Disaster Prevention Council in Japan.

1. Introduction

From recent developments of the waveform inversion analyses for estimating rupture process using strong motion data during large earthquakes, we have understood that strong ground motion is relevant to slip heterogeneity inside the source rather than average slip in the entire rupture area. Asperities are characterized as regions that have large slip relative to the average slip on the rupture area, based on slip distributions estimated from the source inversion (Somerville *et al.* , 1999). Then, the asperity areas as well as total rupture areas scale with seismic moment. We examined that strong motion generation areas approximately coincide with the asperity areas where stresses are largely released (Miyake *et al*., 2003). Based on the scaling relationships, the source model for the prediction of strong ground motions is characterized by two kinds of parameters, outer and inner fault parameters. The outer fault parameters are conventional parameters such as rupture area and seismic moment to outline the overall pictures of the source fault. The inner fault parameters are defined as slip heterogeneity inside the source, area of asperities, and stress drop on each asperity. We developed a recipe for predicting strong ground motions, which is to characterize the source model for the future large earthquakes based on geological and geomorphological surveys.

2. Strong Motion Prediction Program in Japan

The basic policy for defining the seismic hazard in Japan is based on the 1999 fundamental mission statement governing earthquake research over the next ten years as “The promotion of earthquake research – comprehensive basic policies for the promotion of seismic research through the observation, measurement, and survey of earthquakes –“, established by the Headquarters for Earthquake Research Promotion (Director: Ministry of Education,

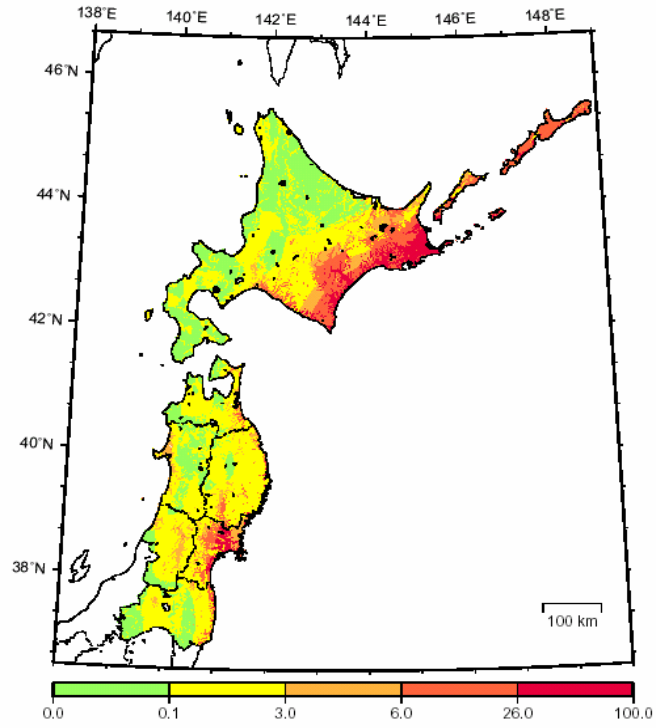

Fig. 1. Probability of suffering strong motion more than seismic intensity 6- within 30 years from 2005 AD (Earthquake Research Committee, 2005).

Culture, Sports, Science, and Technology). It initiated the creation of seismic hazard maps by promoting the survey of active faults, long-term evaluation of occurrence potentials and prediction of strong ground motion.

There were established two subcommittees under the Headquarter. One is for long term evaluation of earthquakes. The other is for strong motion evaluation that started in 1998 to make the seismic hazard maps from two different approaches, probabilistic and deterministic.

The probabilistic seismic hazard map is shown as the predicted likelihood of a ground motion level such as PGA, PGV, and seismic intensity occurring in a given area within a set period of time shown in Fig. 1. It provides important information for land planning, design standards of structures and people's enlightening as to seismic risks.

The deterministic seismic hazard map is shown as the distribution of the ground motion level predicted for individual specific earthquakes assuming their fault models. The strong ground motions at specific sites near each source fault are estimated as time history, based on the recipe characterizing the source and numerical simulation considering the 3-D structures from the source to the target sites. Such time histories of the ground motions are useful for nonlinear dynamic analysis of structures, which is needed to design earthquake-resistant buildings and critical structures such as bridges, lifelines, electric power plants, and so on.

The Central Disaster Prevention Council belonging to the Cabinet Office also made seismic hazard maps for the Tokai, Tonankai and Nankai earthquakes shown as Fig. 2, which are feared likely to occur within the next half century. They made damage and causality estimates to determine disaster management plans for those earthquakes.

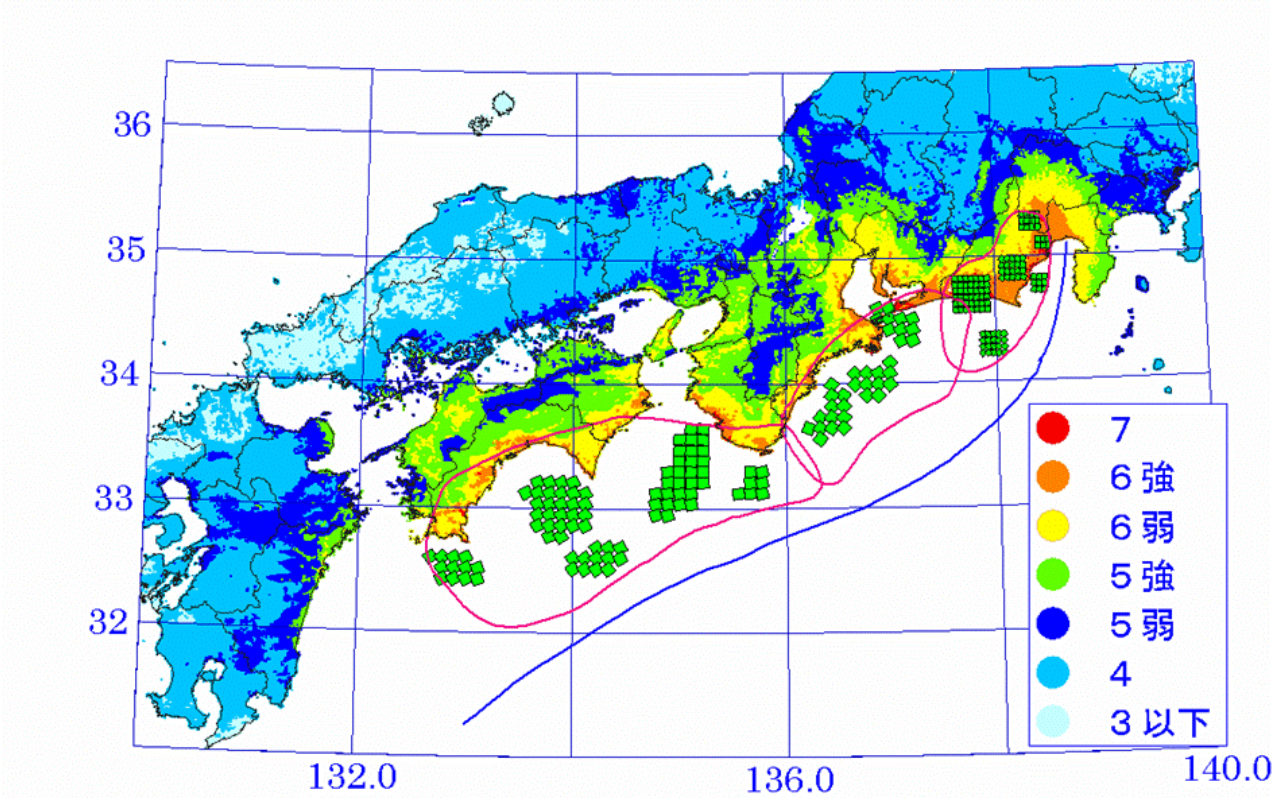

Fig. 2. Seismic intensity map from three earthquakes, Tokai, Tonankai, and Nankai earthquakes continuously generated (Central Disaster Prevention Council, 2003).

References

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