Summary

This report presents the results of the project “Research on rapid estimation of the parameters for large earthquakes along trenches”, which was conducted by the Seismology and Tsunami Research Department, MRI, over six years from FY 2010 to FY 2015. The report consists of four chapters.

Chapter 1: Estimation of earthquake magnitude and related parameters

Chapter 2: Estimation of fault rupture length and slip distribution

Chapter 3: Estimation of aftershock distribution

Chapter 4: Estimation of distribution of strong ground motion

Chapter 1 reports on methods of rapid estimation of earthquake magnitude and source parameters that were developed to overcome difficulties encountered during determination of the magnitude of the 2011 off the Pacific coast of Tohoku Earthquake (2011 Tohoku earthquake hereafter). Section 1.1 describes various methods for the rapid determination of magnitude of great earthquakes. Section 1.2 describes a method of magnitude estimation based on peak ground displacement for various cut-off periods. Section 1.3 describes the characteristics of rupture propagation inferred from the duration of strong motion. Section 1.4 describes a method for categorizing focal mechanisms.

Chapter 2 reports on methods for rapid estimation of the length of rupture of the earthquake fault and the slip distribution. Section 2.1 describes a method for estimation of the length of rupture of the earthquake fault from the distribution of seismic intensity. Section 2.2 describes a method to estimate the area of large coseismic slip by using an array technique for long-period seismic waves. Section 2.3 describes the source process analysis for the 2011 Tohoku earthquake. Section 2.4 describes the source process analyses for major aftershocks of the 2011 Tohoku earthquake. Sections 2.5 and 2.6 describe real-time methods for estimation of tsunami source parameters using both of onshore GNSS data and offshore tsunami data.

Chapter 3 reports on methods of hypocenter determination, related studies of aftershocks, and improvements in the precision of hypocenter determinations. Section 3.1 describes an automated method of hypocenter determination that uses Bayesian analysis. Section 3.2 describes an automated method for estimation of aftershock distributions by using envelope data. Section 3.3 describes seismicity recorded by pop-up OBSs in the outer rise area of the Nankai trough. Section 3.4 describes long-term pop-up OBSs that were developed to improve seismic observation data in offshore areas. Section 3.5 describes a crustal structure model of the Japanese islands estimated to improve the precision of hypocenter determinations. Section 3.6 describes a method for fast determination of hypocenters by using 3D traveltime tables. Section 3.7 describes seismicity activated after the 2011 Tohoku earthquake in various areas of Japan.

Chapter 4 reports on methods for estimation of the distribution of strong ground motion. Section 4.1 describes the relationship between subsurface structure and ground motion of various periods. Section 4.2 describes the strong ground motion of the 2011 Tohoku earthquake. Section 4.3 describes a method for estimation of seismic wave propagation by using a data assimilation technique.

Some of the methods described here have been used to improve tsunami warnings since March 2013.