MCMCを用いたリアルタイムGNSSデータによる断層モデル即時推定の不確実性定量評価の試み

Trial of quantitative uncertainties estimation for the rapidly estimated coseismic fault model deduced from real-time GNSS data using MCMC approach

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It is extremely important to immediately understanding the size of the huge earthquake in the offshore region and its fault expansion for the near-field tsunami forecasting. Since September 2012, Geospatial Information Authority of Japan (GSI) and Tohoku University is jointly developing the GEONET real-time analysis system (REGARD) . The system has two different fault model estimation approach which are slip distribution in the plate interface and single rectangular fault model. One of the problem in those fault model estimation is the estimation accuracy in the offshore region because insufficient sensitivity of the offshore fault slip based on the only onshore GNSS data. Understanding of such uncertainties are also important for the understanding of the uncertainties of resulting tsunami. Thus, we try to estimate the quantitative estimation of coseismic fault model uncertainties based on MCMC (Markov Chain Monte Carlo methods), which is probabilistic approach based on Bayesian statistics. In the MCMC, we can obtain estimation result as probability density function (PDF) of unknown parameters.

In this study, we estimated a single rectangular fault model deduced from permanent coseismic displacement field by the real-time GNSS data. We adopted basic MCMC Metropolis Hasting method with minor modification for more appropriate estimation. For the problem simplification, the fault plane was assumed to be located in the plate interface. We applied this approach to the 2011 Tohoku-Oki earthquake. In the estimation, we discard the first 1×10^6 samples as having memory of the initial parameters and regard the subsequent $1x10^7$ samples as samples drawn from the posterior PDF. Obtained results clearly shows the tradeoff between the fault dimension and the slip amount. The obtained PDF of the slip amount shows the complex shape. Thus we focused on the stress drop value. Based on the multiple Markov chains with different threshold of stress drop value, we obtained simple PDF shape of the slip amount in each threshold value. It is interest that all of the fault model based on different threshold value of the stress drop can explain the data well. This results suggest that the data cannot constraint these parameters, and our results clearly shows the possibility of the quantitative uncertainties estimation of the tsunami forecasting based on the onshore real-time GNSS data.

We will shows the more detail characteristic of the unknown parameters estimation using MCMC approach. Furthermore, we will expand this approach to the not only single rectangular fault model but also the slip distribution in the plate interface.

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