# Uncertainty evaluation of source parameter estimates by MCMC in Oklahoma

*Nana Yoshimitsu[1], Takuto Maeda[2], William Ellsworth[3]

1. The University of Tokyo, Earthquake Research Institute, 2. Hirosaki University, 3. Stanford Univerisy

Stress drop is important parameter to understand earthquake source characteristics and to improve hazard assessment. Many studies use the spectral ratio method to measure the moment ratio and two corner frequencies by comparing theoretical and observed spectral ratio in the frequency domain and obtain the stress drop. Accurate stress drop estimates are difficult to make because it depends on the accuracy of the three parameters. The Markov Chain Monte Carlo (MCMC) method is effective to estimate high dimensional parameters. In this study, we evaluate the uncertainty of the estimation and trade-off among parameters from a statistical perspective.

We analyzed five clusters of events near Cushing, Oklahoma, each containing a M 4+ event. Empirical Green’ s function events used as the denominator all locate within 2 km of the target event. We analyzed 5.12 seconds of the time-aligned seismogram from twice the S wave arrival time. Spectral ratios between a large event ($M_L > 4$) and small events were formed by stacking all stations to remove path effects. Then, analyzed spectral ratios between event pairs using the Metropolis-Hastings algorithm to estimate moment ratio and two corner frequencies for the Brune model. We updated the value of moment ratio and two corner frequencies with 300,000 iterations which first 100,000 calculations was ignored as burn-in.

In most cases, the distribution of the sampling showed ellipsoidal shape in the 3D parameter space. We searched the axial direction of the sampling distribution by principal component analysis (PCA), and estimated loadings of the principal component and contribution rate. Some spectral ratio showed irregular shape from ideal shape because of small magnitude difference or contamination by noise. The percentage of the contribution rate indicates how well the sampling distribution is explained by each component. The contribution rate of the first principal component with irregular shape of the spectral ratio was lower than 80 % while it was higher than 80 % with normal shape of the spectral ratio. The loadings among three parameters and three principal components also showed different pattern in the case of normal shape and irregular shape of the spectral ratio. These different trend of the contribution rate and the loadings indicates different pattern of the sampling distribution of a spectral ratio that have irregular shape. Thus, the combination of MCMC and PCA analysis have a possibility that to automatically classify spectral ratios which have irregular shape and ideal shape.

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