Importance of covariance components in the inversion of seismic waveforms (2): source inversion without non-negative constraint

Yuji Yagi[1]; Yukitoshi Fukahata[2]

[1] Univ. of Tsukuba; [2] Dept. Earth and Planet. Science, Univ. Tokyo

The non-negative constraint has been widely applied to the estimation of rupture process of large earthquakes in seismic waveform data analysis. The non-negative constraint is useful in stably obtaining the results that are apparently plausible. On the other hand, the non-negative constraint conceals inappropriateness in the setting of inverse models, since apparently plausible results are usually obtained due to the non-negative constraint, which leads to improper estimation of source models. Therefore, if possible, it is clearly better to solve inverse problems without the non-negative constraint. Substantial negative slips, which emerges in the inversion analysis without non-negative constraint, are commonly caused by some systematic errors. By taking the data covariance components into account, we can mitigate the effect of systematic errors. In this study, we first calculated the covariance matrix of waveform data considering the effect of discretization errors and filtering. We next performed source inversion without the non-negative constraint for several earthquakes. Then, comparing the inverted results with the data covariance components to those without the covariance components, we found that the slip distributions obtained by the new formulation is stable, whereas the slip distributions obtained by the traditional formulation tend to concentrate into small patches. By considering the data covariance components, we have succeeded in obtaining plausible slip distributions without the condition of non-negative slip. This is a clear advance to the estimation of proper slip distributions of earthquakes.