Waveform inversion for source processes in an incomplete model (2): Seismic source analyses with green's function uncertainties

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Seismic waveform inversion has been a popular tool to construct seismic source models. As pointed out by many researchers, however, seismic source models for the same earthquake are often quite different from one another. In our previous study, we introduced the simplified covariance components due to the effect of inelastic attenuation of the Earth, and demonstrate the importance of covariance components in inversion analyses (Yagi and Fukahata, 2008, GJI). This covariance matrix is convenient for inverse analysis, but they neglected green's function uncertainties.

In seismic waveform data analysis, green's function error could strongly bias the inversion results. In actuality, it is impossible to construct a true structure model in computers, and to calculate a true green's function, so we should construct new formulation with assumption that we couldn't obtain a true green's function. In this study, we developed a method of seismic source inversion taking the data covariance components owing to an incomplete modeling of a seismic source and an underground structure into take account, and then applied this method to teleseismic waveform data of large earthquakes.

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 and contain large negative slip. 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.