Dynamic Source Inversion Analysis based on the Formulation Avoiding Undesirable Sensitivity

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In recent years, source rupture processes of many large earthquakes were reported based on kinematic source inversion method. However, kinematic inversion method is only based on physical plausible considerations. Some researchers pointed out those results were noncausal by unphysical constraints on the rupture velocity, source time function and total slip.

Dynamic source model satisfies physical relationship between stress and strain field near the fault plane. The method simulates the source rupture process based on several parameters, such as initial stress, yield stress, residual stress and slip weakening distance. Peyrat and Olsen (2004) applied dynamic source model to inversion analysis in order to estimate the source parameters from strong motion records during the 2000 Western Tottori, Japan, earthquake. However, their method is so sensitive that only direct search method can be applied for the inversion algorithm. It results that long calculation time is required.

We propose a new dynamic source inversion method, which is formulated by introducing a suitable set of dynamic parameters named 'consolidated dynamic parameters'. Rupture time is included in the consolidated dynamic parameters to eliminate the undesirable sensitivities, which is the effect of abrupt rupture caused by small change in the yield traction. We also propose a stage-by-stage inversion process, in which the number of estimated values increase as the stage turns, in order to give adequate initial values and to clarify the resolution of the inversion problem. A calculation time of proposed method is 160 times faster than the Peyrat and Olsen's method.

Reference

Payrat. S and K. B. Olsen (2004).

Nonlinear dynamic rupture inversion of the 2000 Western Tottori Japan, Earthquake, Geophysical Research Letters, Vol.31, L05604.