Dynamic simulation of a dipping fault using a 3D-FDM with nonuniform spacing

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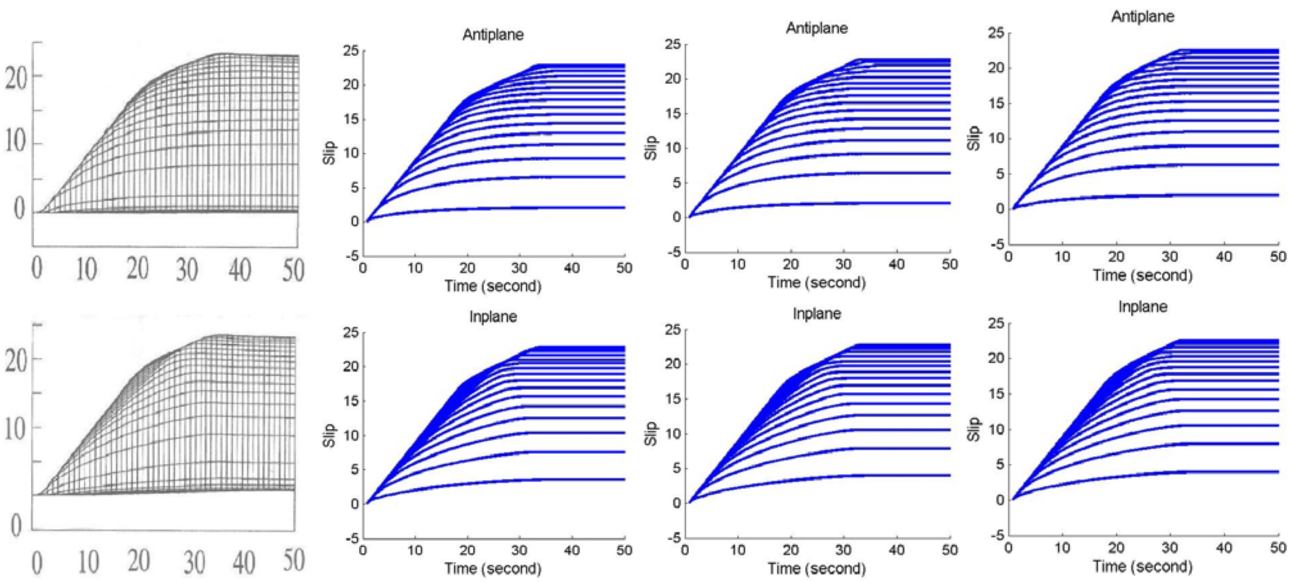
1. Introduction

The finite-difference method (FDM) has been widely used for numerical modeling of seismic source problems, including investigation on the dynamic source processes. Owing to both conceptual and computational constraints of FDM, fault models have largely been limited to the cases that the fault planes are parallel to the FDM grid, such as faults in unbounded media, horizontal or vertical faults. However, recent observation and kinematic inversion results discover that more complex fault geometry models, such as bending faults or curved faults, are needed to explain some earthquake phenomena. Thus, we need to develop an approach of FDM to analyze a nonvertical fault model that the fault plane is slanted with respect to the FDM grid.

In this study, we propose a method to analyze the dynamic source problems of nonvertical faults, using a 3D FDM with nonuniform grid spacing presented by *Pitarka* (1999). This approach does not require aligning the fault plane to the FDM grid for implementation of FDM. We estimate the shear stress on the nonvertical fault plane from the six stress components obtained in FDM calculation with respect to the force balance condition and the coordination transformation. This method can deal with a more realistically complex fault geometry model.

2. Validation of the method

We validate our method by studying two cases of the dynamic source problems which have been analyzed by *Madariaga et al.* (1998). One is the instantaneous rupture model of a circular fault embedded in a homogeneous elastic medium; another is the spontaneous rupture model of a rectangular fault which starts from a local circular asperity on the fault plane. We analyze the inclined fault models against the space grid coordination for both of the rupture problems and compare our simulations with previous results obtained by *Madariaga et al.* (1998) using the horizontal fault plane model. The comparisons show that our simulations are similar with those of *Madariaga et al.* (1998). These results validate that our method can be used to analyze the dynamic rupture processes of dipping fault models.



(a) (b-1) (b-2) (b-3)

Figure 1 Slip as a function of time for an instantaneous rupture of a circular fault
[(a).Result of *Madariaga, et al.*, 1998, dip=0°; (b) This study: (1) dip=15°, (2) dip=30°, (3) dip=45°]