Geophysical Research Abstracts, Vol. 9, 10029, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-10029

Quantitative fault discontinuity modeling using the Partition of Unity Method

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Accurate quantitive knowledge of the stress field in a fault area is important in the assessment of seismic hazard. Regions of high Coulomb stress, whether induced by nearby earthquakes, deep stress relaxation or other mechanisms, have been shown to correlate closely to the location and orientation of subsequent seismic events. The past decades have seen extensive research in this field, resulting in the various types of models that are in use today; ranging from the boundary element method applied to an elastic half space to complex three-dimensional finite element models. Because of the discontinuous nature of fault systems, however, many of these models are either oversimplified or computationally very demanding.

In this contribution we propose a different modeling strategy, based on the Partition of Unity Method, an enhanced finite element method that originates from the field of material failure mechanics. Discontinuities introduced by fractures are modeled separately from the finite element mesh, which can therefore remain regular even in fracture zones. Advantages of this approach are simplicity of implementation, flexibility in adding fractures to an existing mesh, accuracy due to the absense of distorted elements, and overall elegance. The concept will be demonstrated by computations on strike-slip induced stress in elastic media.

Aiming to improve present day's earthquake hazard assessments, future work will focus on applying the Partition of Unity Method to a full three-dimensional stress model. It is anticipated that modern space-geodetic measurements will provide the observational material required to constrain this approach.