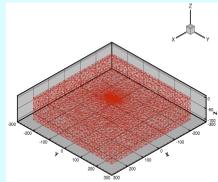


Parallel performance and validation of the GeoFEST system

Earth Science Technology Office Computational Technologies Project

Validation of numerical accuracy

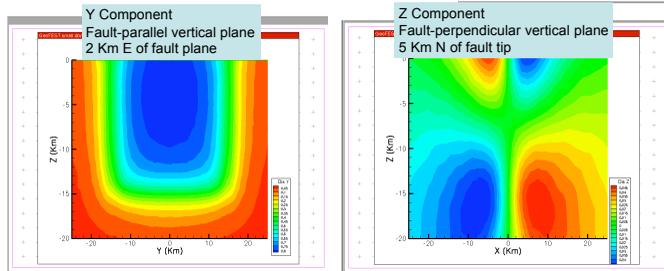
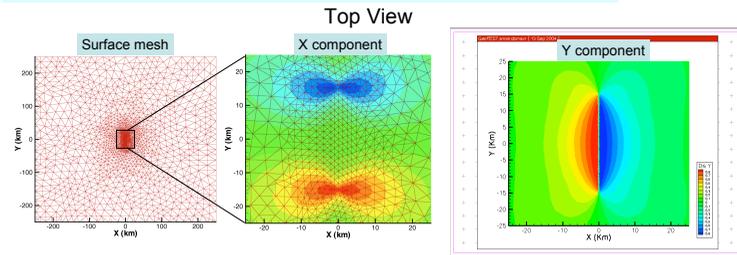


Linear tetrahedral mesh:
 Strike-slip 30x15 km fault
 G: Elastic block 500x500x100 km
 D: Elastic half space (analytic)

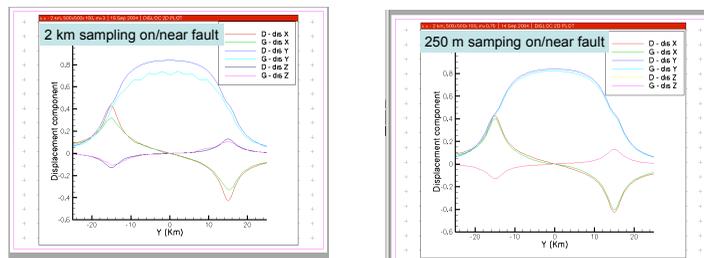
Jay Parker, Gregory Lyzenga, Cinzia Zuffada, Margaret Glasscoe
 (Jet Propulsion Laboratory/California Institute of Technology)
 Teresa Baker (Massachusetts Institute of Technology)
 Marlon Pierce (Indiana University)

The Geophysical Finite Element Simulation Tool (GeoFEST) has been developed at JPL for the purpose of providing high-fidelity two- and three-dimensional continuum models of elastic and quasi-static viscoelastic earth deformation models. GeoFEST provides specialized modeling capabilities useful for studying problems of coseismic, postseismic and earthquake cycle tectonic deformation, as well as other problems of geophysical interest that involve spatially heterogeneous material properties and various kinds of mechanical and gravitational loading. In recent development, GeoFEST has demonstrated the capability of performing several-million-element simulations of three-dimensional domain, through the use of parallel cluster computing. In addition to this advance, as an element of the QuakeSim framework, GeoFEST modeling and mesh generation facilities are being made available to the community in the form of web services.

This presentation describes recent accomplishments of the GeoFEST effort in addressing problems of scientific interest and of technological validation. First-order correctness and high-performance scaling is demonstrated through models of the Landers and Northridge earthquakes, as well as ongoing strain accumulation in the Los Angeles basin. In parallel with these modeling efforts, validation comparisons of GeoFEST results with analytic results and the results of other codes are being carried out. We present a study of mesh refinement accuracy in the modeling a strike slip fault in an elastic half space, validated against an analytic solution. We further present and discuss the results of validation benchmark models emerging from the SCEC working group on Community Finite Element Models for Fault Systems and Tectonic Studies, in which the GeoFEST team is an active participant.

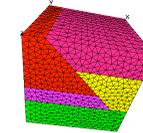


Resolution study



Cooperative Validation

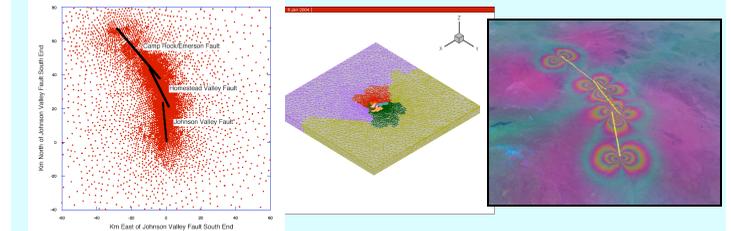
Participated in "Workshop on Community Finite Element Models for Fault Systems and Tectonic Studies"
 August 16-18 2004, Los Alamos New Mexico



- Mesh courtesy of Carl Gable, made with LaGrit
- Imported to GeoFEST, computed Benchmark #5 (Elastic thrust event, analytic solution imposed at boundaries)
- Solution comparison to other codes in progress

Parallel scaling on cluster computers

PYRAMID partitioning and management of message-passing Conjugate-gradient iterative solution (1.4 Million element mesh)
 1000 viscoelastic time steps in 2.8 hours on Linux cluster, 64 CPUs

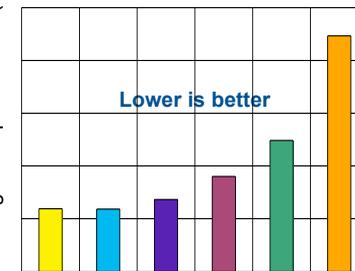


Community modeling with web portal

GeoFEST is available through the QuakeSim WWW portal environment.

Setting problem geometry (QuakeTables fault database)
 Mesh generation
 GeoFEST simulation, job submission and control
 Quick-view visualization

Average time per iteration (ms)



- Apple 2.0 GHz PPC G5 (Infiniband)
- Intel 3.0 GHz Pentium IV (GigE)
- Intel 2.4 GHz Pentium Xeon (Myrinet)
- SGI 1.5 GHz Altix 3000 (NUMA)
- HP 1.0 GHz Itanium 2 (QsNET)
- Apple 1.0 GHz PPC G4 (GigE)

