2005 SCEC Annual Report

Improvements of the SCEC community fault model (CFM) for southern California

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Proposal Categories:	Data and products
Primary Focus Area:	Structural Representation
Primary Discipline Group:	Geology
Task:	CFM

TECHNICAL REPORT

Summary

This past year's efforts were highlighted by the delivery of a new version of the SCEC Community Fault Model (CFM version 2.5) (http://structure.harvard.edu/cfm). The CFM is an object-oriented, 3-D representation of more than 150 active faults in southern California, defined by surface geology, earthquake hypocenters and focal mechanisms, well bore, and seismic reflection data. CFM version 2.5 includes more than 50 new fault representations (Plesch et al., 2005), guided by contributions from more than 20 SCEC investigators. The model, including its alternative fault representations, was evaluated and approved by the SCEC Community this year in a "virtual workshop," where scientists used the LA3D software tool, developed by the SCEC Intern Program, to visualize and analyze the faults. Based on feedback from this evaluation, we defined the inventory of CFM version 2.5. In addition, we developed a new version of the model with simplified, rectangular representations of fault segments, referred to as the CFM-R (2.5). This model is intended to serve a wide variety of modeling studies and hazard assessment efforts that require simplified fault representations.

Improvements to the CFM

This year, SCEC completed an extensive review of the Community Fault Model (CFM 2.0), which including a virtual workshop facilitating peer-review of the model using LA3D, a multi-platform visualization tool developed by the SCEC intern program. The review led to the addition of more than 50 new fault representations, many of which providing more geometrically and kinematically viable depictions of how major fault systems interact at depth. Reviewers of the CFM were also instructed to rate the quality of fault surface representations. These ratings were used to define a ranking of preferred and alternative fault models. These improvements and rankings are manifest in CFM 2.5 (Figure 1), which was released at the Annual Meeting (Plesch et al., 2005).

Several of SCEC's current research efforts in seismic hazards assessment and fault systems modeling (e.g., Bird et al., 2004; Rundle et al., 2004; Meade and Hager, 2004) require fault representations that are rectilinear (i.e., faults composed of rectangular planes). These are generally much simpler representations than the triangulated fault surfaces found in the CFM. This need for simpler fault representations inspired the development of a new fault model, CFM-R (Figure 2), which provides rectilinear fault representations that are derived from the native triangulated surfaces that comprise the CFM. The first version of the CFM-R (listed as 2.5 to reflect the CFM version on which it was based), was delivered at the Annual Meeting. The CFM-R model is currently being updated to include all of the alternative fault representations present in CFM 2.5, and through collaboration with the U.S. and California Geological Surveys will be used as the basis for various planned seismic hazard assessments. As part of the process of generating CFM and CFM-R 2.5, we have also released a new fault trace map. These models and derivative products are available at http://structure.harvard.edu.

Examples of collaborative studies employing the CFM

Mechanical Modeling based on the CFM

With our assistance, the SCEC Faults Systems group is pursuing a range of mechanical modeling studies that employ the CFM and CBM to investigate geodetic, geologic, and seismologic constraints on fault system behavior. These studies have addressed the longstanding controversy about the nature of strain accommodation in the northern Los Angeles basin (vertical thickening vs. escape tectonics), highlighting the role of active blind-thrust fault in accommodating shortening (Griffith and Cooke, 2005; Argus, 2005). In addition, collaborations between modelers and tectonic geomorphologists have evaluated alternative geometries and slip rates on various fault systems, including the Puente Hills Thrust, Hollywood, and Raymond faults (e.g., Fawcett et al., 2005; Cooke et al., 2005). These efforts highlight that modeling studies can help to address gaps in our geologic and geodetic constraints of fault slip rates, and in turn make direct contributions to the CFM through evaluation of alternative fault representations.

Seismicity

This past year, we have also initiated a collaboration with E. Hauksson (Caltech) and R. Wesson (USGS) to evaluate hypocenter locations with respect to the fault surfaces represented in the CFM (Hauksson et al., 2005). The aim of this study is to assess what percentage of regional seismicity is associated with major faults represented in the CFM, and how seismicity is distributed along complex fault zones.

Hazard assessment

Working in partnership with the Seismic Hazard Analysis Focus area in SCEC, we have developed a series of alternative, comprehensive fault models that reflect significant uncertainties in our knowledge of major earthquake sources. Alternative models have been produced for the Los Angeles basin, the Western Transverse Ranges (including the Santa Barbara Channel), the central segment of the San Andreas Fault, and the Death Valley region. We are currently working with the U. S. and California Geological Surveys to generate rectilinear (CFM-R) versions of these alternative fault representations, which will be used as the basis for future hazard assessment projects.

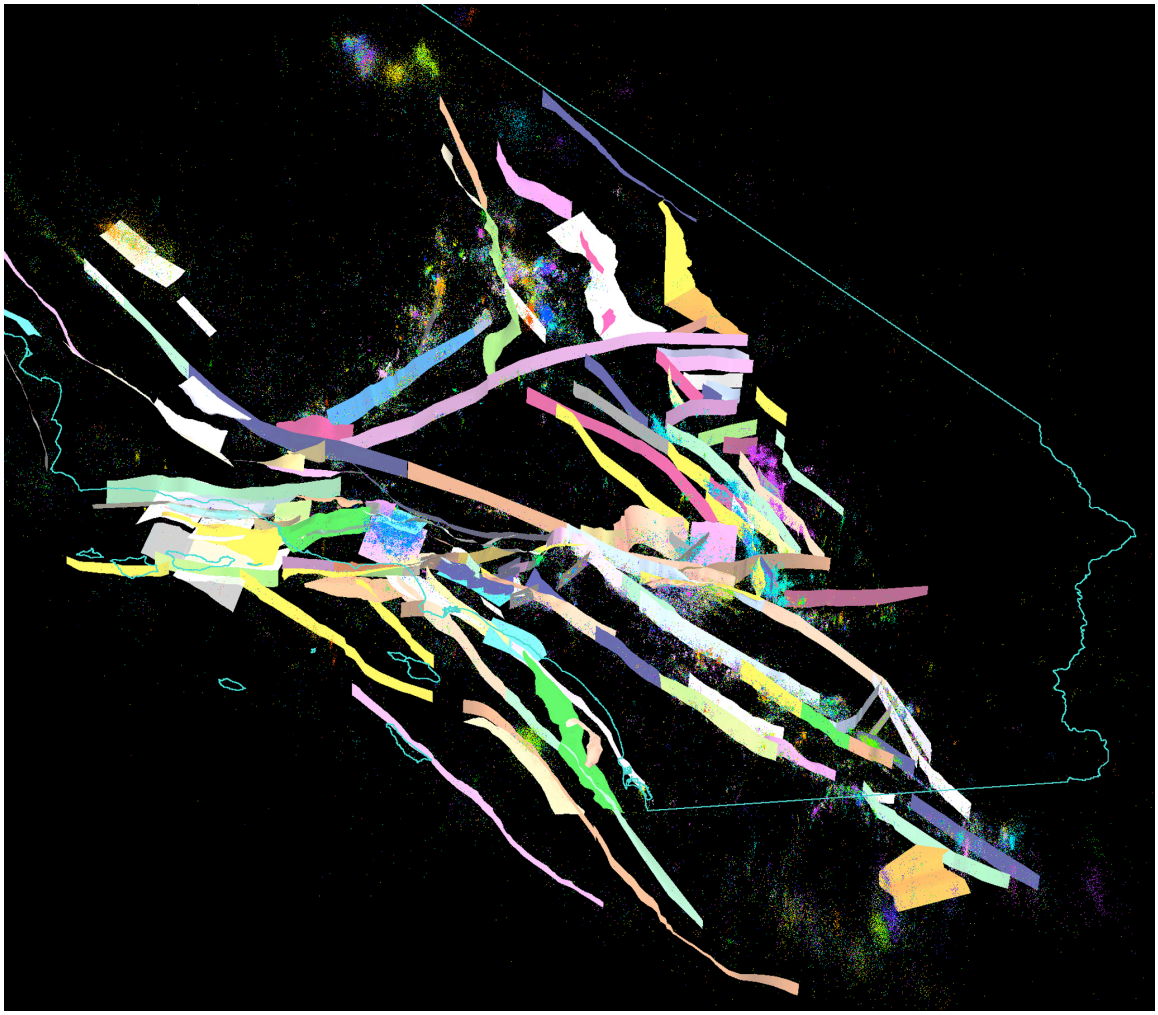

Figure 1: Perspective view of the SCEC Community Fault Model (CFM version 2.5). Seismicity is from Hauksson (2000) and color-coded by year of occurrence. (Plesch et al., 2005).

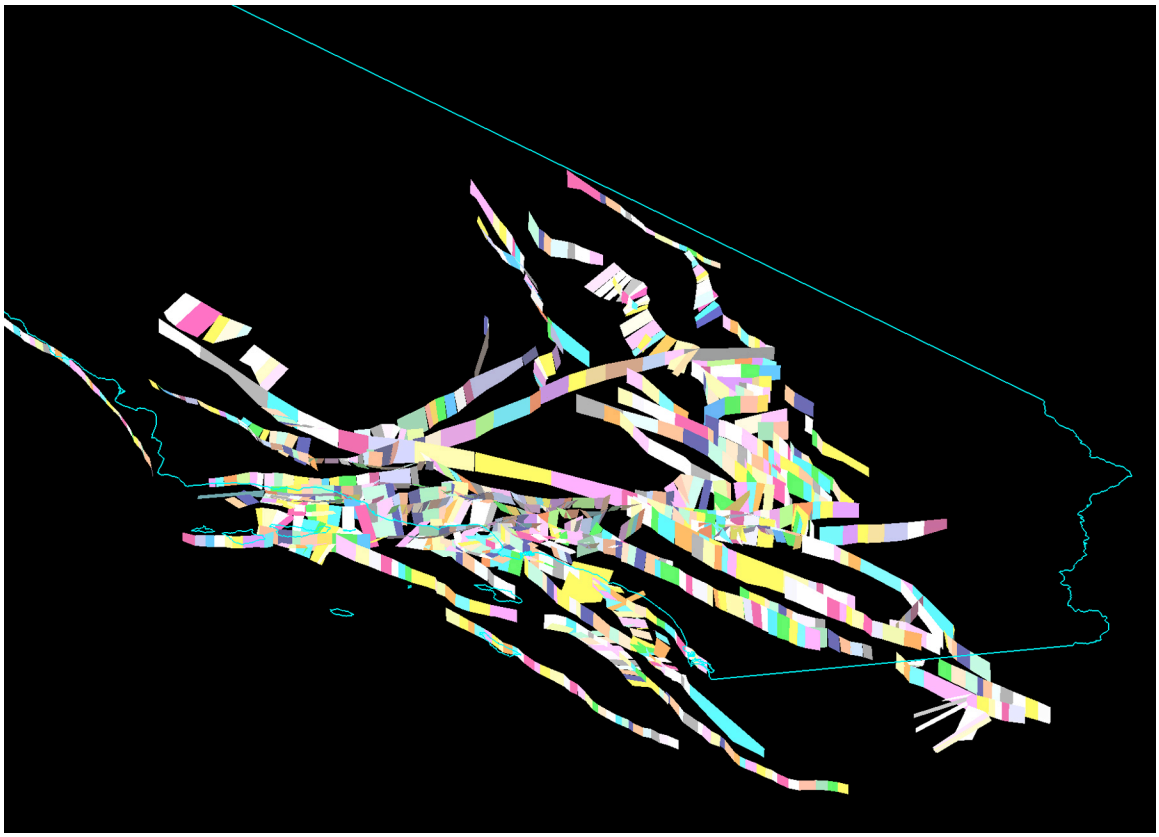

Figure 2: Perspective view of the new rectilinear version of the SCEC Community Fault Model (CFM-R 2.5). Faults are defined by rectangular patches that were derived from the triangulated surface representations in the CFM. (Plesch et al., 2005).

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