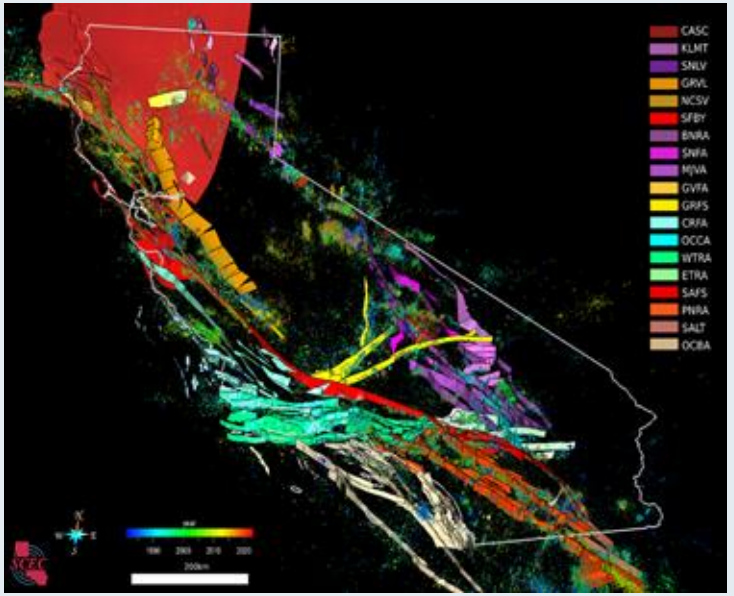
# The Next Generation Community Fault Model

## Technical Activity Group Plans


**Scott Marshall**
Appalachian State University

**Andreas Plesch**
Harvard University

**John H. Shaw**
Harvard University


**September 1, 2026**

SCEC Annual Meeting, Palm Springs, CA

CFM Homepage | https://www.scec.org/science/community-fault-model/

# The Community Fault Model (CFM)

## What is the CFM?

The CFM is an object-oriented, **fully 3D** geometric representation of active faults in California, adjacent offshore basins, and beyond

## Who develops the CFM?

Andreas Plesch

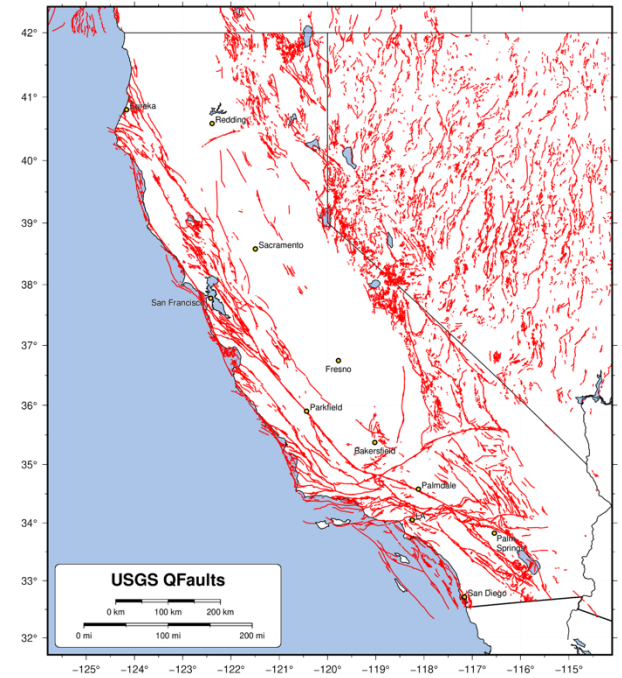
John Shaw

*Harvard University*

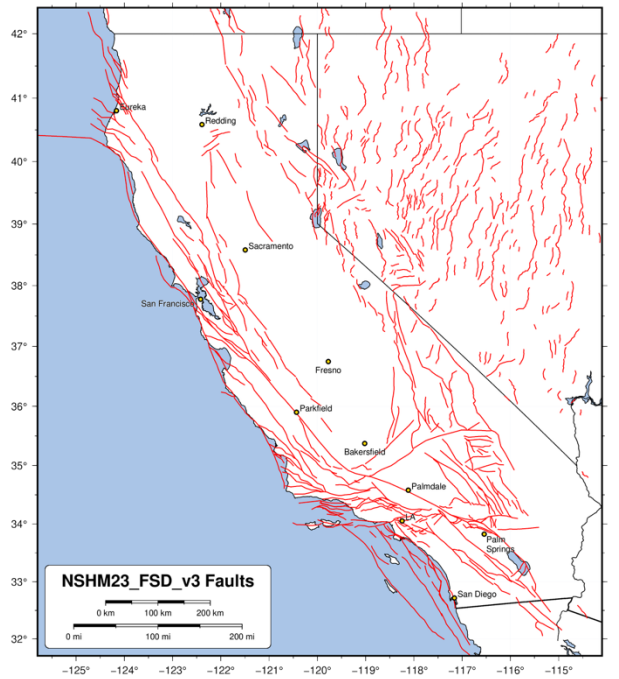
Scott Marshall

*Appalachian State University*

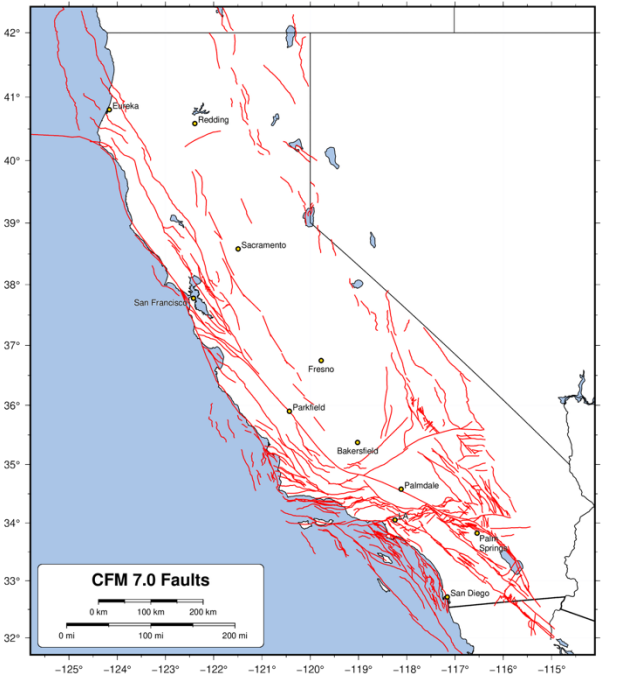
# Fault Models Comparison




- 2D Model (traces)
- Geometrically complex
  - Defined mainly by mapping
- Identifies activity of faulting




- 2.5D Model
  - Builds on UCERF3/CFM
- Geometrically smooth
- Developed for hazard analyses



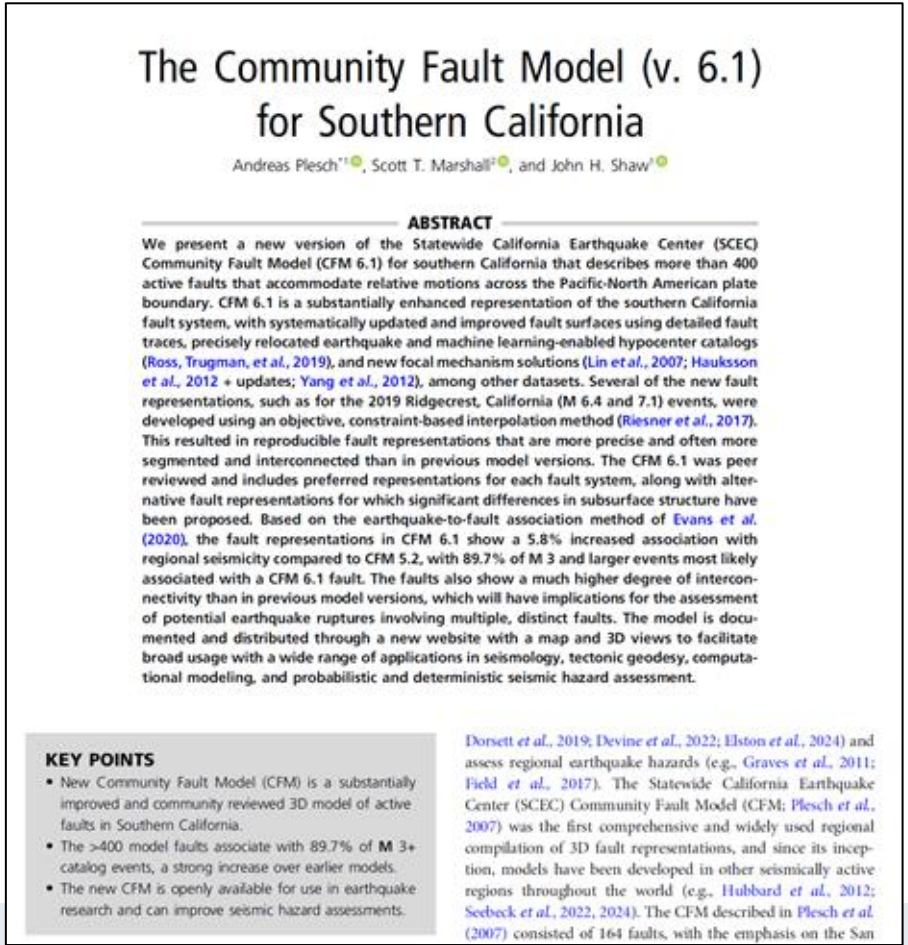

- Full 3D Model
- Geometrically complex
  - Defined by source data
- Serves a variety of SCEC initiatives

# The CFM 6.1 is Now Published (BSSA)

## The CFM is well-established in southern California

**Plesch et al. (2026, BSSA)**
https://doi.org/10.1785/0120250247

- CFM 6.1 is substantially improved and community reviewed 3D model of southern California faults.
- 89.7% of M 3+ events are associated with a CFM fault, a strong increase over earlier models.
- The CFM is openly available for use in earthquake research and hazard assessments.



The Community Fault Model (v. 6.1) for Southern California

Andreas Plesch*[1], Scott T. Marshall[1], and John H. Shaw[1]

**ABSTRACT**

We present a new version of the Statewide California Earthquake Center (SCEC) Community Fault Model (CFM 6.1) for southern California that describes more than 400 active faults that accommodate relative motions across the Pacific-North American plate boundary. CFM 6.1 is a substantially enhanced representation of the southern California fault system, with systematically updated and improved fault surfaces using detailed fault traces, precisely relocated earthquake and machine learning-enabled hypocenter catalogs (Ross, Trugman, *et al.*, 2019), and new focal mechanism solutions (Lin *et al.*, 2007; Hauksson *et al.*, 2012 + updates; Yang *et al.*, 2012), among other datasets. Several of the new fault representations, such as for the 2019 Ridgecrest, California (M 6.4 and 7.1) events, were developed using an objective, constraint-based interpolation method (Riesner *et al.*, 2017). This resulted in reproducible fault representations that are more precise and often more segmented and interconnected than in previous model versions. The CFM 6.1 was peer reviewed and includes preferred representations for each fault system, along with alternative fault representations for which significant differences in subsurface structure have been proposed. Based on the earthquake-to-fault association method of Evans *et al.* (2020), the fault representations in CFM 6.1 show a 5.8% increased association with regional seismicity compared to CFM 5.2, with 89.7% of M 3 and larger events most likely associated with a CFM 6.1 fault. The faults also show a much higher degree of interconnectivity than in previous model versions, which will have implications for the assessment of potential earthquake ruptures involving multiple, distinct faults. The model is documented and distributed through a new website with a map and 3D views to facilitate broad usage with a wide range of applications in seismology, tectonic geodesy, computational modeling, and probabilistic and deterministic seismic hazard assessment.

**KEY POINTS**

- New Community Fault Model (CFM) is a substantially improved and community reviewed 3D model of active faults in Southern California.
- The >400 model faults associate with 89.7% of M 3+ catalog events, a strong increase over earlier models.
- The new CFM is openly available for use in earthquake research and can improve seismic hazard assessments.

Dorsett *et al.*, 2019; Devine *et al.*, 2022; Elston *et al.*, 2024) and assess regional earthquake hazards (e.g., Graves *et al.*, 2011; Field *et al.*, 2017). The Statewide California Earthquake Center (SCEC) Community Fault Model (CFM; Plesch *et al.*, 2007) was the first comprehensive and widely used regional compilation of 3D fault representations, and since its inception, models have been developed in other seismically active regions throughout the world (e.g., Hubbard *et al.*, 2012; Seebeck *et al.*, 2022, 2024). The CFM described in Plesch *et al.* (2007) consisted of 164 faults, with the emphasis on the San

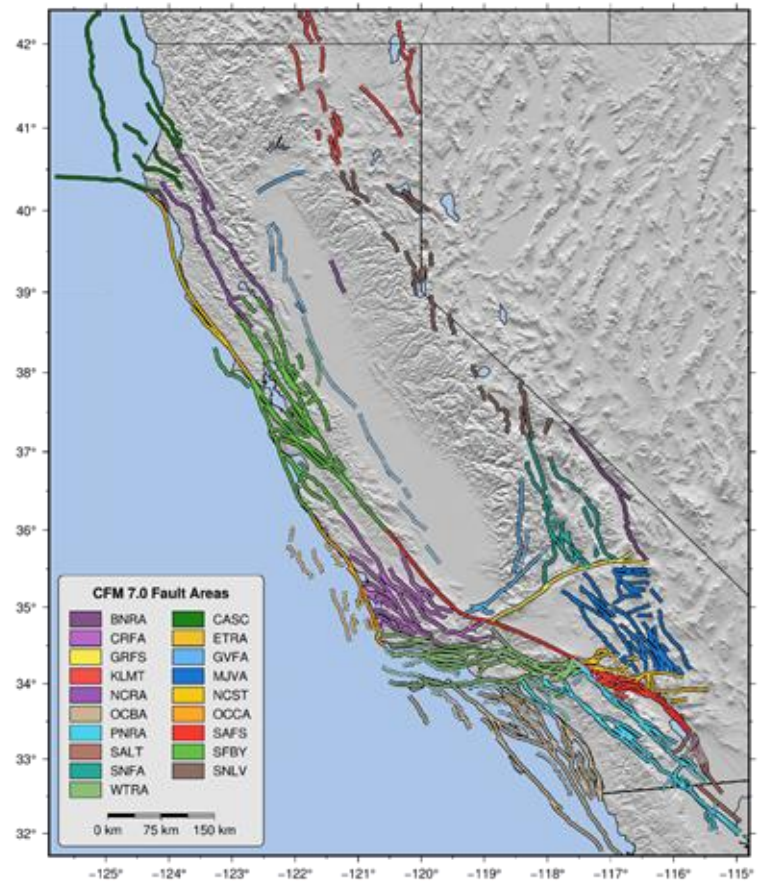
# CFM 7.0 Community Evaluation

CFM in NorCal was evaluated by 48 experts in SCEC and CRESCENT teams

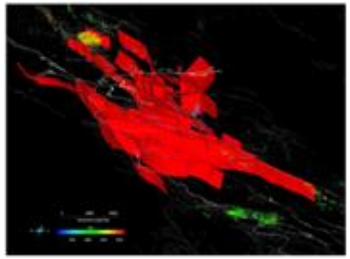
Groups focused on CFM major fault areas

132 faults received feedback
52 proposed new faults (51% in Walker Lane)

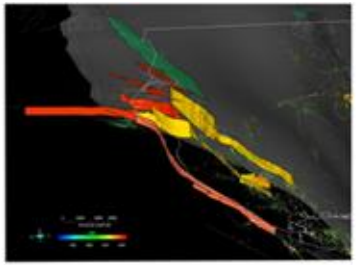
Current work focuses on:
SF Bay area Calaveras-Hayward-Rodgers Creek-Healdburg system
MTJ offshore/onshore region



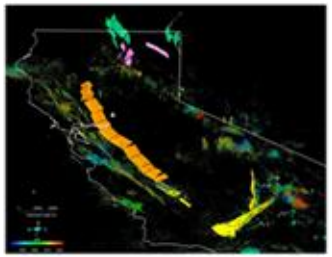
# Summary of Updates Needed



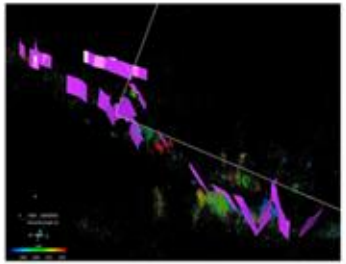
SFBY evaluation area: **39** specific suggestions, **8** candidates for addition



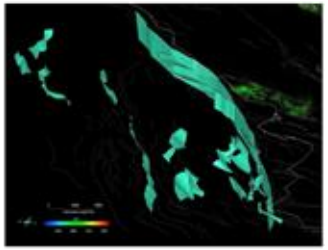
CASC, NCRA, NCST evaluation areas: **11** specfic suggestion, **6** faults candidates for addition



KLMT, GRVA evaluation areas: **2** specfic suggestion, **8** faults candidates for addition



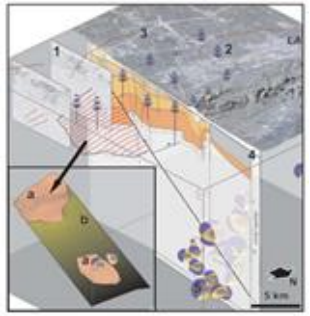
SNLV evaluation area: ca. **30** specific suggestions, **27** candidates for addition



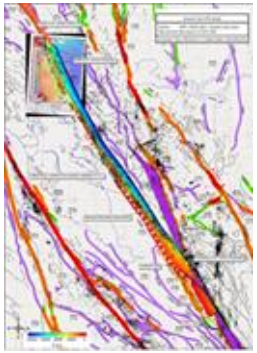
OCCA evaluation area: **8** specific suggestions

# How the CFM is built

## Georeferenced Data



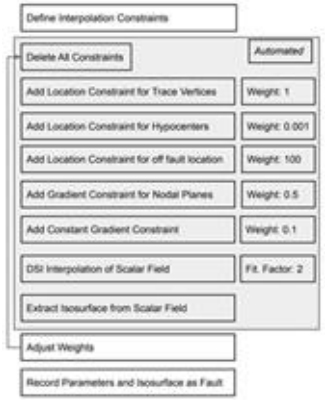
Plesch et al. (2007)



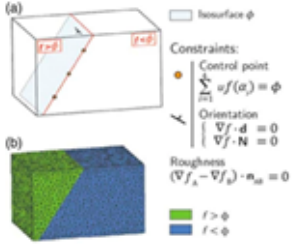
This meeting

(1) seismic reflection profiles
(2) wells
(3) surface fault traces
(4) geologic cross sections
(5) focal mechanisms
(6) geodetic models
(7) relocated hypocenters
(8) existing 3d model
(9) structure contours

## Reproducible Interpolation

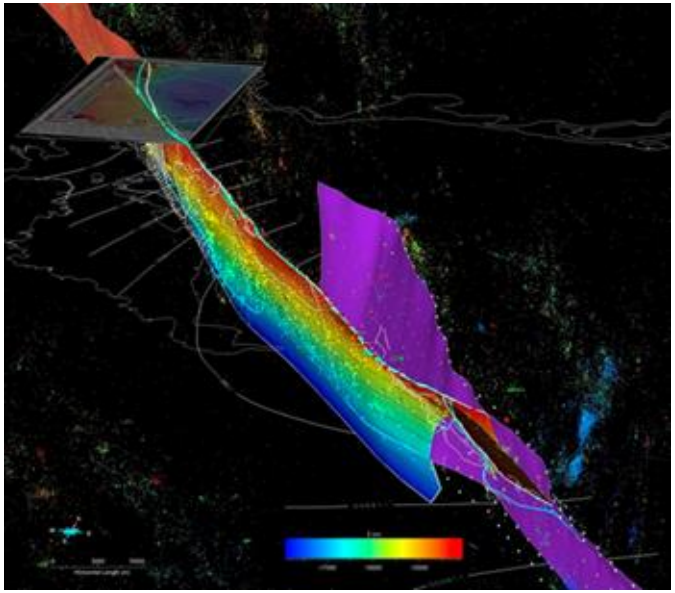



semiautomated workflow, Plesch et al. (2019)




weighted constraints for scalar field, Riesner et al. (2017)

## Iterated 3D Fault



3D fault representation (Hayward fault, this meeting)

# EQ to Fault Association

**Evans et al. (2020, BSSA)**
https://doi.org/10.1785/0120190115

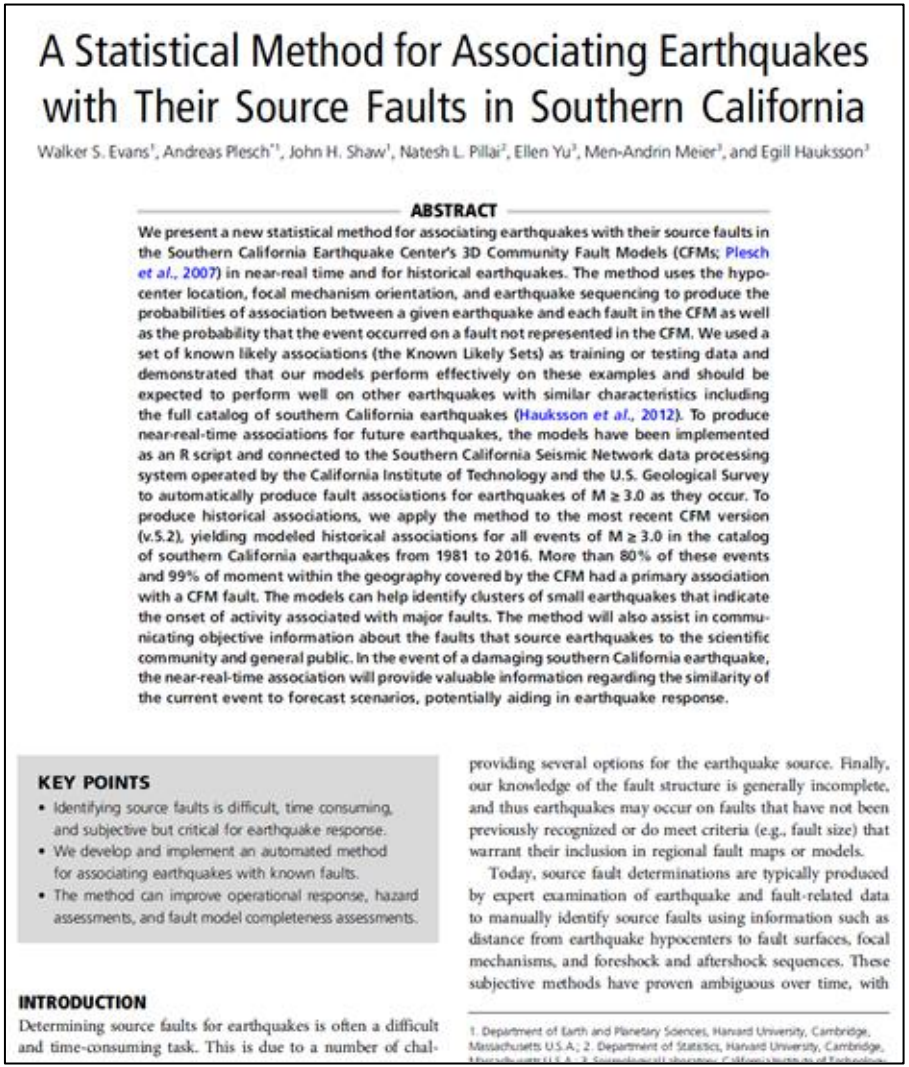
**Use Case #1: CFM Association Email Service**

- The CFM TAG is working to extend the CFM Association service statewide
- Coordinating between the southern and northern California EQ data centers

**Use Case #2: How "Complete" is the CFM?**

- In SoCal, 89.4% of EQs associate with a CFM fault
- Earthquake-to-fault associations are being used to test the northern California CFM

See Poster #74 (Group B), Callejas et al.



A Statistical Method for Associating Earthquakes with Their Source Faults in Southern California

Walker S. Evans[1], Andreas Plesch[*1], John H. Shaw[1], Natesh L. Pillai[2], Ellen Yu[3], Men-Andrin Meier[3], and Egill Hauksson[3]

**ABSTRACT**

We present a new statistical method for associating earthquakes with their source faults in the Southern California Earthquake Center's 3D Community Fault Models (CFMs; Plesch *et al.*, 2007) in near-real time and for historical earthquakes. The method uses the hypocenter location, focal mechanism orientation, and earthquake sequencing to produce the probabilities of association between a given earthquake and each fault in the CFM as well as the probability that the event occurred on a fault not represented in the CFM. We used a set of known likely associations (the Known Likely Sets) as training or testing data and demonstrated that our models perform effectively on these examples and should be expected to perform well on other earthquakes with similar characteristics including the full catalog of southern California earthquakes (Hauksson *et al.*, 2012). To produce near-real-time associations for future earthquakes, the models have been implemented as an R script and connected to the Southern California Seismic Network data processing system operated by the California Institute of Technology and the U.S. Geological Survey to automatically produce fault associations for earthquakes of $M \geq 3.0$ as they occur. To produce historical associations, we apply the method to the most recent CFM version (v.5.2), yielding modeled historical associations for all events of $M \geq 3.0$ in the catalog of southern California earthquakes from 1981 to 2016. More than 80% of these events and 99% of moment within the geography covered by the CFM had a primary association with a CFM fault. The models can help identify clusters of small earthquakes that indicate the onset of activity associated with major faults. The method will also assist in communicating objective information about the faults that source earthquakes to the scientific community and general public. In the event of a damaging southern California earthquake, the near-real-time association will provide valuable information regarding the similarity of the current event to forecast scenarios, potentially aiding in earthquake response.

**KEY POINTS**

- Identifying source faults is difficult, time consuming, and subjective but critical for earthquake response.
- We develop and implement an automated method for associating earthquakes with known faults.
- The method can improve operational response, hazard assessments, and fault model completeness assessments.

**INTRODUCTION**

Determining source faults for earthquakes is often a difficult and time-consuming task. This is due to a number of challenges, including providing several options for the earthquake source. Finally, our knowledge of the fault structure is generally incomplete, and thus earthquakes may occur on faults that have not been previously recognized or do meet criteria (e.g., fault size) that warrant their inclusion in regional fault maps or models.

Today, source fault determinations are typically produced by expert examination of earthquake and fault-related data to manually identify source faults using information such as distance from earthquake hypocenters to fault surfaces, focal mechanisms, and foreshock and aftershock sequences. These subjective methods have proven ambiguous over time, with

1. Department of Earth and Planetary Sciences, Harvard University, Cambridge, Massachusetts U.S.A.; 2. Department of Statistics, Harvard University, Cambridge,

# EQ to Fault Association

**Evans et al. (2020, BSSA)**
https://doi.org/10.1785/0120190115

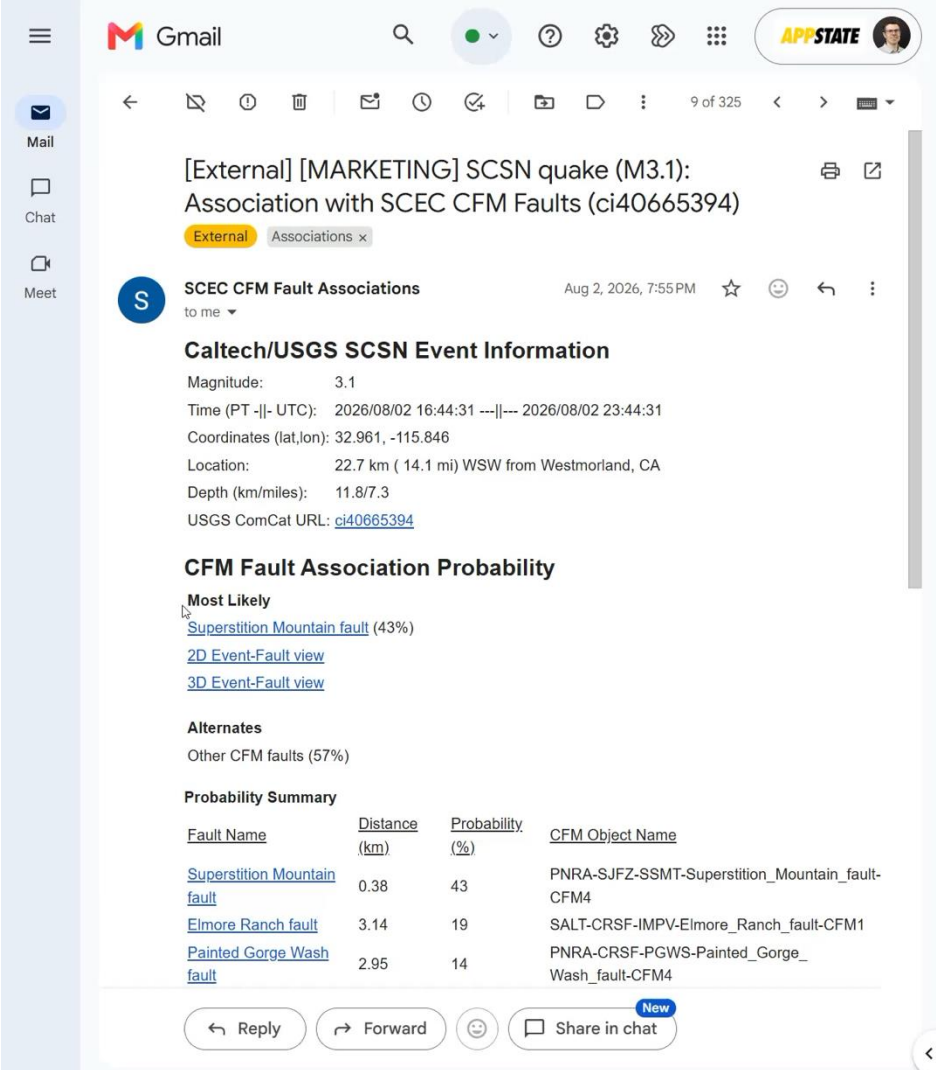
**Use Case #1: CFM Association Email Service**

- The CFM TAG is working to extend the CFM Association service statewide
- Coordinating between the southern and northern California EQ data centers

**Use Case #2: How "Complete" is the CFM?**

- In SoCal, 89.4% of EQs associate with a CFM fault
- Earthquake-to-fault associations are being used to test the northern California CFM

See Poster #74 (Group B), Callejas et al.



# Future TAG Efforts

Travis Alongi – USGS
- Automated 3D fault generation from EQs

Christodoulos Kyriakopoulos – CERI
- 3D Virtual Reality experiences with the CFM

John Suppe & Yu-Huan Hsieh – U. Houston
- Fault representations using multiscale data in SoCal

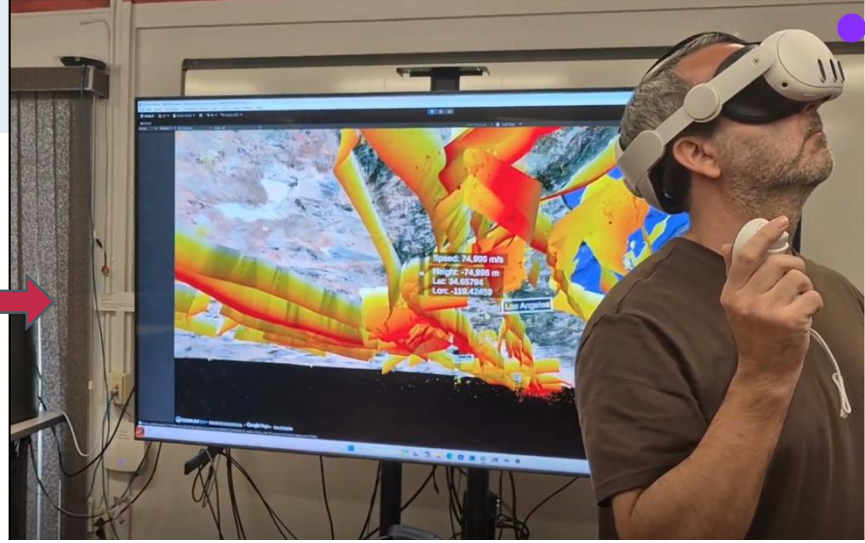
Alex Hatem - USGS
- Addressing differences between NSHM/CFM

Becky Fildes – CRESCENT
- Ensuring compatibility between CRESCENT and SCEC CFMs

Caltech & UC Berkeley
- Extending the CFM associations statewide

Badie Rowshandel – CEA
- Ground motion models using the CFM

Deformation Modeling with the CFM
- See poster #56 by Roland-Sagui & Marshall



*We discovered a low velocity channel under the Transverse Ranges*

*The low velocity channel cuts the San Andreas Fault*