

# Collaboratory for the Study of Earthquake Predictability (CSEP)

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# Collaboratory for the Study of Earthquake Predictability (CSEP)

- **Motivation**

- Earthquake prediction research is hampered by inadequate infrastructure for conducting scientific prediction experiments

- **Primary objective**

- Rigorous *comparative* testing of scientific prediction experiments spanning a variety of fault systems to study the physical basis for earthquake predictability

- **Status**

- SCEC has received a grant from the Keck Foundation to develop components of CSEP infrastructure
- CSEP will build on the RELM program and related efforts

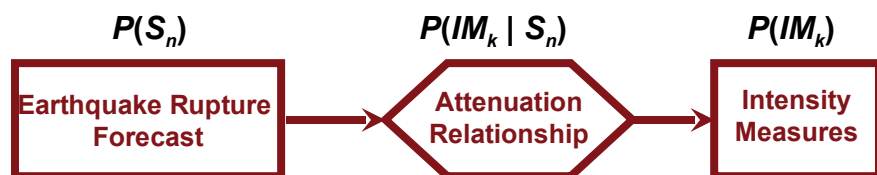


- **Future**

- International partnerships will establish natural laboratories for scientific earthquake prediction experiments

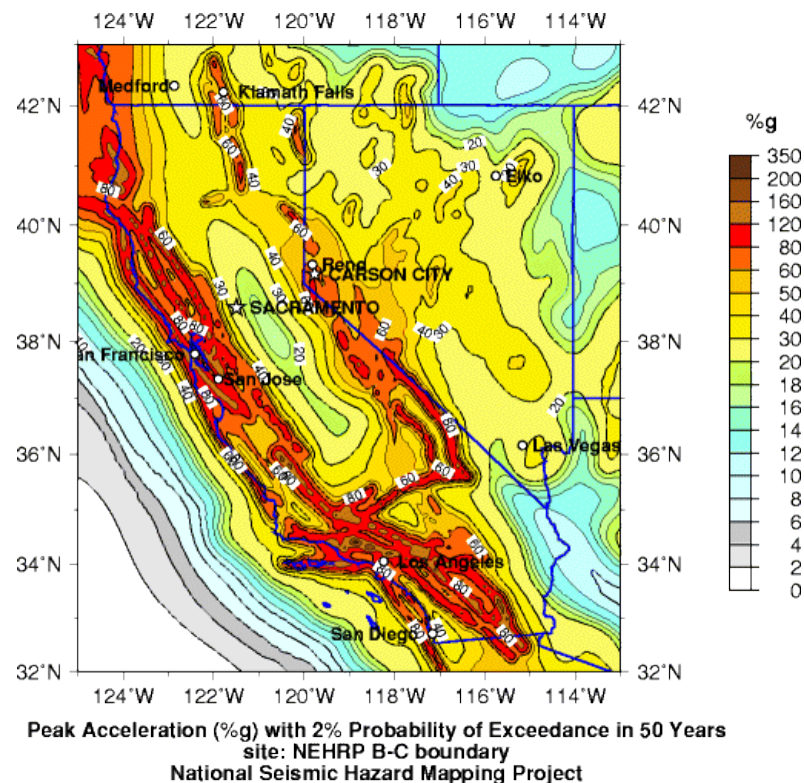
# Rationale for CSEP

- PSHA requires long-term, system-specific earthquake rupture forecasts
  - Time-dependent ERF methodologies not widely implemented nor validated
  - Comparisons across different fault systems could accelerate progress



## Probabilistic Seismic Hazard Analysis (PSHA)

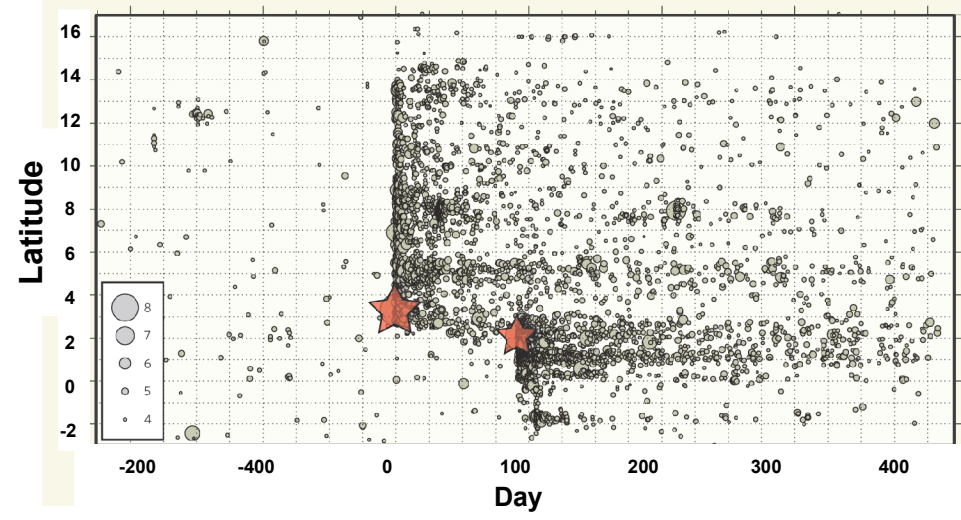
## U.S. National Seismic Hazard Map (2002)





# Rationale for CSEP

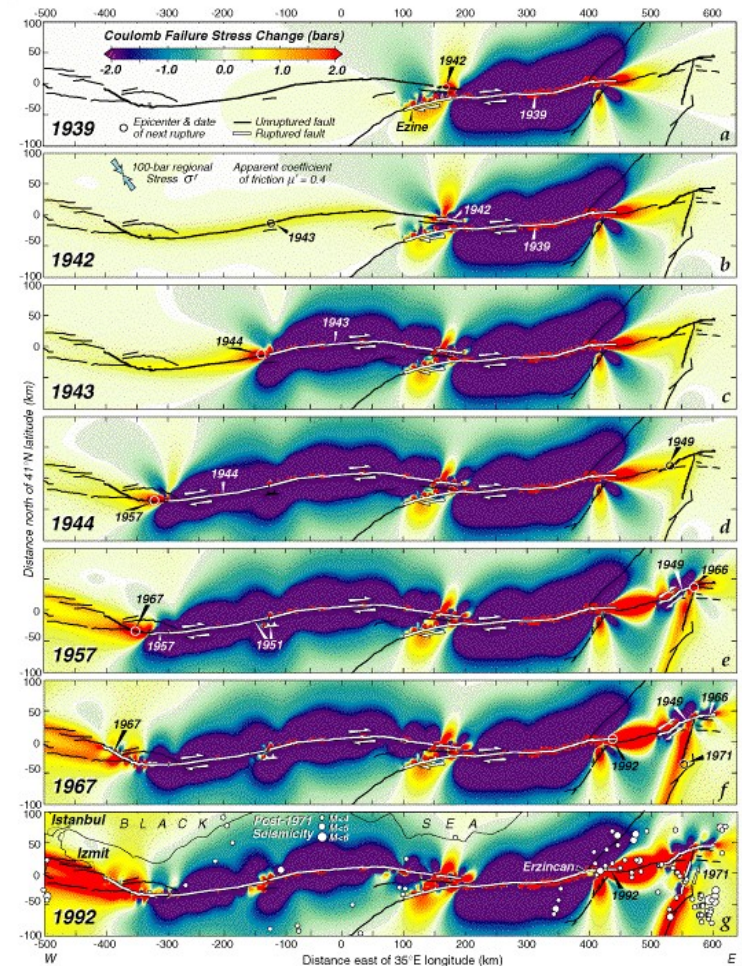
- PSHA requires long-term, system-specific earthquake rupture forecasts
  - Time-dependent ERF methodologies not widely implemented nor validated
  - Comparisons across different fault systems could accelerate progress
- Earthquake catalogs demonstrate short-term predictability
  - Triggering models (e.g. ETAS) capture significant predictability
  - High-resolution imaging of faulting-related transients may improve models



Sumatra Earthquake Sequence  
(Ammon, 2006)

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- Earthquake catalogs demonstrate short-term predictability
  - Triggering models (e.g. ETAS) capture significant predictability
  - High-resolution imaging of faulting-related transients may improve models
- Stress-evolution models may provide a physical basis for intermediate-term predictability
  - Better catalogs can improve the testing of scientific prediction experiments

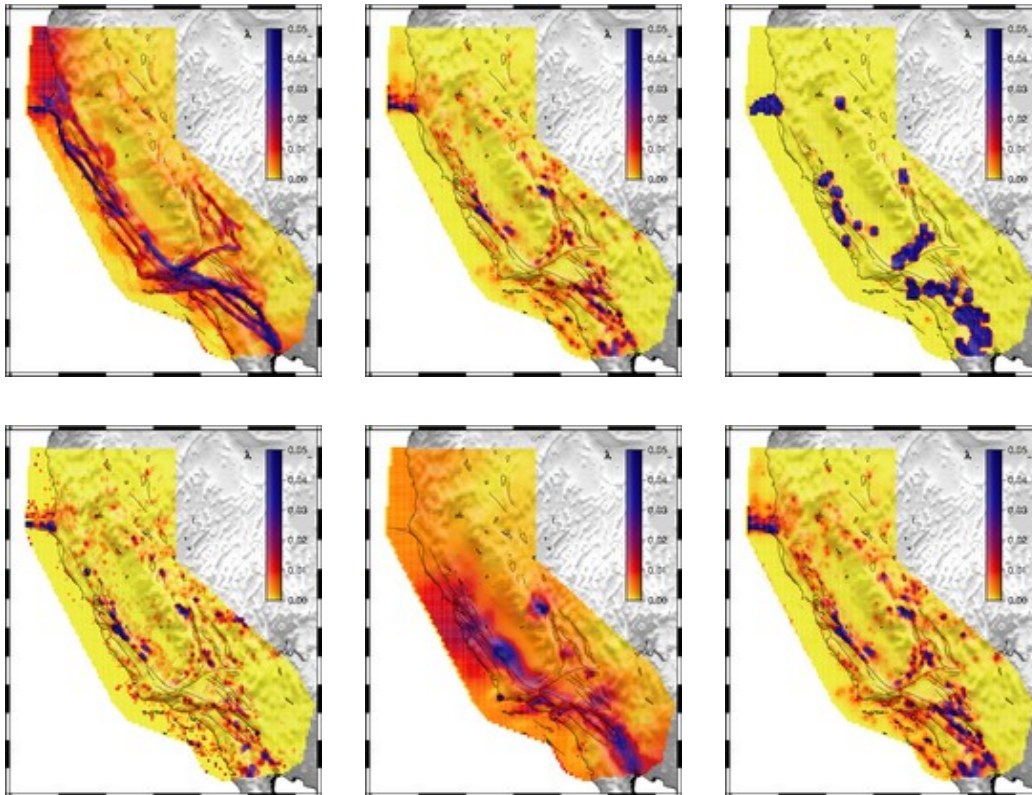


Stress Evolution of the North Anatolian Fault System (Stein et al., 1997)

# Problems in Assessing Predictions

- **Scientific publications provide insufficient information for independent evaluation**
- **Active researchers are constantly tweaking their procedures, which become moving targets**
- **Standards are lacking for testing predictions against reference forecasts**
- **Data to evaluate prediction experiments are often improperly specified**
- **Infrastructure for conducting and evaluating long-term prediction experiments does not exist**

## SCEC/USGS Working Group on Regional Earthquake Likelihood Models (RELM)

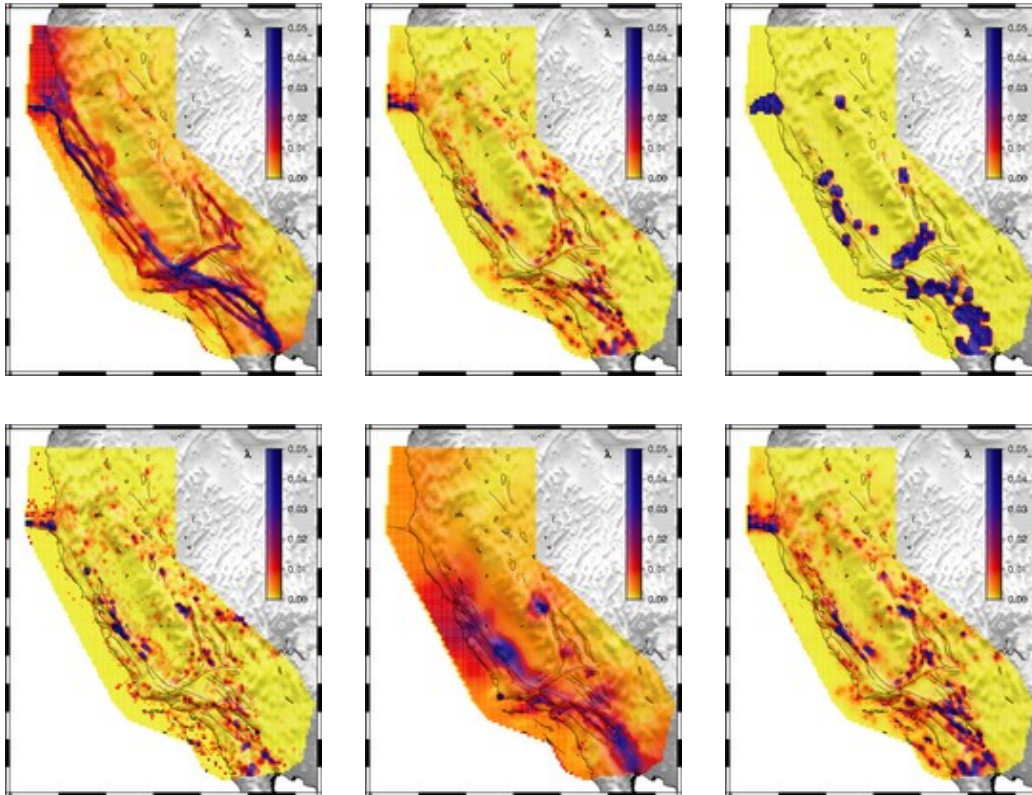


- California is the natural laboratory
- **ANSS catalog is the authorized data source**
- Model types and model registration are restricted
- **Testing procedures are standardized**
- NEPEC and CEPEC are cognizant of procedures and will review results

RELM papers will appear in special issue of *SRL*, February, 2007

SCEC/USGS Working Group on

# Regional Earthquake Likelihood Models (RELM)



## 5-yr RELMs submitted to the ETHZ Testing Center

### Bird & Liu

SHIFT main shock model

SHIFT main shock + aftershock model

### Ebel et al.

5-yr main shock+aftershock model

5-yr main shock model

### Helmstetter, Kagan, Jackson

HKJ 2005 long-term main shock model

HKJ 2005 long-term main shock + aftershock model

### Holliday et al.

Pattern Informatics

### Kagan et al.

5-yr main shock model

5-yr main shock + aftershock model

### Shen, Jackson, and Kagan

Geodetic main shock model

Geodetic main shock + aftershock model

### Ward

combo81

geodetic81

geodetic85

geologic81

seismic81

simulation

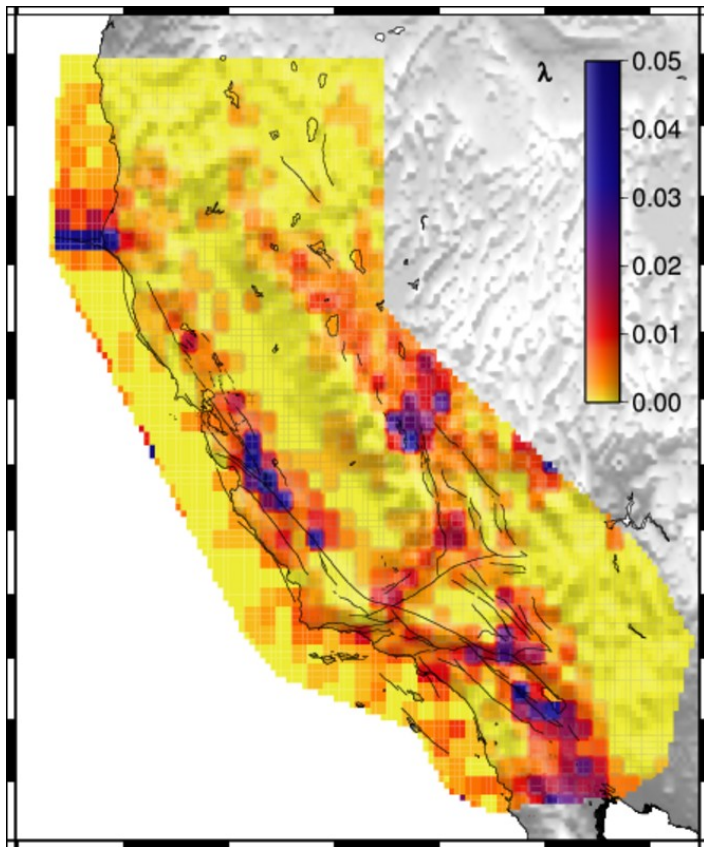
### WG 2002

National Hazard Model

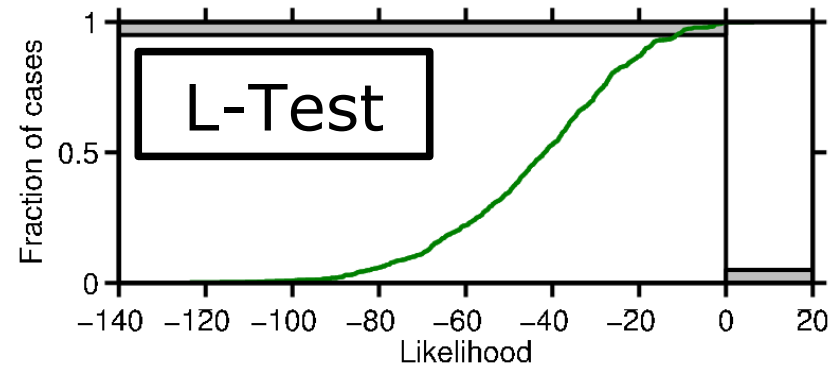
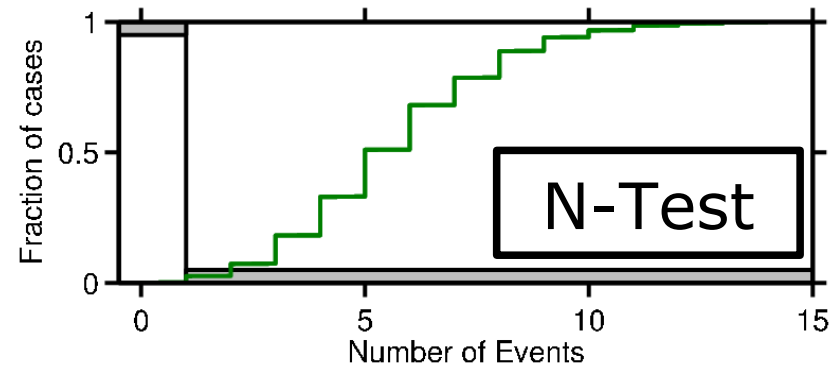
### Wiemer & Schorlemmer

Asperity Likelihood Model

## SCEC/USGS Working Group on Regional Earthquake Likelihood Models (RELM)



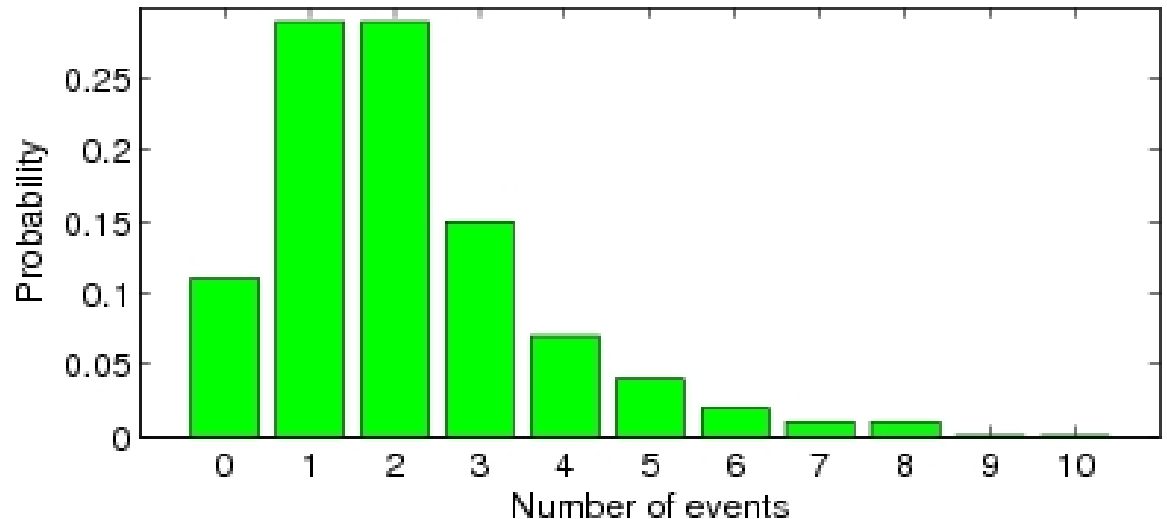
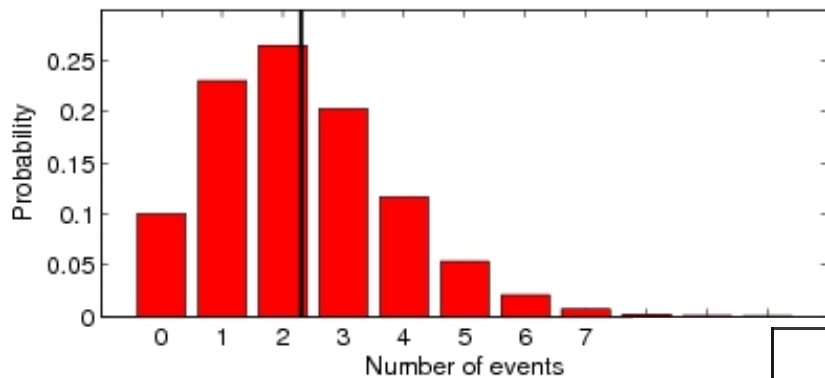
### Example: Ebel Mainshock Model



- Testing began Jan 1, 2006
- Expected number of events for 10-mo testing period is 4.7
- 1 event has occurred

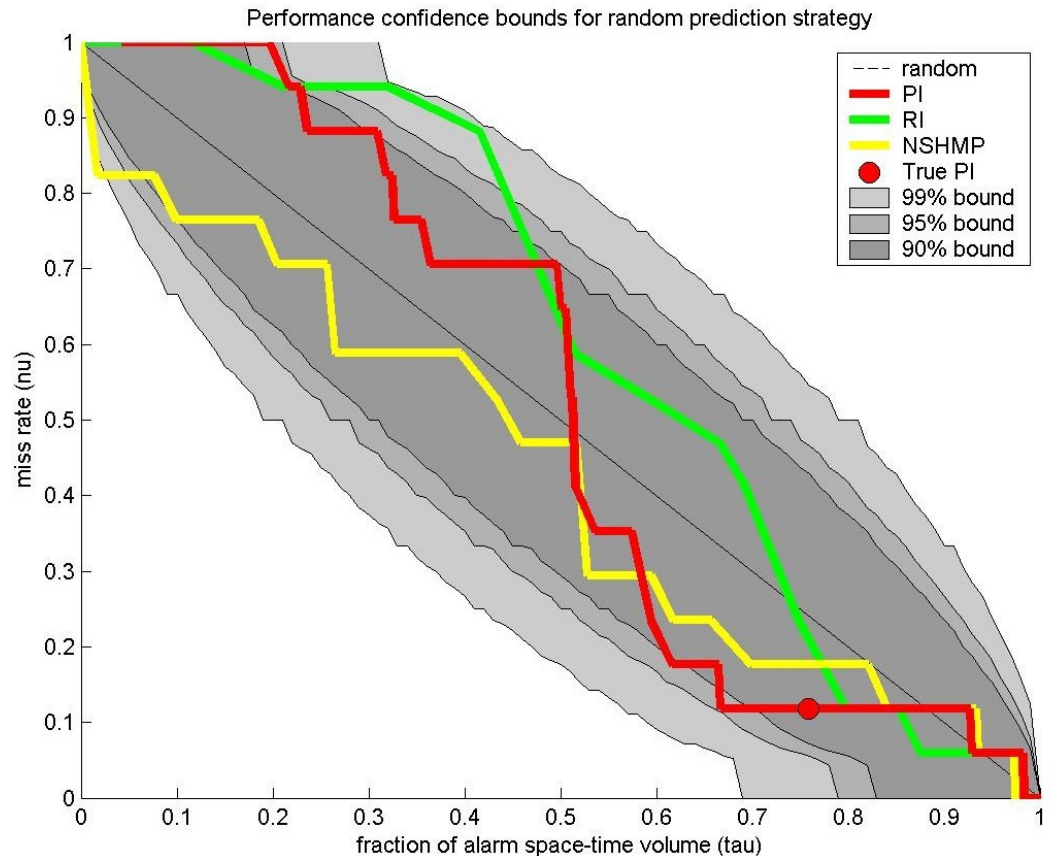
# CSEP will build on RELM

- by extending the testing standards to include
  - other probability distributions



# CSEP will build on RELM

- by extending the testing standards to include
  - new testing procedures, including alarm-based methods

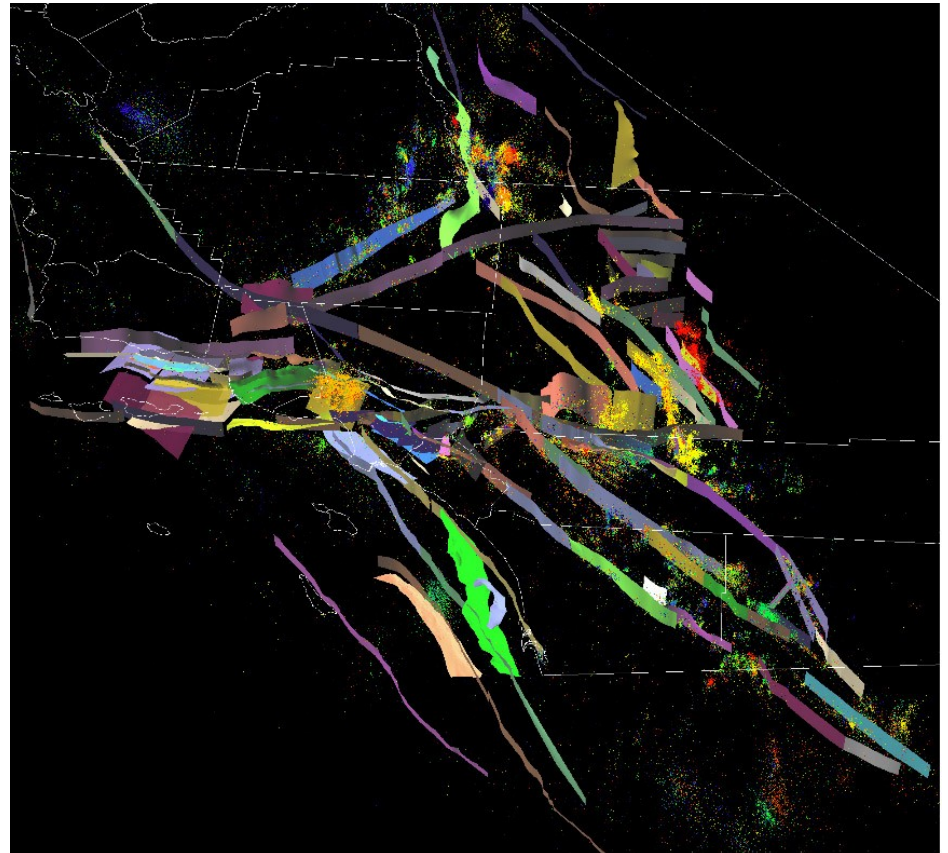


Zechar & Jordan  
(S12A-04, this meeting)

# CSEP will build on RELM

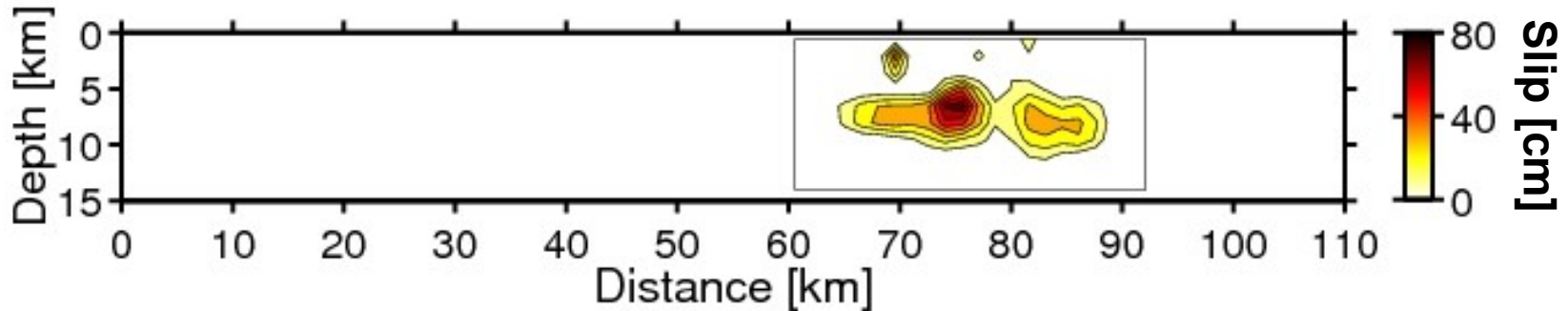
- by expanding the model space to include
  - **fault-based predictions**

SCEC Community Fault Model  
(Plesch, Shaw et al., 2006)



# CSEP will build on RELM

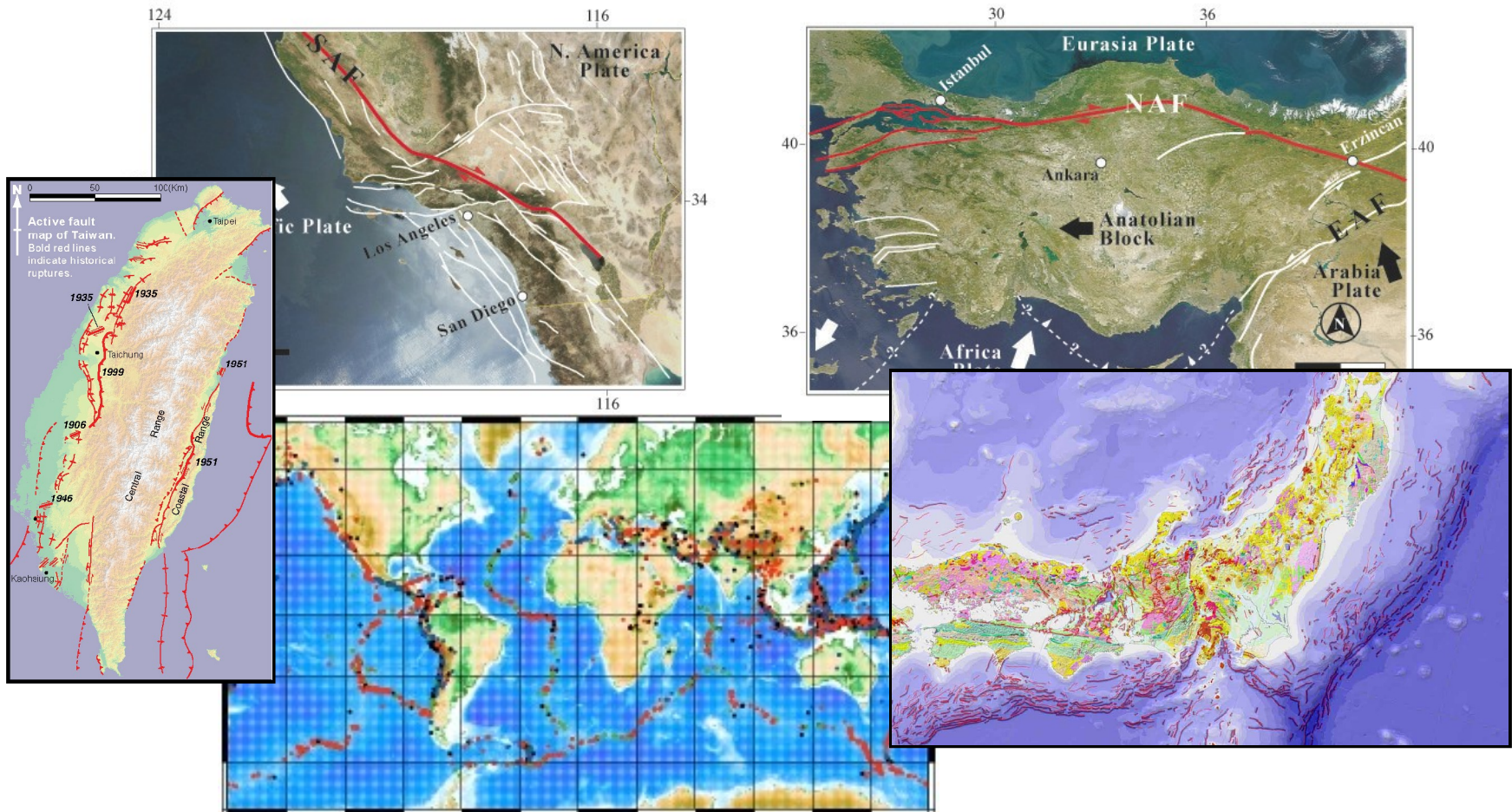
- by expanding the model space to include
  - **additional data sources**



Slip distribution of the 2004 Parkfield event  
Courtesy of Chen Ji

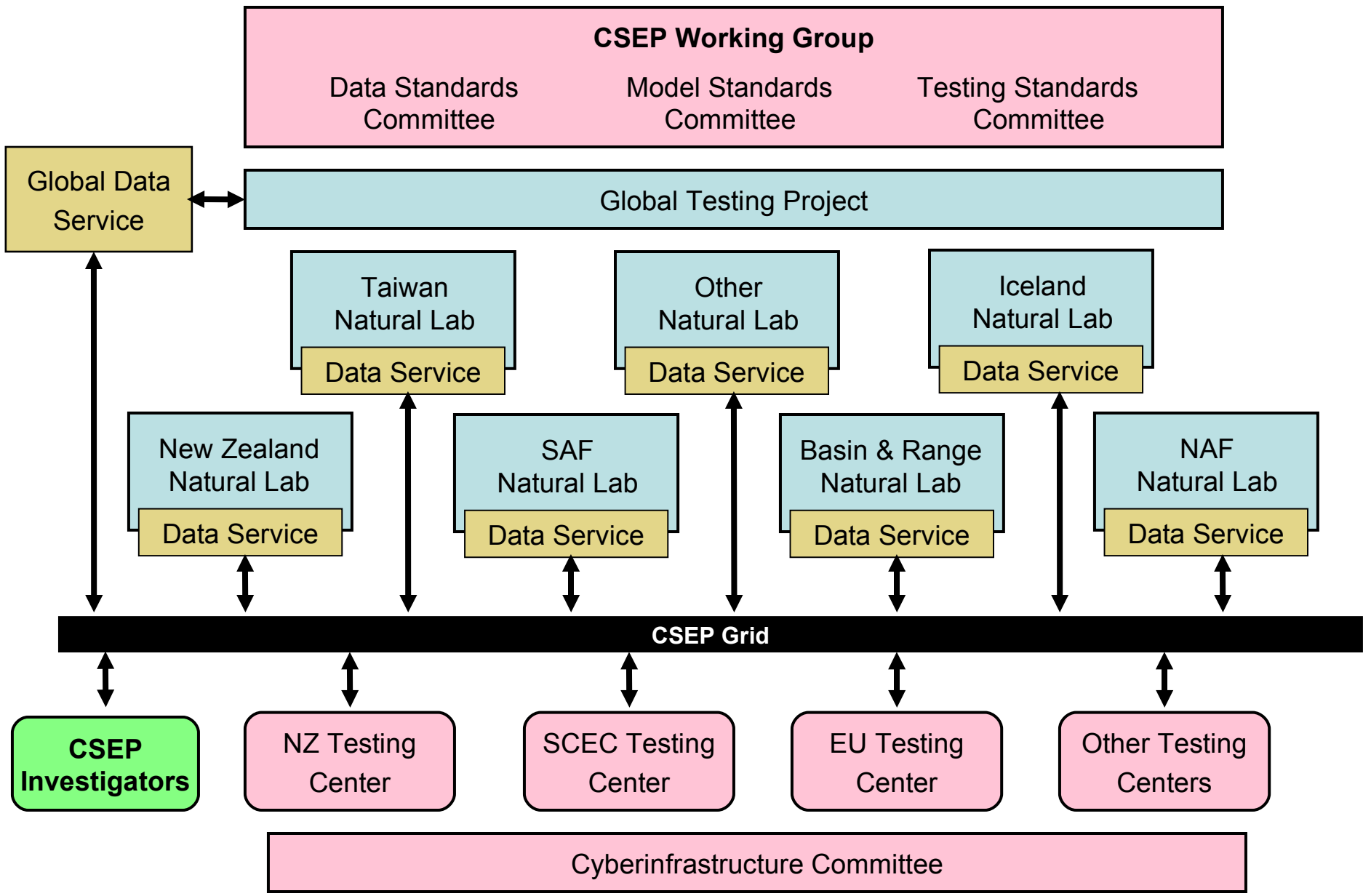
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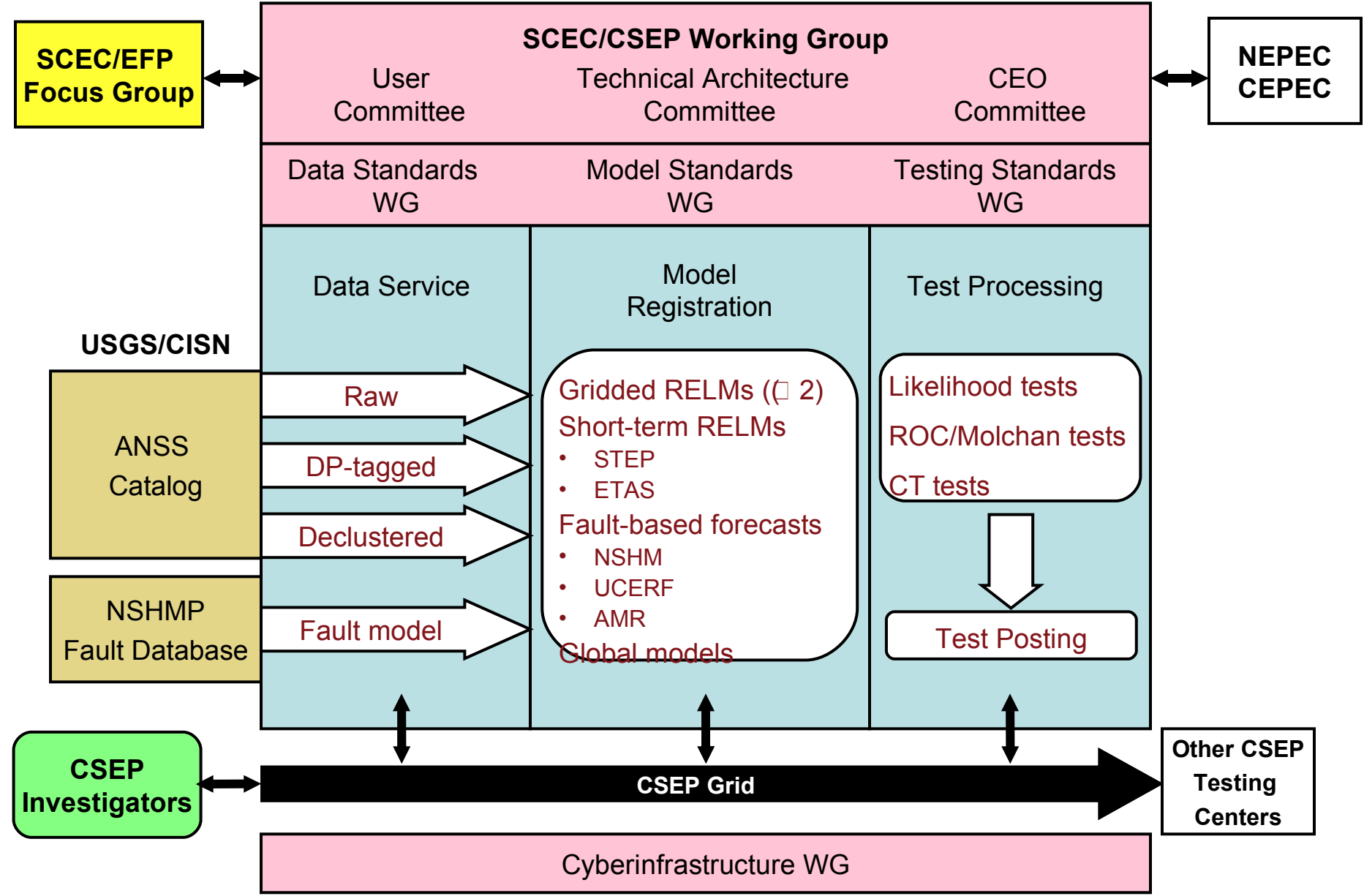
- by expanding the model space to include
  - other natural laboratories



# Four Essential CSEP Components

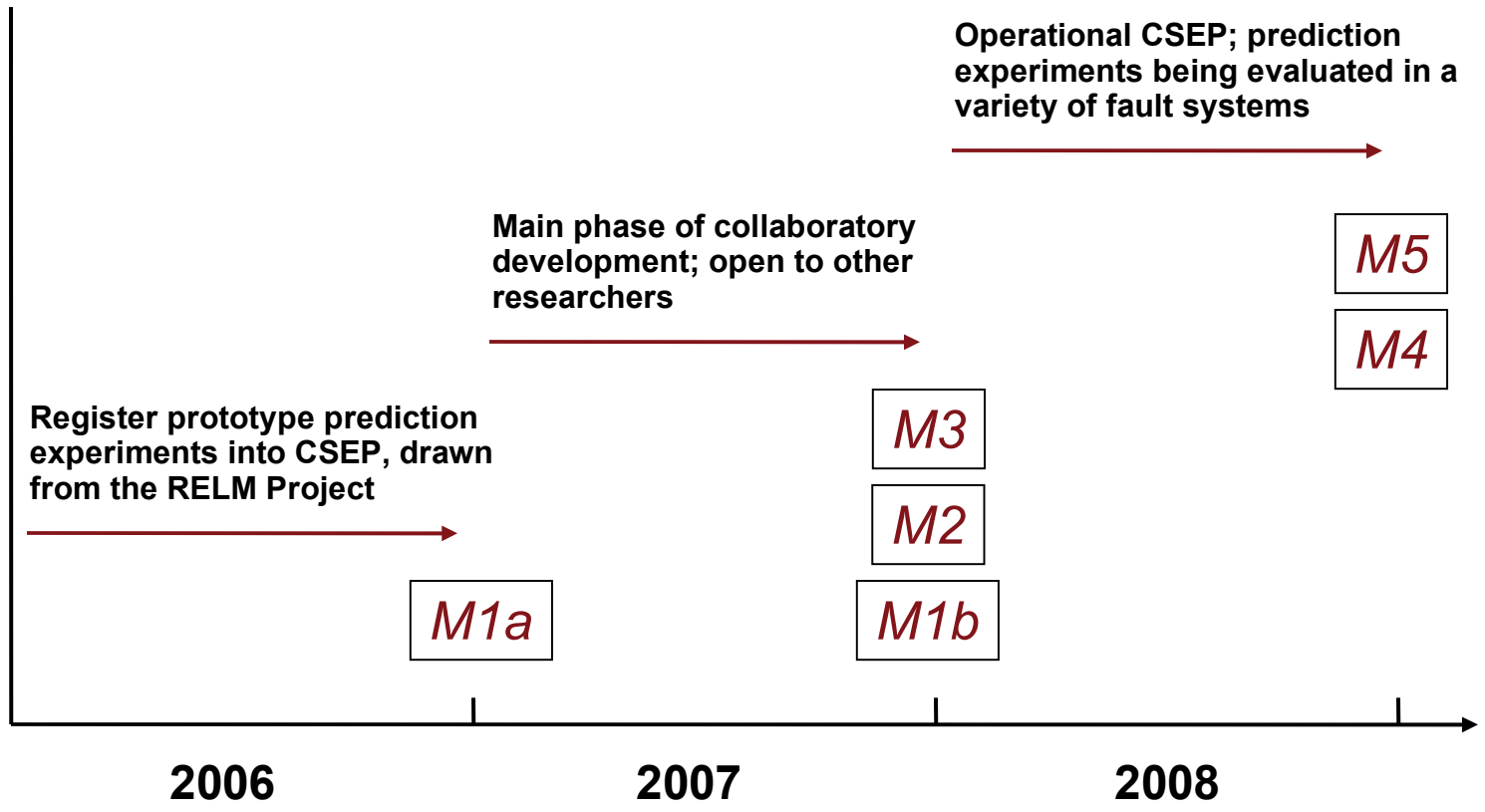
- **Regional natural laboratories with adequate, authorized data sources**
- **Community standards for the registration and evaluation of scientific prediction experiments**
- **Testing facilities with validated procedures for conducting and evaluating true (prospective) prediction experiments**
- **Communication grids that connect the natural laboratories and testing centers**
  - **scientific community, including professional societies**
  - **government ministries responsible for earthquake risk assessment**
  - **commercial interests and the general public**







# Project Timeline



## **CSEP is an *open, international* collaboration with three main goals:**

- 1. Reduce the controversy surrounding earthquake prediction through a collaboratory infrastructure to support a wide range of scientific prediction experiments**
- 2. Promote rigorous research on earthquake predictability through global partnerships**
- 3. Help the responsible government agencies assess the feasibility of earthquake prediction and the performance of proposed prediction algorithms**



**End**