

RELM Testing Program



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- Develop a variety of viable, geophysically based earthquake-rupture forecast (ERF) models for the region.
- Examine and compare the implications of each model with respect to seismic hazard and loss estimate.
- Test these models for consistency with existing geophysical data (e.g., historical seismicity) and design and document conclusive tests

- Develop a variety of viable, geophysically based earthquake-rupture forecast (ERF) models for the region.

Large variety of models have been developed

- Examine and compare the implications of each model with respect to seismic hazard and loss estimate.

OpenSHA

- Test these models for consistency with existing geophysical data (e.g., historical seismicity) and design and document conclusive tests

Community-agreed testing procedure & Testing Center

Why is testing so important?

- Evaluate potentially successful forecasts
Detect overly enthusiastic claims
- Certification process for models (Documentation)
- Validation of models
- Estimation of comparative performance of models
Avoid testing only against 'dumb' null hypotheses

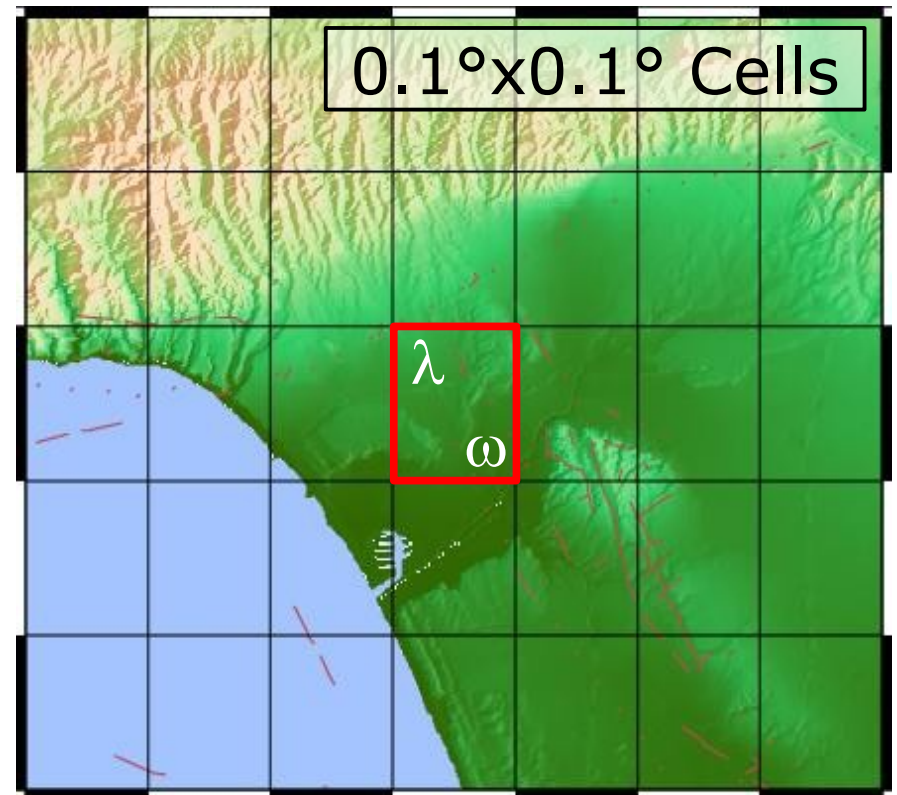
The testing area is separated into cells (grid-based models)

A bin defines a volume (cell), magnitude range, and range of focal mechanism angles for which a forecast is issued

In each bin: **Expectation** λ
Observation ω

The default binning:

Lon/Lat	$0.1^\circ \times 0.1^\circ$
Depth	0-30km
Magnitude	0.1
Focal Mech.	None (30°)



Computing the **likelihood** as the Poissonian probability of making an observation given an expectation.

We apply 3 different tests:

L-Test

Examines the consistency of a model with the observation (in the likelihood space)

N-Test

Test if the number of observed events is in the range of the expectation of a model

R-Test

Compares 2 models by its log-likelihood-ratio. It estimates the differences in spatial performance.

In each test we compare observed values with the value obtained from catalogs simulated based on expectations of a model.

Test data-consistency and compare each model's performance

Parameter uncertainties

error distributions of location, magnitude, and FM angles

Independence probabilities (Declustering)

aftershock vs. main shock

Magnitude completeness windows

time and magnitude

Resolution independent

location, magnitude, focal mechanisms angles

Analysis of spatial and magnitude-range performance

These problems need to be addressed in CSEP:

- Poissonian distribution
- Failure of a model if an event occurs in a bin with expectation 0.
- Computationally very intensive for time-dependent models, e.g. 1-day models
- Tests cover only one type of forecasts (grid-based probabilistic forecasts)
- Test results depend on the metric

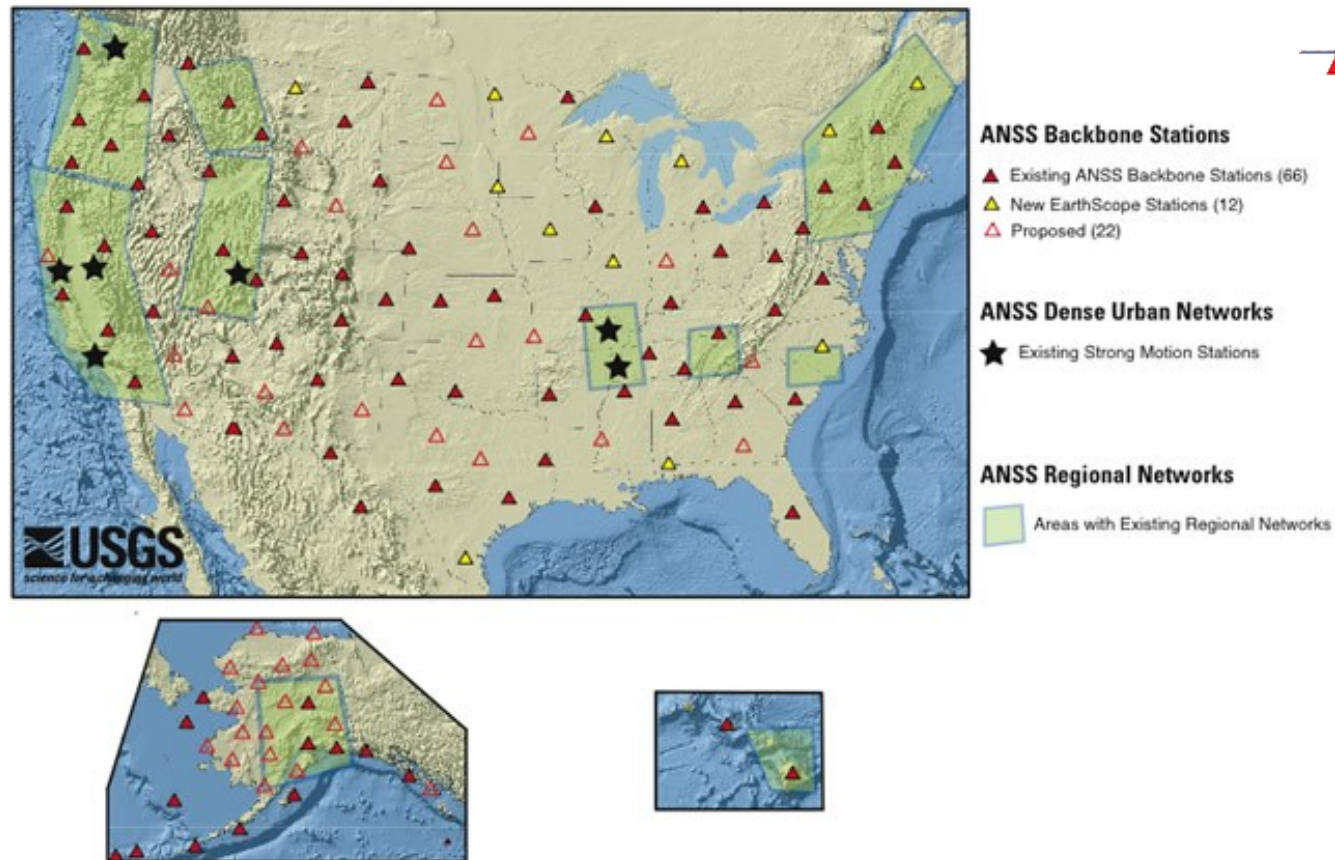
What does the testing implementation additionally include?

- Model definitions (Classes of models)

	5-year	1-year	1-day
Forecast duration	5 years	1 year	1 day
Aftershocks	yes/no	yes/no	yes
Magnitude range	5-9	5-9	4-9
Modeler provides	numbers	code	code
Revised data	no	yes	yes

What does the testing implementation additionally include?

- Model definitions
- Authorized data sources (Independent)
Earthquake catalog

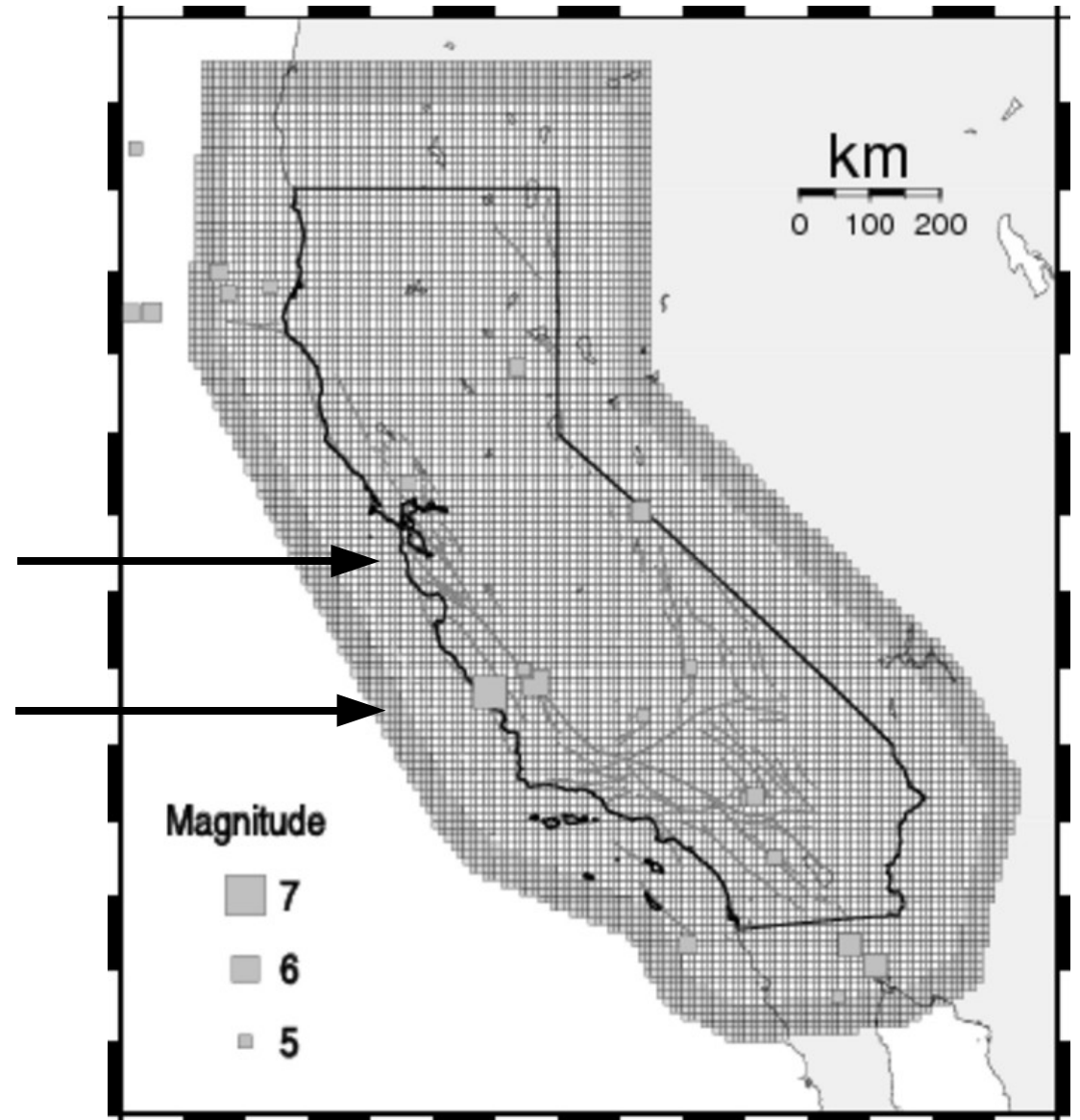


What does the testing implementation additionally include?

- Model definitions
- Authorized data sources
- Definition of testing bins

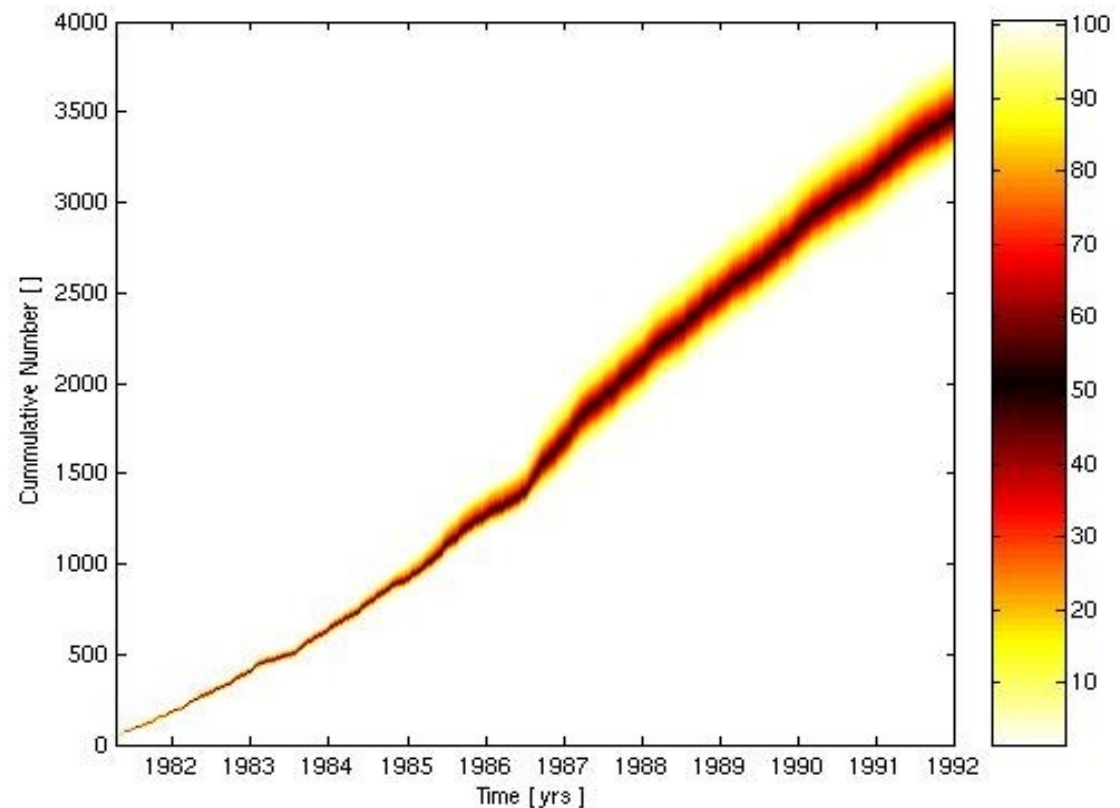
Testing Area

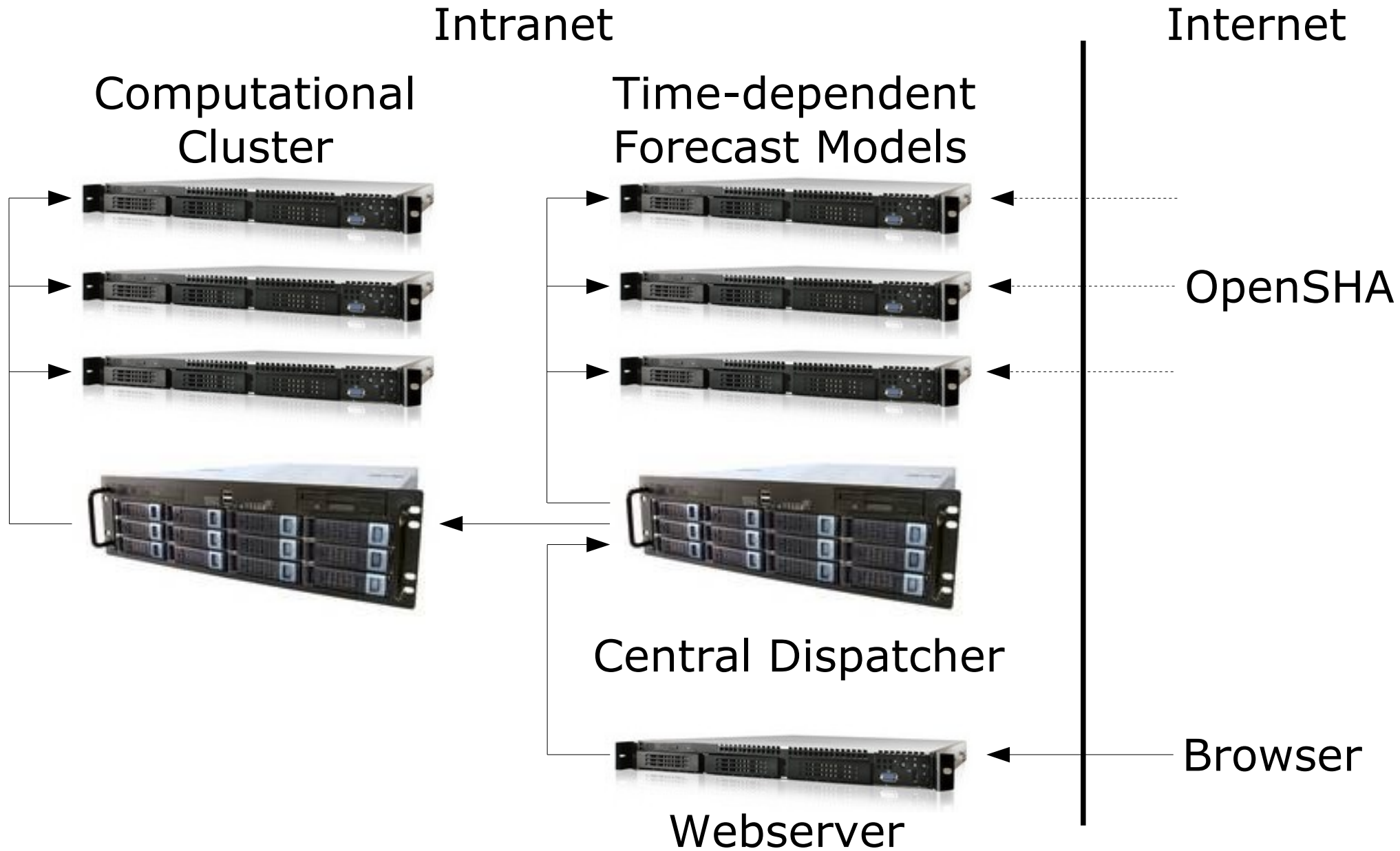
Collection Area



What does the testing implementation additionally include?

- Model definitions
- Authorized data sources
- Definition of testing bins
- Declustering





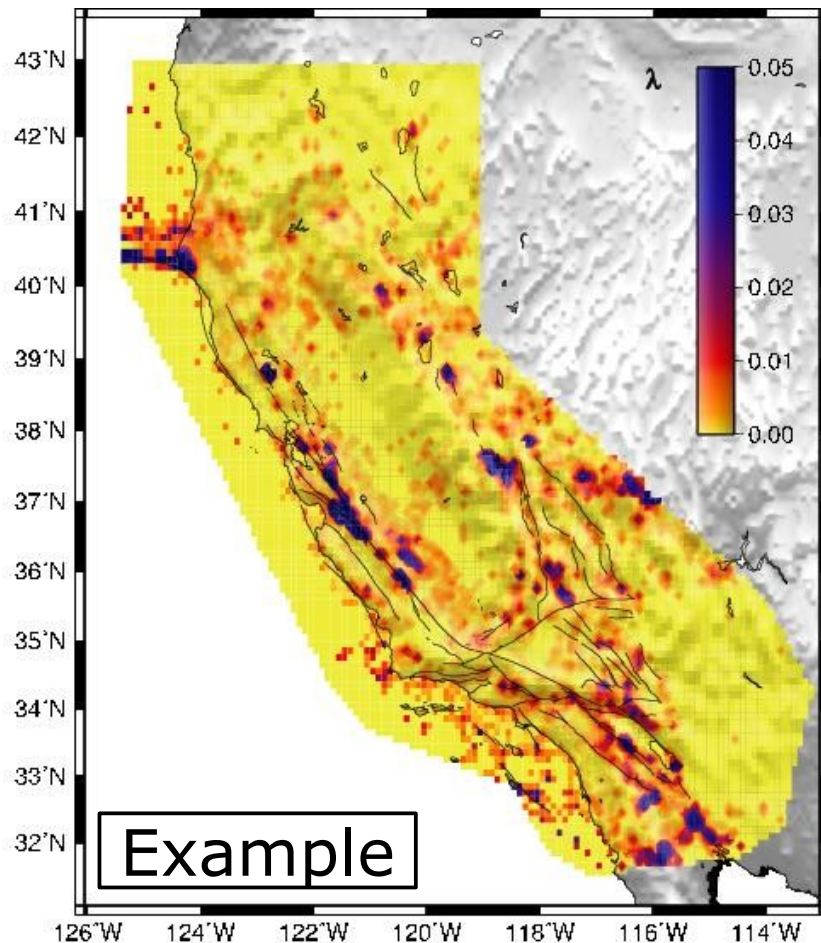
Why a Testing Center?

A controlled environment for:

- Test multiple models against each other
- Re-run the tests with alternative options (different magnitude ranges)
- Re-run the tests in case of bugs in the testing procedure
- Document each models code and potential changes to it
- Track the modeler's additional data and deposit it
- 'Certify' all steps of testing

- Convince the public that nobody cheated!

17 5-year models have been submitted to the Testing Center



Bird & Liu

SHIFT (quasi-static Poissonian forecast, including aftershocks)

Ebel et al.

5-yr main shock+aftershock model
5-yr main shock model

Frankel

1996 National Hazard Model

Helmstetter, Kagan, Jackson

HKJ 2005 long-term model (De-clustered)
HKJ 2005 long-term model (Complete)

Holliday et al.

Pattern Informatics

Shen, Jackson, and Kagan

Geodetic De-clustered Forecast
Geodetic Complete Forecast

Ward

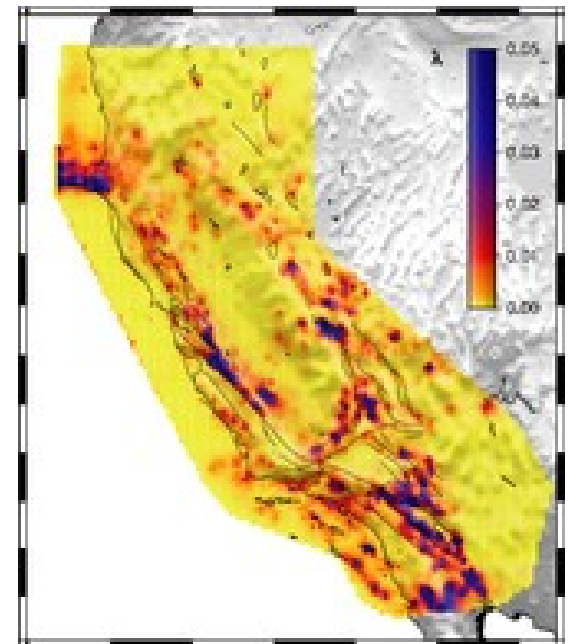
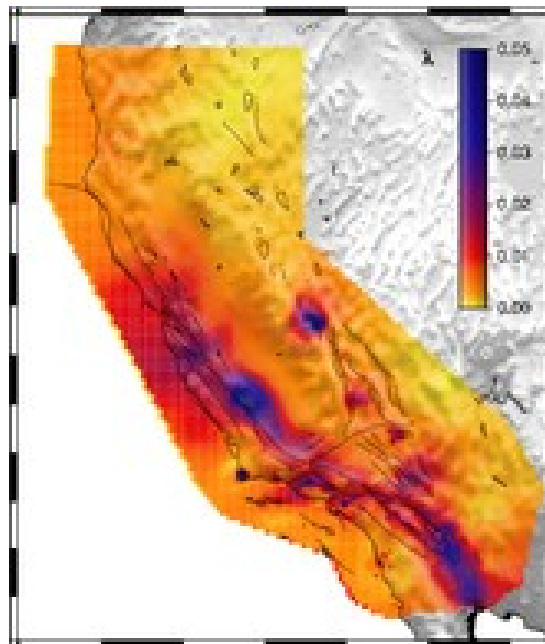
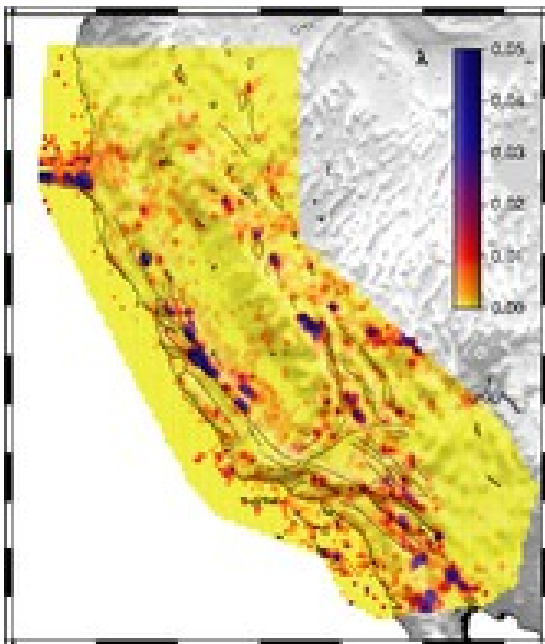
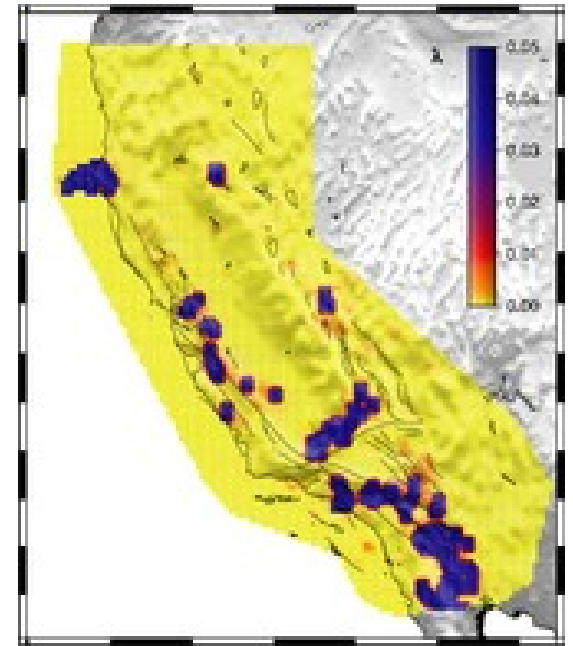
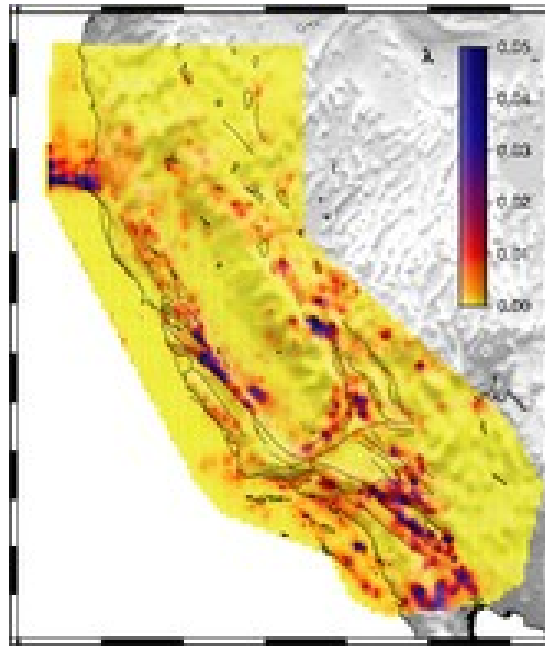
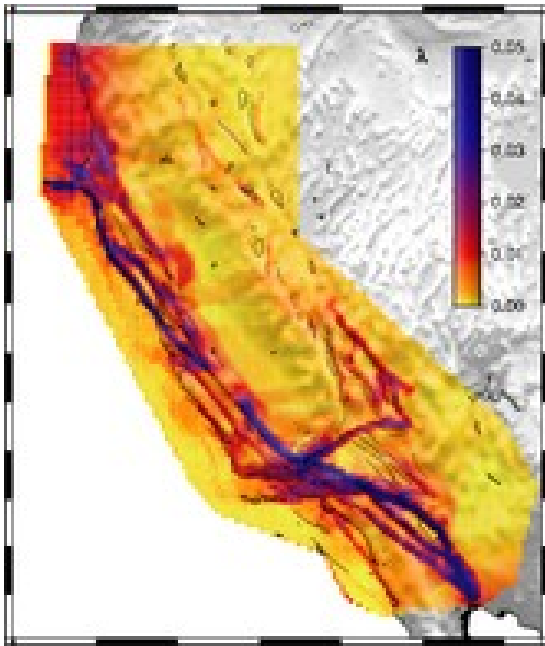
combo81
geodetic81
geodetic85
geologic81
seismic81
simulation

Wiemer & Schorlemmer

Asperity Likelihood Model

WG 2002

National Hazard Model



- RELM achieved most of its goals:
 - Development of models
 - OpenSHA
 - Community-accepted testing is underway
- RELM established a new standard in rigorous testing of probabilistic earthquake forecasts (Testing Center)
- Testing of 1-day/1-year models is postponed to start under CSEP