The Collaboratory for the Study of Earthquake Predictability: Perspectives on Evaluation & Testing for Seismic Hazard

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The fundamental principle of science, the definition almost, is this: the sole test of the validity of any idea is experiment.

Richard P. Feynman
Why Evaluation & Testing?

- Scientific best practice
- Increase acceptance of models and concepts
- Surprises (e.g. Seismic Gap Hypothesis)
- Explore validity of common concepts
- Reduce epistemic uncertainty (Disregard models)
- Extension of the peer-review concept
Evaluation & Testing

What can be tested?

- Model output

**CALIFORNIA AREA EARTHQUAKE PROBABILITIES**

<table>
<thead>
<tr>
<th>Magnitude</th>
<th>30-Year Probability *</th>
</tr>
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<tbody>
<tr>
<td>6.7</td>
<td>&gt;99%</td>
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* Probabilities do not include the Cascadia Subduction Zone.
Evaluation & Testing

Uniform California Earthquake Rupture Forecast UCERF2

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- Ingredients that cause the bulge cannot readily be identified
- No constraints on what went wrong
Evaluation & Testing

What can be tested?

- Model output
- Outputs of components
  - Fault model
  - Deformation model
  - Earthquake-rate model
  - Probability model
Evaluation & Testing

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– Scientific hypotheses
  – Magnitude-area (-fault length) relationships
  – Frequency-magnitude distribution
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- Make the model as testable as possible
Scientific Process

What does Evaluation & Testing do differently than the process of peer reviewed publications?

- Standardization & Formalization
- Nomenclature
- Agreement between scientists
- Rigor
- Reproducibility

- Tests involve researchers but are conducted independently
What Evaluation & Testing is NOT

- Testing software codes
- Evaluating input data and their generation (catalogs, various databases, etc.)
- Evaluation & testing targets scientific not technical problems
Status Quo
In Progress

– Earthquake Early Warning testing center
In Progress

- Earthquake Early Warning testing center
- Source Inversion Validation project with testing center

from database of M. Mai
In Progress

- Earthquake Early Warning testing center
- Source Inversion Validation project with testing center
- Reference models for all CSEP testing centers
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- Scientific hypotheses:
  - Characteristic Earthquake
  - Predictive power of Coulomb stress
  - Maximum magnitude per fault
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- Evaluation and Testing for
  - Global Earthquake Model (GEM)
  - UCERF3
GEM & UCERF3

First testing targets discussed for GEM & UCERF3:

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Courtesy of M. Wyss
GEM & UCERF3

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Making the model testable:

- Ground-motion intensities should always be expressed in MMI to be tested against “Did You Feel It?” data with each earthquake
Long-term Goals

- Make GEM & UCERF3 as testable as possible
- Test as many ingredients to the models as possible
- Explore the uncertainties and the validity of ingredients
- Create simple reference models to test GEM & UCERF3 and selected ingredients against
- Employ methods of the Collaboratory for the Study of Earthquake Predictability (CSEP)
Thank You!

If you're doing an experiment, you should report everything that you think might make it invalid — not only what you think is right about it... Details that could throw doubt on your interpretation must be given, if you know them.

Richard P. Feynman