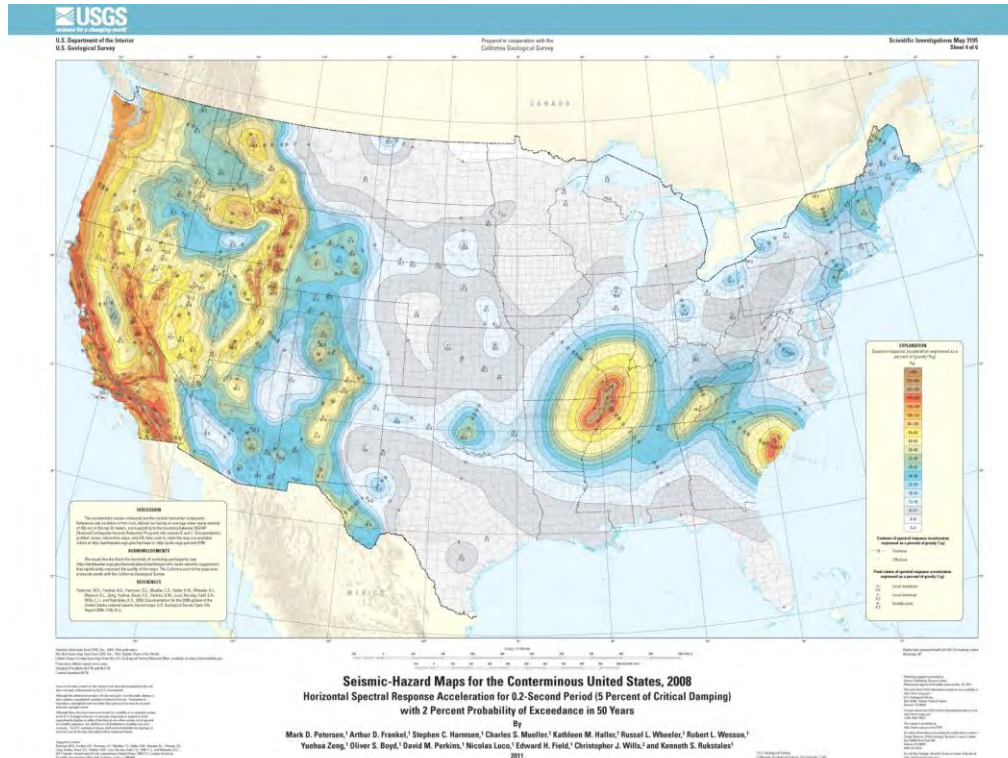# Workshop on the ground motion models applied in the National Seismic Hazard Maps
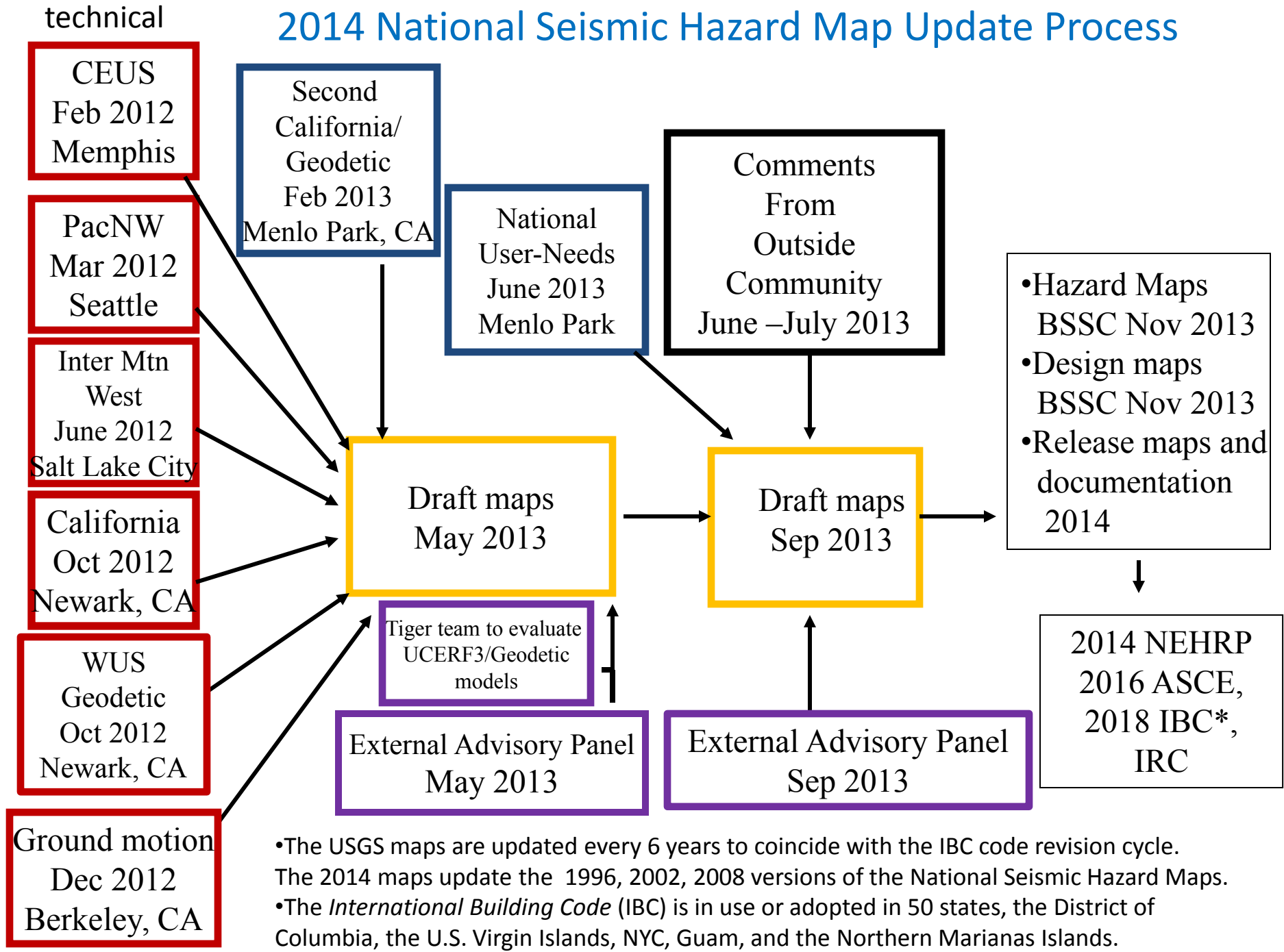## December 12-13, 2012 Berkeley, CA

Thanks to the Pacific Earthquake Engineering Research Center for hosting this workshop (Yousef Bozorgnia, Heidi Fasion, Sanaz Rezaeian)

Comments

- Status of NGA-East (2015), NGA-Subduction (just starting), NGA-West II (Jan, 2013), EPRI GMPE project (Early 2013).
- In this meeting we will consider CEUS, subduction (interface and intraslab), and active shallow crustal GMPE's. We will show you our implementation of the current GMPE models and resultant hazard maps. We welcome developer comments at this workshop and will need the developers to continue assisting us in our quest to Q/A the results.
- Many of the NGAW II GMPEs are preliminary – the authors have until January to publish the final models.
- We will also need to make maps for Alaska and we would like some advice on whether the subduction zone models are appropriate for both Cascadia and Alaska.
- We may update the 2014 maps over the next few years as these different NGA projects are completed (as research maps). They will be considered in future versions of the National Seismic Hazard Maps.
- If you would like us to post your presentation on our website, Sanaz Rezaeian has a sign-up sheet.

2014 National Seismic Hazard Map Update Process

technical

CEUS
Feb 2012
Memphis

PacNW
Mar 2012
Seattle

Inter Mtn
West
June 2012
Salt Lake City

California
Oct 2012
Newark, CA

WUS
Geodetic
Oct 2012
Newark, CA

Ground motion
Dec 2012
Berkeley, CA

Second
California/
Geodetic
Feb 2013
Menlo Park, CA

National
User-Needs
June 2013
Menlo Park

Comments
From
Outside
Community
June –July 2013

Draft maps
May 2013

Draft maps
Sep 2013

Tiger team to evaluate
UCERF3/Geodetic
models

External Advisory Panel
May 2013

External Advisory Panel
Sep 2013

- Hazard Maps
  BSSC Nov 2013
- Design maps
  BSSC Nov 2013
- Release maps and
  documentation
  2014

2014 NEHRP
2016 ASCE,
2018 IBC*,
IRC

- The USGS maps are updated every 6 years to coincide with the IBC code revision cycle.
  The 2014 maps update the 1996, 2002, 2008 versions of the National Seismic Hazard Maps.
- The *International Building Code* (IBC) is in use or adopted in 50 states, the District of
  Columbia, the U.S. Virgin Islands, NYC, Guam, and the Northern Marianas Islands.

Purpose of this workshop

- Which published GMPE's should we use in 2014 update?

- How should we consider in weighting of models? (appropriate model parameters, residual analysis, extrapolation, expert opinion)

- We consider applications beyond building codes. How should we develop models for Vs30=760m/s and other NEHRP categories?

Cooke's Approach for Expert Elicitation

- It is a *structured* elicitation process
- The approach is subject to:
    - Scrutiny/accountability [data/process open]
    - Empirical control [quantitative, subject to empirical quality control with observable data to validate]
    - Neutrality [encourage experts to provide their true beliefs, and help avoid bias]
    - Fairness [expertise are not pre-judged]
- Weights are determined based on Experts' relative performance to <u>seed/quiz questions</u> (for which the answers are known to the facilitator)
- Scoring system (<u>Calibration score</u> and <u>Information score</u>) gives experts a positive incentive to report their true probability beliefs honestly

Kishor Jaiswal

Considerations in weighting models

1. Does the model apply appropriate science-based parameters ("seismological principles") needed to describe ground shaking? (Geometric spreading, kappa, Moho, hanging wall-footwall terms, site effects, non-linearity, etc).

2. How does the model compare with data? (Residual analysis as a function of magnitude and distance, total residuals for each model, e.g., kai-squared model, weights by class or "cluster" of model).

3. How does the model extrapolate to regions with no data? (form of equation, limits of applicability).

4. How does the model compare to other equations? (median, sigma, extra epistemic uncertainty for earthquakes not recorded yet).

5. What do the experts think about the equations and do the models as a group encompass reasonable outcomes (based on experience).

6. Does the equation use modeled hazard parameters? (Vs30, distance metric, Magnitude, SA parameters).

7. Do we allow different weighting for low and high frequencies (e.g., EPRI), for regional differences, for different magnitudes?

1. 2008 Central-Eastern U.S. Ground Motion Models

2008 Maps		Type	Weight
1.	Toro (2002)	Single corner	0.2
2.	Frankel et al. (1996)	Single corner	0.1
3.	Silva et al. (2002)	Single corner – constant stress drop	0.1
4.	Atkinson and Boore (2006)	Dynamic corner	
	• 140 bar stress drop		0.1
	• 200 bar stress drop		0.1
5.	Tavakoli and Pezeshk (2005)	Hybrid	0.1
6.	Campbell (2003)	Hybrid	0.1
7.	Somerville et al. (2001)	Full waveform simulation	0.2

1. Central-Eastern U.S. Ground Motion Models

	GMPE	2008	2014	gs	kappa
1.	Toro (2002)	yes	yes	1/r	0.01
2.	Frankel et al. (1996)	yes	yes	1/r	0.01
3.	Silva et al. (2002)	yes	yes	1/r	0.01
4.	~~Atkinson and Boore (2006)~~				
	• ~~140 bar stress drop~~	~~yes~~	~~no~~	~~$1/r^{1.3}$~~	~~0.02~~
	• ~~200 bar stress drop~~	~~yes~~	~~no~~	~~$1/r^{1.3}$~~	~~0.02~~
4.	Atkinson and Boore 2006 '	no	yes	$1/r^{1.3}$	0.02
5.	Atkinson and Boore 2008 '	no	yes	$1/r^{1.3}$	0.02
6.	~~Tavakoli and Pezeshk (2005)~~	~~yes~~	~~no~~	~~1/r~~	~~0.01~~
6.	Pezeshk et al. (2011)	no	yes	$1/r^{1.3}$	0.02
7.	~~Campbell (2003)~~	~~yes~~	~~yes~~	~~1/r~~	~~0.01~~
8.	Somerville et al. (2001)	yes	yes	1/r	0.01

2. Subduction Ground Motion Models

Interface GMPE	2008	2014	Weight
1. Zhao et al. (2006)	yes	yes	50%
2. Geomatrix – Youngs et al. (1997)	yes	yes	25%
3. Atkinson and Boore – global (2003)	yes	yes	25%
4. Zhao et al. (2012) – mag scaling	no	yes	--
5. BC Hydro (*published?)	no	yes*	--

Intraslab (deep) GMPE	2008	2014	Weight
~~1. Geomatrix – Youngs et al. (1997)~~	~~yes~~	~~no~~	~~50%~~
2. Atkinson and Boore – global (2003)	yes	yes	25%
3. Atkinson and Boore – Cascadia (2003)	yes	yes	25%
4. Zhao et al. (2006, 2012)	no	yes	--
5. BC Hydro (published?)	no	yes	--

3. Western U.S. Ground Motion Models

2008 Maps   Weight

1.   Boore and Atkinson (2008) -- NGA   1/3
2.   Campbell and Bozorgnia (2008) -- NGA   1/3
3.   Chiou and Youngs (2008) – NGA   1/3

2014 Maps

1.   Abrahamson and Silva (2008 or 2012) – NGAW1&2
2.   BSSA (2012) – NGAW2
3.   Campbell and Bozorgnia (2012) – NGAW2
4.   Chiou and Youngs (2012) – NGAW2
5.   Idriss (2012) – NGAW2
6.   Graizer and Kalkan (2009/2012)

Agenda for Wednesday

- CEUS ground motions
  - GMPEs for 2014
  - Parameters
  - Residual analysis
  - Sensitivity
  - Weighting
- Subduction (interface and intraslab)
  - GMPEs for 2014
  - Sensitivity
  - Weighting

Agenda for Thursday

- WUS ground motions
  - GMPEs for 2014
  - Sensitivity
  - Weighting
- Discussion 2-5 pm
  - Attendees invited to show up to 3 slides