



# NGA Ground Motion Database

**Carola Di Alessandro**

Post-Doctoral Fellow @ PEER – UC Berkeley (\*)

Pacific Earthquake Engineering Research Center

**2012 PEER ANNUAL MEETING**

October 26 - 27, 2012  
Berkeley, California

\* Currently at GeoPentech, Inc.

# PURPOSE

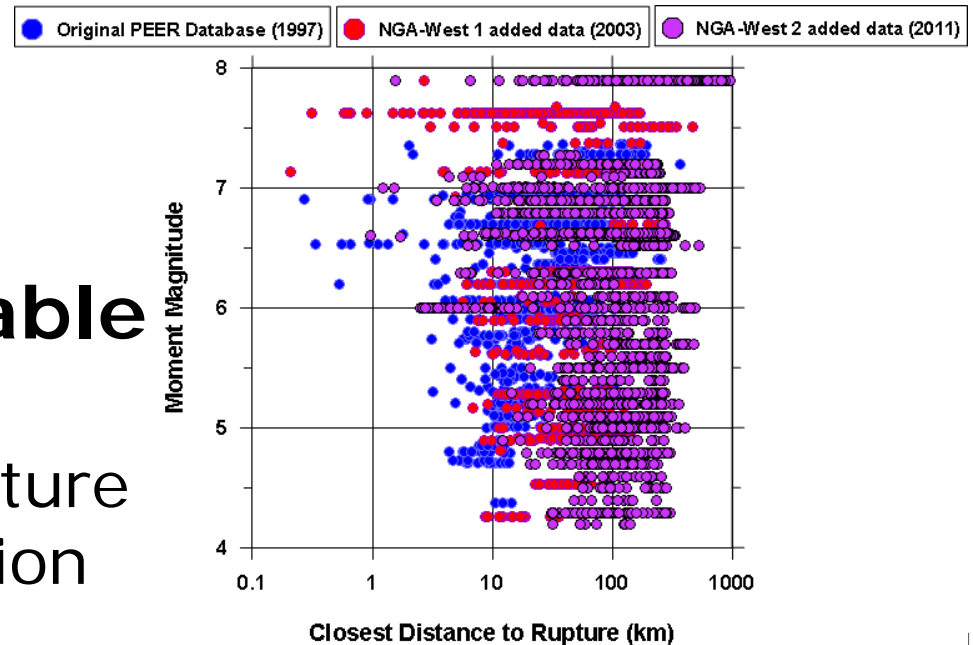
- **Update of the PEER Ground Motion Database – 2010 Beta Version**

*([http://peer.berkeley.edu/peer\\_ground\\_motion\\_database](http://peer.berkeley.edu/peer_ground_motion_database))*

New NGA-West2 Database has been finalized and will be made public in 2013

- **Collect User's feedback on desirable features**

Search options in the future interactive web application



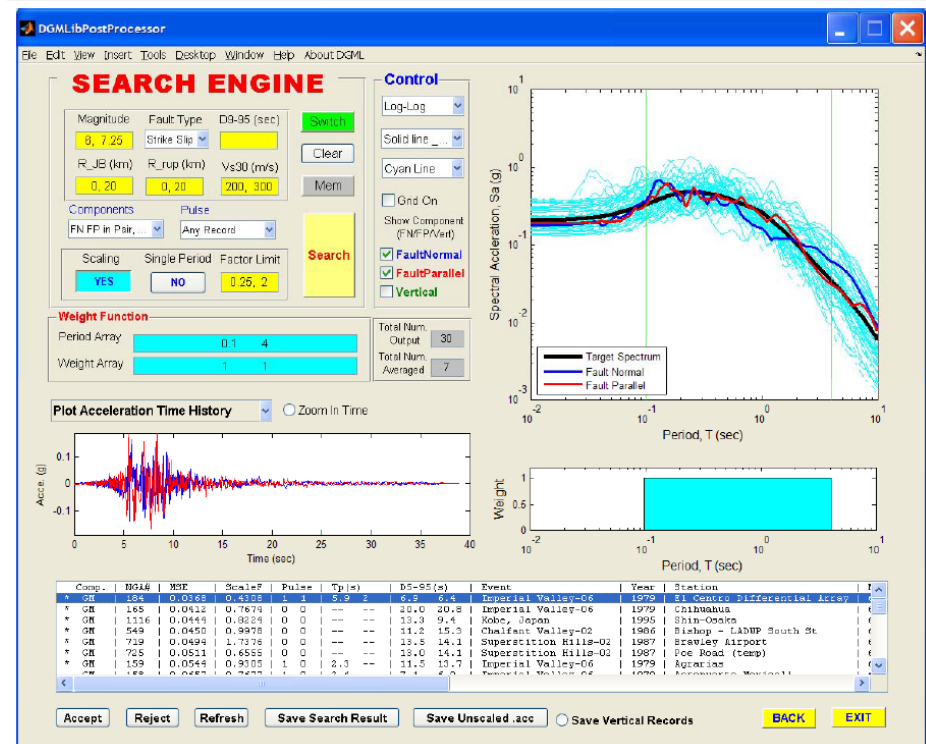
# PEER Ground Motion Database 2010 Beta Version

- Based on DGML Application
  - Interactive web application based on DGML Ver. 2.0 software package

w/ funding from



w/ thanks to



# PEER Ground Motion Database 2010 Beta Version

- Presented in several occasions





- PEER & NEES Annual Meeting, San Francisco, October 2010

- PEER Annual Meeting, Berkeley, October 2011




Time	General Daily Schedule	Presentation Title	Speakers
12:00 - 1:30 pm	LUNCH	LOCATED IN BOILER ROOM & COURTYARD	
		Seismic Hazard Analysis	<b>Jack Baker</b> (Stanford) ★
1:30 - 3:00 pm	PLENARY	Computational Simulation	<b>Frank McKenna</b> (PEER Center & OpenSees)

- GeoEngineering Lecture, May 2012

### 30th Annual Geo-Engineering Distinguished Lecture Series



Friday May 4th, 2012

This is our 30<sup>th</sup> year of bringing great lectures to great audiences in the GeoEngineering community. This year we are very excited about our Lecturers. In honor of our 30<sup>th</sup> anniversary we have a very Blue and Gold line-up, both Professors Kramer and Kavazanjian received their graduate degrees at Berkeley. In addition we have a brief presentation from PEER on their new interactive online Ground Motion Database program. It is designed to be used by both researchers and practicing engineers in the fields of structural and geotechnical engineering.

# 2010 Improvements vs. previous DB versions

## ■ 2005 PEER NGA Database

Used to develop 2008 NGA relations

Purge events not associated to shallow crustal earthquakes in active tectonic regimes

Remove controversial recordings/stations

**Table B-2: List of PEER-NGA Records Excluded in PGMD Database**

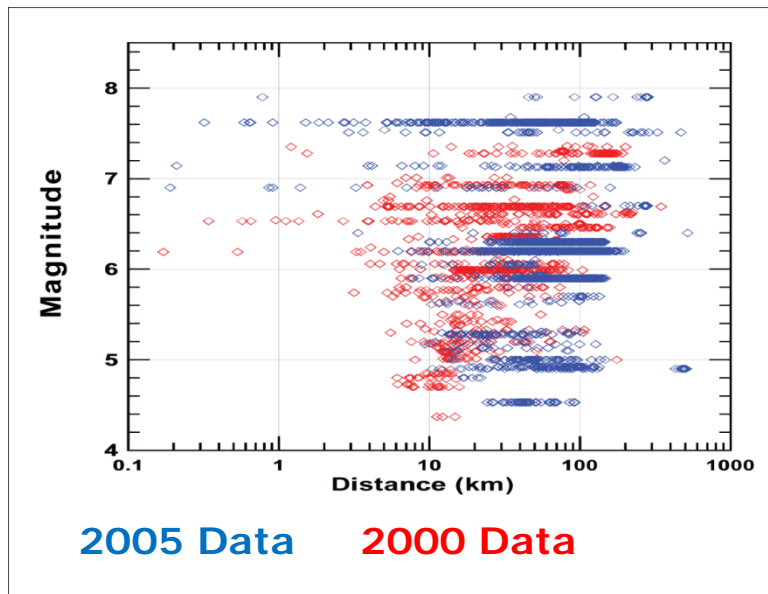
Record Sequence Number	Earthquake Name	YEAR	MODY	Station Name	Earthquake Magnitude	Fault Type	Closest Distance* (km)	Preferred Vs30** (m/s)	FW/HW Indicator***	Reason for exclusion <sup>†</sup>
360	Chi-Chi, Taiwan-04	1999	0920	HWA2	6.20	SS	91	[244]	na	i
361	Chi-Chi, Taiwan-05	1999	0922	HWA2	6.20	RV	56	[244]	nu	i
362	Chi-Chi, Taiwan-05	1999	0922	TAP066	6.20	RV	151	663	nu	c
363	Chi-Chi, Taiwan-05	1999	0922	TAP103	6.20	RV	150	429	nu	c
364	Chi-Chi, Taiwan-05	1999	0922	TCU081	6.20	RV	101	[301]	nu	c
365	Chi-Chi, Taiwan-06	1999	0925	HWA2	6.30	RV	56	[244]	nu	i
366	Chi-Chi, Taiwan-06	1999	0925	TAP103	6.30	RV	141	429	nu	c
367	Chi-Chi, Taiwan-06	1999	0925	TCU081	6.30	RV	90	[301]	nu	c
368	Loma Prieta	1989	1018	Los Gatos - Lexington Dam	6.93	RV-OBL	5.0	1070	fw	j <sup>†</sup>
369	Northridge-01	1994	0117	Monte Nido Fire Station	6.69	RV	25.6	660	hw	j <sup>†</sup>
370	Northridge-01	1994	0117	Loma Linda, VA Hospital, North Freefield	6.69	RV	112	275	nu	j <sup>†</sup>
371	Northridge-01	1994	0117	Loma Linda, VA Hospital, South Freefield	6.69	RV	112	275	nu	j <sup>†</sup>
372										
373	Notes:									
374										
375	* Closest distance (Rrup) in red were estimated using epicentral and hypocentral distances and simulations for earthquakes not having fault rupture models (Chiou and Youngs, 2008b, Appendix B).									
376	** Updated preferred Vs30 values for Central Weather Bureau Taiwan sites are shown in brackets (Chiou and Youngs, 2008b, Appendix C).									
377	*** FW/HW indicators are defined in the documentation of the PEER-NGA database flatfile: fw – footwall site; hw – hanging wall site; nu – neutral region site; na – not applicable.									
378	† The records were not included for various reasons including one or more of the following:									
379	(a) records considered to be from tectonic environments other than shallow crustal earthquakes in active tectonic regions, e.g. records from subduction zones;									
380	(b) earthquakes poorly defined;									
381	(c) records obtained in recording stations not considered to be sufficiently close to free-field conditions, e.g. records obtained in basements or on the ground floor of tall or heavy buildings;									
382	(d) absence of information on soil/geologic conditions at recording stations;									
383	(e) records had only one horizontal component;									
384	(f) records had not been rotated to FN and FP directions because of absence of information on sensor orientations or fault strike;									
385	(g) records of questionable quality;									
386	(h) proprietary data;									
387	(i) duplicate record;									
388	(j) other: (j <sup>1</sup> ) misc; (j <sup>2</sup> ) uncertain sensor orientation; (j <sup>3</sup> ) foundation problem; (j <sup>4</sup> ) no spectrum value.									

# 2010 Improvements vs. previous DB versions

## ■ 2000 PEER Ground Motion Database

First public database

Significant increase of recordings number



### 1: Search earthquake or station characteristics and peak values

Earthquake Any  
Mechanism Any  
Magnitude (Range)  -   ML  M  MS  Any  
Distance (km)  -   Closest  Hypocentral  Projection of fault plane (JB distance)  Any  
Site Classification USGS  Any [\(Compare to NEHRP classifications\)](#)  
Geomatrix Any  
Taiwan CWB Any  
Mapped Local Geology Any  
Instrument Housing Any  
Data Source Any

PGA (g)  -  Range 0.001 ... 2.086  
PGV (cm/sec)  -  Range 0.1 ... 263.1  
PGD (cm)  -  Range 0.01 ... 430.00

### 2: Search response spectra

Maximum   
Pseudo Acceleration (g)

Minimum

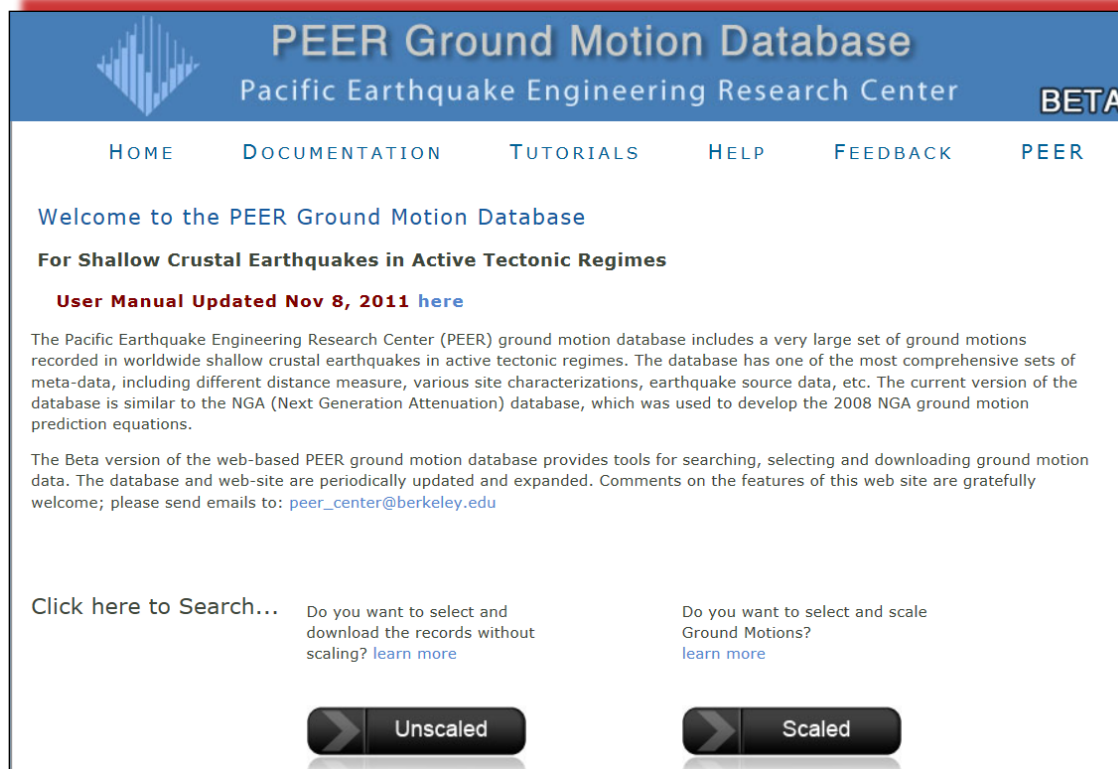
Low High

PEER Strong Motion Plotter

Y-axis: PAA (g)  
X-axis: Period (seconds)

# PEER Ground Motion Database 2010 Beta Version

- Search features
  - Unscaled or Scaled options



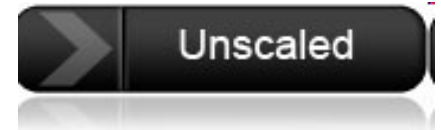
The screenshot shows the PEER Ground Motion Database website. The header features the PEER logo (a stylized diamond shape with vertical bars) and the text "PEER Ground Motion Database" and "Pacific Earthquake Engineering Research Center". A "BETA" badge is visible in the top right corner. The navigation menu includes "HOME", "DOCUMENTATION", "TUTORIALS", "HELP", "FEEDBACK", and "PEER". The main content area starts with a welcome message: "Welcome to the PEER Ground Motion Database" and "For Shallow Crustal Earthquakes in Active Tectonic Regimes". It includes a link to the "User Manual Updated Nov 8, 2011 here". A paragraph describes the database's scope: "The Pacific Earthquake Engineering Research Center (PEER) ground motion database includes a very large set of ground motions recorded in worldwide shallow crustal earthquakes in active tectonic regimes. The database has one of the most comprehensive sets of meta-data, including different distance measure, various site characterizations, earthquake source data, etc. The current version of the database is similar to the NGA (Next Generation Attenuation) database, which was used to develop the 2008 NGA ground motion prediction equations." Another paragraph states: "The Beta version of the web-based PEER ground motion database provides tools for searching, selecting and downloading ground motion data. The database and web-site are periodically updated and expanded. Comments on the features of this web site are gratefully welcome; please send emails to: [peer\\_center@berkeley.edu](mailto:peer_center@berkeley.edu)". At the bottom, there are two search options: "Click here to Search..." with a link to "Do you want to select and download the records without scaling? [learn more](#)" and "Do you want to select and scale Ground Motions? [learn more](#)". Below these are two buttons: "Unscaled" and "Scaled", each with a right-pointing arrow icon.



# SEARCH FOR GROUND MOTION RECORDS

## ■ UNSCALED Records

- Based on earthquake parameters OR
- Event name / NGA Sequence or Station Name



### New Unscaled Search

PEER-NGA Spectrum

Magnitude	<input type="text" value="6, 7.25"/>	(min,max)
Fault Type	<input type="text" value="All types"/>	▼
D9-95(sec)	<input type="text"/>	
R_JB(km)	<input type="text" value="0, 20.5"/>	(min,max)
R_rup(km)	<input type="text" value="0, 20.5"/>	(min,max)
Vs30(m/s)	<input type="text" value="200,300"/>	(min,max)
Pulse	<input type="text" value="Any Record"/>	▼

### New Unscaled Search

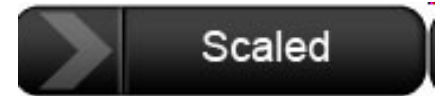
PEER-NGA Spectrum

Event Name	<input type="text"/>	▼
NGA Sequence Numbers	<input type="text"/>	
Station Name	<input type="text"/>	▼



# SEARCH FOR GROUND MOTION RECORDS

## ■ **SCALED** Records

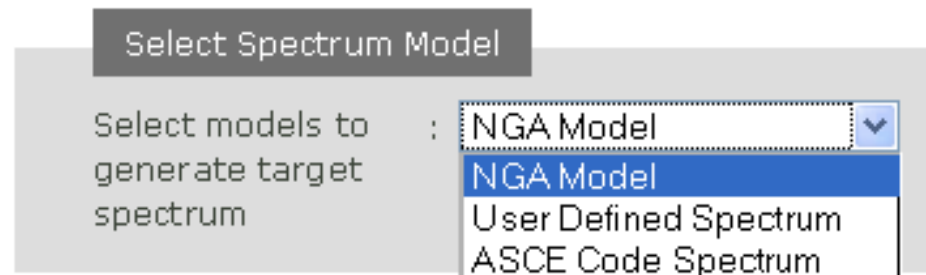


- Applies linear scale factor – shape preserved!

## ■ Needs a **TARGET SPECTRUM**

- NGA Model
- User Defined Spectrum
- ASCE Code Spectrum

### Target Spectrum



# PEER – NGA TARGET SPECTRUM

- **EPSILON:**
  - Number of Standard Deviations

- **CONDITIONAL MEAN:**
  - Option to apply the Conditional Mean Method

- **PERIOD of CONDITIONAL MEAN Method:**
  - Specifies the period for the Conditional Mean Method

PEER-NGA Spectrum

<input checked="" type="checkbox"/>	Abrahamson-Silva	<input checked="" type="checkbox"/>	Boore-Atkinson
<input checked="" type="checkbox"/>	Campbell-Bozorgnia	<input checked="" type="checkbox"/>	Chiou-Youngs
<input checked="" type="checkbox"/>	Idriss		
Magnitude	:	<input type="text" value="7"/>	
Fault Type	:	<input type="text" value="Strike Slip"/>	<input type="button" value="v"/>
DIP(deg)	:	<input type="text" value="90"/>	
ZTOR(km)	:	<input type="text" value="0"/>	
Width(km)	:	<input type="text" value="100"/>	
Rrup(km)	:	<input type="text" value="20"/>	
Rx(km)	:	<input type="text" value="20"/>	
Rjb(km)	:	<input type="text" value="20"/>	
Vs30(m/s)	:	<input type="text" value="569"/>	<input checked="" type="checkbox"/> estimated
Z1.0(km)	:	<input type="text" value="0.12333"/>	<input checked="" type="checkbox"/> default
Z2.5(km)	:	<input type="text" value="0.96237"/>	<input checked="" type="checkbox"/> default
Averages	:	<input checked="" type="radio"/> Geometric	<input type="radio"/> Arithmetic
Epsilon	:	<input type="text" value="1"/>	
Cond Mean	:	<input checked="" type="radio"/> Yes	<input type="radio"/> No
T_eps(s)	:	<input type="text" value="2"/>	

*Input panel to create PEER-NGA Spectrum*

# PEER – NGA TARGET SPECTRUM

## ■ EPSILON:

- Number of Standard Deviations away from the median value (e.g. epsilon=1.0 for an 84th-percentile spectrum)

## ■ 1<sup>st</sup> OPTION:

- Generate a constant Epsilon Spectrum

- Examples of constant epsilon spectra generated using the average of five NGA models and epsilon = 0, 1, and 2

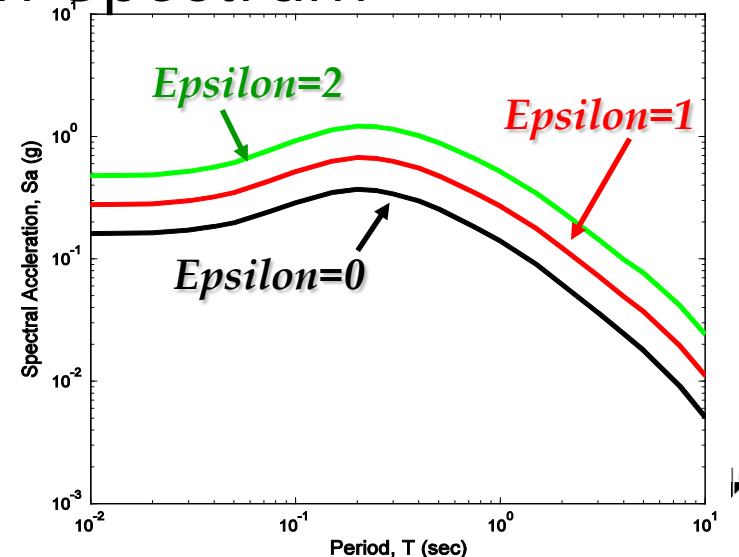
Averages :  Geometric  Arithmetic

Epsilon :

Cond. Mean :  Yes  No

T\_eps(s) :

Conditional Mean Option "NO"



# PEER - NGA TARGET SPECTRUM

## 2<sup>nd</sup> OPTION:

- Develop a Conditional Mean Spectrum

(Baker & Cornell, 2006)

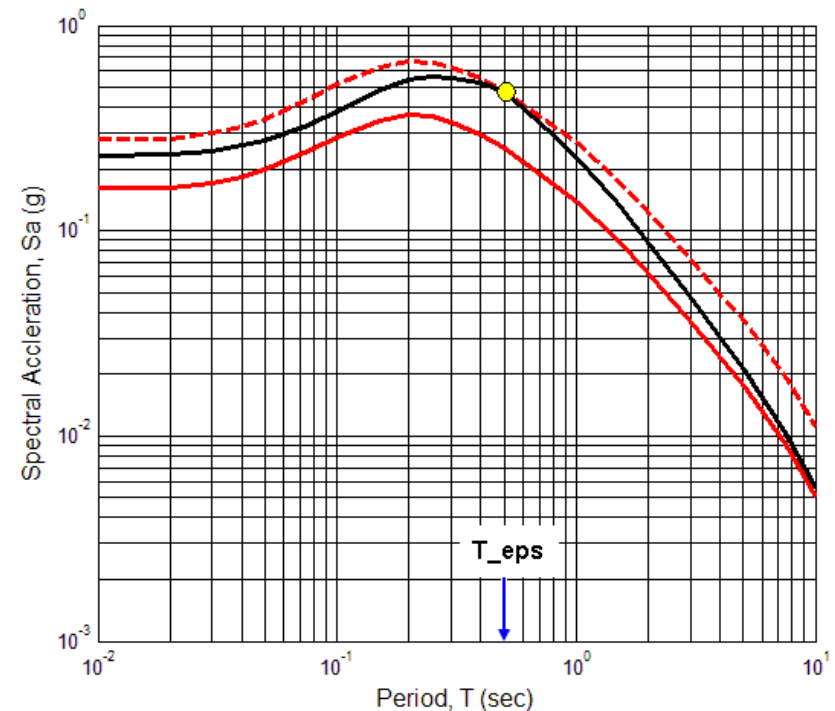
- Specify the value of Epsilon at a Spectral Period

(correlation model by Baker & Jayaram, 2008)

- Example of a conditional mean spectrum (CMS) created for an epsilon value of 1.0 anchored at a spectral Period of 0.5 seconds

Conditional Mean Option "YES"

Epsilon	:	1	<input type="text"/>
Cond. Mean	:	<input checked="" type="radio"/> Yes <input type="radio"/> No	
T_eps(s)	:	0.5	<input type="text"/>



# SEARCH ENGINE

## RECORD ACCEPTANCE CRITERIA:

- Perform search over NGA Database

## WEIGHT FUNCTION:

- Specification of Weight function used for scaling records

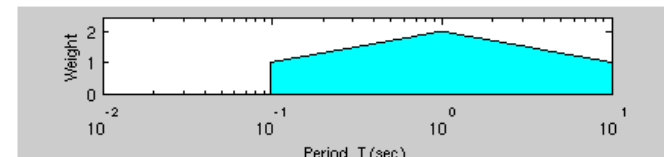
PEER-NGA Spectrum

Magnitude	:	<input type="text" value="6, 7.25"/>	(min,max)
Fault Type	:	<input type="text" value="All types"/>	
D9-95(sec)	:	<input type="text"/>	
R_JB(km)	:	<input type="text" value="0, 20.5"/>	(min,max)
R_rup(km)	:	<input type="text" value="0, 20.5"/>	(min,max)
Vs30(m/s)	:	<input type="text" value="200,300"/>	(min,max)
Pulse	:	<input type="text" value="Any Record"/>	
Scaling	:	<input checked="" type="checkbox"/> <a href="#">learn more</a>	
Single Period	:	<input type="checkbox"/>	
Factor Limit	:	<input type="text"/>	(min,max)
T (sec)	:	<input type="text"/>	

[Additional Search Options](#)

Weight Function

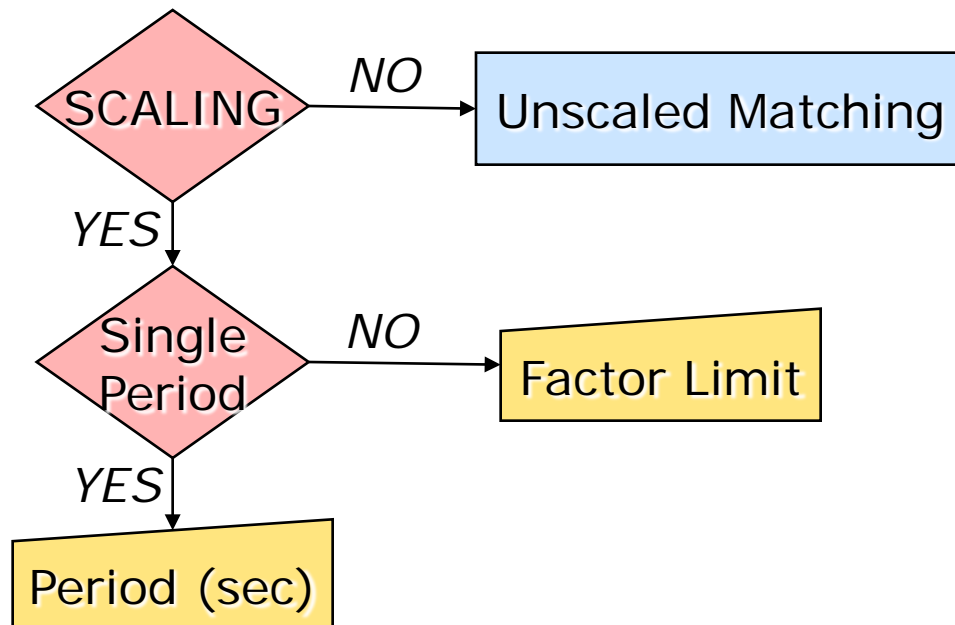
Period	:	<input type="text" value="0.1 1 10"/>	(min max)
Weight	:	<input type="text" value="1 2 1"/>	(wt. wt.)



# SEARCH ENGINE

## RECORD ACCEPTANCE CRITERIA:

- Seismological parameters
- Scaling options:



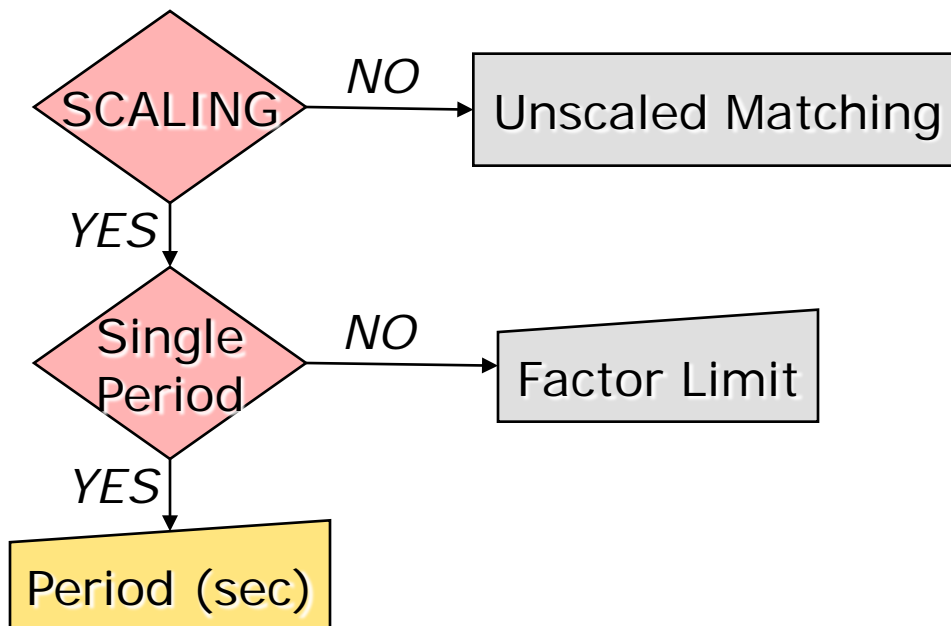
PEER-NGA Spectrum

Magnitude	:	<input type="text" value="6, 7.25"/>	(min,max)
Fault Type	:	<input type="text" value="All types"/>	
D9-95(sec)	:	<input type="text"/>	
R_JB(km)	:	<input type="text" value="0, 20.5"/>	(min,max)
R_rup(km)	:	<input type="text" value="0, 20.5"/>	(min,max)
Vs30(m/s)	:	<input type="text" value="200,300"/>	(min,max)
Pulse	:	<input type="text" value="Any Record"/>	
Scaling	:	<input checked="" type="checkbox"/>	<a href="#">learn more</a>
Single Period	:	<input type="checkbox"/>	
Factor Limit	:	<input type="text"/>	(min,max)
T (sec)	:	<input type="text"/>	

# SEARCH ENGINE

## 1) *Scale the record to match the target spectrum to a single period:*

the records are scaled to match the target spectrum at a specific spectral period, called  $T_s$  (sec)



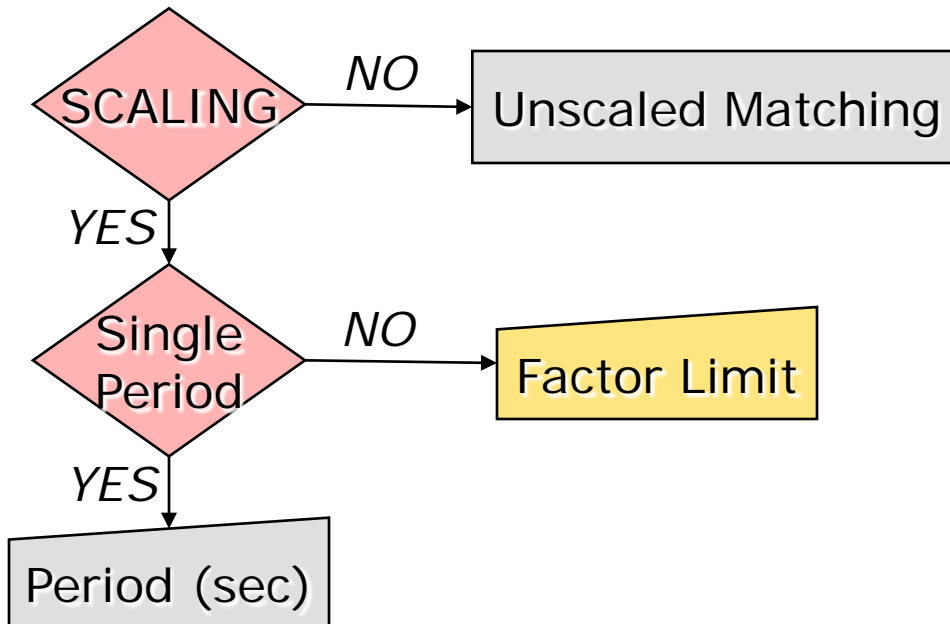
$$f = \frac{SA^{target}(T_s)}{SA^{record}(T_s)}$$



# SEARCH ENGINE

## 2) Scale the record to match the target spectrum over a period range:

the records are scaled by a factor that minimizes the mean squared error (MSE) between the geometric mean spectra of the scaled records horizontal components and the target spectrum

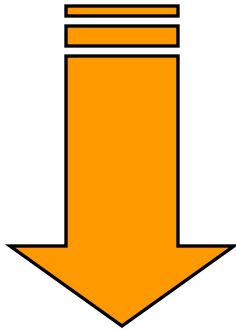


$$\ln f = \frac{\sum_i w(T_i) \ln \left( \frac{SA^{\text{target}}(T_i)}{SA^{\text{record}}(T_i)} \right)}{\sum_i w(T_i)}$$

# SEARCH ENGINE

- **RANKING of MATCHING RECORDS :**
  - Ranking is a function of **weight function**

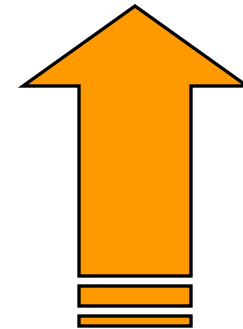
$$\ln f = \frac{\sum_i w(T_i) \ln \left( \frac{SA^{\text{target}}(T_i)}{SA^{\text{record}}(T_i)} \right)}{\sum_i w(T_i)}$$



**INCREASING  
MSE**

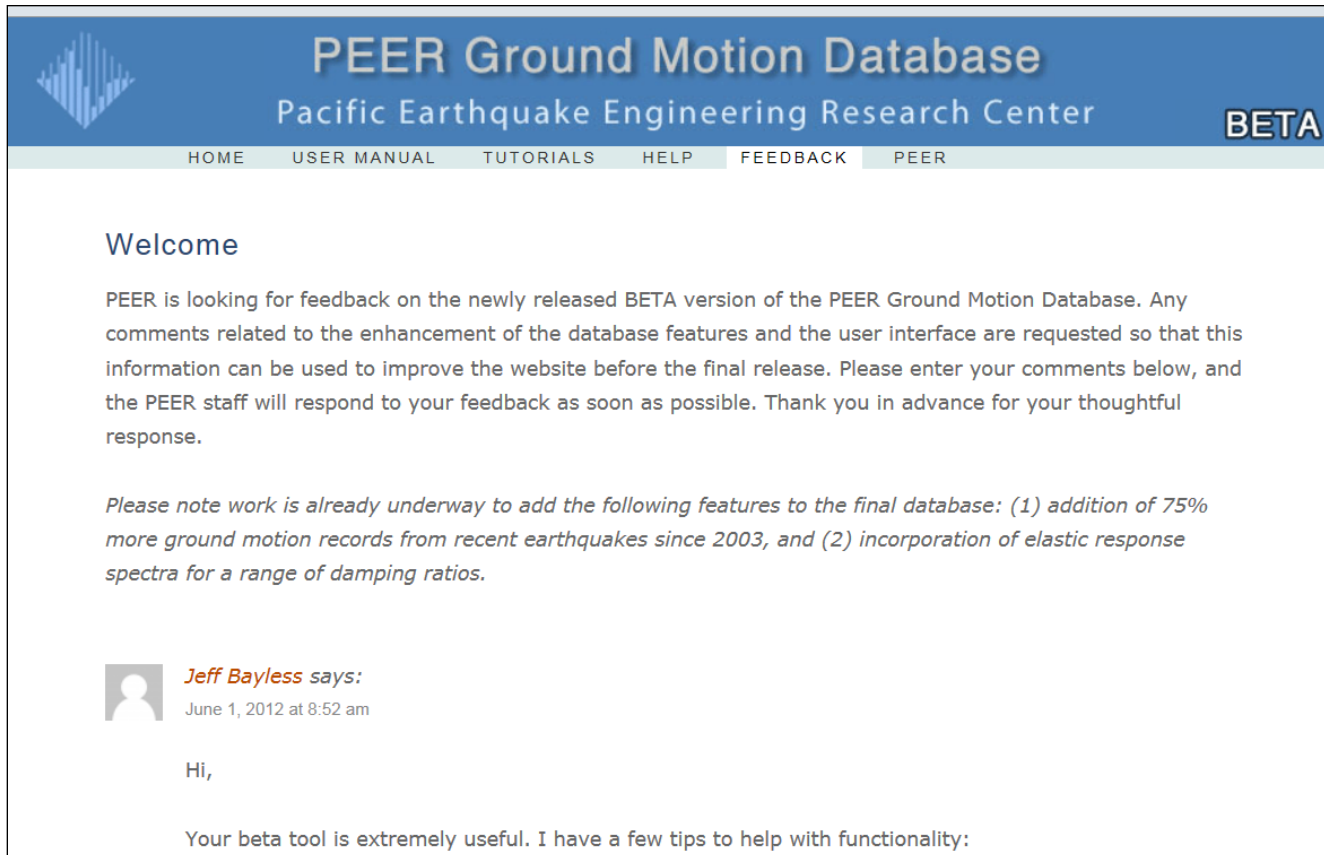
***MATCHING  
RECORDS***

**INCREASING  
BEST MATCHING**



# FEEDBACK

## ■ DEDICATED PAGE:



The screenshot shows the PEER Ground Motion Database BETA website. The header includes the PEER logo, the title "PEER Ground Motion Database Pacific Earthquake Engineering Research Center", and the "BETA" label. A navigation bar contains links for HOME, USER MANUAL, TUTORIALS, HELP, FEEDBACK, and PEER. The main content area features a "Welcome" section with a paragraph of text and a note about upcoming features. Below this is a user comment from Jeff Bayless dated June 1, 2012.


**PEER Ground Motion Database**  
Pacific Earthquake Engineering Research Center **BETA**

HOME USER MANUAL TUTORIALS HELP FEEDBACK PEER

### Welcome

PEER is looking for feedback on the newly released BETA version of the PEER Ground Motion Database. Any comments related to the enhancement of the database features and the user interface are requested so that this information can be used to improve the website before the final release. Please enter your comments below, and the PEER staff will respond to your feedback as soon as possible. Thank you in advance for your thoughtful response.

*Please note work is already underway to add the following features to the final database: (1) addition of 75% more ground motion records from recent earthquakes since 2003, and (2) incorporation of elastic response spectra for a range of damping ratios.*

 **Jeff Bayless says:**  
June 1, 2012 at 8:52 am

Hi,

Your beta tool is extremely useful. I have a few tips to help with functionality:

# FEEDBACK – UNSCALED Search

- Consistency with FN / FP Rotation:

Results

\*Click on the record below to display Spectra and Time series  Plot Selected

<input checked="" type="checkbox"/>	Result#	Comp.	NGA#	Pulse	Tp(s)	D5-95(s)	Event	Year	Station
<input checked="" type="checkbox"/>	1	GM	585	0 0	-- --	3.6 3.1	Baja California	1987	Cerro Prieto

Save Original Unscaled Time Series Records    Save Search Spectra

As recorded

FN / FP rotated

- Apparent loss of records wrt 2005 version

# FEEDBACK – SCALED Search

## ■ Consistency with Scaling:

\*Click on the record below to display Spectra and Time series  Plot Selected

<input checked="" type="checkbox"/>	Result#	Comp.	NGA#	MSE	ScaleF	Pulse	Tp (s)	D5-95 (s)	Event	Year	Station	Mag	Mechanis
<input checked="" type="checkbox"/>	1	GM	184	0.0287	0.2689	1 1	5.9 2	6.9 6.4	Imperial Valley-06	1979	El Centro Differential Array	6.53	Strike-Sl
<input checked="" type="checkbox"/>	2	GM	162	0.0375	0.6516	0 0	-- --	11.2 14.5	Imperial Valley-06	1979	Calexico Fire Station	6.53	Strike-Sl
<input checked="" type="checkbox"/>	3	GM	718	0.0555	0.9589	0 0	-- --	16.4 12.8	Superstition Hills-01	1987	Wildlife Liquef. Array	6.22	Strike-Sl
<input checked="" type="checkbox"/>	4	GM	549	0.0564	0.6966	0 0	-- --	11.2 15.3	Chalfant Valley-02	1986	Bishop - LADWP South St	6.19	Strike-Sl
<input checked="" type="checkbox"/>	5	GM	719	0.0666	1.0407	0 0	-- --	13.5 14.1	Superstition Hills-02	1987	Brawley Airport	6.54	Strike-Sl
<input checked="" type="checkbox"/>	6	GM	725	0.0685	0.4608	0 0	-- --	13.0 14.1	Superstition Hills-02	1987	Poe Road (temp)	6.54	Strike-Sl
<input checked="" type="checkbox"/>	7	GM	949	0.0718	0.4978	0 0	-- --	13.3 13.5	Northridge-01	1994	Arleta - Nordhoff Fire Sta	6.69	Reverse

Buttons:

FN / FP rotated  
AND scaled

FN / FP rotated  
but NOT scaled

As recorded

# FEEDBACK – SCALED Search

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- **Ability to select Horizontal Component to perform search**
  - Actually, FN/FP components are used in pair (Geom. Mean)
  - New spectral value will be GMRotD50
- **Increase n. records in search result**
  - 30 recordings are displayed due to copyright issues
- **Incorrect naming, orientation inconsistencies**



*Ali says:*

November 17, 2011 at 11:40 am

Seems to me that the fault parallel component NGA\_1614DUZCE.1061\_FP.acc is not named correctly and two fault normal components (NGA\_1614DUZCE.1061\_FN.acc and NGA\_1614DUZCE.106\_FN.acc) are reported for Lamon 1061 station instead. Please have this corrected in the rotated database.

# FEEDBACK – SEARCH Options

## ■ Peak Spectral Values

- PGA, PGV, PGD (?) – Feature available in former DB versions

## ■ Arias Intensity

- Currently D<sub>5-95</sub> is an option

## ■ Site Conditions beside $V_{s,30}$

- NEHRP, Geomatrix 3<sup>rd</sup> letter, Superficial Geology, Instrument Housing

## ■ Data Source

2000 Version

1: Search earthquake or station characteristics and peak values

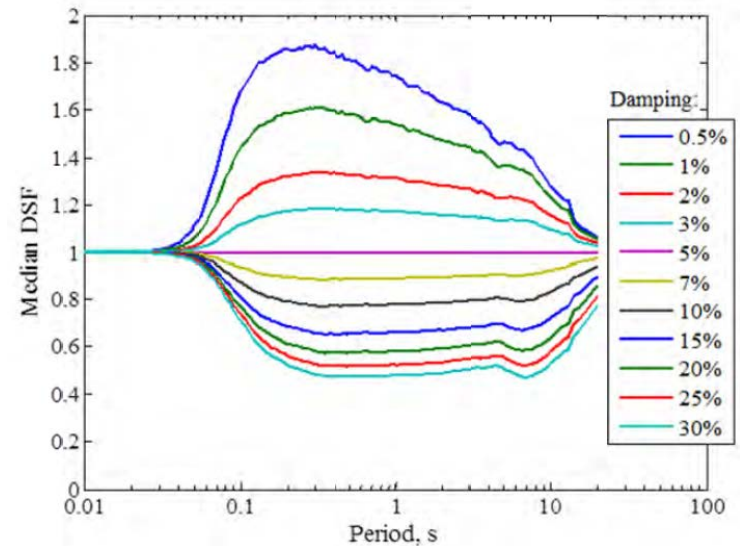
Earthquake	Any	
Mechanism	Any	
Magnitude (Range)	-	<input type="radio"/> ML <input type="radio"/> M <input type="radio"/> MS <input checked="" type="radio"/> Any
Distance (km)	-	<input type="radio"/> Closest <input type="radio"/> Hypocentral <input type="radio"/> Projection of fault plane (JB distance) <input checked="" type="radio"/> Any
Site Classification	USGS	Any <a href="#">(Compare to NEHRP classifications)</a>
	Geomatrix	Any
	Taiwan CWB	Any
Mapped Local Geology	Any	
Instrument Housing	Any	
Data Source	Any	
	PGA (g)	Range 0.001 ... 2.086
	PGV (cm/sec)	Range 0.1 ... 263.1
	PGD (cm)	Range 0.01 ... 430.00

Search Clear



# PLANNED NEW FEATURES

- **Incorporation of elastic response spectra for 11 damping ratios.**
  - Following the work by S. Rezaeian et al. (2012)



- **Other spectral search methods**
  - Under debate – GSMW workforce