NGA Ground Motion Database

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PURPOSE

- **Update of the PEER Ground Motion Database – 2010 Beta Version**
  (*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**
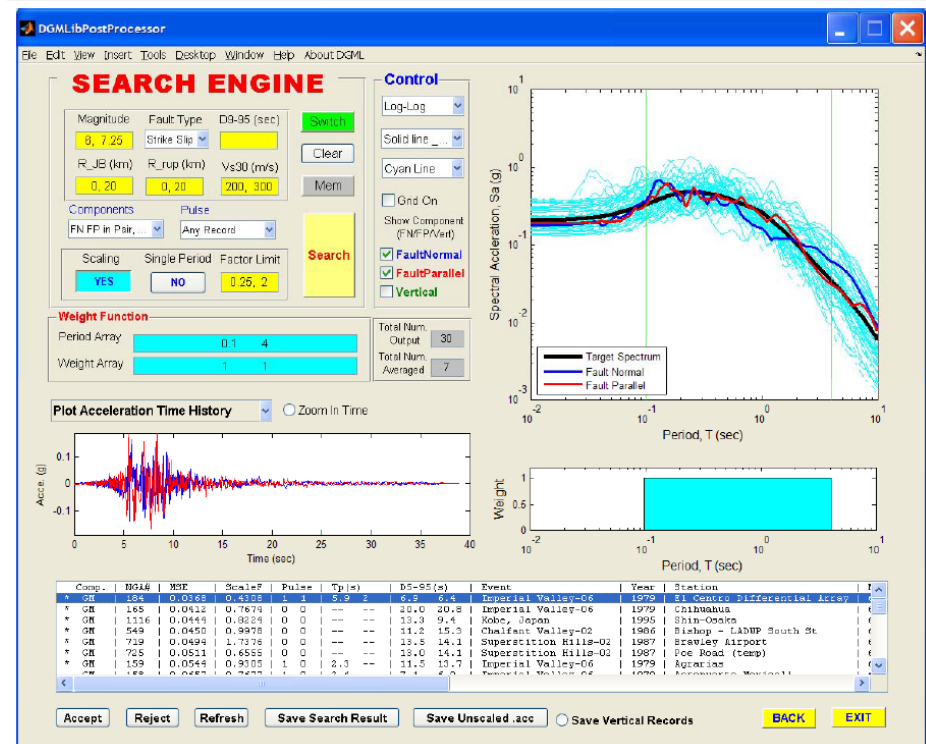 Search options in the future interactive web application
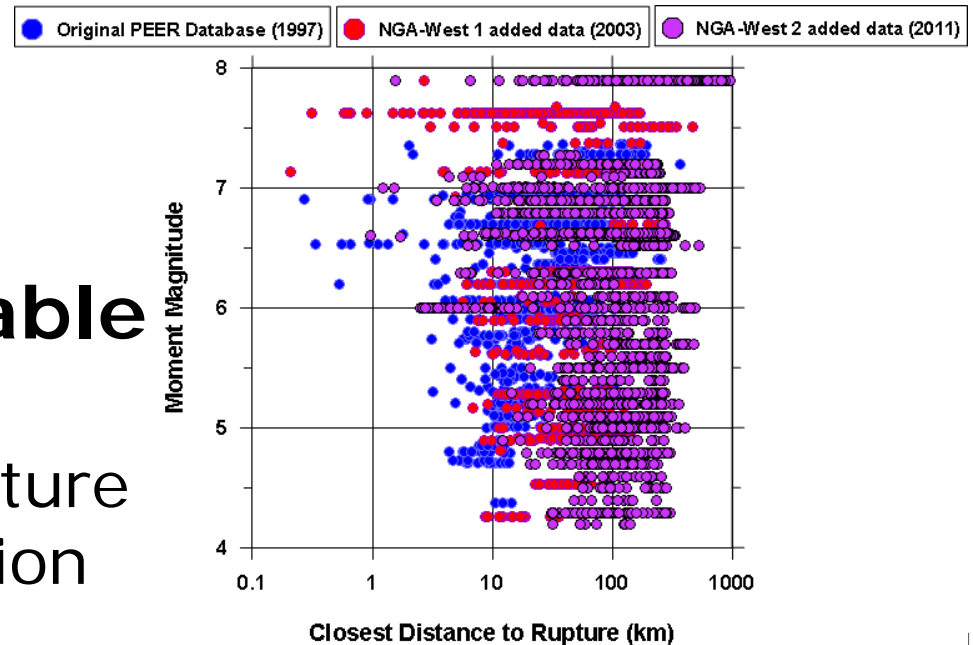
PEER Ground Motion Database 2010 Beta Version

- ## 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	**Jack Baker** (Stanford) ★
1:30 - 3:00 pm	PLENARY	Computational Simulation	**Frank McKenna** (PEER Center & OpenSees)

  - GeoEngineering Lecture, May 2012

30th Annual Geo-Engineering Distinguished Lecture Series

Friday May 4th, 2012

This is our 30th 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 30th 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△
2802	Chi-Chi, Taiwan-04	1999	0920	HWA2	6.20	SS	91	[244]	na	i
3041	Chi-Chi, Taiwan-05	1999	0922	HWA2	6.20	RV	56	[244]	nu	i
3134	Chi-Chi, Taiwan-05	1999	0922	TAP066	6.20	RV	151	663	nu	c
3155	Chi-Chi, Taiwan-05	1999	0922	TAP103	6.20	RV	150	429	nu	c
3191	Chi-Chi, Taiwan-05	1999	0922	TCU081	6.20	RV	101	[301]	nu	c
3364	Chi-Chi, Taiwan-06	1999	0925	HWA2	6.30	RV	56	[244]	nu	i
3438	Chi-Chi, Taiwan-06	1999	0925	TAP103	6.30	RV	141	429	nu	c
3476	Chi-Chi, Taiwan-06	1999	0925	TCU081	6.30	RV	90	[301]	nu	c
3548	Loma Prieta	1989	1018	Los Gatos - Lexington Dam	6.93	RV-OBL	5.0	1070	fw	j^4
3549	Northridge-01	1994	0117	Monte Nido Fire Station	6.69	RV	25.6	660	hw	j^4
3550	Northridge-01	1994	0117	Loma Linda; VA Hospital, North Freefield	6.69	RV	112	275	nu	j^4
3551	Northridge-01	1994	0117	Loma Linda; VA Hospital, South Freefield	6.69	RV	112	275	nu	j^4

Notes:

* 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).

** Updated preferred Vs30 values for Central Weather Bureau Taiwan sites are shown in brackets (Chiou and Youngs, 2008b, Appendix C).

*** 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.

△ The records were not included for various reasons including one or more of the following:

(a) records considered to be from tectonic environments other than shallow crustal earthquakes in active tectonic regions, e.g. records from subduction zones;

(b) earthquakes poorly defined;

(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;

(d) absence of information on soil/geologic conditions at recording stations;

(e) records had only one horizontal component;

(f) records had not been rotated to FN and FP directions because of absence of information on sensor orientations or fault strike;

(g) records of questionable quality;

(h) proprietary data;

(i) duplicate record;

(j) other: (j^1) misc; (j^2) uncertain sensor orientation; (j^3) foundation problem; (j^4) no spectrum value.

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2010 Improvements vs. previous DB versions

■ **2000 PEER Ground Motion Database**

First public database

Significant increase of recordings number

2005 Data   **2000 Data**
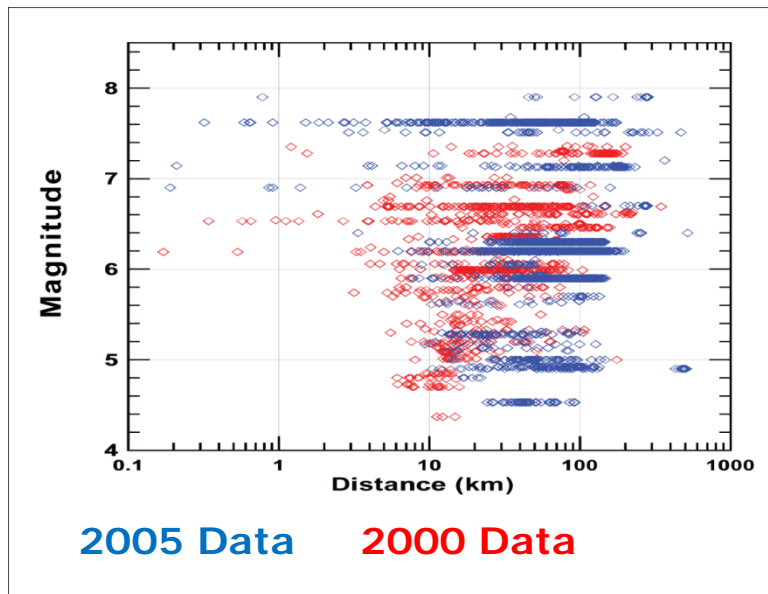
1: Search earthquake or station characteristics and peak values

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

[Search] [Clear]

2: Search response spectra

Maximum
Pseudo Acceleration (g)
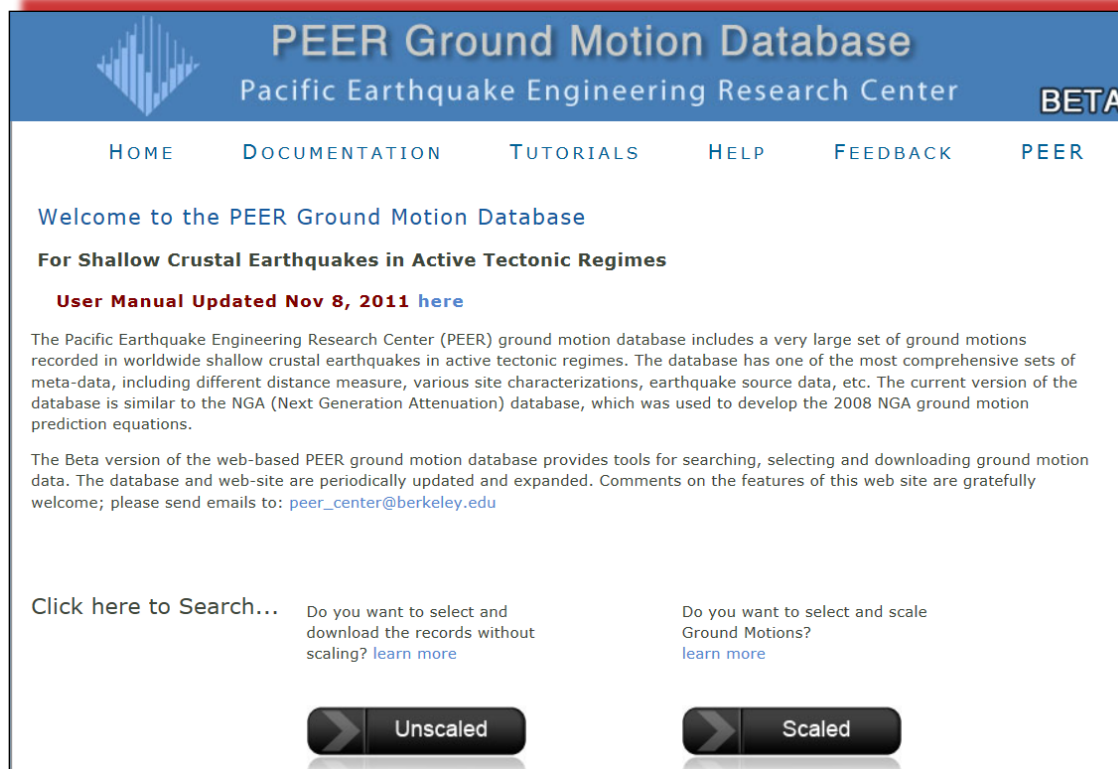
PEER Strong Motion Plotter

Minimum

Low   High

PEER Ground Motion Database 2010 Beta Version

- ## Search features
  - Unscaled or Scaled options

SEARCH FOR GROUND MOTION RECORDS

- **UNSCALED Records**
  - Based on earthquake parameters OR
  - Event name / NGA Sequence or Station Name
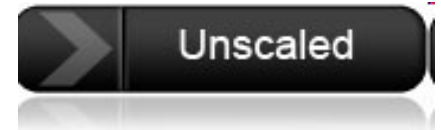
Unscaled

New Unscaled Search

PEER-NGA Spectrum

Magnitude	6, 7.25	(min,max)
Fault Type	All types	
D9-95(sec)		
R_JB(km)	0, 20.5	(min,max)
R_rup(km)	0, 20.5	(min,max)
Vs30(m/s)	200,300	(min,max)
Pulse	Any Record	

Load Default Values   Clear

New Unscaled Search

PEER-NGA Spectrum

Additional Search Options

Event Name	
NGA Sequence Numbers	
Station Name	

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SEARCH FOR GROUND MOTION RECORDS

SCALED Records
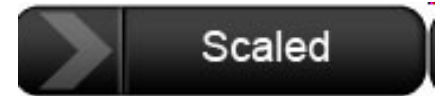
- Applies linear scale factor – shape preserved!

Needs a **TARGET SPECTRUM**

- NGA Model
- User Defined Spectrum
- ASCE Code Spectrum
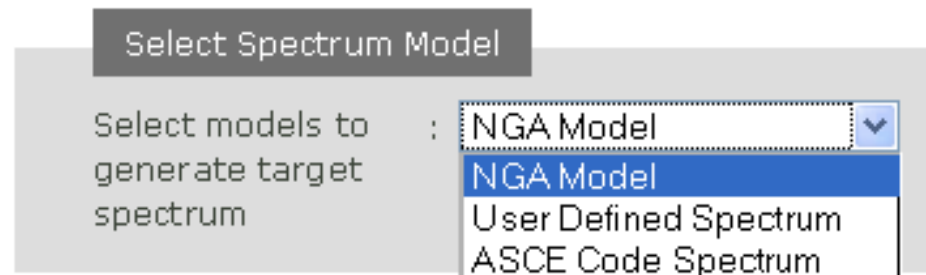
PEER – NGA TARGET SPECTRUM

- **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

☑ Abrahamson-Silva   ☑ Boore-Atkinson
☑ Campbell-Bozorgnia   ☑ Chiou-Youngs
☑ Idriss

Magnitude	:	7
Fault Type	:	Strike Slip
DIP(deg)	:	90
ZTOR(km)	:	0
Width(km)	:	100
Rrup(km)	:	20
Rx(km)	:	20
Rjb(km)	:	20
Vs30(m/s)	:	569 ☑ estimated
Z1.0(km)	:	0.12333 ☑ default
Z2.5(km)	:	0.96237 ☑ default
Averages	:	◉ Geometric ○ Arithmetic
Epsilon	:	1
Cond Mean	:	◉ Yes ○ No
T_eps(s)	:	2

Input panel to create PEER-NGA Spectrum

PEER

PEER – NGA TARGET SPECTRUM

Averages	: ⊙ Geometric ○ Arithmetic
Epsilon	: 1
Cond.Mean	: ⊙ Yes ○ No
T_eps(s)	: 2

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

- ## **1st OPTION:**

  Conditional Mean Option "NO"

  - Generate a constant Epsilon Spectrum

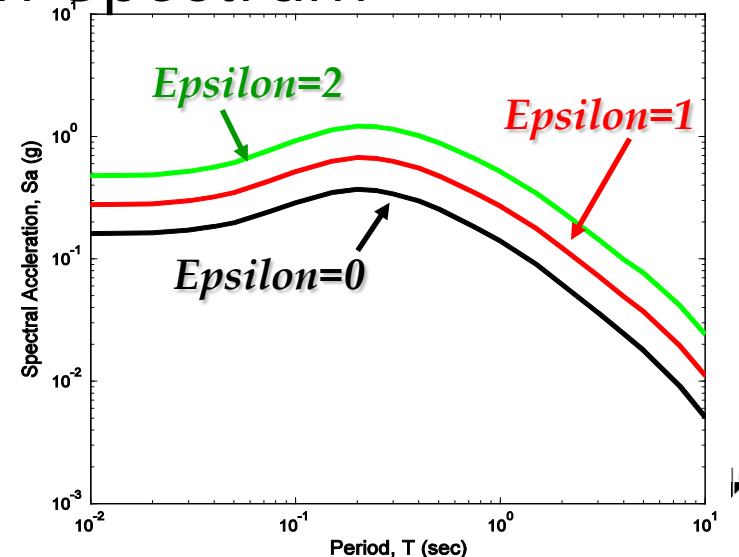   - Examples of constant epsilon spectra generated using the average of five NGA models and epsilon = 0, 1, and 2

Epsilon=2

Epsilon=1

Epsilon=0

PEER – NGA TARGET SPECTRUM

- **2ⁿᵈ OPTION:** Conditional Mean Option "YES"
  - Develop a Conditional Mean Spectrum

    (Baker & Cornell, 2006)

Epsilon	:	1
Cond.Mean	:	⊙Yes ○No
T_eps(s)	:	0.5

  - 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
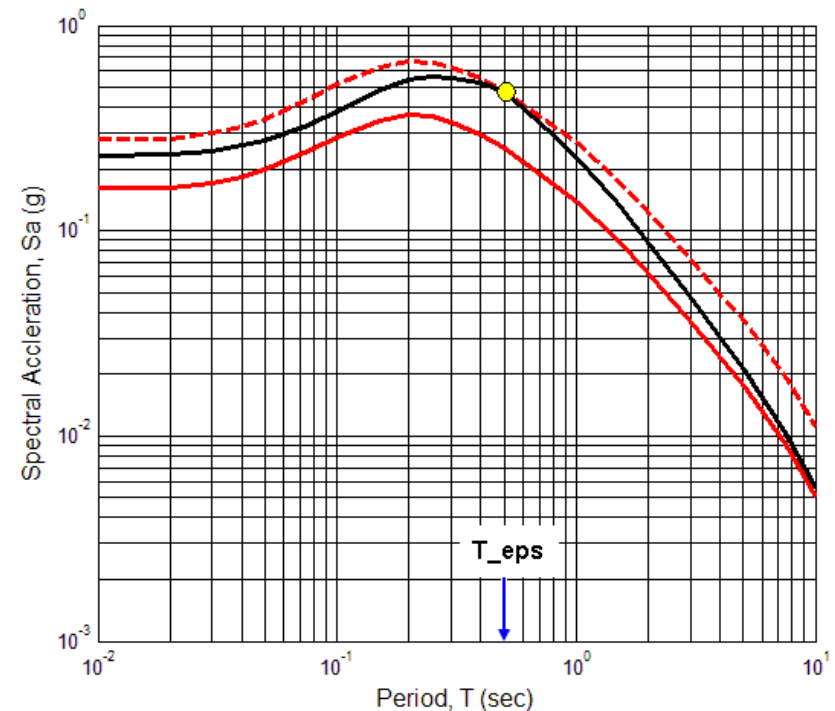
SEARCH ENGINE

- **RECORD ACCEPTANCE CRITERIA:**
  - Perform search over NGA Database

- **WEIGHT FUNCTION:**
  - Specification of Weight function used for scaling records

SEARCH ENGINE

- **RECORD ACCEPTANCE CRITERIA:**
  - Seismological parameters
  - Scaling options:

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 *Ts* (sec)
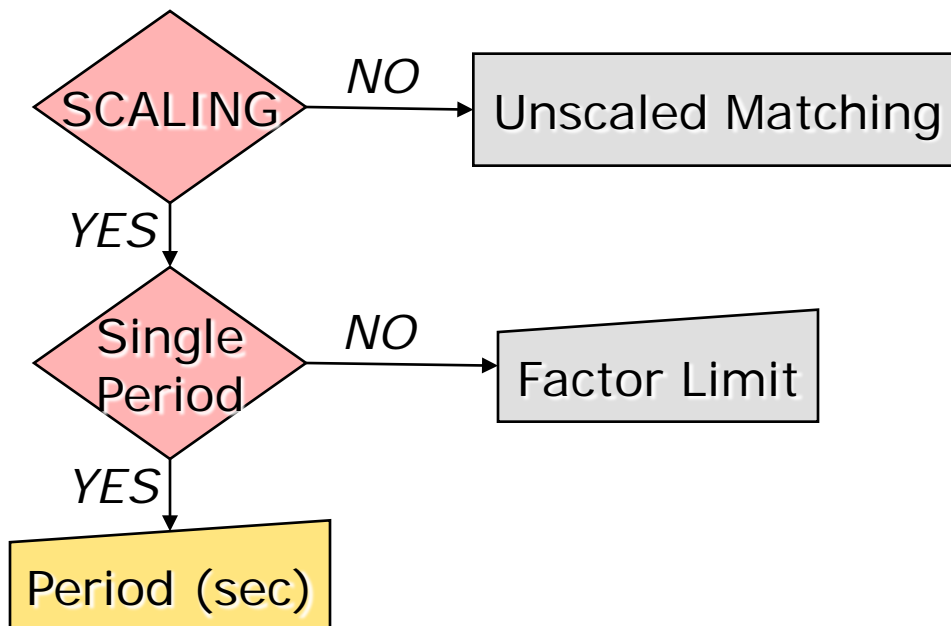
$$f = \frac{SA^{t\,\arg et}(T_s)}{SA^{record}(T_s)}$$

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
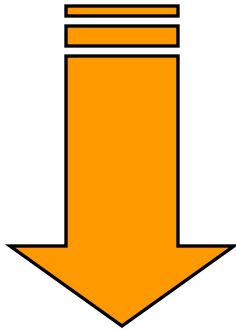
SCALING — NO → Unscaled Matching

YES

Single Period — NO → Factor Limit

YES

Period (sec)
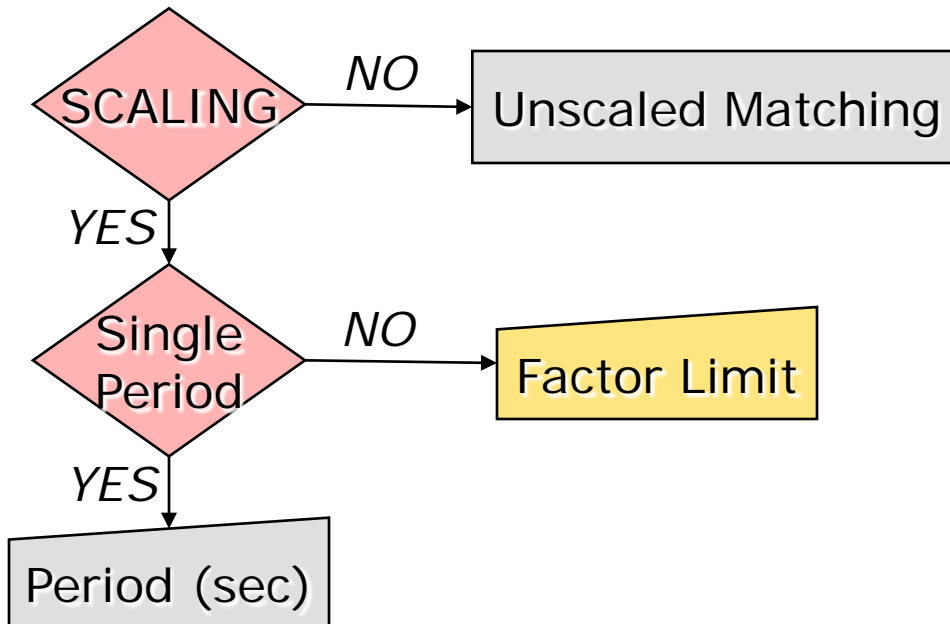
$$\ln f = \frac{\sum_i w(T_i) \ln\left(SA^{target}(T_i) \Big/ SA^{record}(T_i)\right)}{\sum_i w(T_i)}$$

SEARCH ENGINE

- **RANKING of MATCHING RECORDS :**

  - Ranking is a function of weight function

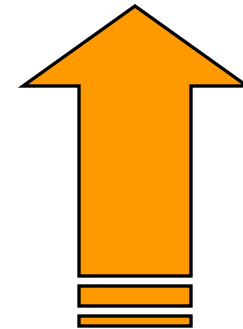$$\ln f = \frac{\sum_i w(T_i) \ln \left(SA^{target}(T_i) \Big/ SA^{record}(T_i) \right)}{\sum_i w(T_i)}$$

INCREASING BEST MATCHING

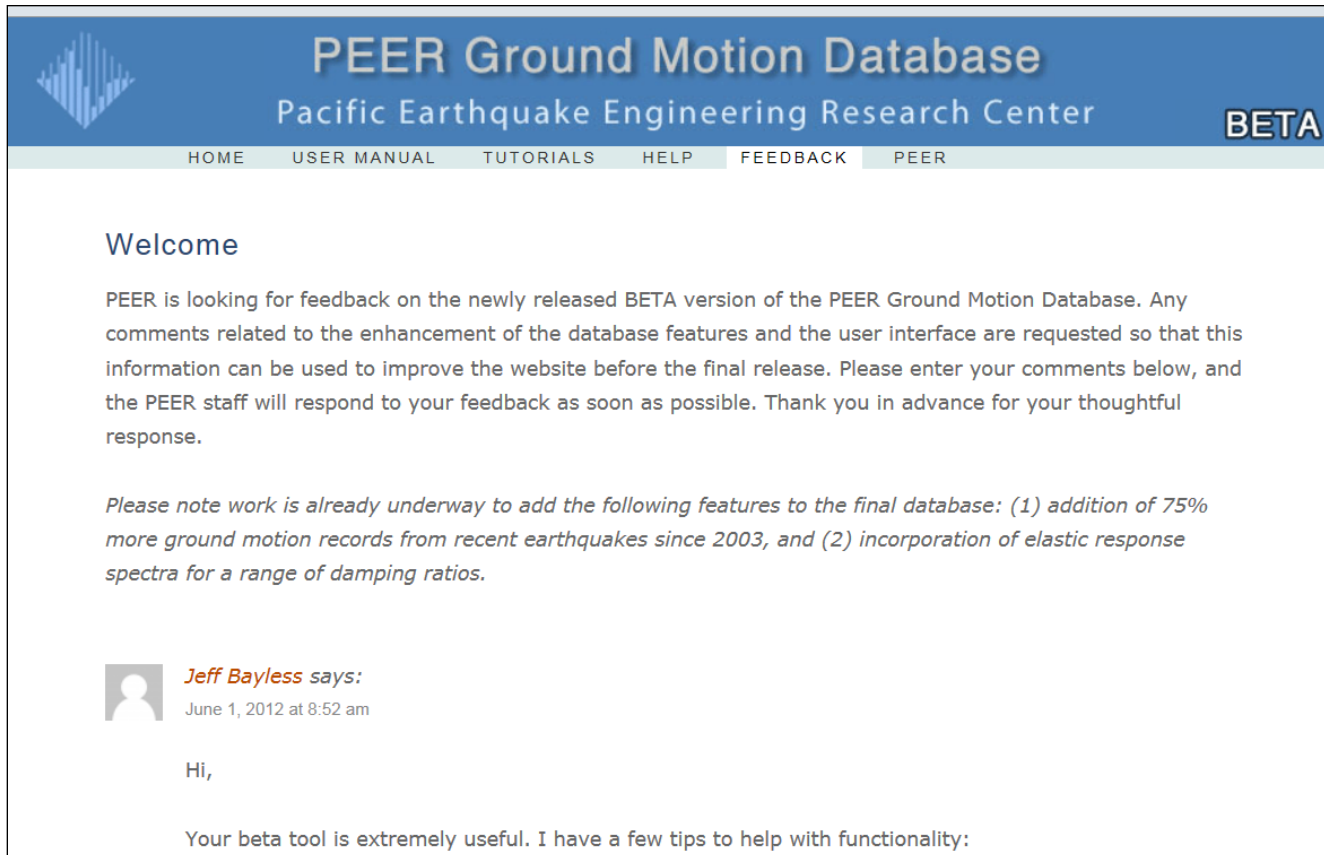**MATCHING RECORDS**

INCREASING MSE

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FEEDBACK

- ## DEDICATED PAGE:

FEEDBACK – UNSCALED Search

- ## Consistency with FN / FP Rotation:

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 | Refresh |

☑	Result#	Comp.	NGA#	MSE	ScaleF	Pulse	Tp (s)	D5-95 (s)	Event	Year	Station	Mag	Mechanis
☑	1	GM	184	0.0287	0.2689	1 1	5.92	6.9 6.4	Imperial Valley-06	1979	El Centro Differential Array	6.53	Strike-Sl
☑	2	GM	162	0.0375	0.6516	0 0	-- --	11.2 14.5	Imperial Valley-06	1979	Calexico Fire Station	6.53	Strike-Sl
☑	3	GM	718	0.0555	0.9589	0 0	-- --	16.4 12.8	Superstition Hills-01	1987	Wildlife Liquef. Array	6.22	Strike-Sl
☑	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
☑	5	GM	719	0.0666	1.0407	0 0	-- --	13.5 14.1	Superstition Hills-02	1987	Brawley Airport	6.54	Strike-Sl
☑	6	GM	725	0.0685	0.4608	0 0	-- --	13.0 14.1	Superstition Hills-02	1987	Poe Road (temp)	6.54	Strike-Sl
☑	7	GM	949	0.0718	0.4978	0 0	-- --	13.3 13.5	Northridge-01	1994	Arleta - Nordhoff Fire Sta	6.69	Reverse

| Show Alg. Mean | | Save Time Series Records | | Save Original Unscaled Time Series Records |
| Save Search Spectra |

FN / FP rotated
AND scaled

FN / FP rotated
but NOT scaled

As recorded

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FEEDBACK – SCALED Search

- **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.

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FEEDBACK – SEARCH Options

- **Peak Spectral Values**
  - PGA, PGV, PGD (?) – Feature available in former DB versions

- **Arias Intensity**
  - Currently D_{5-95} is an option

- **Site Conditions beside** $V_{s,30}$

  - NEHRP, Geomatrix 3rd letter, Superficial Geology, Instrument Housing

- **Data Source**

2000 Version

PEER

PLANNED NEW FEATURES

- **Incorporation of elastic response spectra for 11 damping ratios.**
  - Following the work by S. Rezaeian et al. (2012)
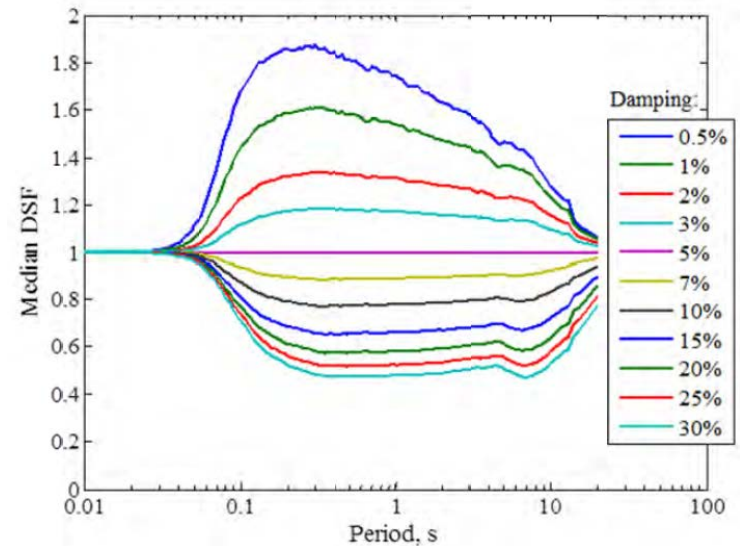
- **Other spectral search methods**
  - Under debate – GMSM workforce