Overview of the NGA Program

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June 8, 2009

PEER-Lifelines NGA Program

- Sponsors
  - Caltrans
  - PG&E
  - California Energy Commission

- Collaboration between PEER, USGS, and SCEC

Acronyms

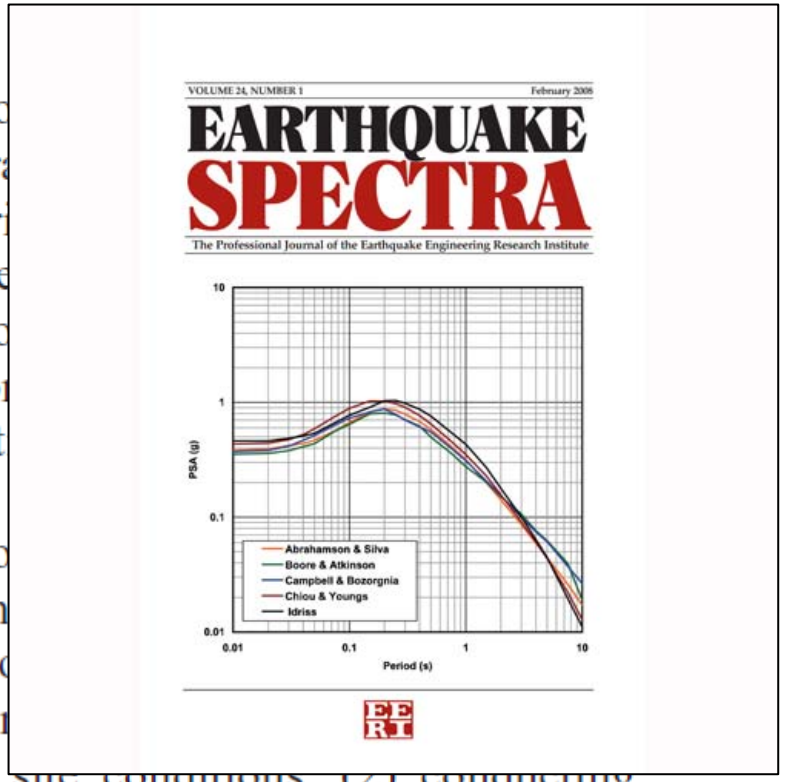
- NGA: **N**ext **G**eneration of **A**ttenuation model
  - Cliff Roblee coined this name
  - "*Introduction to the PEER-LL Next Generation Attenuation (NGA) Program*", October, 2002

- GMPE: **G**round **M**otion **P**rediction **E**quation
  - In lieu of attenuation relationship, attenuation relation, or attenuation model

An Overview of the NGA Project

Maurice Power,[a] **M.EERI, Brian Chiou,**[b] **Norman Abrahamson,**[c] **M.EERI, Yousef Bozorgnia,**[d] **M.EERI, Thomas Shantz,**[b] **and Clifford Roblee,**[b] **M.EERI**

The "Next Generation of Ground-Motic
project is a multidisciplinary research progra
Program of the Pacific Earthquake Engineeri
partnership with the U.S. Geological Surve
Earthquake Center. The objective of the pro
motion prediction relations through a compr
research program. Five sets of ground-mot
teams working independently but interacting
development process. The development o
supported by other project components, wh
updated and expanded PEER database of rec
supporting information on the strong-motio
sources, travel path, and recording station site conditions, (2) conducting
supporting research projects to provide guidance on the selected functional



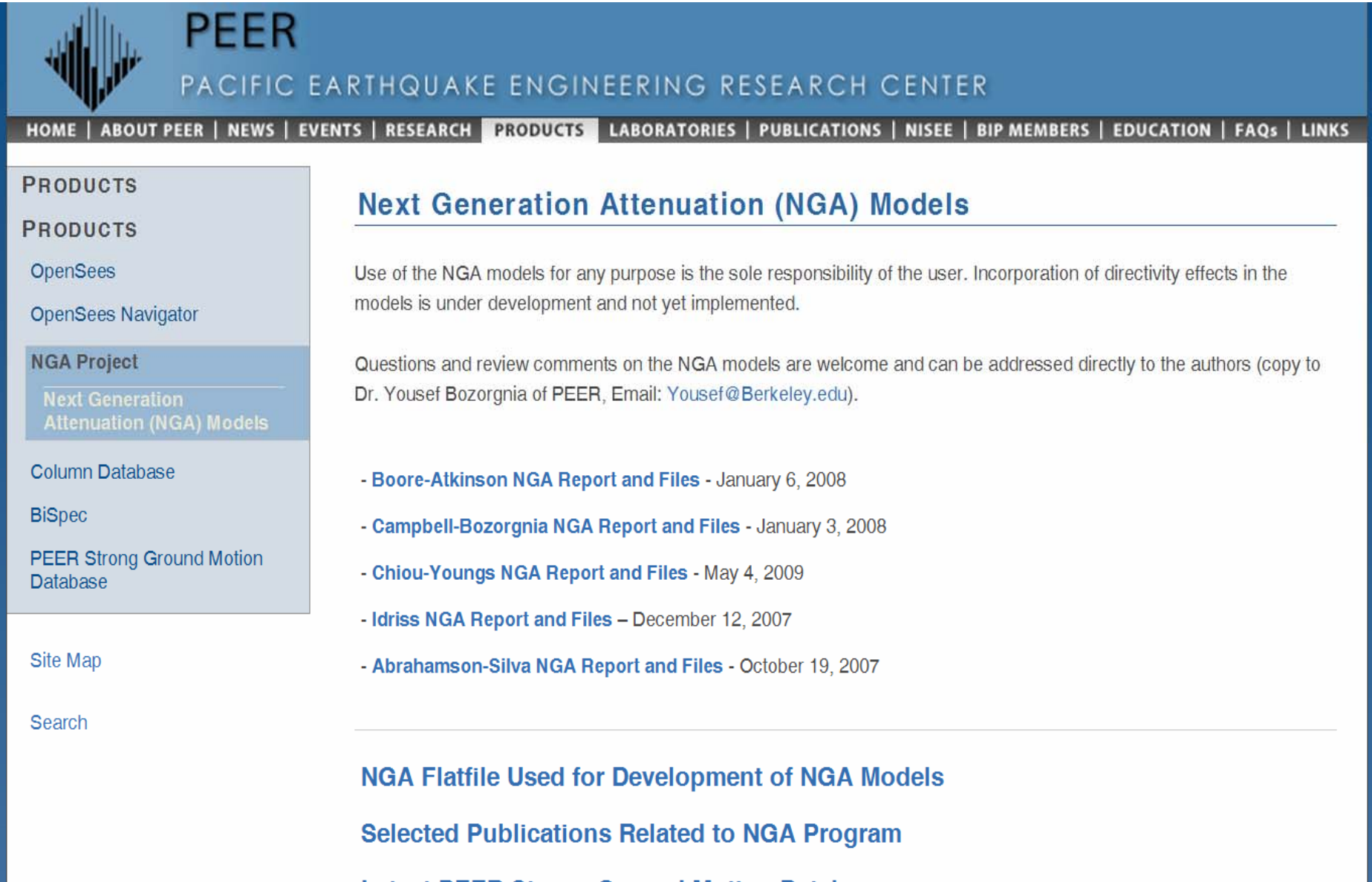
Program Overview

- Duration and cost
  - Multi-year program: 2002 - 2007
  - Cost
    - In-kind service
    - Cost share
    - Unpaid help
- Participants
  - 5 teams, 9 model developers
  - About 40 researchers from USGS, SCEC, PG&E, Caltrans, consultants
  - Users

Program Overview

- Approach
  - Coordinated study by various institutions
    - Leverage resources and expertise of each participating institutions
  - Interaction between model developers
    - Check and peer review of each other's model
  - External reviews by USGS/CGS
    - Ready for deployment

Products: PEER-NGA Web Site

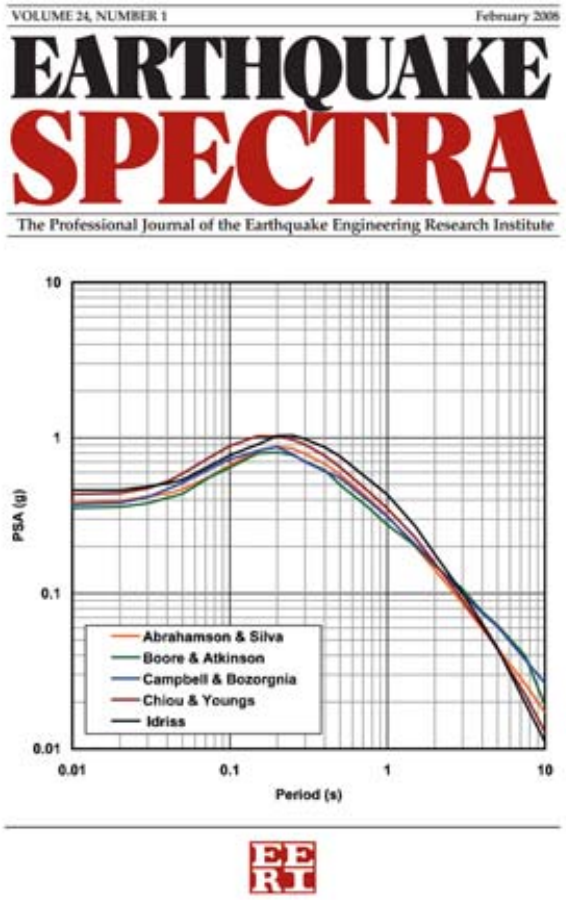


Products: PEER-NGA Web Site

- PEER reports
- Resources for implementing NGA models, provided by developers
  - Fortran codes
  - Excel spreadsheets
- NGA database
- Meeting notes, workshop presentations, documentations
- Selected publications related to NGA program

Products: Earthquake Spectra Special Issue (Feb, 2008)

- Overview
- Synthesis
- Five NGA models
- Directivity model
- NGA resources (selected)
  - Database
  - Site response
  - 3-D basin response
- Other papers
  - Correlation between periods
  - Maximum response



NGA Models

- NGA developers consider the NGA models to be improvements over their previous models
  - Previous models have much smaller data sets and not as much review of the data sets
  - Working together has provided checks and peer reviews along the way

Deployment

- Models were adopted by USGS for the 2007 update of national hazard map.
- Models were adopted by Caltrans for the update of deterministic seismic hazard map

→ ***ARS – Online***
(Next presentation)

Ongoing Work

- Strike-normal/strike-parallel components (2009)
  - Correction factor to NGA model predictions
  - Why stops at SN/SP components? -- Rotation to any direction!
- Vertical Component (?)
  - Currently, not a high priority for Caltrans!

Ongoing Work

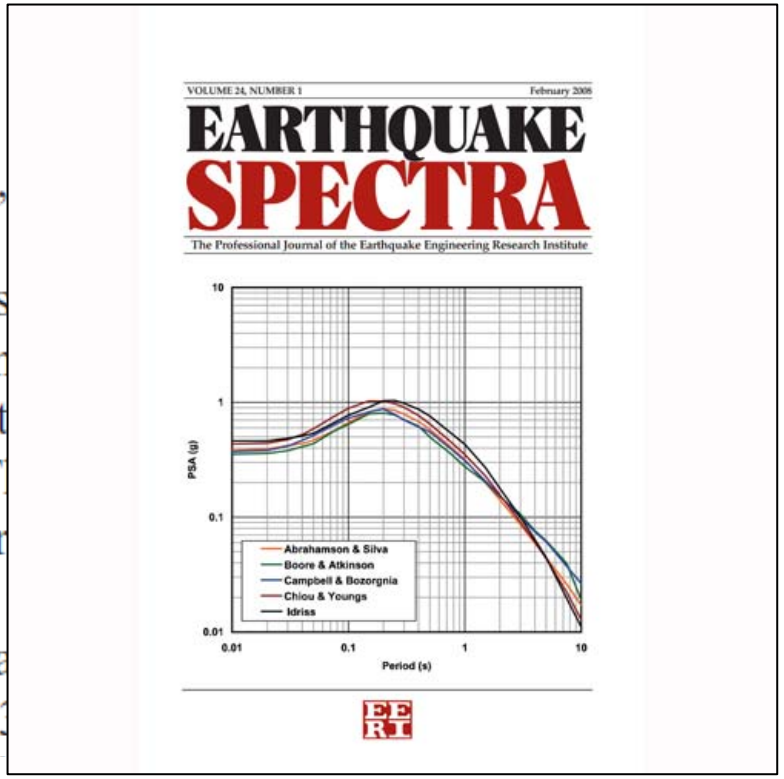
- Epistemic uncertainty is not fully captured
  - Additional uncertainty (conservatism) has been recommended by the NGA developers
  - NGA project plans to issue a white paper on this issue

- Model extension
  - Small-to-moderate earthquake ($3 \leq \mathbf{M} \leq 5.5$)
    - Chiou and others (2009), to be submitted to *Earthquake Spectra*

Comparisons of the NGA Ground-Motion Relations

Norman Abrahamson,[a)] M.EERI, Gail Atkinson,[b)] M.EERI, David Boore,[c)] Yousef Bozorgnia,[d)] M.EERI, Kenneth Campbell,[e)] M.EERI, Brian Chiou,[f)] I. M. Idriss,[g)] M.EERI, Walter Silva,[h)] M.EERI, and Robert Youngs,[i)] M.EERI

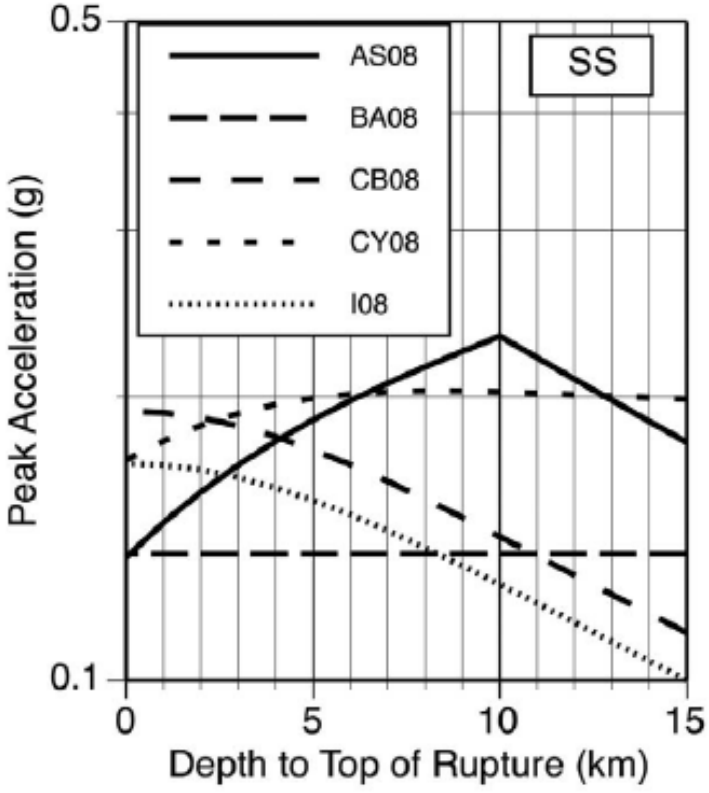
The data sets, model parameterizations,
models for shallow crustal earthquakes
compared. A key difference in the data sets
aftershocks. A comparison of the median
earthquakes shows that they are within a fact
6.0 and 7.0 for distances less than 100 km. T
of 2 for M5 and M8 earthquakes, for buried r
than 100 km. For soil sites, the differences
depth effects increase the range in the media
M7 strike-slip earthquakes to a factor of



New Features of NGA Models

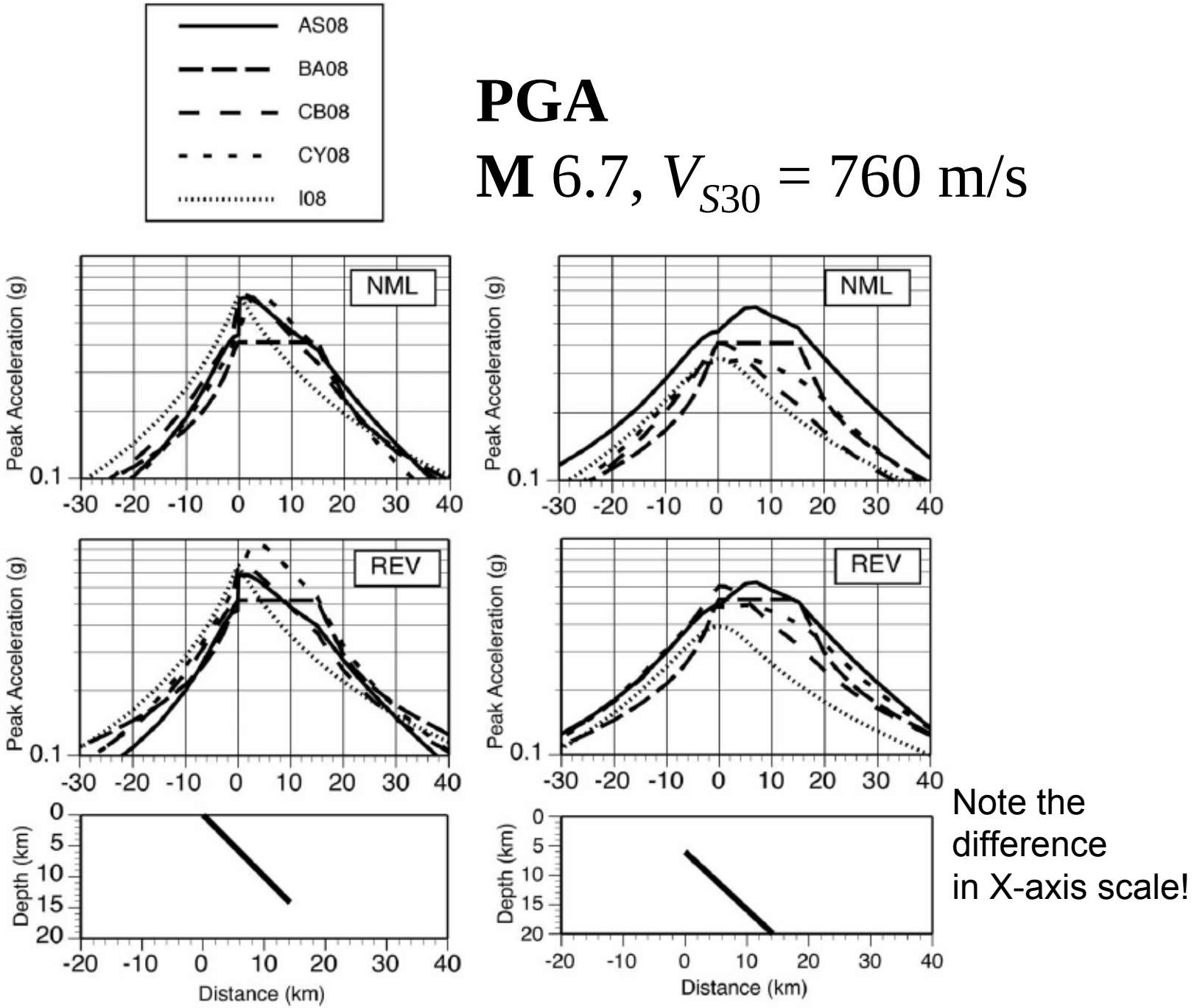
- Depth to the top of rupture (AS08 & CY08)

- Hanging wall effect
  - No hard boundary for region affected by hanging wall effect
  - Poorly constrained effect



PGA

M 6, R_{JB}=10 km



PGA

M 6.7, V_{S30} = 760 m/s

Note the difference in X-axis scale!

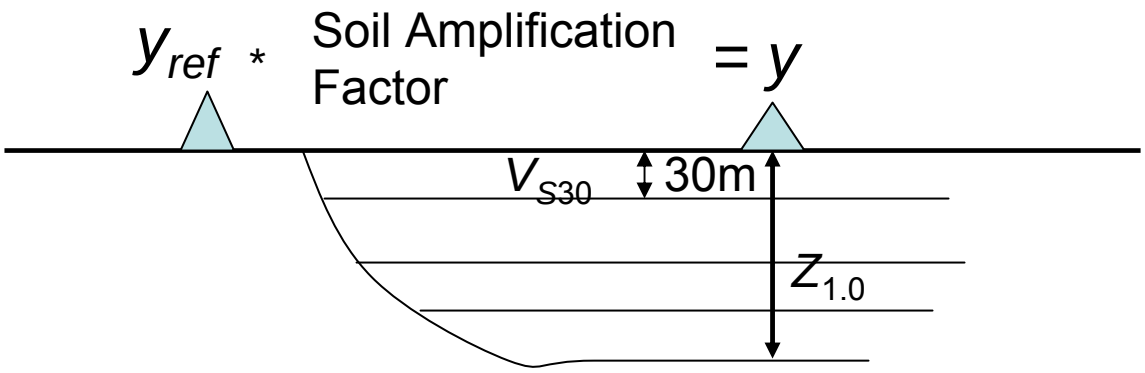
Soil Response

- Previous study: rock-soil category
  - A model for each category
  - Ambiguity in rock definition
    - Many ‘rock’ sites were misclassified earlier
- In NGA, V_{S30} is used as the primary predictor of soil response

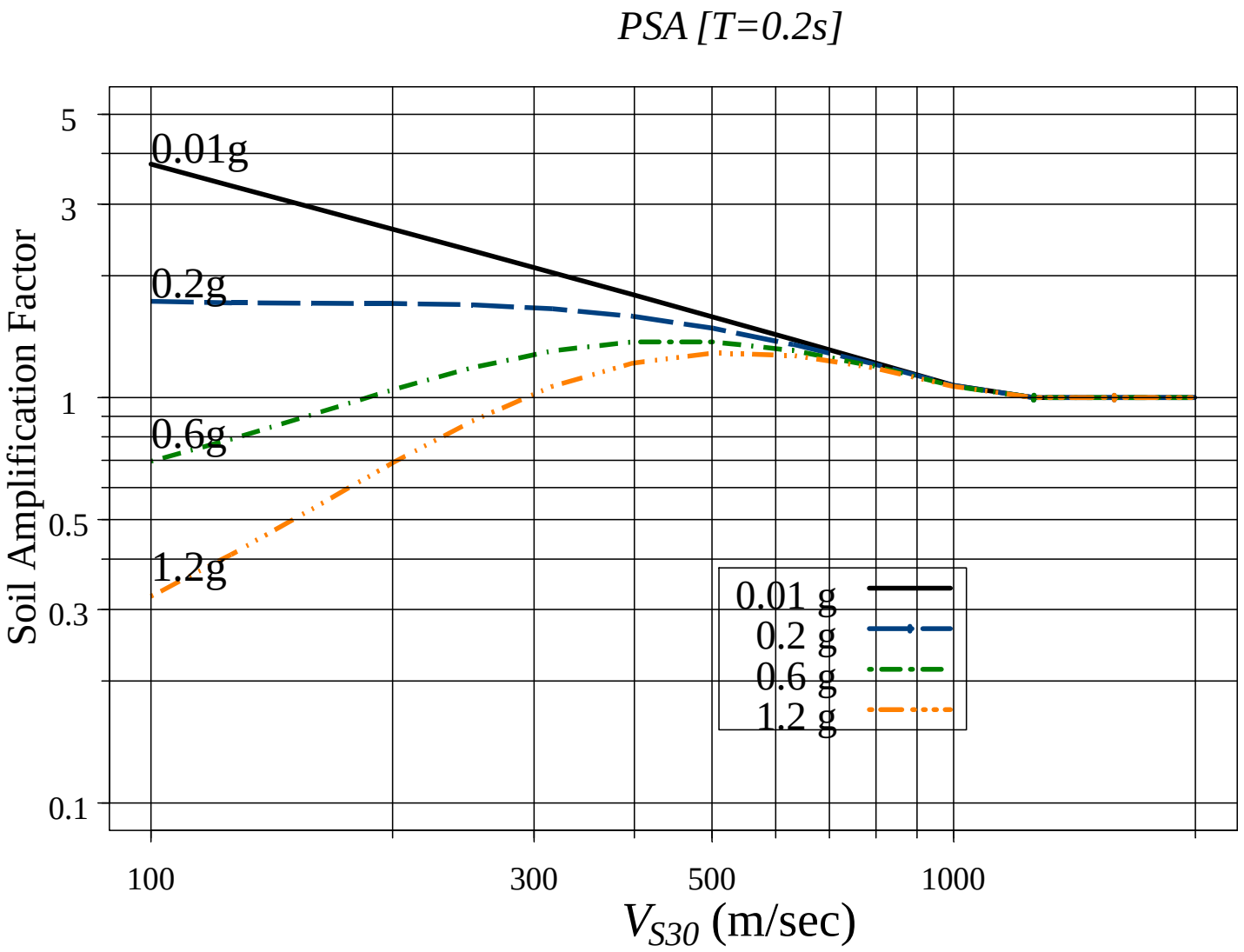
Model	V_{S30} of Generic Rock
Abrahamson & Silva (1997)	~ 550 m/sec
Boore, Joyner, and Fumal (1997)	620 m/sec
Campbell and Bozorgnia (2003)	~ 620 m/sec
Sadigh and others (1997)	~ 520 m/sec

Soil Response

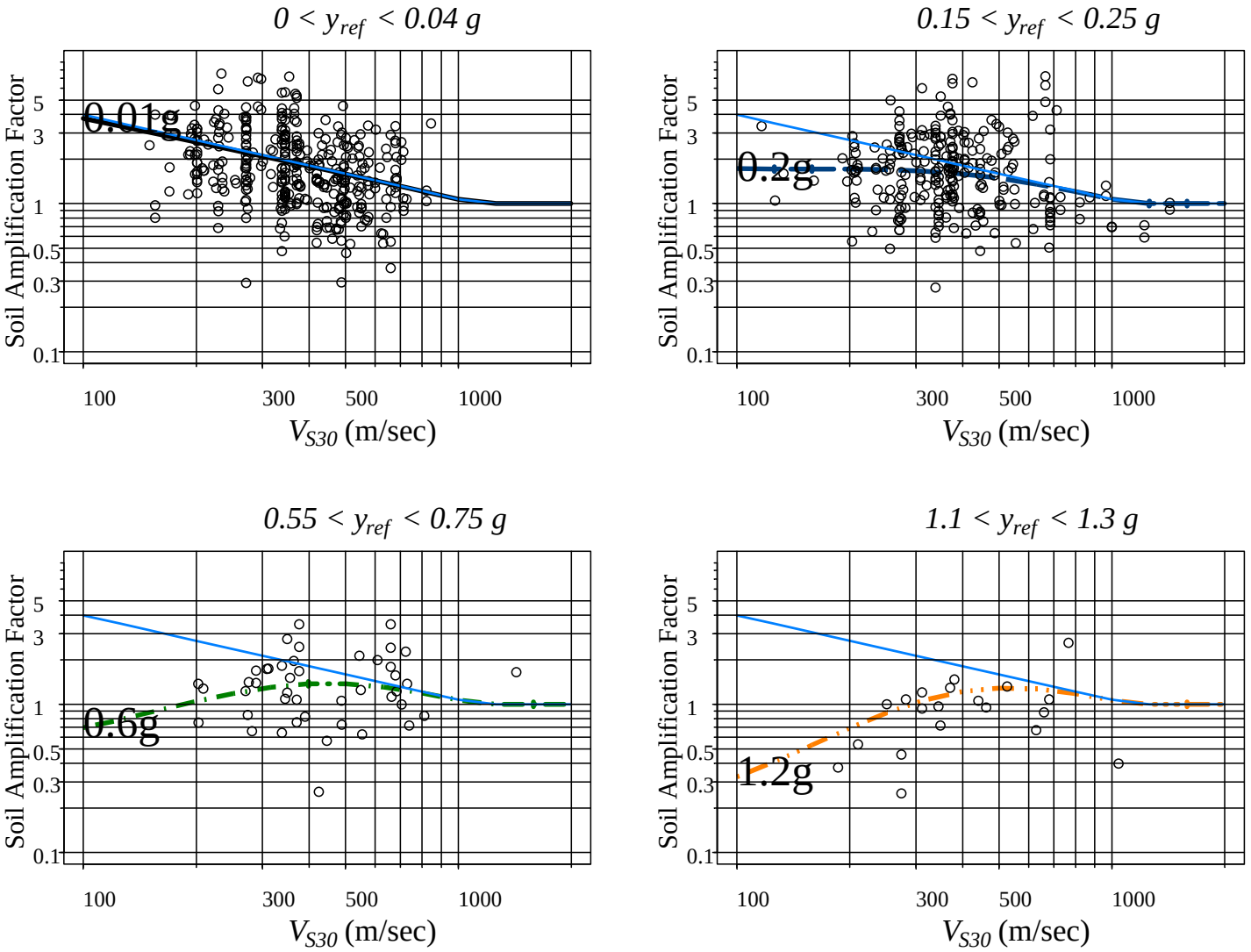
- Nonlinear soil response is explicitly modeled
- Soil amplification factor is a function of
  - y_{ref}
    - ground motion on rock, PGA or spectral acc.
  - $Ln(V_{S30})$



Nonlinear Soil Response Model



Nonlinear Soil Response in the NGA Data

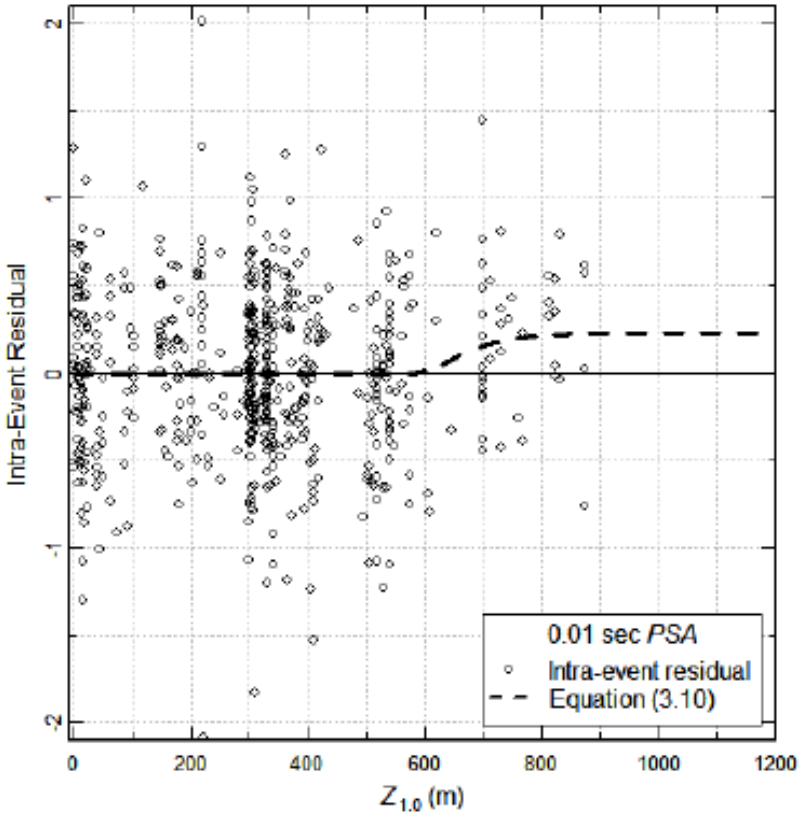


Depth to Bedrock

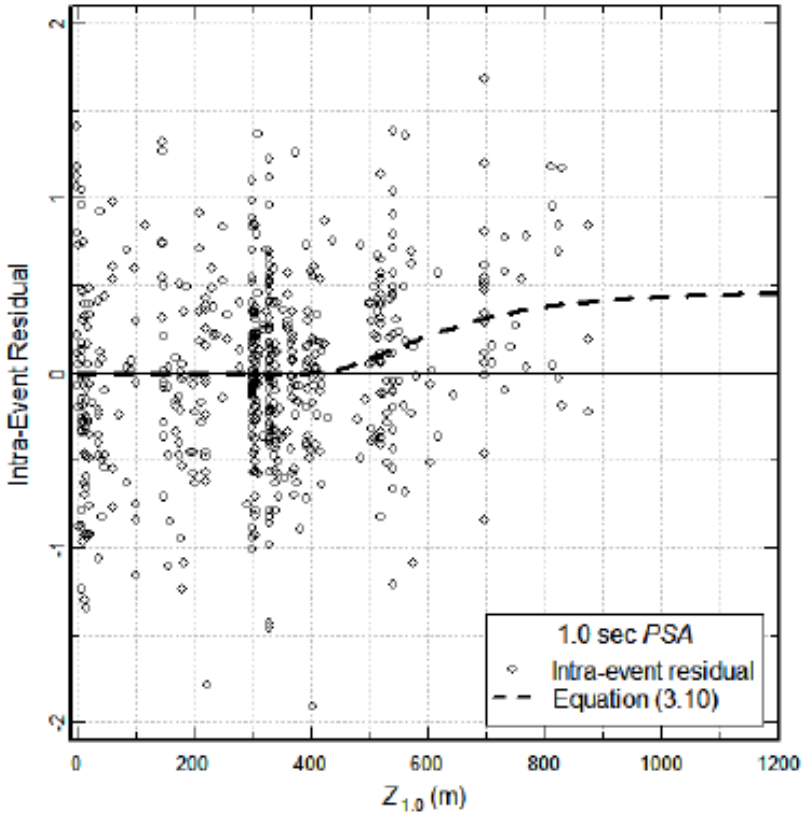
- Depth to bedrock ($Z_{1.0}$ & $Z_{2.5}$)
  - Bedrock
    - $Z_{1.0}$ = Depth to 1.0 km/s shear-wave velocity horizontal
    - $Z_{2.5}$ = Depth to 2.5 km/s shear-wave velocity horizontal
  - Amplification for large $Z_{1.0}$ site (>> 400m), or large $Z_{2.5}$ site (>> 3km)
    - Maximum amplification varies with period
  - Currently, no reliable resource for depth estimate, except southern California sites

Depth to Bedrock ($Z_{1.0}$)

PGA



1-Sec



Thank You