

Status of the NGA East Ground-Motion Database

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Goal: ground motions and metadata for development
of new CENA ground-motion prediction equations

- CENA data: complete for magnitude ≥ 4 + well-recorded smaller earthquakes (mag $\geq \sim 2.5$)
- Data from other SCRs (selection criteria under study)
- Uniform processing & QA
- Metadata (e.g., Vs30)
- Products similar to NGA West

CENA Data Sources

- Very old records (poor quality, long-period only)
 - 1925 M6.4 Charlevoix
 - 1929 M7.3 Grand Banks
 - 1935 M6.2 Timiskaming
 - 1944 M5.8 Cornwall-Massena
- Older strong-motion & short-period (variable quality)
- Modern broadband (ANSS, TA, regional networks)
 - Thousands of new records (since ~1990)
 - Sources IRIS DMC, CNDC, and regional networks
- Modern strong-motion (Etna, IA, Netquake, ANSS)

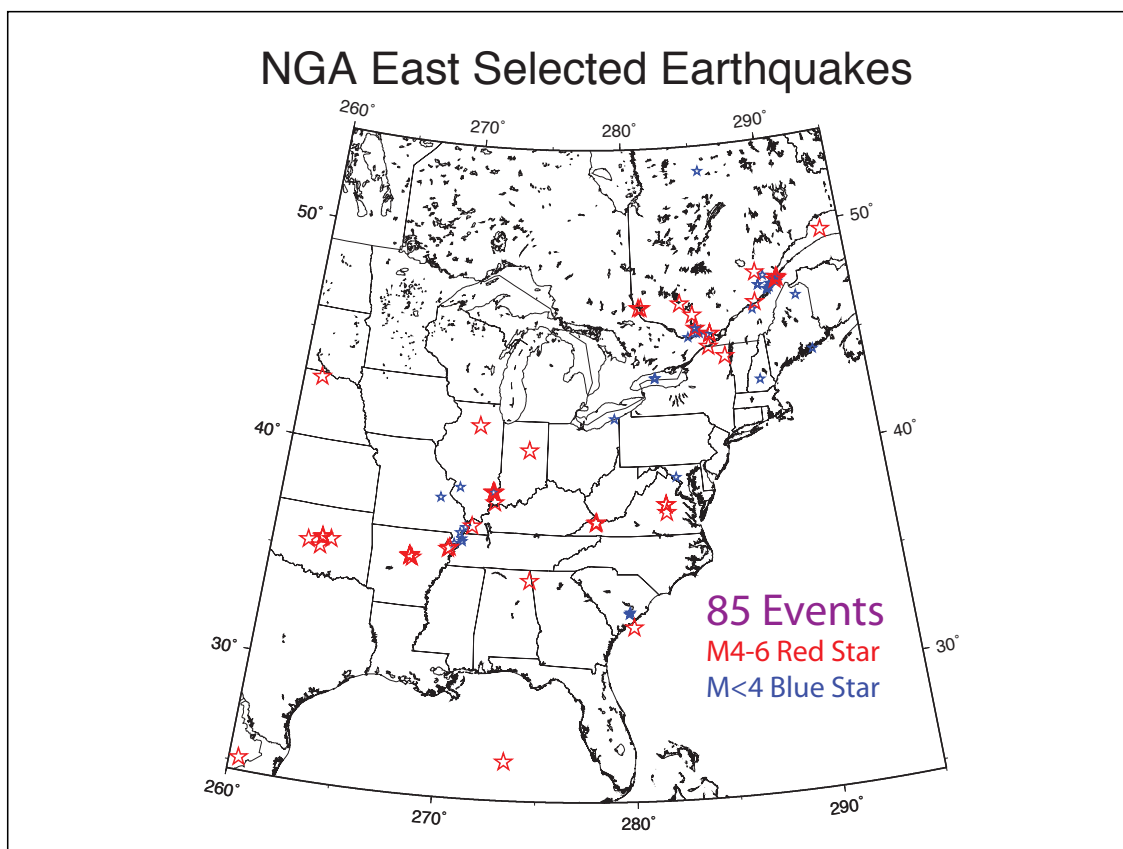
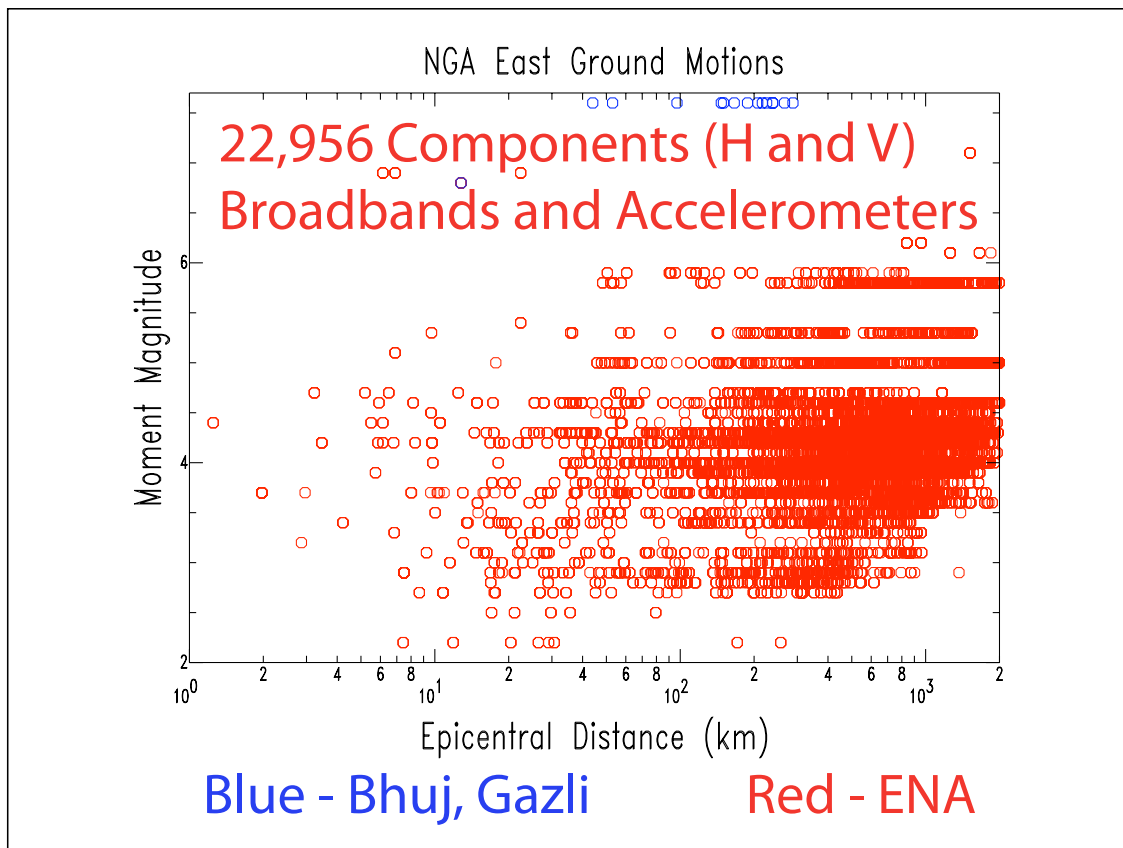
30 Sep 2011: CENA is finished!

- ✓ 85 earthquakes, through 2011 Mineral VA
- ✓ GM flatfiles: PGA + PGV + PGD + 105 periods (0.01-10s) ASIS 5% damped and GMRotD50 & GMRotD100 for 5 damping levels
- ✓ Waveforms

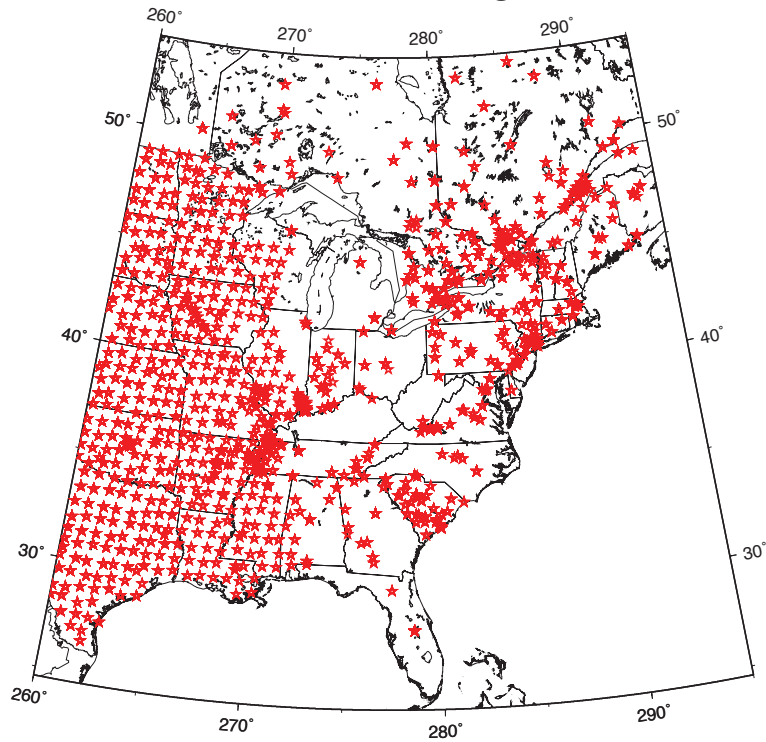
Overview

- Summary
- Data Processing and Time Series Files
- Data Quality Assurance
- Results of Current GMPE Comparisons for M5s
- 2001 M7.6 Bhuj Comparison

Summary



NGA East Recording Stations



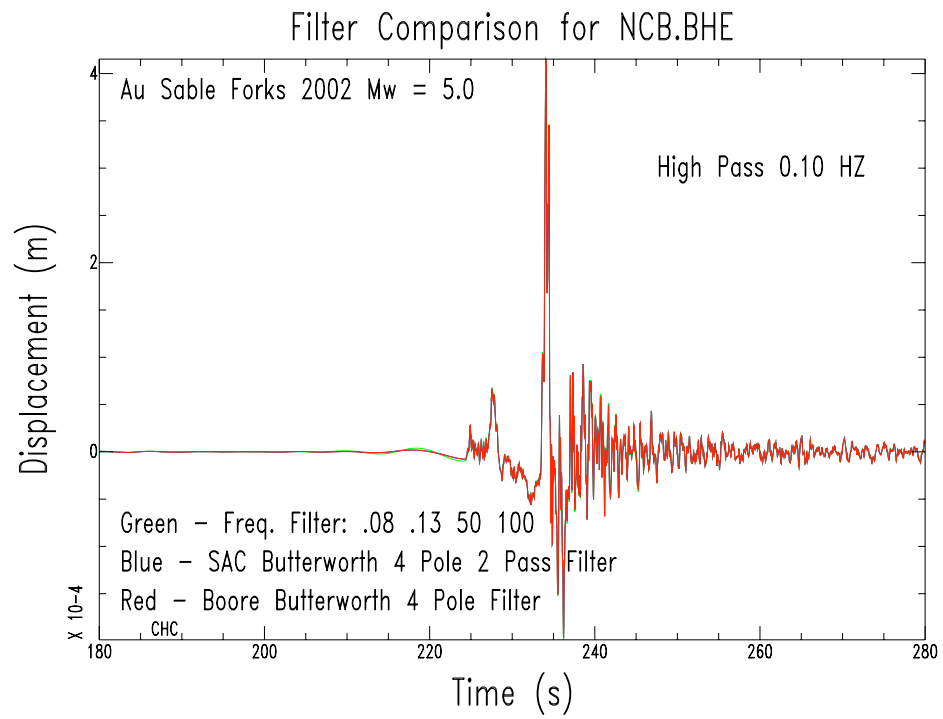
Data Processing

Summary of Processing

- Data Processing using Seismic Analysis Code (SAC)
- Download Uncorrected Waveforms and PZ Files
- Review Waveforms for Obvious Problems
- Instrument Correction and Initial Filtering
- Generate Signal and Pre-event Noise Spectra and Select Final Filter Corners
- Final Bandpass Filtering for Acc, Vel, Dsp
- Extract NGA Ground Motion Values (PGA, PGV, PGD, and 105 Sa)

Instrument Correction and Filtering

- Instrument Correction
 - Remove Mean, Detrend (linear), 2% Cosine Taper
 - SAC TRANSFER Function
 - PZ Files (for Displacement)
 - Successively Specify Acc, Vel, none (Dsp)
- Waveform Filtering
 - Frequency Domain, Acausal, Cosine-Tapered Bandpass Filter in SAC TRANSFER Function
 - Checked via Dave Boore's Processing and Butterworth Filtering (same results)



Time Series

NGA East Time Series Files

- Produced from SAC acc, vel, and dsp files
- ASCII files are in NGA format

NGA East ASCII Header Format

```
PEER NGA-EAST EARTHQUAKE RECORD, QUAL= A basement of house, 10-bit dig
MINERAL VA EQ, 2011/08/23, 17:51      QC.8653.BNE, EW ( 90 deg)  48 KM EPDIST
ACCELERATION TIME SERIES IN UNITS OF G. FILTER: HP= 0.62 Hz LP=  5.60 Hz
  9000  0.0200 2011 235 17 50 17.472      0.000 NPTS, DT, YR, JDY, HR, MN, SC, B
-4.499905E-05 -3.265414E-05 -3.432345E-05 -6.558303E-05 -1.204758E-04
-1.666269E-04 -1.660433E-04 -1.083081E-04 -2.620221E-05  2.463322E-05
 8.247393E-06 -6.213682E-05 -1.320869E-04 -1.441116E-04 -7.751443E-05
 3.429017E-05  1.168496E-04  9.453454E-05 -5.594150E-05 -2.683109E-04
-4.055106E-04 -3.462470E-04 -8.865212E-05  2.188147E-04  3.664374E-04
 2.361525E-04 -1.039297E-04 -4.414616E-04 -5.611053E-04 -3.740394E-04
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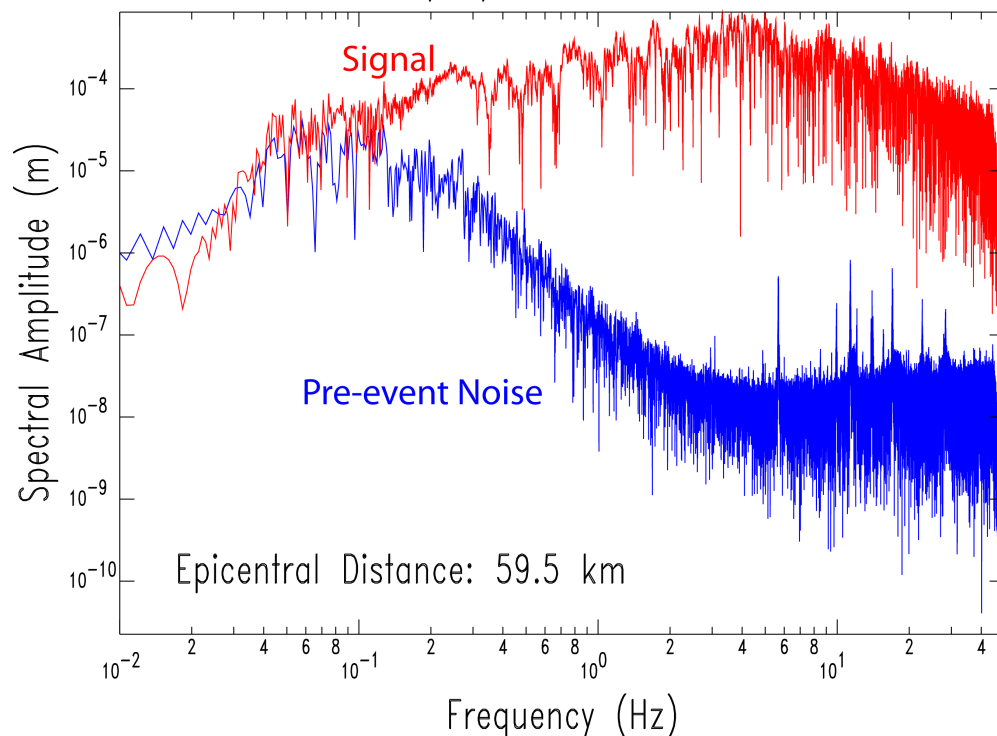
Data Quality Assurance

Quality Assurance

- Examine Original Waveforms
 - Clipping/Distortion
 - Missing Data / Noise Spikes, etc.
- Determine Spectral Signal to Noise
 - Final Filter Selection
- Review Acc and Disp Record Quality
 - If needed, adjust record length, filtering
- Plot PGA (PGV) vs. Distance
 - PZ or Instrument Problems (outliers)
- Build Waveform Quality Table for each Event

Spectral Signal to Noise

Velocity Spectrum CN.A54.HHE

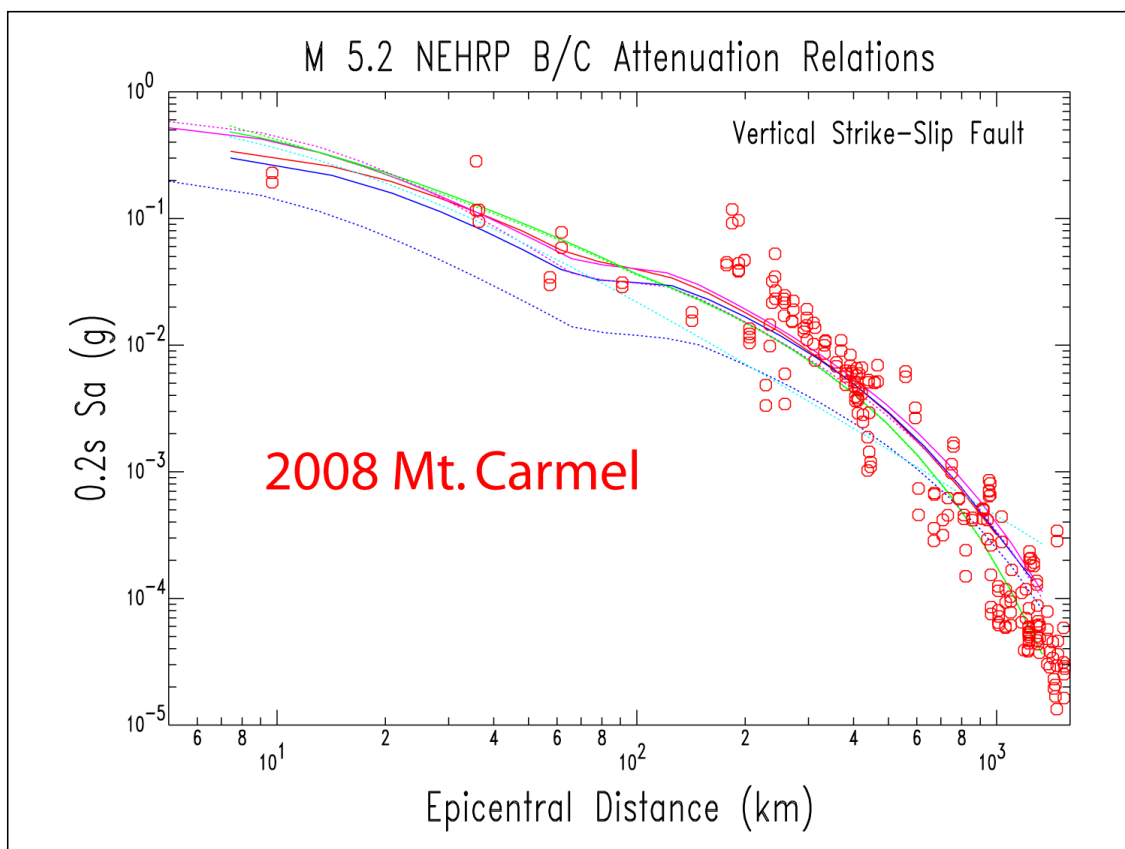
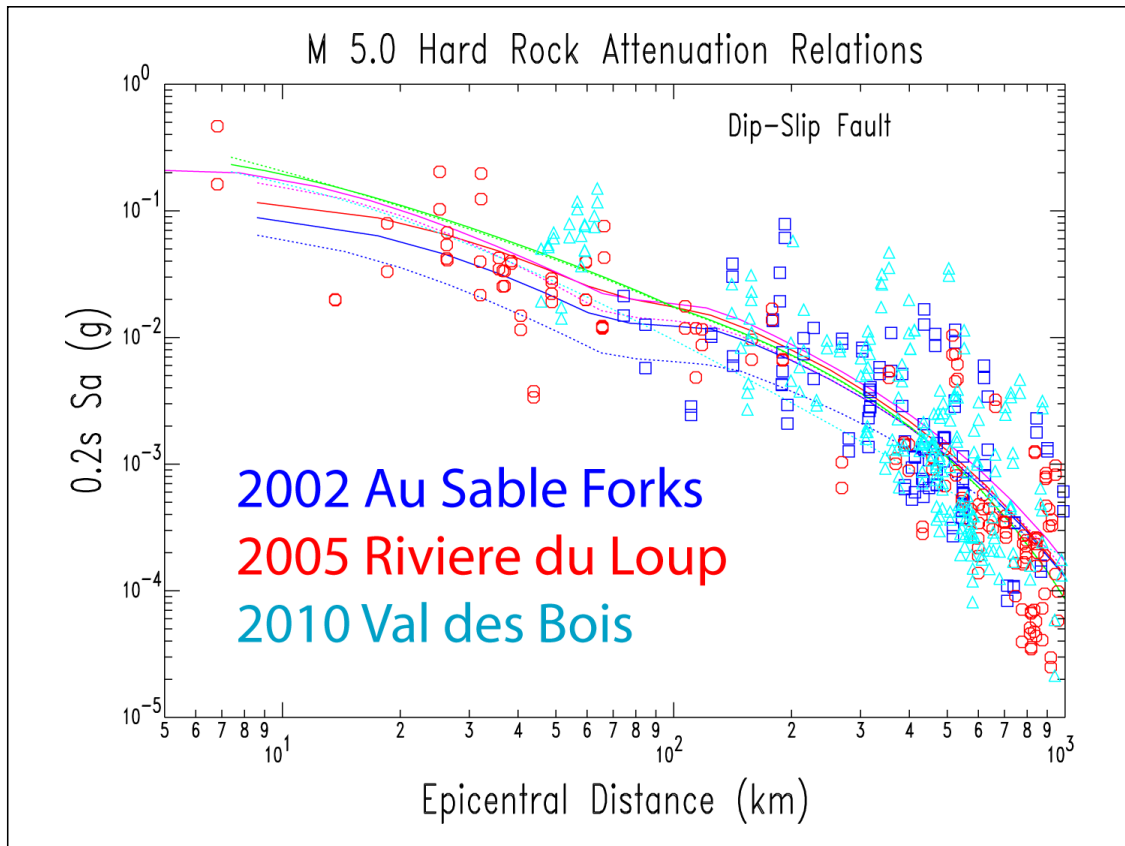


New Quality Assurance Efforts

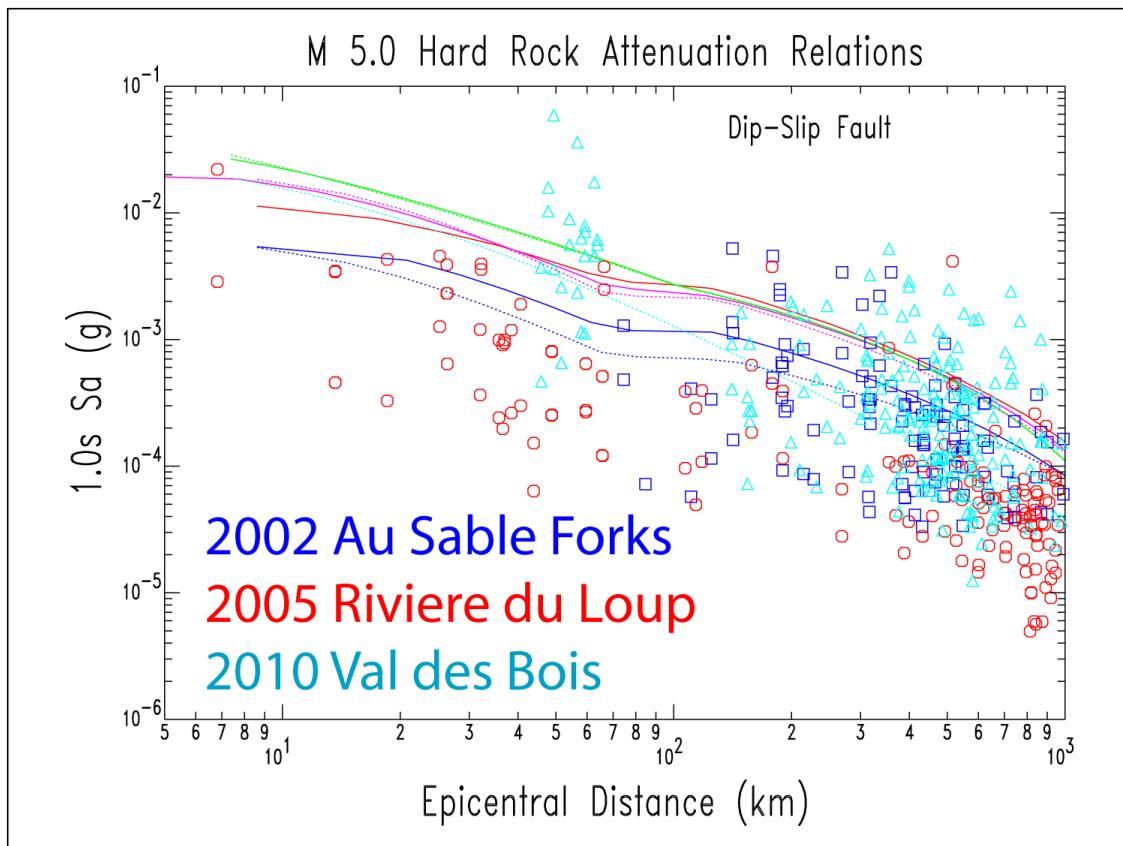
- Check on Horizontal Time Series Alignment for GMrotD
 - Run Cross-Correlation on all pairs
 - Check and Correct or Eliminate Uncorrelated pairs (>30s difference)
- Systematically check Station coordinates among events
 - List each record's Lat, Lon, Elev, Stn ID
 - Sort on Stn ID and compare
 - Correct any discrepancies (> 1 km in Lat, Lon)

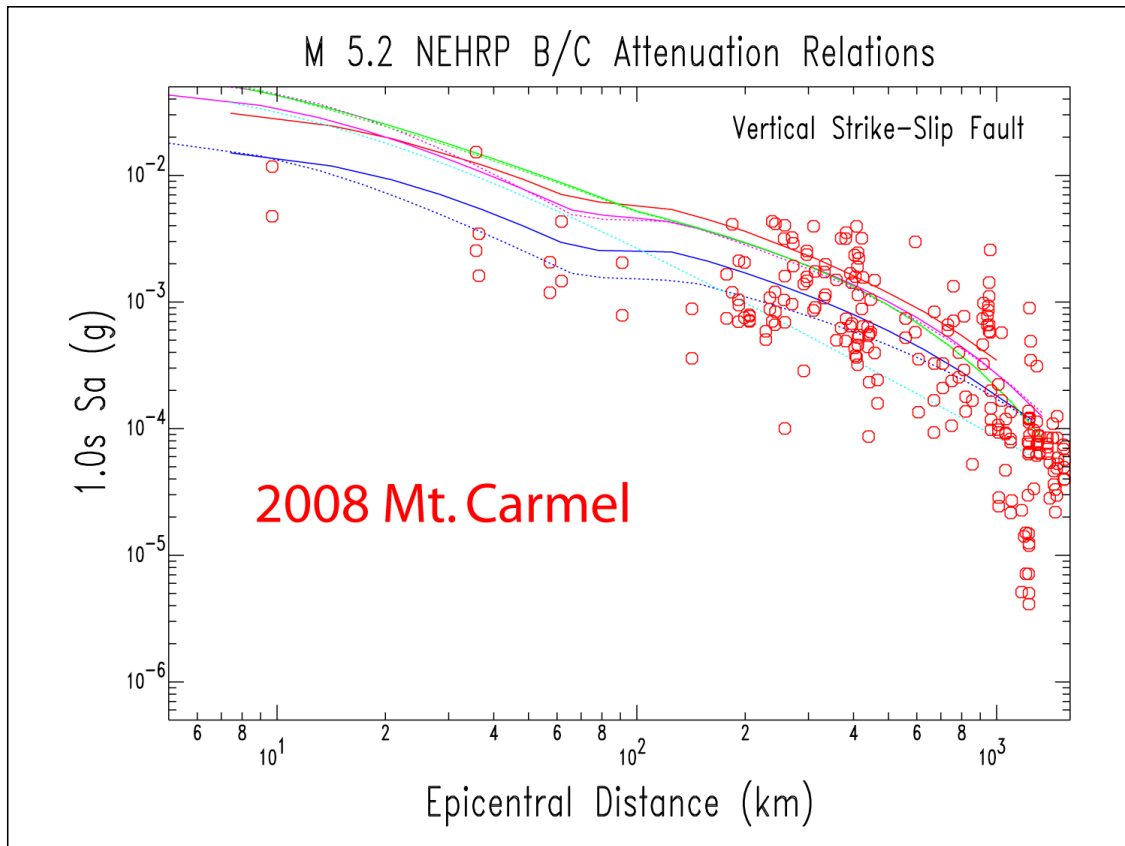
M5 Comparisons with ENA GMPEs

Short Period – 0.2s S_a



Long Period – 1.0s Sa





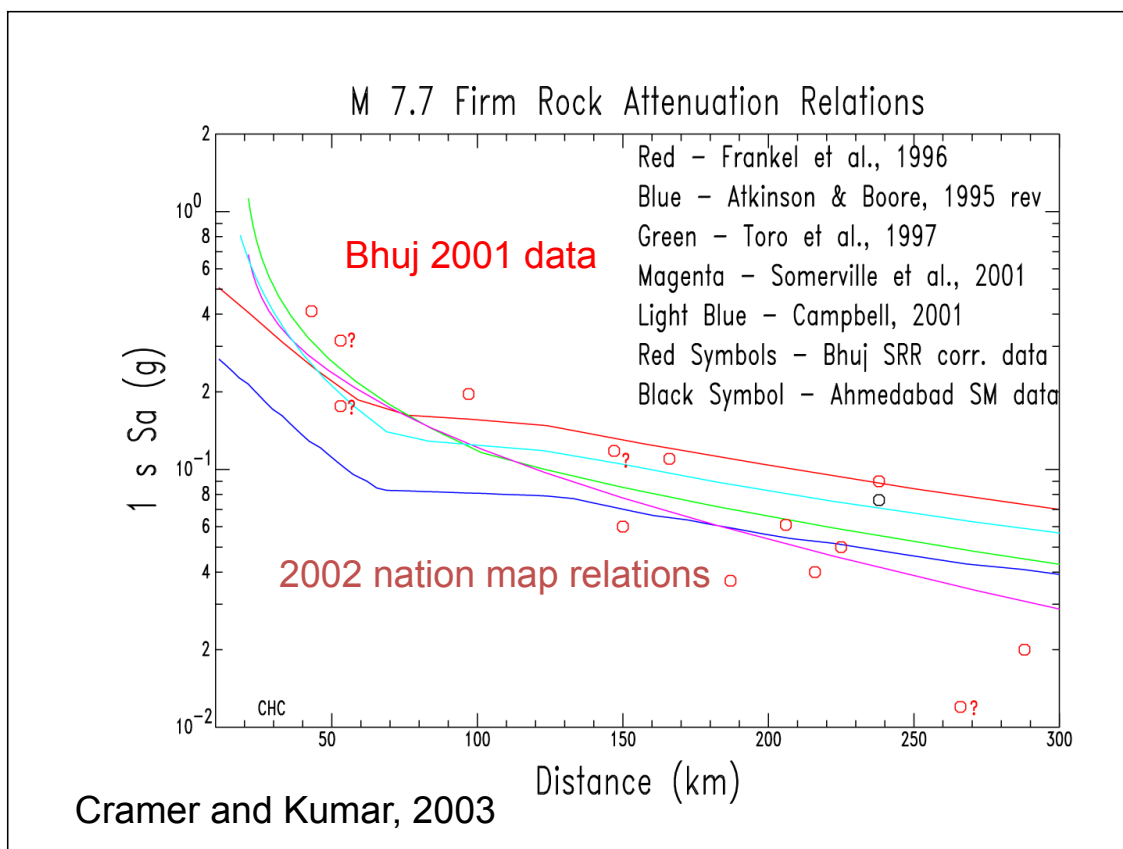
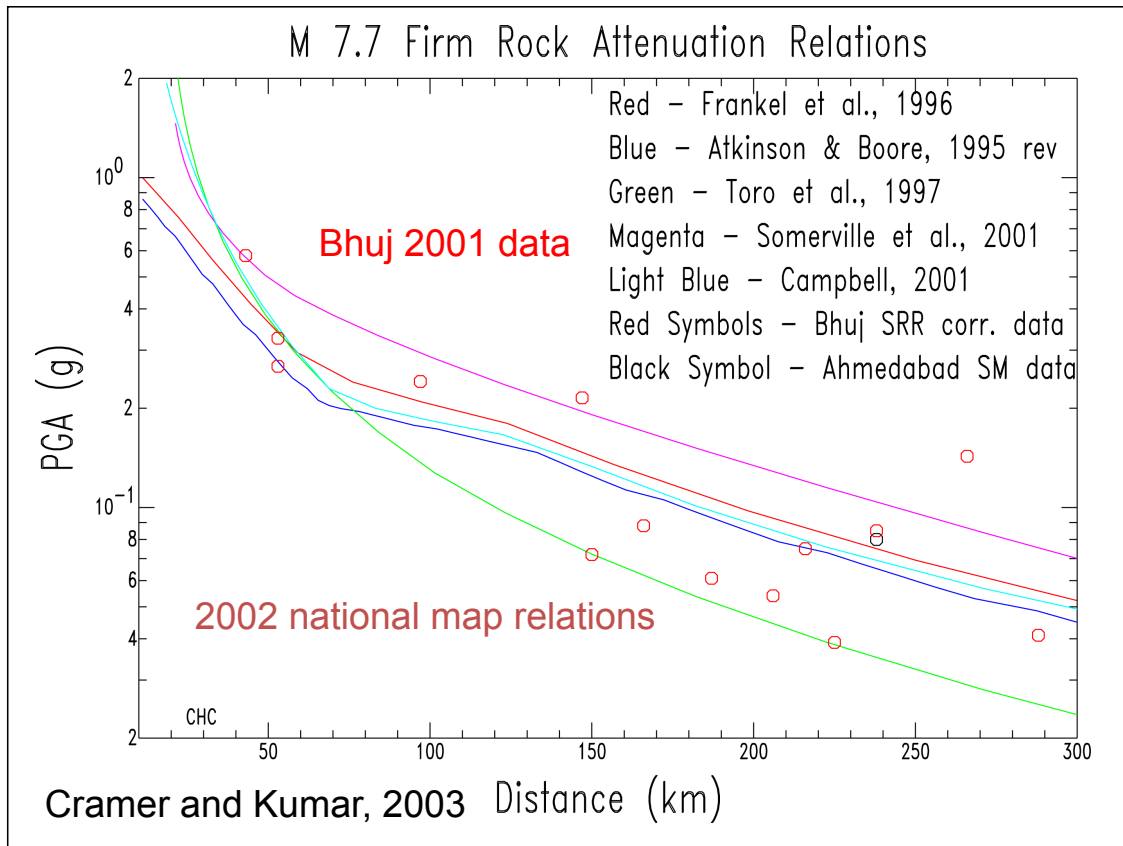
Comparison Summary

- Comparison of current GMPEs as a group to M5 observations indicate that the GMPEs predict similar ground motion levels at short periods and over predict at long periods.
- There are some earthquakes, related to human activities, where this may not hold.
 - Arkansas M.7, well-injection induced, $\Delta\sigma \leq 5$ Mpa, radiation pattern
 - Oklahoma M4s ?
 - western Virginia M4s (2) ?, mine collapse

2001 M7.6 Bhuj Earthquake

2001 Bhuj Earthquakes

- Mainshock (Bodin and Horton, 2004):
 - $\Delta\sigma = 160 \pm 20$ bars (fault geometry, M_0)
 - = 170 bars (circular fault)
 - = ~200 bars (teleseismic - Antolik and Dreger, 2003)
- Aftershocks (Bodin et al., 2004):
 - Fit well by Brune model
 - $\Delta\sigma = 150$ -200 bars
 - $G(R) \rightarrow$ Pentalinear, $R^{-0.5}$ beyond 60 km
 - $Q(f) = 790 f^{0.22}$ (deep), $790 f^{0.35}$ (shallow)
 - $\kappa_0 = 0.01$



Bhuj Summary

- Previously showed the general trend for ground motion observations from ENA M5s at short period is to plot at similar ground motion levels as current ENA GMPEs, but at long period to plot below current ENA GMPEs
- Similar trend for Bhuj M7.6 earthquake, except without ENA intermediate spectral sag.

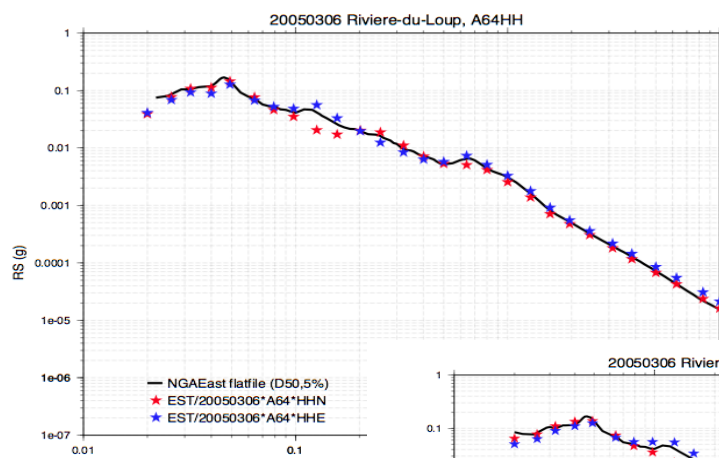
Extra product:

Relational database with Earthquake, Station/Site, and Record tables (Macintosh FileMaker, exportable to Excel)

Advantages:

- ✓ One record per earthquake & station/site (efficient to maintain)
- ✓ Explore dataset: quick searches on distance, magnitude, instrument type, data stream type, etc

Current through Flatfile v1.2 (July 2011)



QA:
Compare
NGAEast
&
ESToolbox

