gnitude Uncertainty from Ground Motion Simulations the 1811-1812 New Madrid Earthquake Sequence

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AGU 2011 Presentation

and

Modified and presented by R. Williams

for

Feb 22, 2012

Memphis National Map Workshop

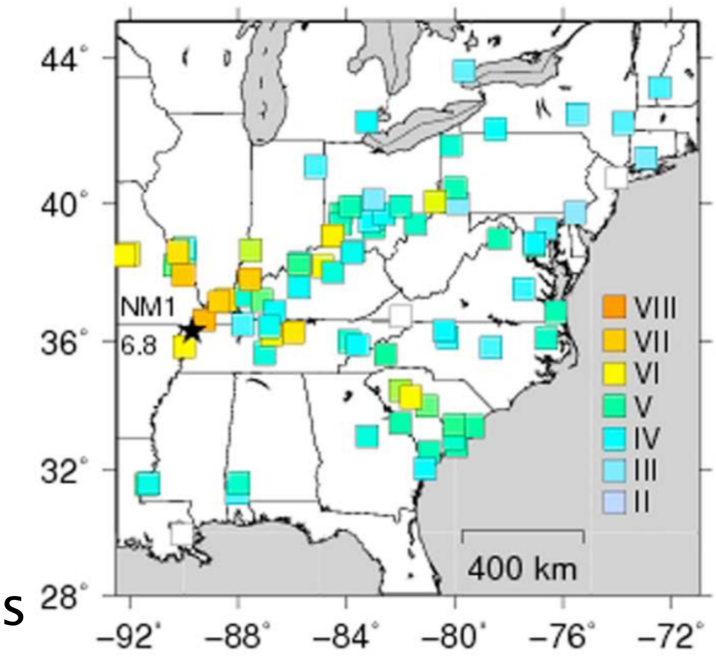
Magnitude Assessment: Dec 16, 1811 Earthquake (NM1)

- Important directivity and 3D effects.

- Can we use the ground motion prediction equations where aforementioned effects are important (i.e. account for directivity, capture behavior and influence of the rift)?

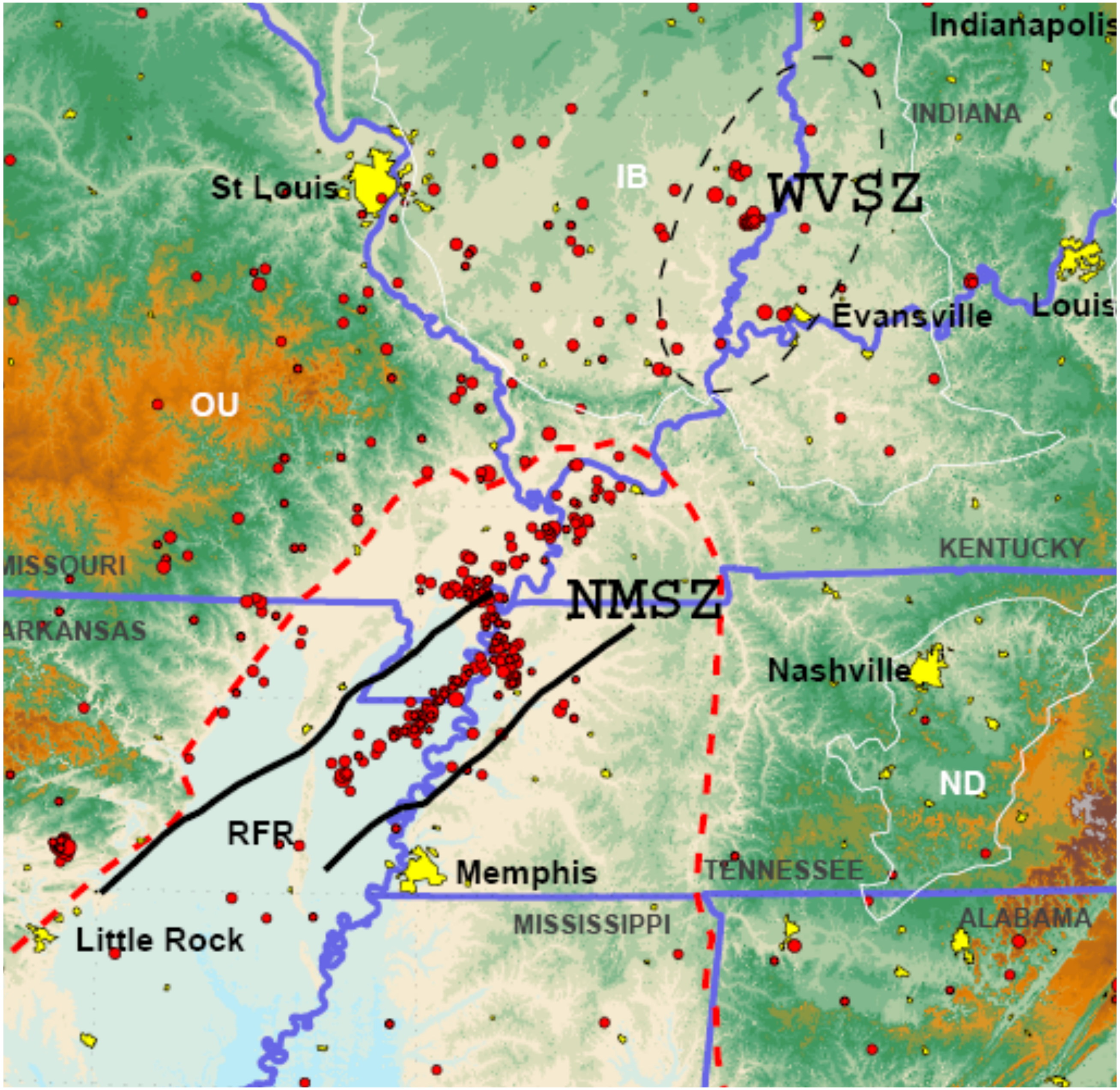
- Preliminary analysis of the magnitude estimates from the simulations sugges Mw > 7.

- Additional constraints: liquefaction and landslides?

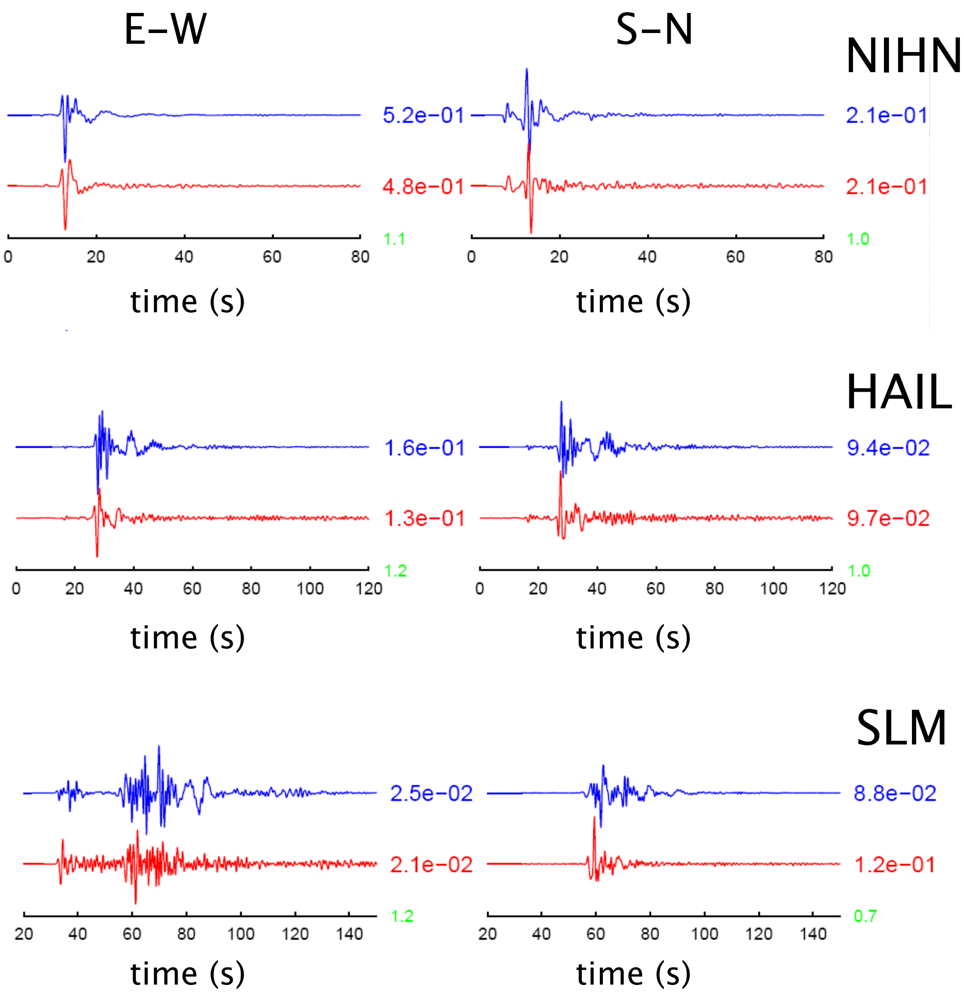


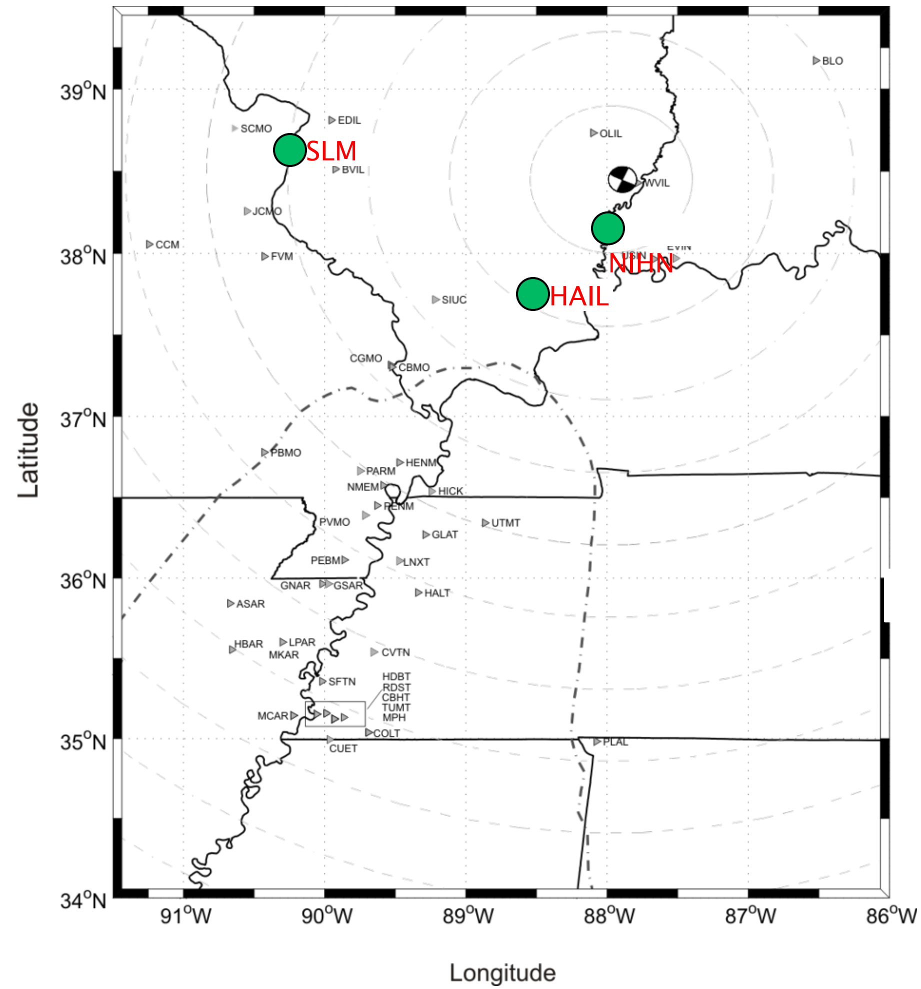
Hough and Page, 2011

3D Velocity Model Area



CUSVM TESTS: 2008 Mt. Carmel Earthquake, Data vs Simulation (Velocity filtered 0.1–0.9Hz)





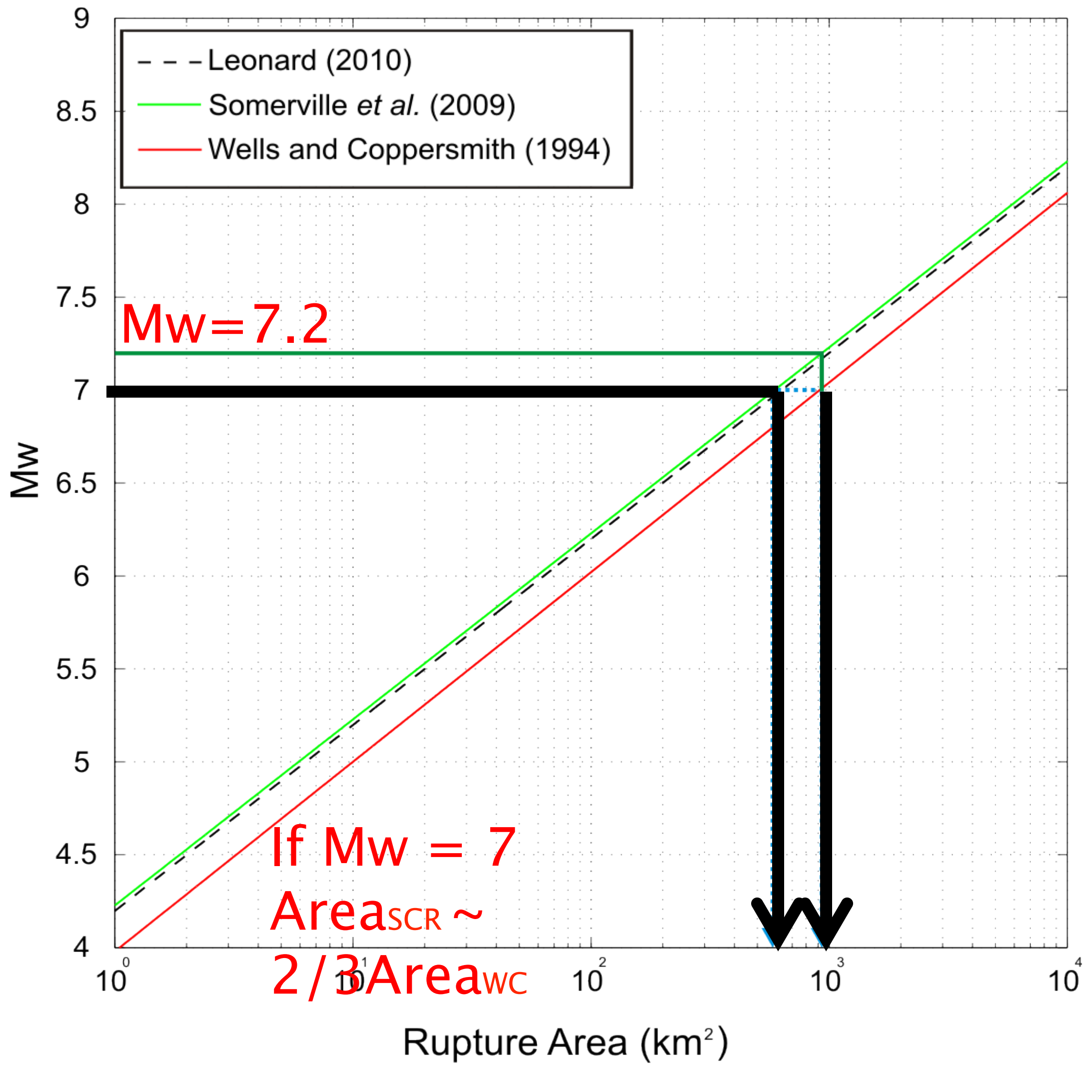
Units : cm/s

Synthetic
Observed

Scenario Definitions

Moment–Area
- Wells and Coppersmith (1994) (WC)
- Stable Continental Regions (SCR)
  - –Leonard (2010)
  - –Somerville et al. (2009)

For the same Mw WC predicts ~1.5 larger Areas than SCR



We fit the largest earthquakes considering the current seismicity

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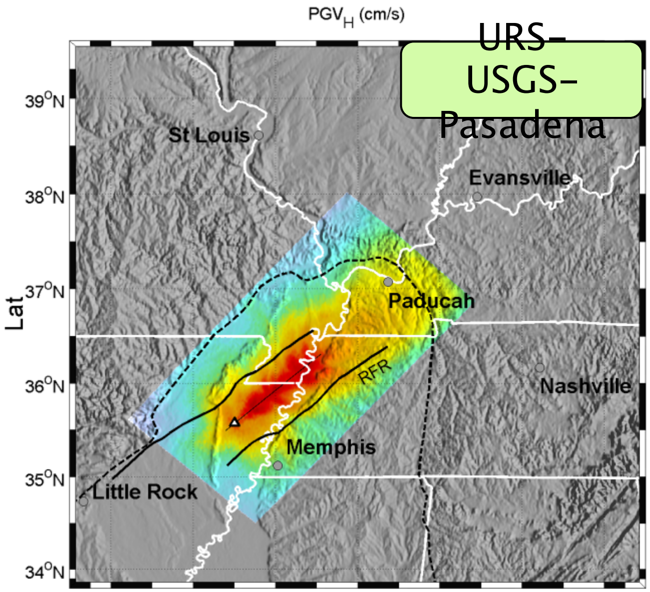
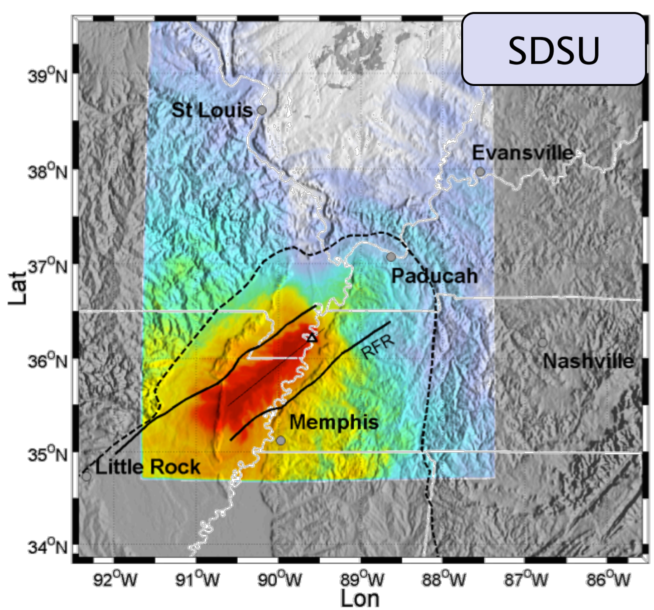
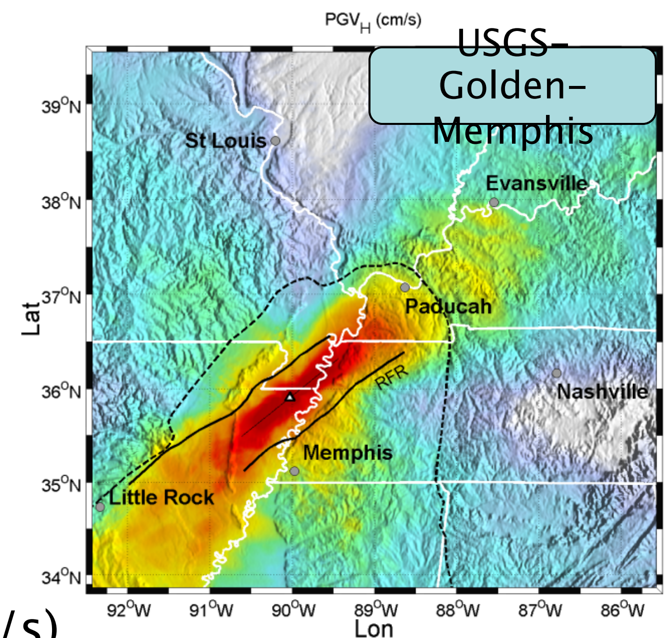
Southern Segment: PGV Mw 7.7



USGS-Golden-Memphis	URS-USGS-Pasadena	SDSU
• FEM • Vsmin=360m/s • 1Hz	• FDM • Vsmin=600m/s • (1Hz)+BB	• FDM • Vsmin=600m/s • (1Hz)

- **Directivity**
- **The Reelfoot Rift acts as a wave guide which directs energy northeast and southwest within the model**

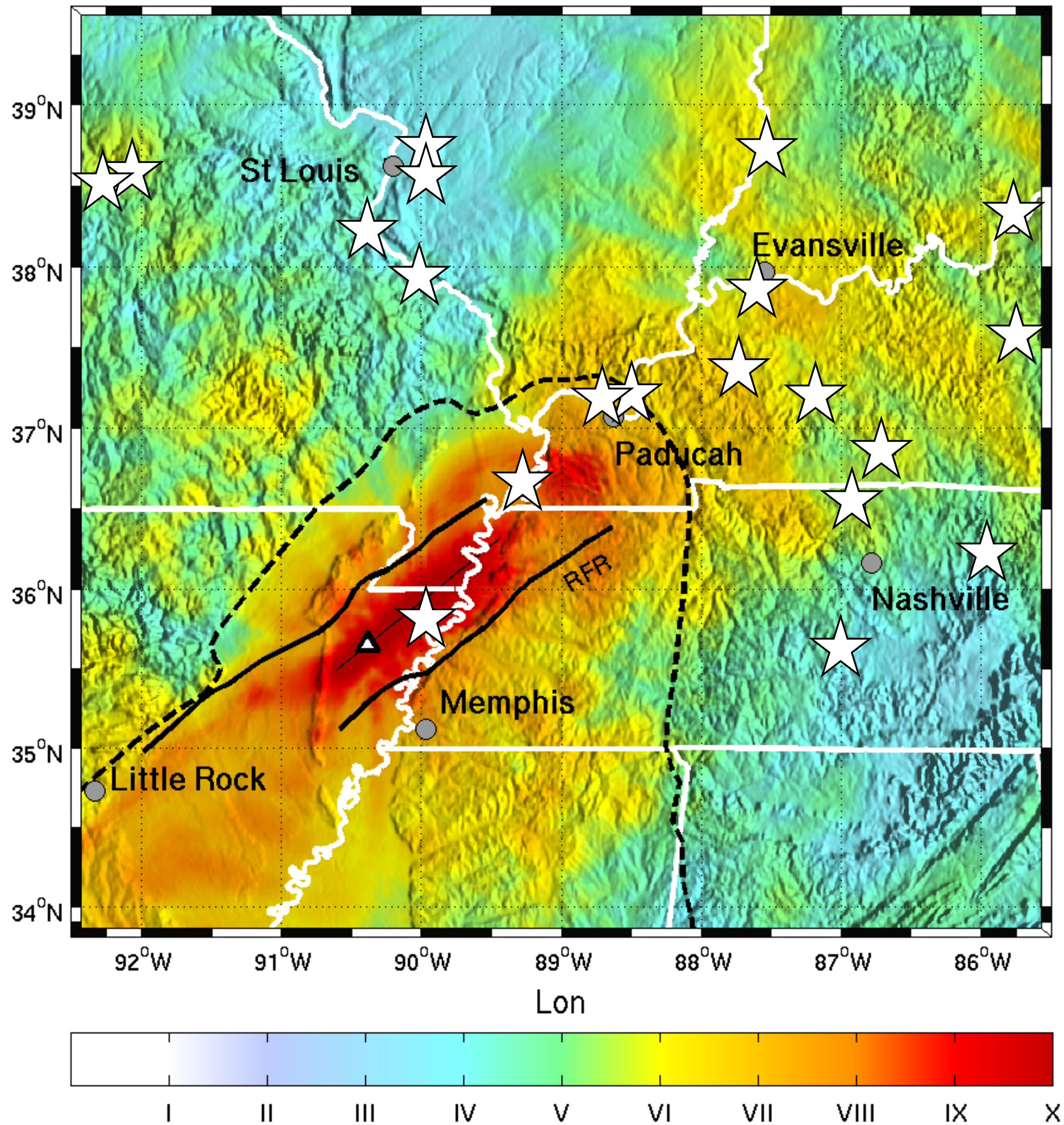




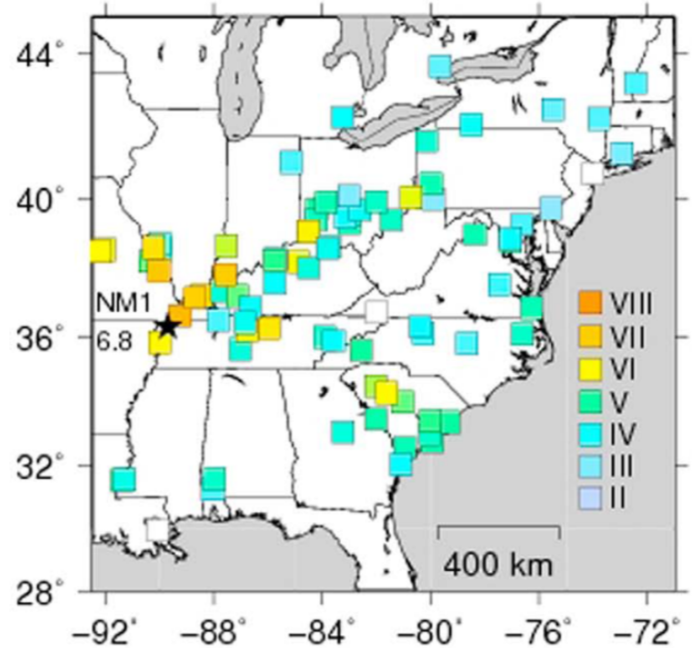
Pgv (cm/s)

MMI Estimate from simulation: Dec 16, 1811, Mw 7.7 (NM1)

Instrumental Intensity (Atkinson & Kaka,2007)



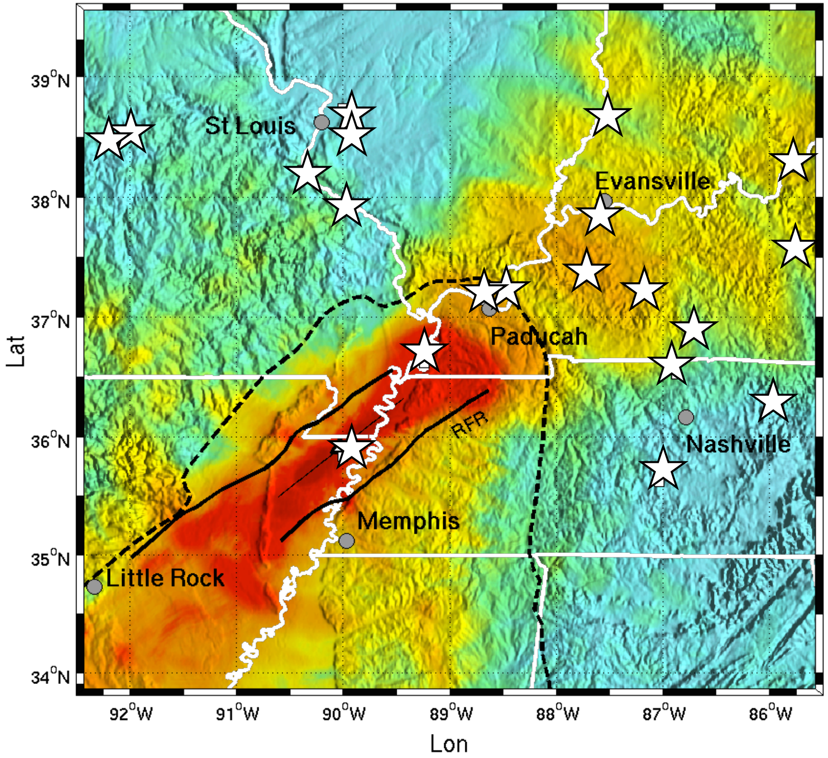
Hough and Page (2011)



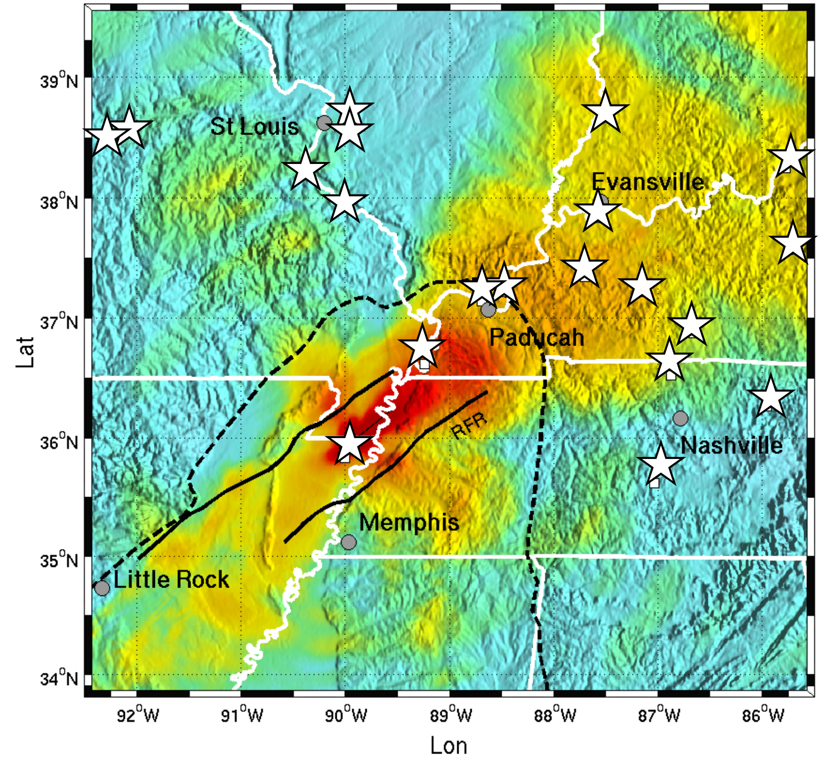
☆ Indicates location of eyewitness account from 1811 earthquake used in Hough and Page (2011)

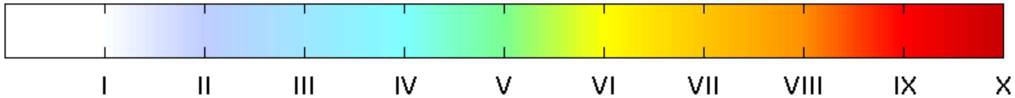
Simulated MMI: NM1

Southern Segment Mw = 7.7
(bilateral rupture)



Southern Segment Mw = 7.0



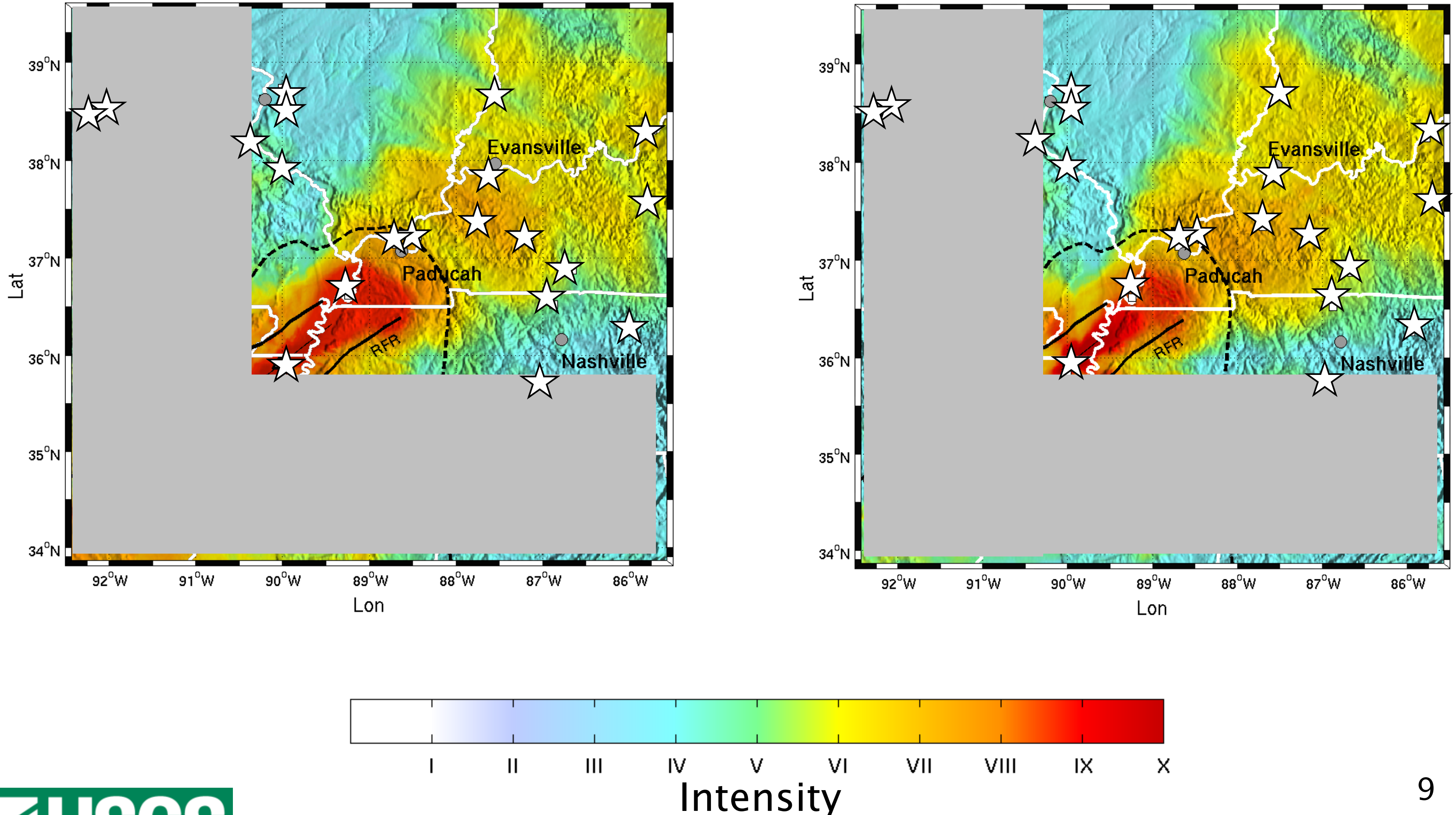


Intensity

Magnitude Determination: NM1

Southern Segment Mw = 7.7 (bilateral rupture)

Southern Segment Mw = 7.0



USGS

Magnitude Determination: NM1

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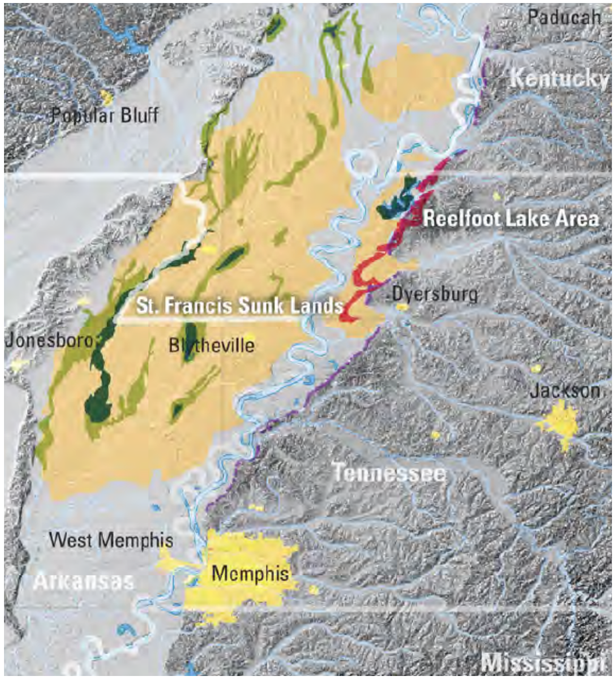

Putting Down Roots, CUS (Modified from Fuller 1912 and Jibson and Keefer, 1988)

CONCLUSIONS

- Estimates of exposed population based on our numerical simulations for the events with large magnitude in the Central and Southern segments indicate that up to 3 million people could be affected by very strong to severe shaking. (MMI VI–VIII)

- 3D and directivity effects can induce very high ground motions in the region.

  The deep structure of the Reelfoot Rift acts as a waveguide.

  Simulations show strong rupture directivity effects, which can amplify motions in the forward direction of the ruptures.

  Both of these effects have a significant impact on the pattern and level of the simulated intensities, which suggests an increased uncertainty in the magnitude estimates of the 1811–1812 sequence based only on limited historic intensity reports.

- Preliminary magnitude estimates suggest **values >7** for the NM1 and NM3 events. Additional constraints, such as liquefaction and landslides triggered during the 1811–1812 sequence, might help to determine with more certainty the magnitudes of the sequence.

USGS