

# Increasing Seismic Monitoring in the South-Central Appalachians by the Kentucky Seismic and Strong-Motion Network

Seth Carpenter<sup>1,2</sup>, Zhenming Wang<sup>1</sup>, Edward Woolery<sup>2</sup>

<sup>1</sup> *Kentucky Geological Survey*

<sup>2</sup> *Dept. of Earth and Environmental Sciences*

*University of Kentucky*

# Outline

- Current Seismic Monitoring Foci
  - Hazard Map
  - Large, Recent CEUS Seismicity
- Kentucky Seismic and Strong Motion Network (KSSMN)
  - Filling a South-central Appalachian monitoring void
  - Recent expansion and upgrades
- Damage in Kentucky from Recent Appalachian Seismicity
- Eastern Tennessee Seismic Zone in Kentucky
  - 2012 Perry County, Kentucky  $M_w$  4.2 earthquake
  - > 25%  $M$  3.9+ ETSZ earthquakes
- Importance of Strong-motion Stations
  - USArray TA station adoption
  - Potential problems with broadband seismographs
- KSSMN recordings of the 2014/02 Edgefield, SC  $M_w$  4.1
- Conclusion

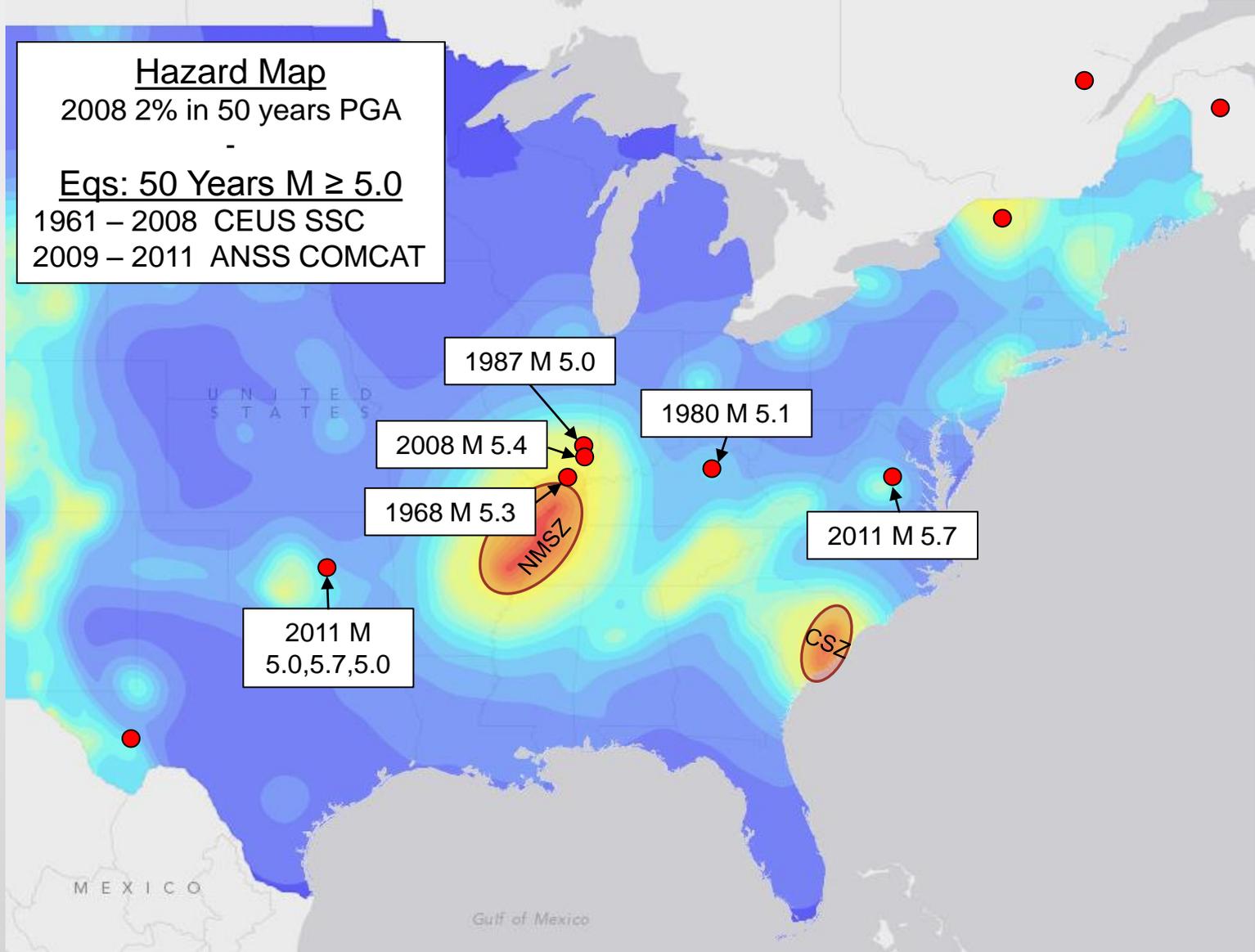
## Hazard Map

2008 2% in 50 years PGA

Eqs: 50 Years  $M \geq 5.0$

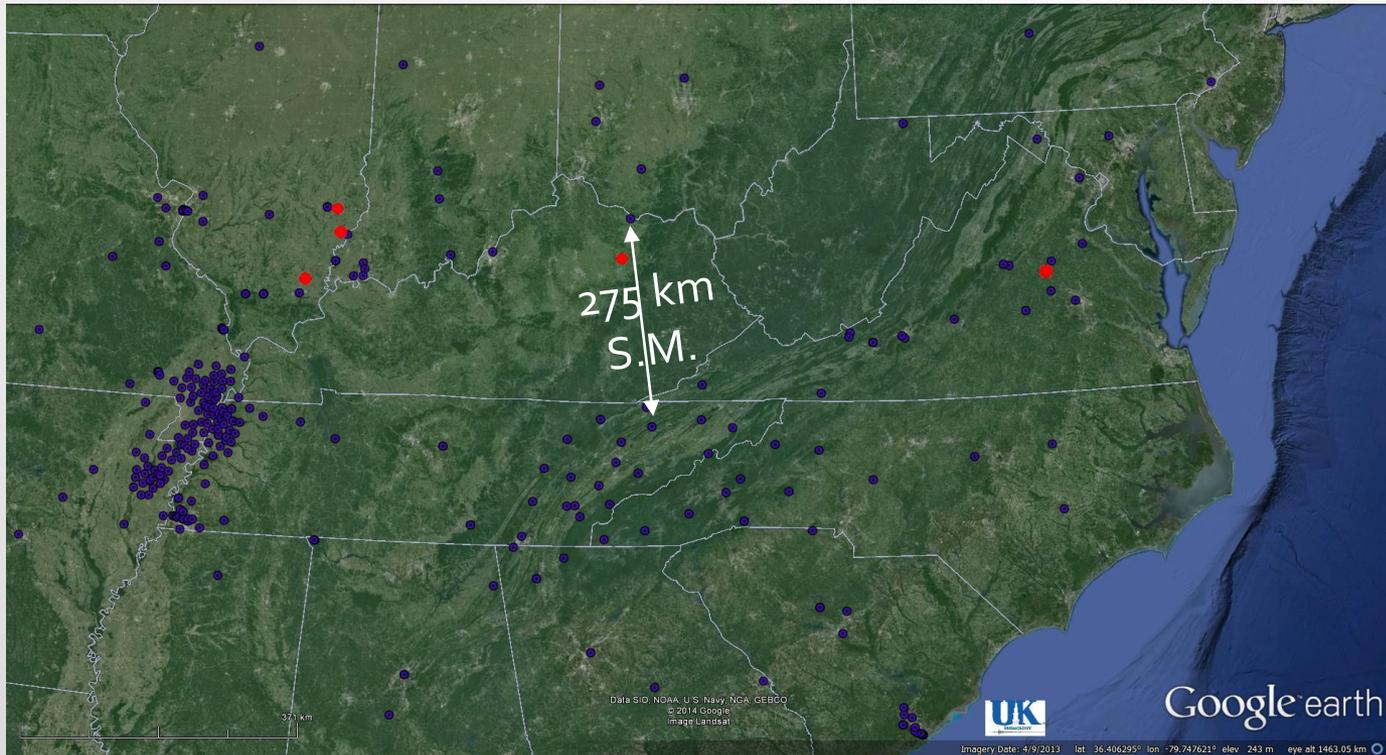
1961 – 2008 CEUS SSC

2009 – 2011 ANSS COMCAT



# Kentucky Seismic and Strong-Motion Network

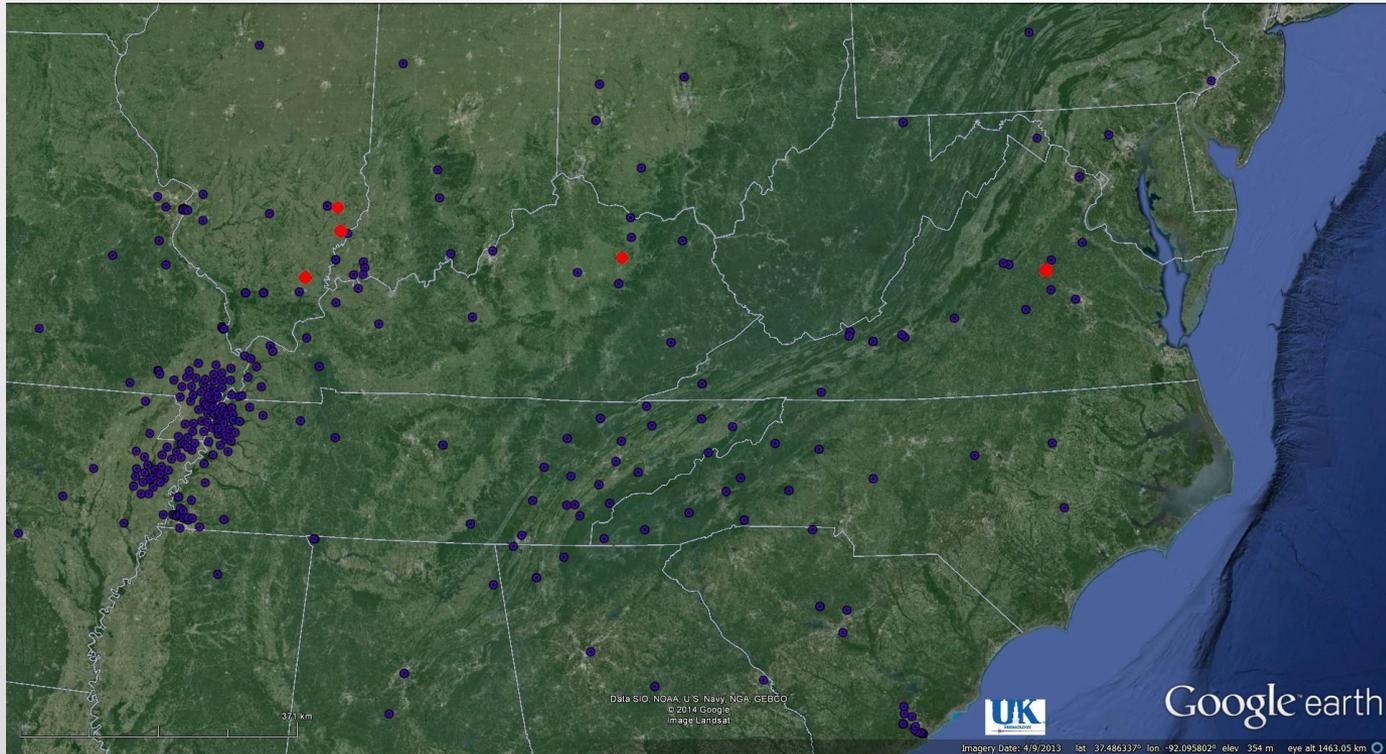
**KSSMN** fills an important,  
unmonitored area.



**50 Years  $M \geq 4.9$**   
1961 – 2008 CEUS SSC Catalog  
2009 – 2011 ANSS Catalog

# Kentucky Seismic and Strong-Motion Network

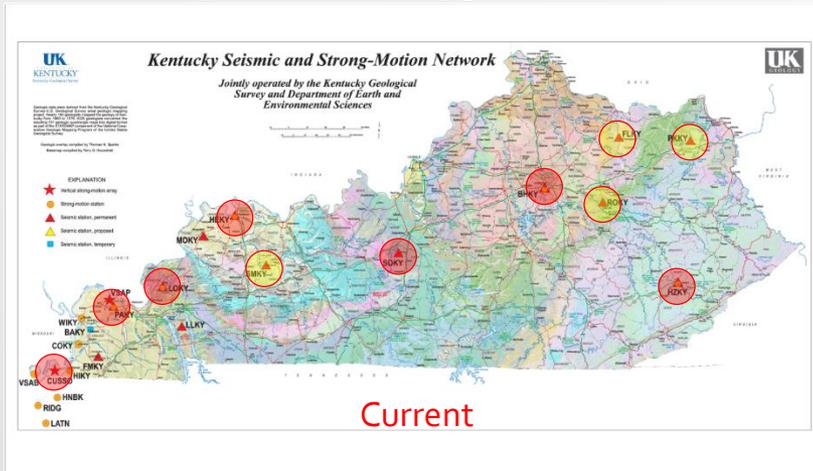
**KSSMN** fills an important,  
unmonitored area.



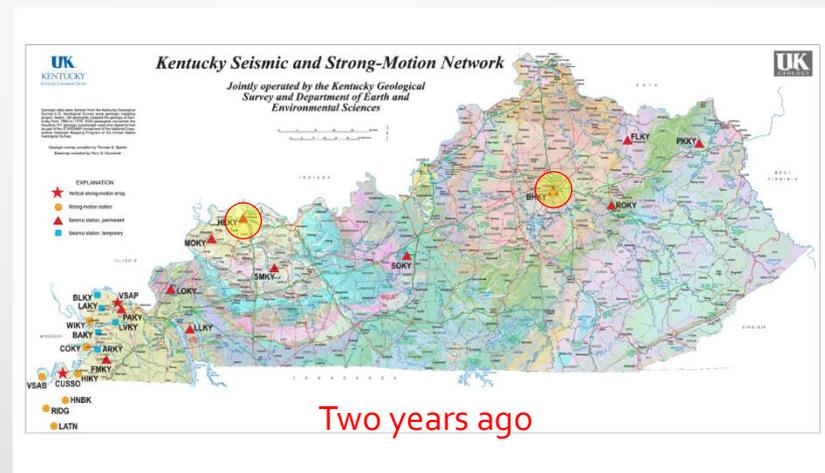
**50 Years  $M \geq 4.9$**   
1961 – 2008 CEUS SSC Catalog  
2009 – 2011 ANSS Catalog

# Kentucky Seismic and Strong-Motion Network

## KSSMN Expansion and Upgrades

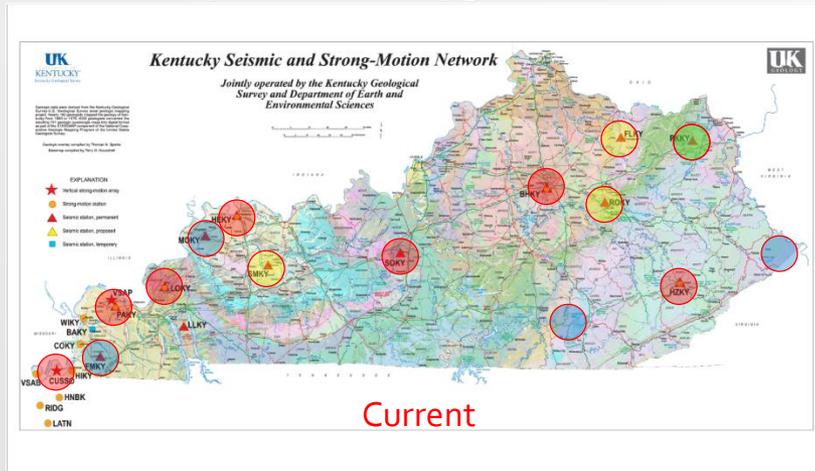


- Real-time Digital
- Real-time Digital + S.M.



# Kentucky Seismic and Strong-Motion Network

## KSSMN Expansion and Upgrades



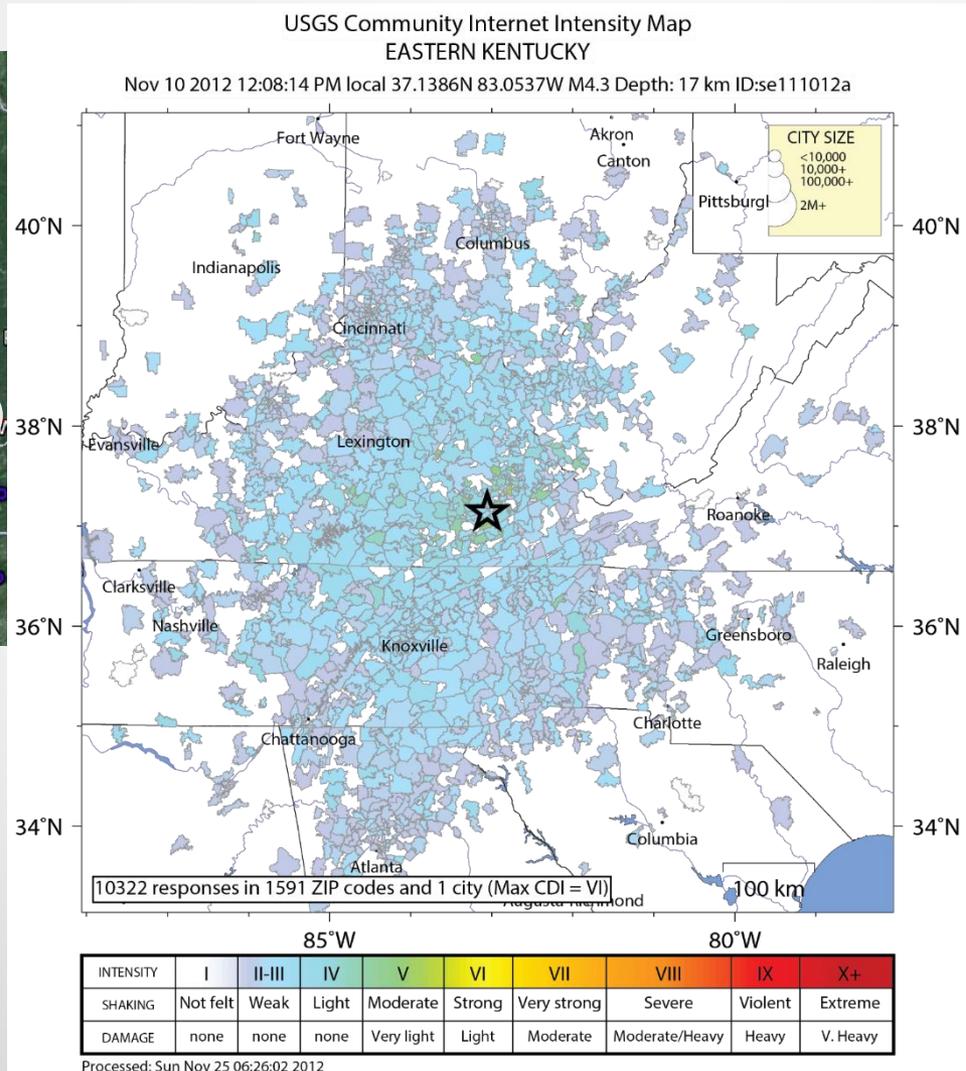
- Real-time Digital
- Real-time Digital + S.M.
- Planned Digital
- Planned Digital + S.M.

- 23 Stations - 14 Real-time
  - Data shares with CER1
  - Data to IRIS
- 7 Real-time strong-motion stations
- 1 New seismic/strong-motion station in northern ETSZ
- Record ~90 seismic events / day (almost entirely blasts)

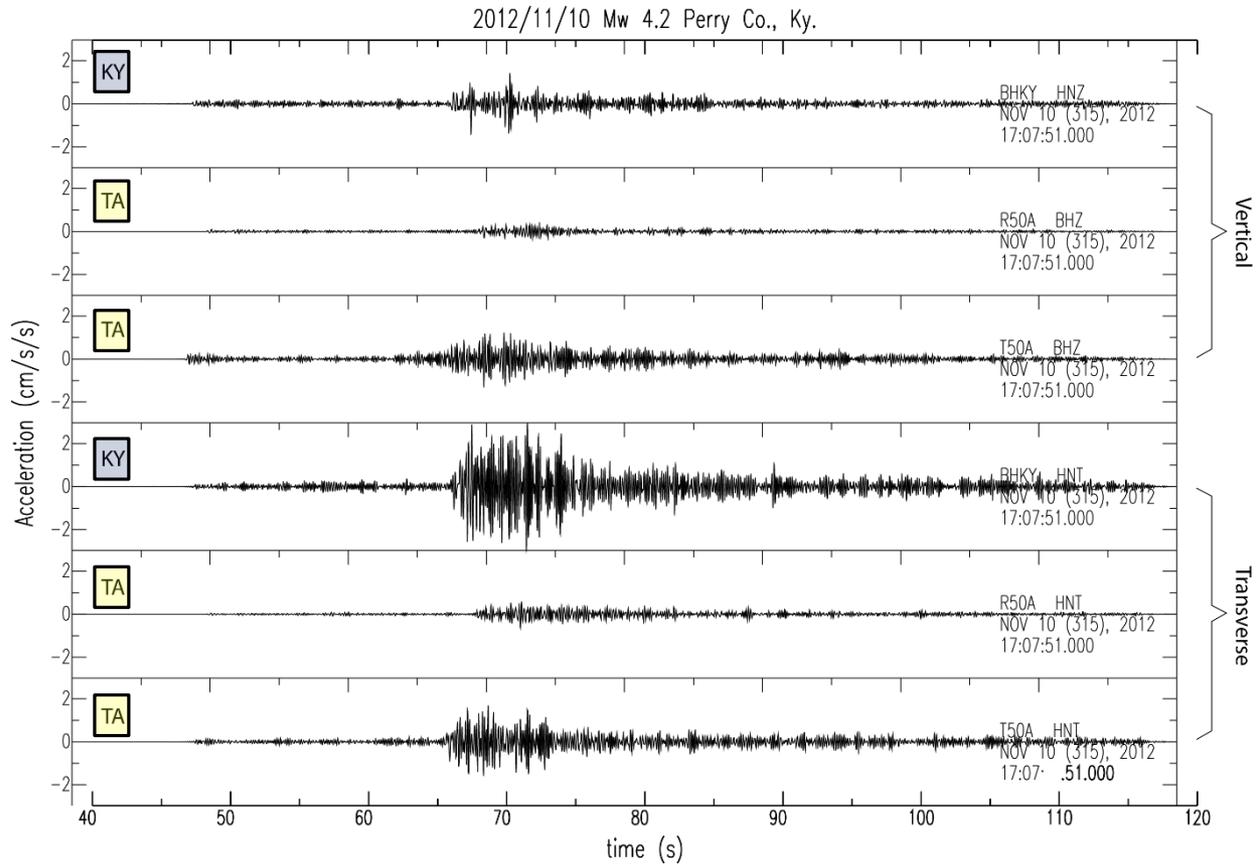
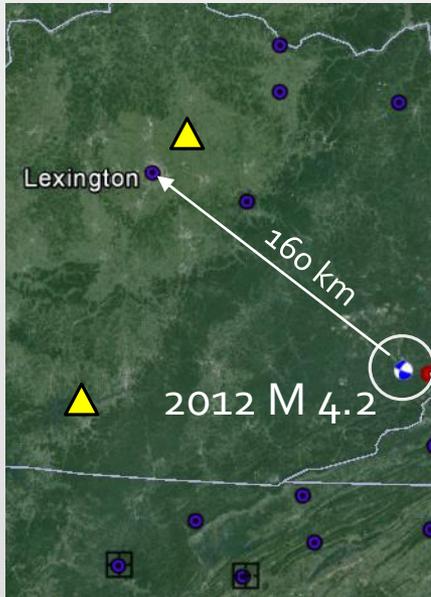
# Damage in the Kentucky Appalachians from Recent Earthquakes



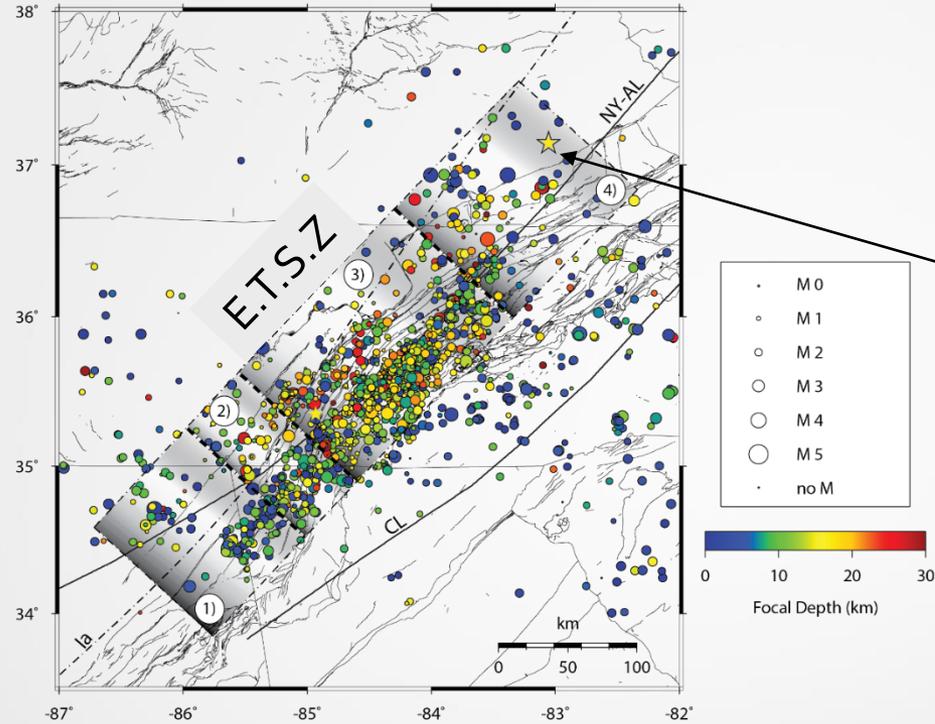
# Recent Southern-Appalachian Earthquakes



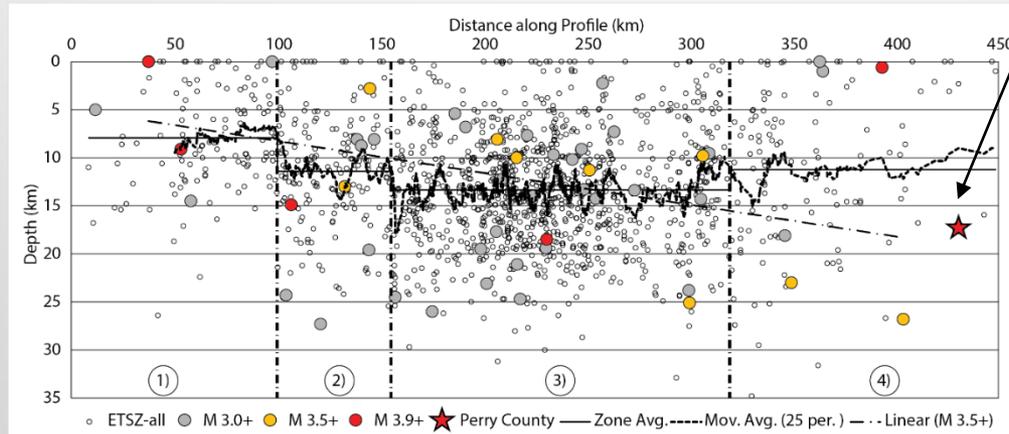
# Recent Southern-Appalachian Earthquakes



# Eastern Tennessee Seismic Zone in SE Kentucky

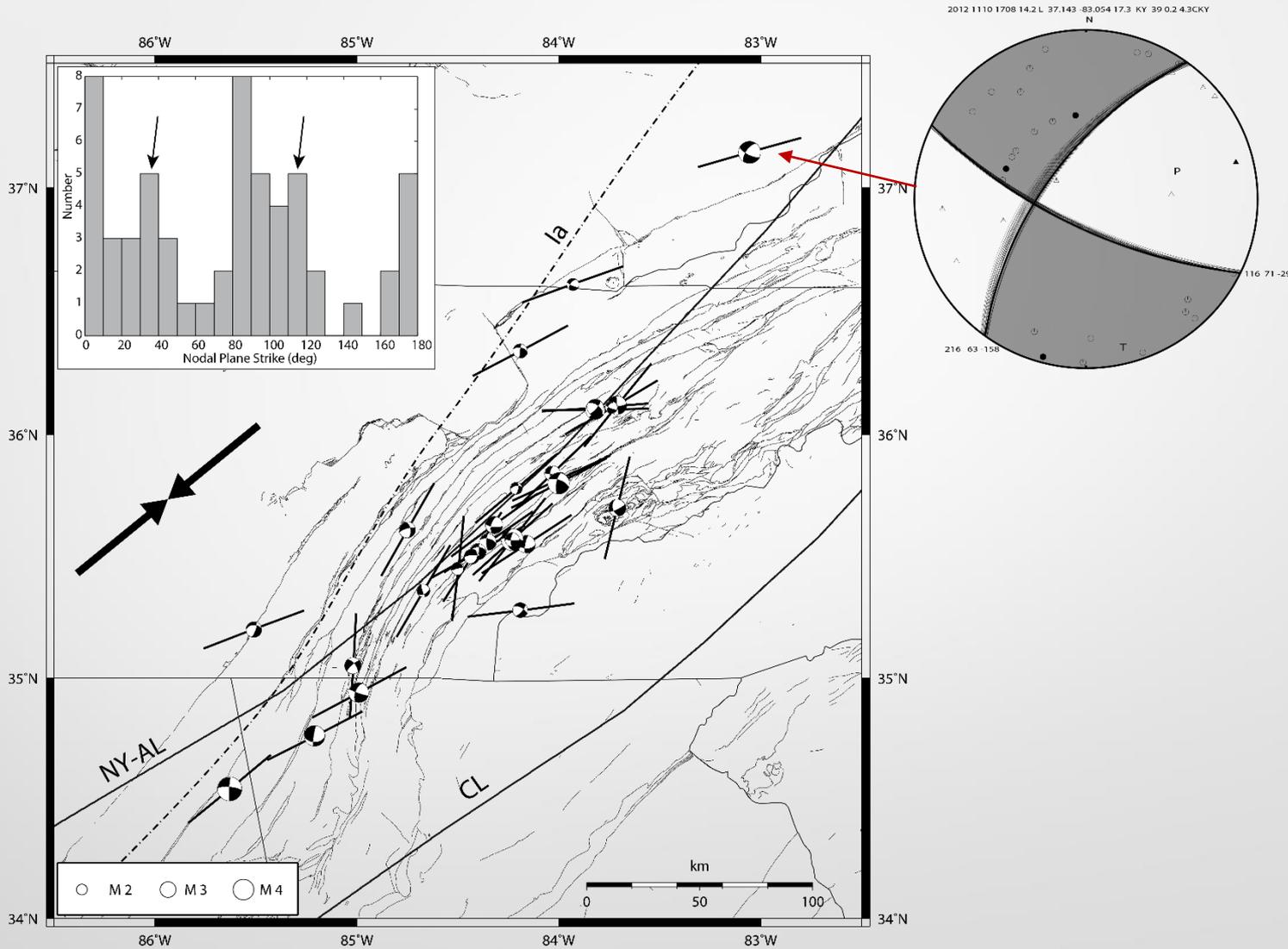


2012 M 4.2



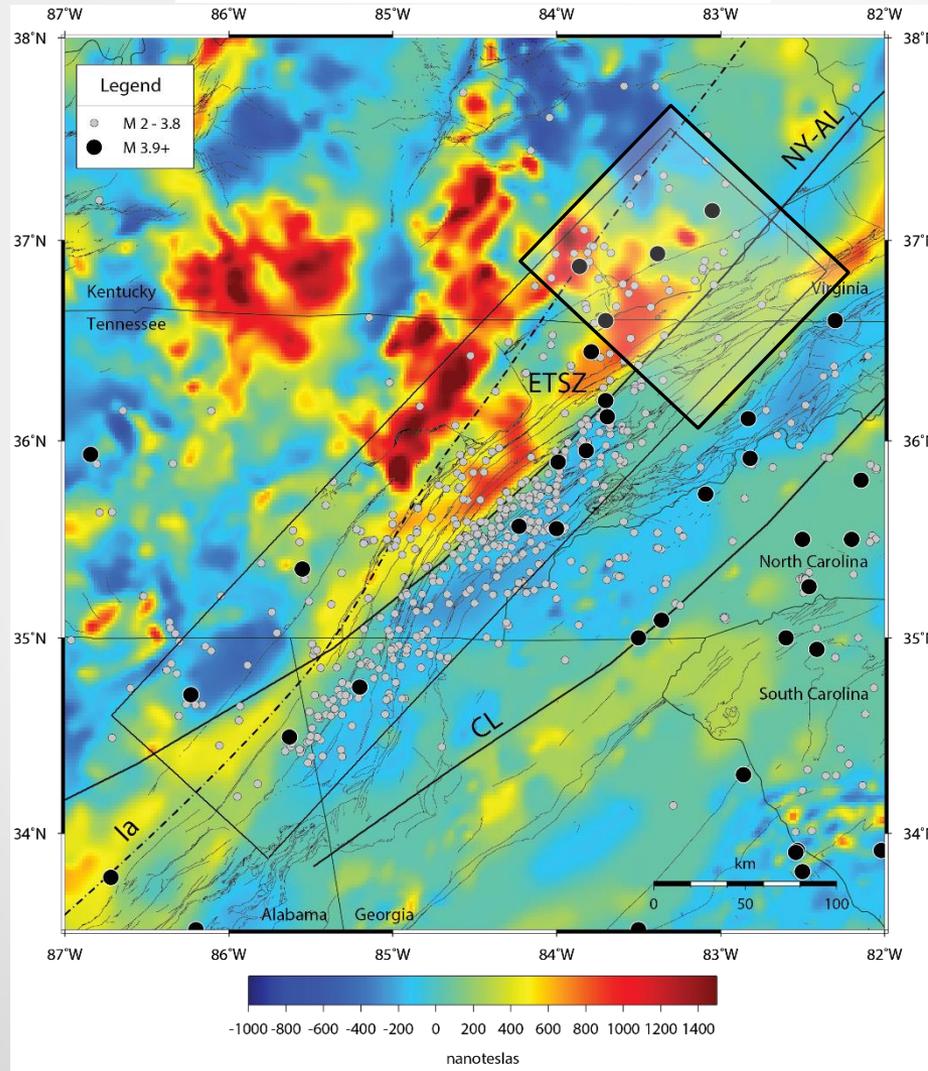
Carpenter et al. (in press)

# Eastern Tennessee Seismic Zone in SE Kentucky



Carpenter et al. (*in press*)

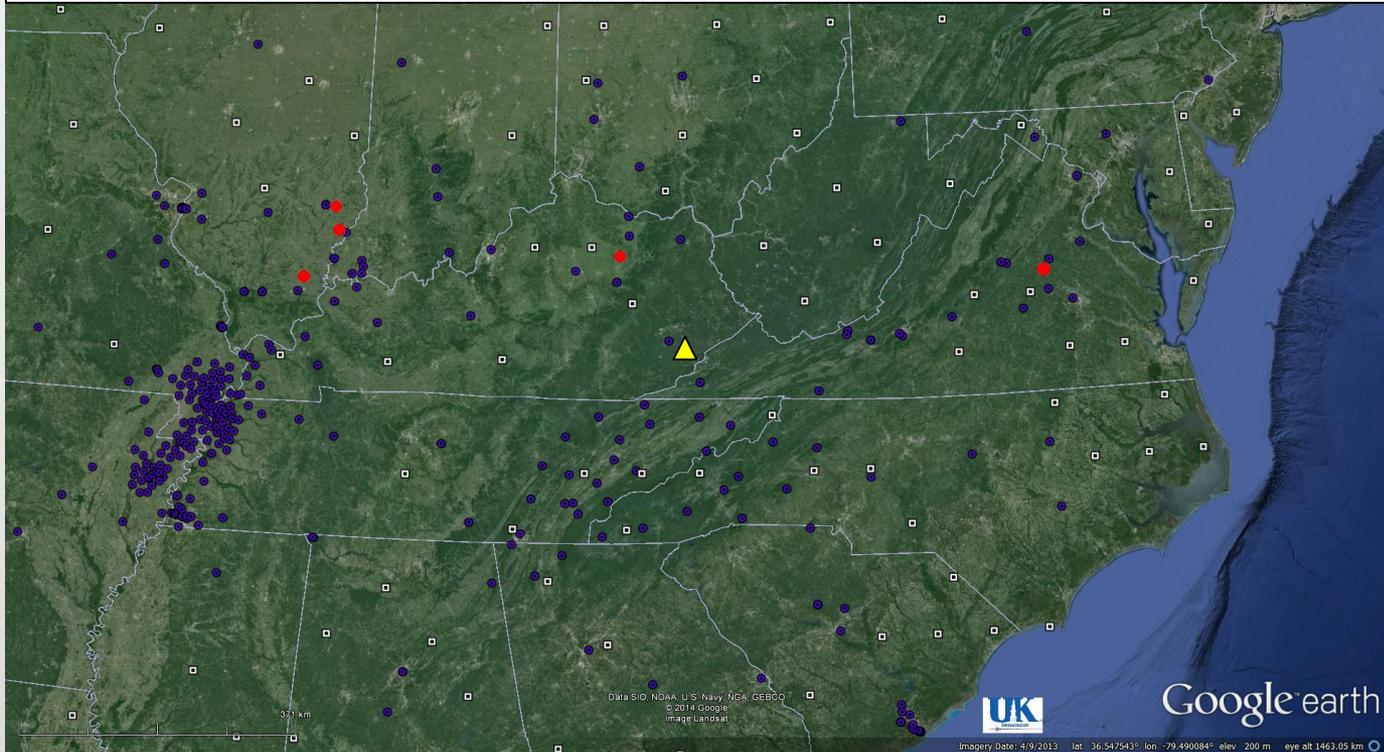
# All Historical $M \geq 3.9$



~25% (4 of 15)  
in SE Kentucky

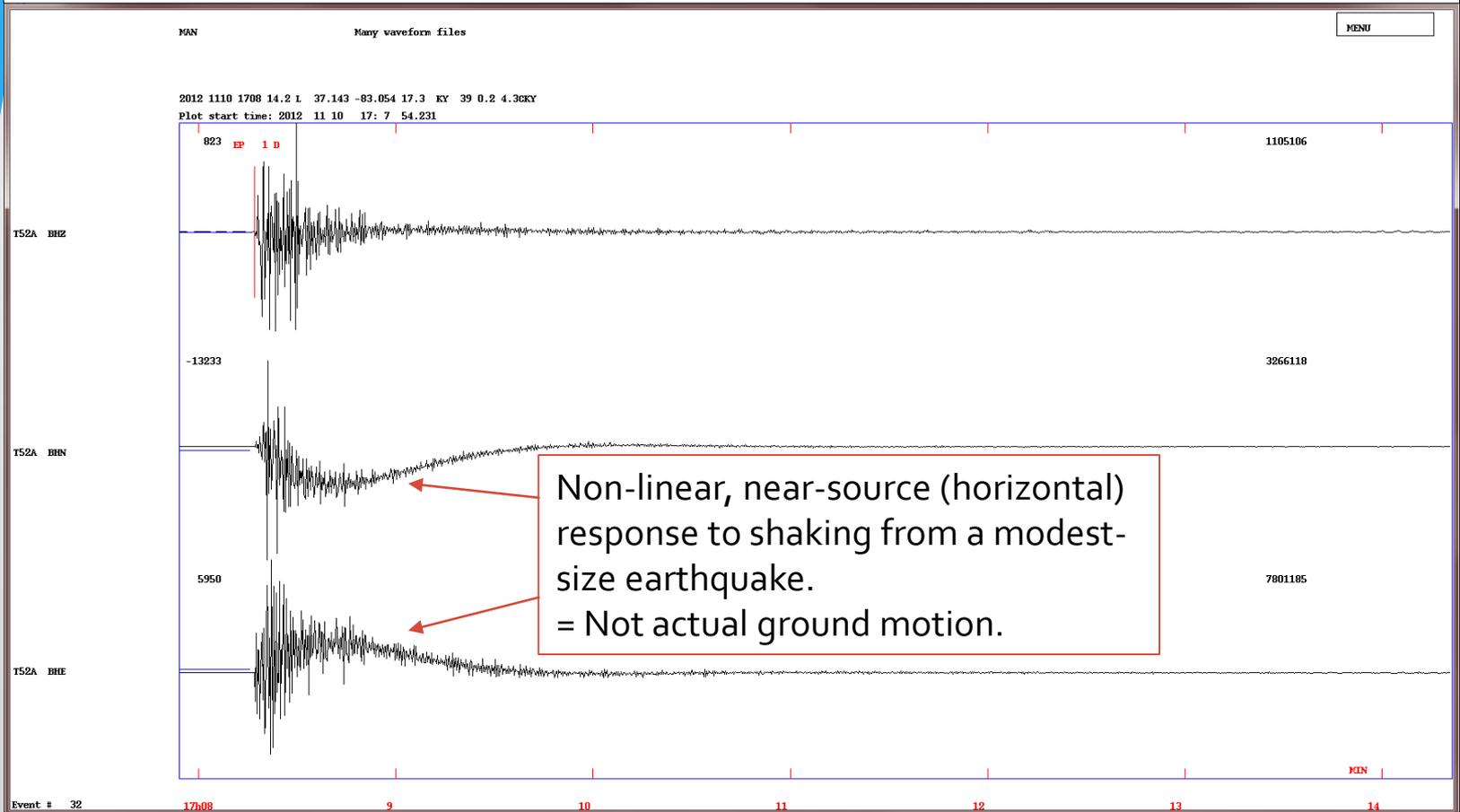
Carpenter et al. (*in press*)

## EarthScope USArray TA Planned Adoption



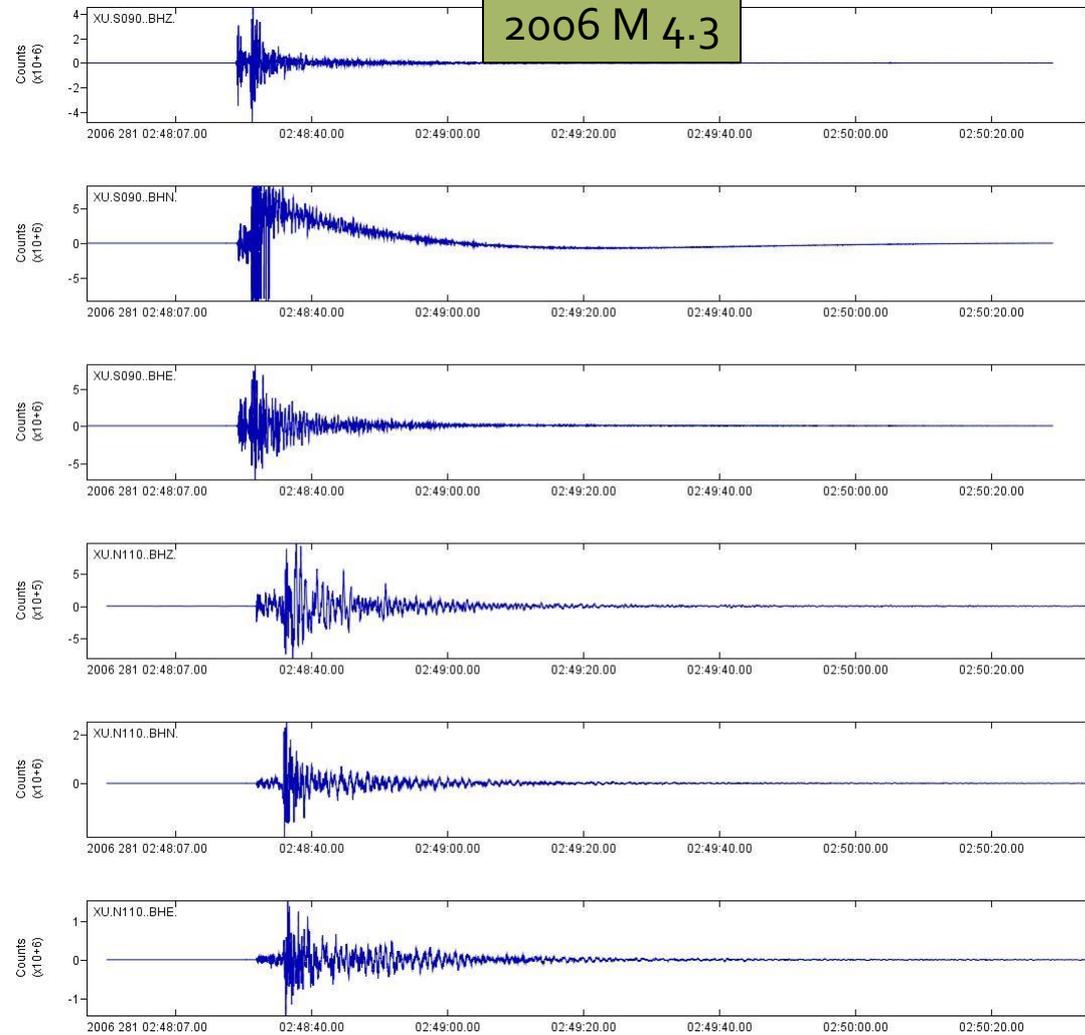
- Good for weak-motion studies
- Limited reliability for near-source and/or strong-motion observations

# TA Station ~19km from source (M 4.2)

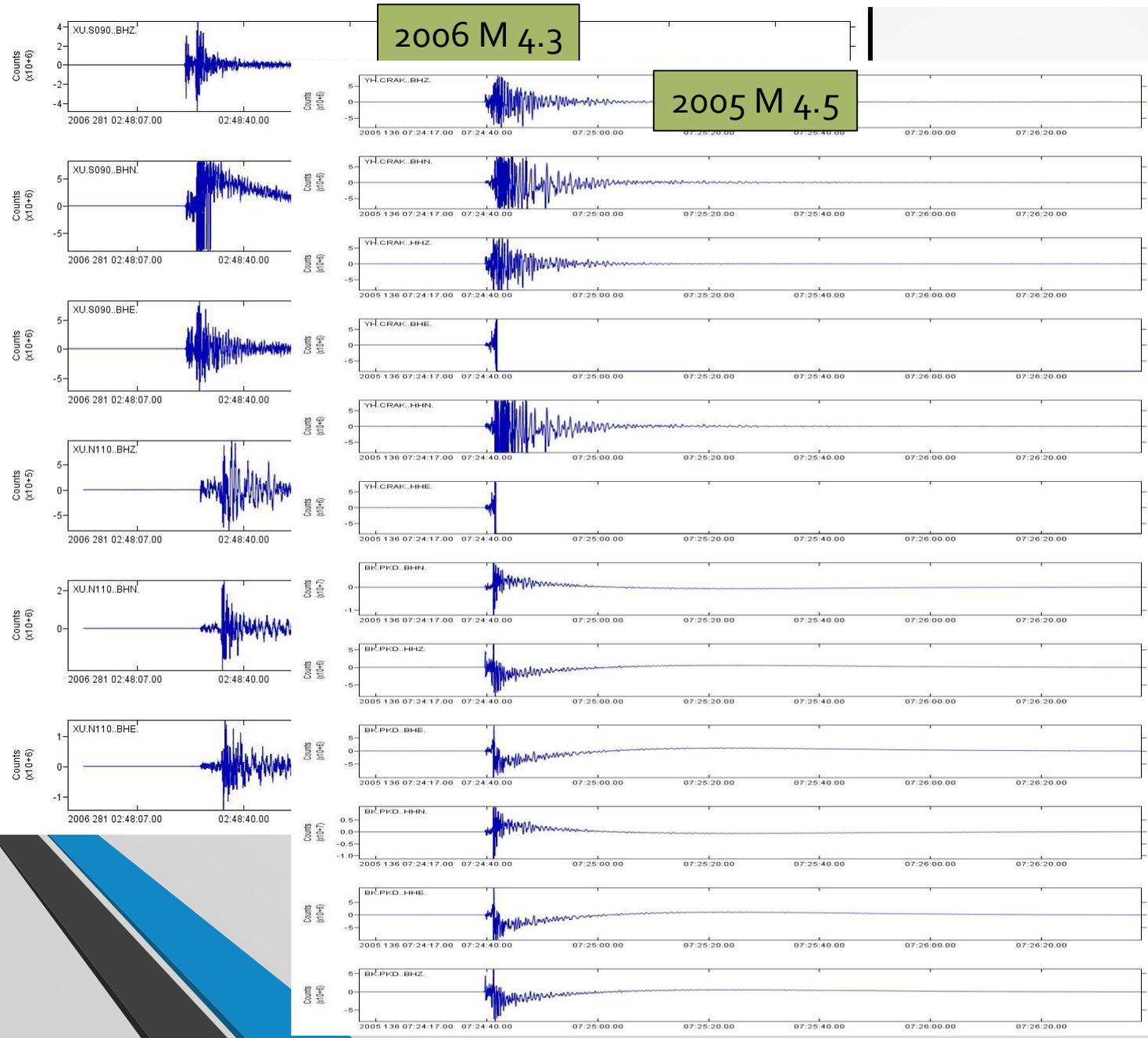


# Near-source Broadbands ( $\Delta \leq 20$ km) Shaken Strongly

2006 M 4.3

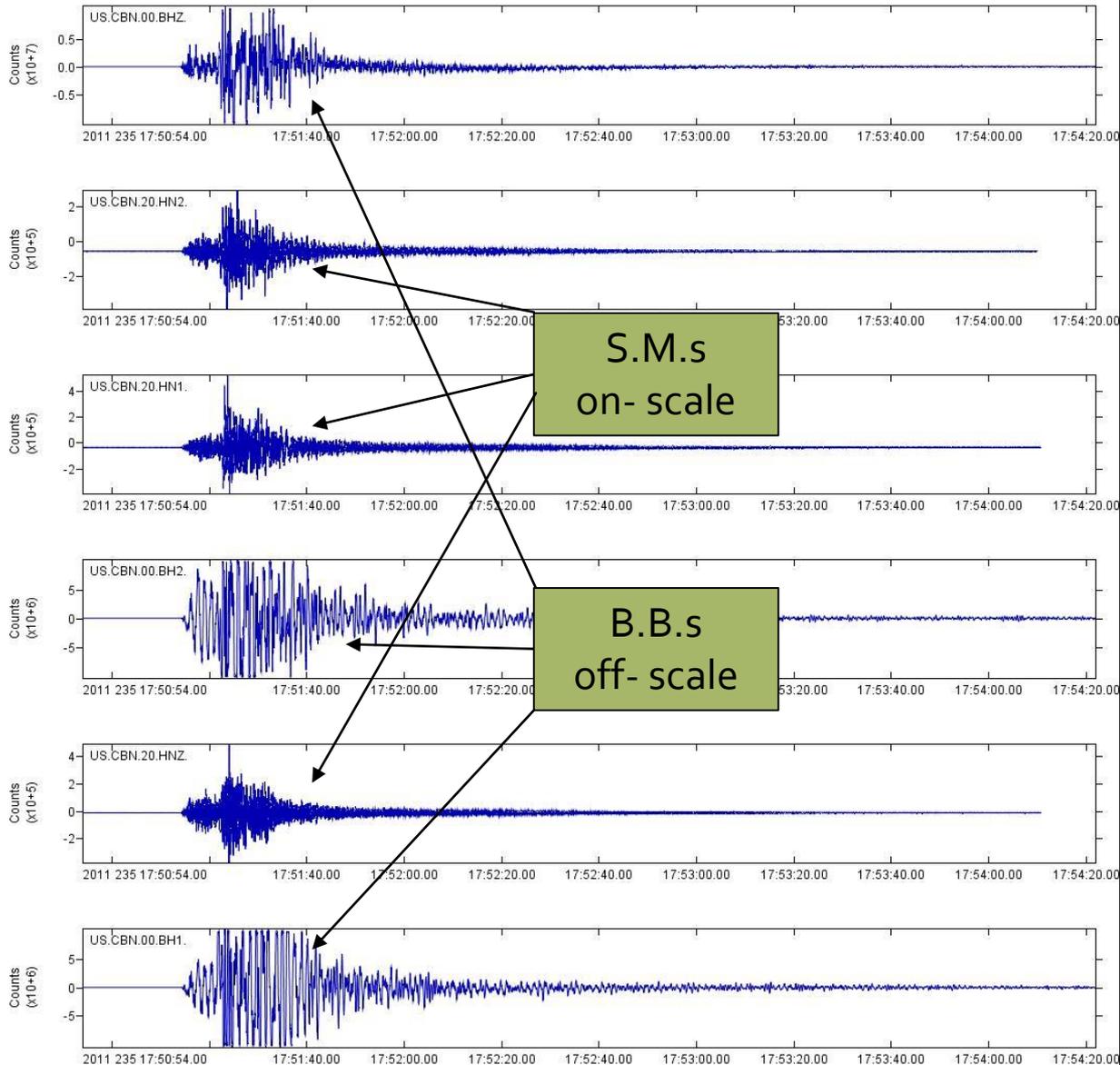


# Near-source Broadbands ( $\Delta \leq 20$ km) Shaken Strongly



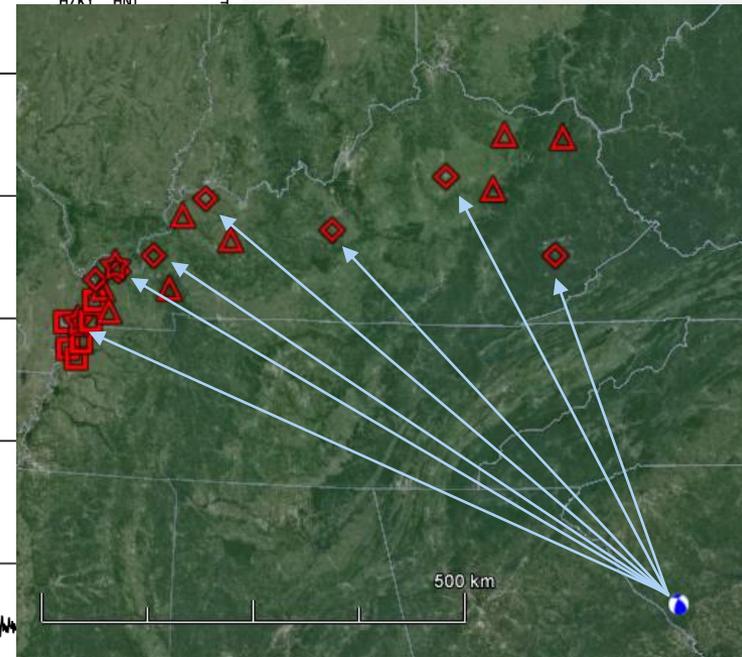
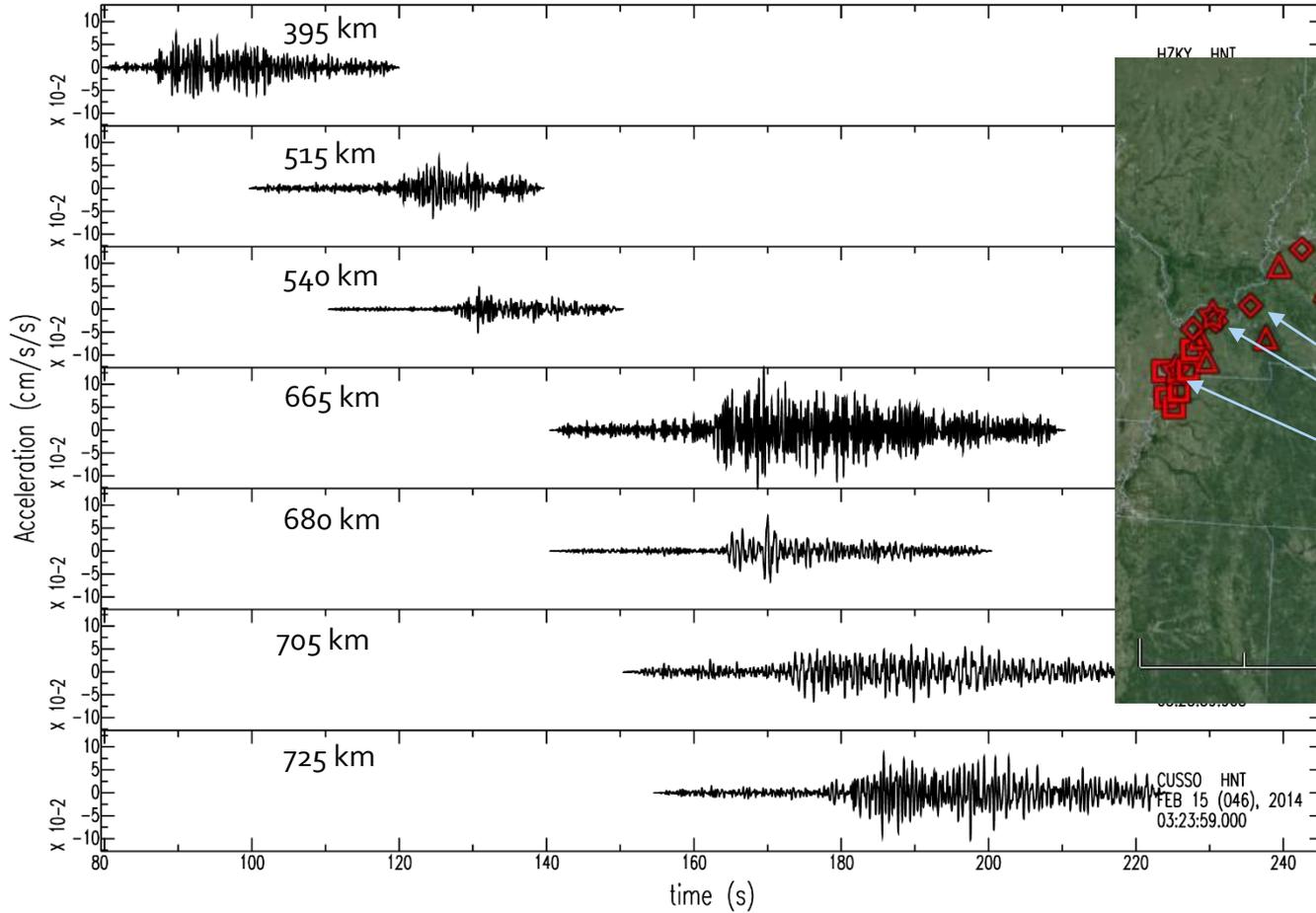


# US Station ~60 km from 2011 Mineral, Va. M 5.7



# KSSMN real-time, strong-motion recordings of the 2014 M 4.1 Edgefield, SC earthquake

2014/02/15 Mw 4.1 Edgefield, SC



# Conclusions

- Recent, large CEUS earthquakes have occurred outside of the 2 major seismic zones: the New Madrid and Summerville (Charleston)
- Because they are rare, we need on-scale recordings of strong CEUS earthquakes for reducing hazard uncertainty.
- The Kentucky Seismic and Strong-Motion Network fills a large monitoring gap in the South-central Appalachians.
- The KSSMN currently records real-time strong motion data, which augments monitoring of the South-central Appalachians, including the northern E. Tenn. Seismic Zone.

