Seismicity and Seismic Hazards in the South-Central Appalachians

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University of Kentucky

Outline

- Current Seismic Monitoring Foci
  - Hazard Map
  - Large, Recent CEUS Seismicity
- Damage in the Kentucky Appalachians from Recent Earthquakes
- Eastern Tennessee Seismic Zone in Kentucky
  - 2012 Perry County, Kentucky M_w 4.2 earthquake
  - > 25% M 3.9+ ETSZ earthquakes in Kentucky
- Kentucky Seismic and Strong Motion Network (KSSMN)
  - Filling a South-central Appalachian monitoring void
  - Recent expansion and upgrades
- Importance of Strong-motion Stations
  - USArray TA station adoption
  - Potential problems with broadband seismographs
- KSSMN recordings of Recent M > 4 Earthquakes
- Conclusion

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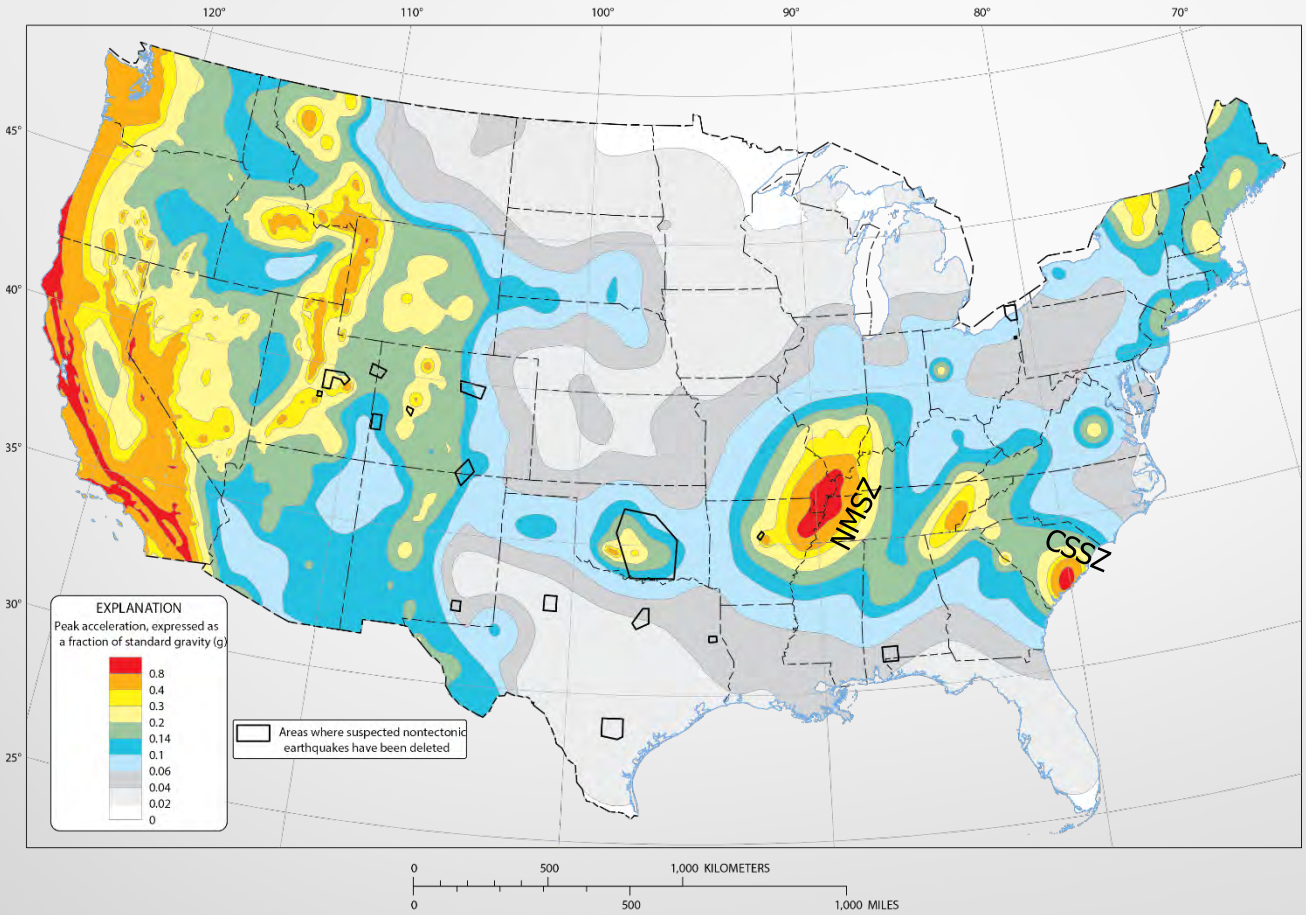
USGS Hazard Map
2014 2% in 50 years PGA



Two-percent probability of exceedance in 50 years map of peak ground acceleration

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Eqs: 50 Years M ≥ 5.0

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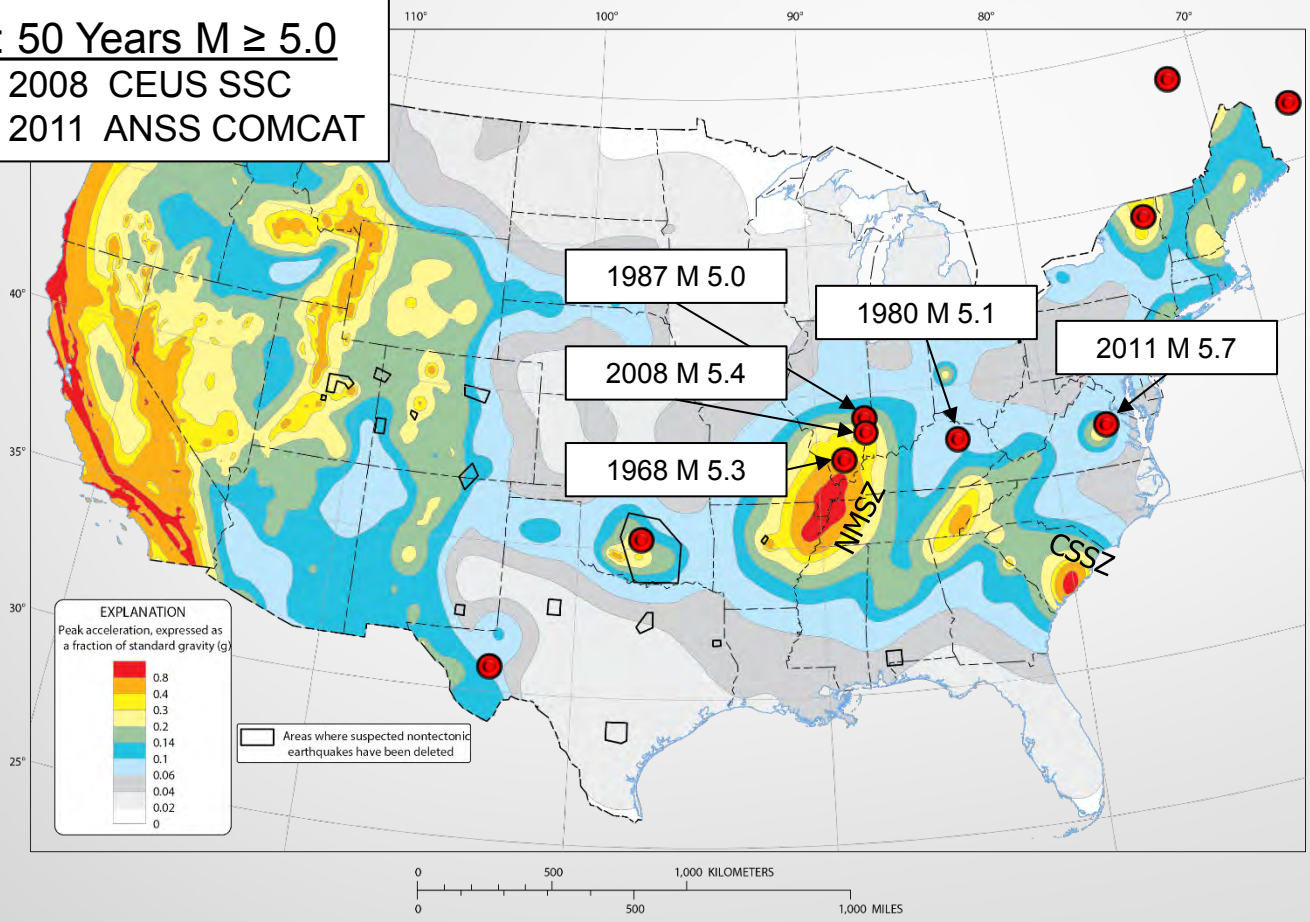

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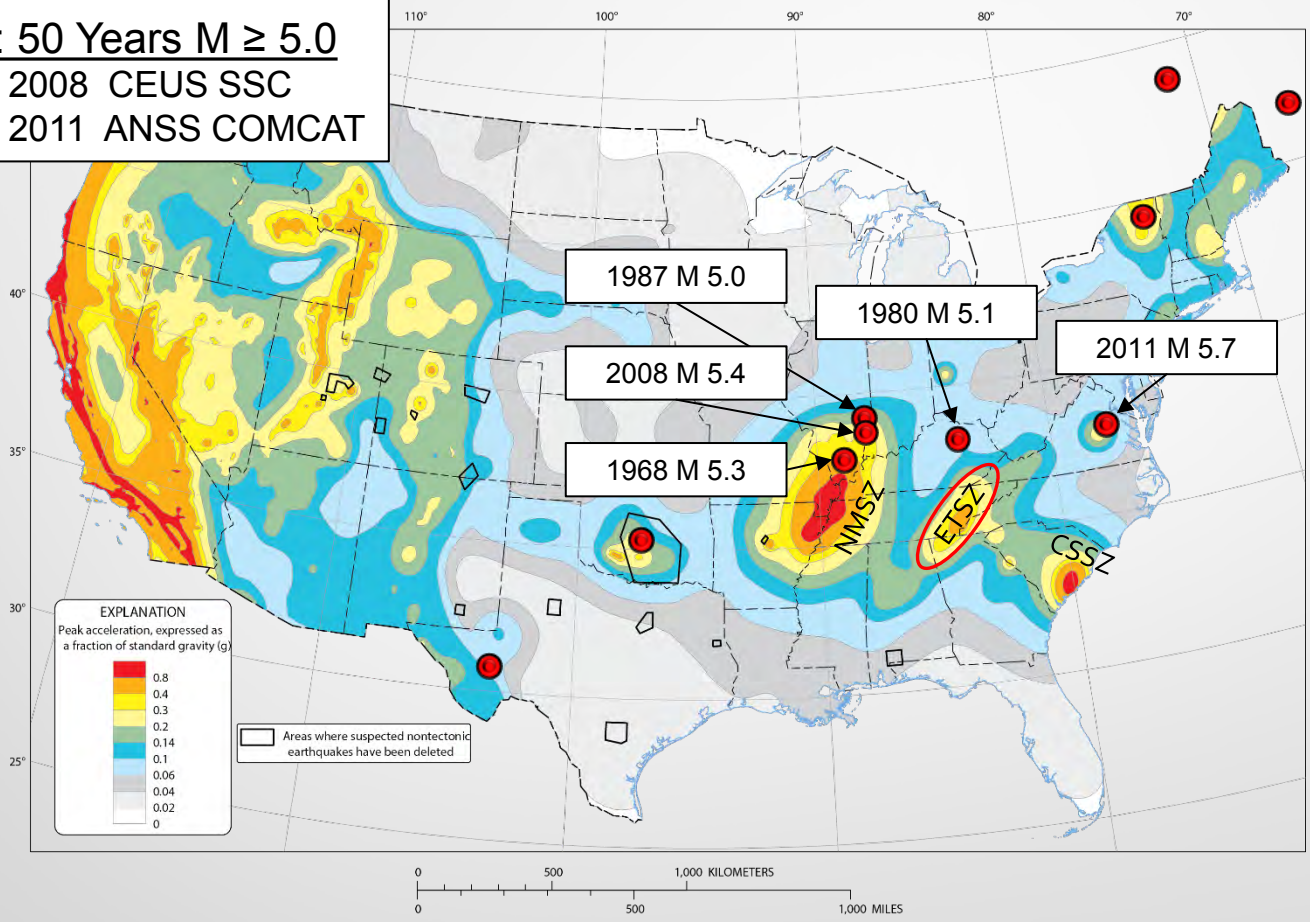

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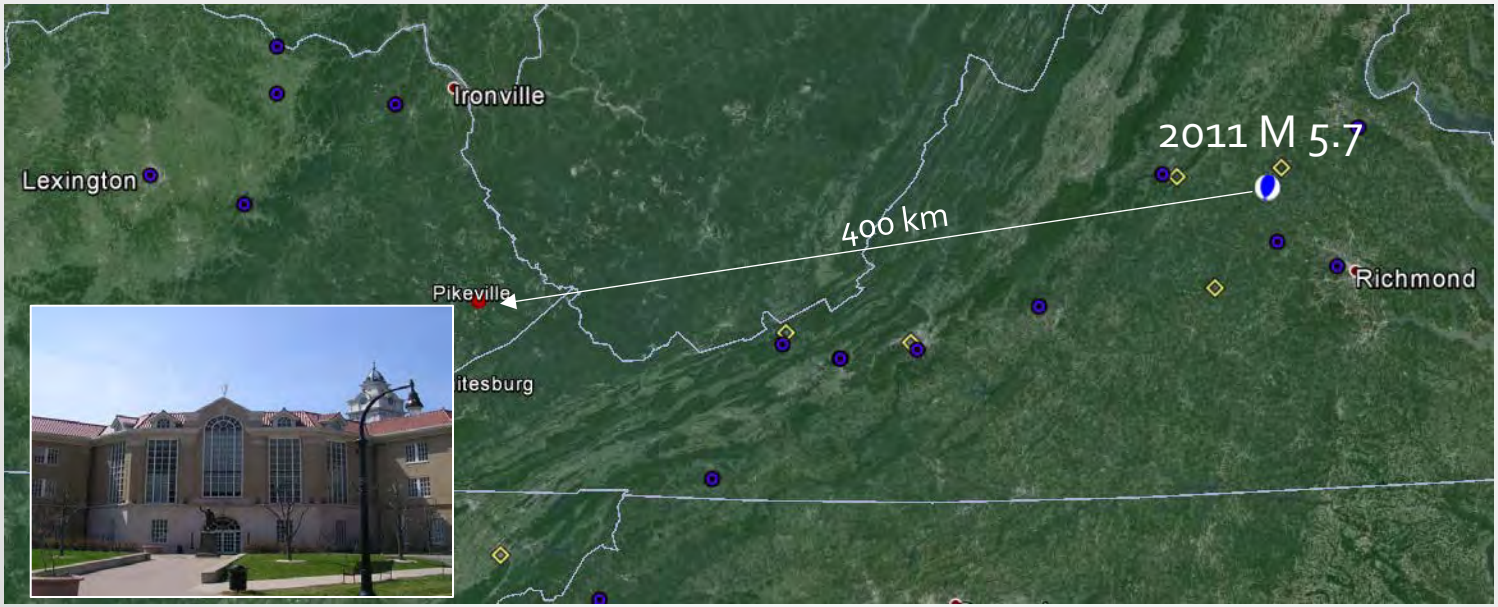
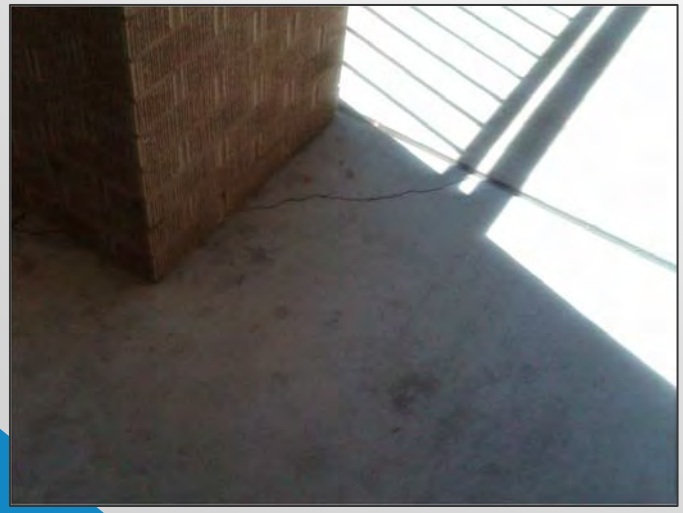
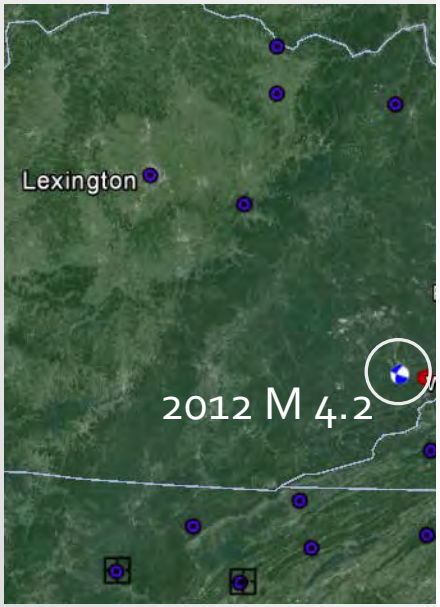
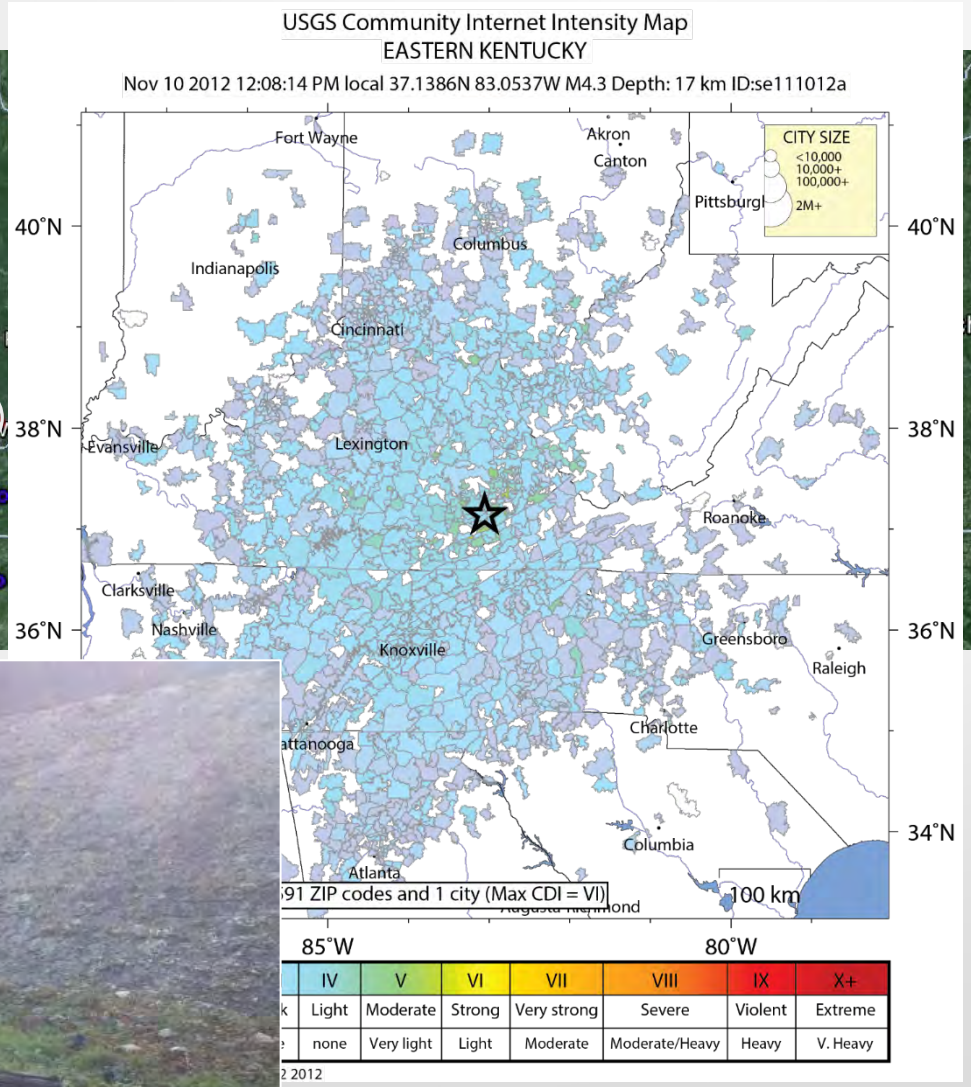
Damage in the Appalachians of Kentucky from Recent Earthquakes





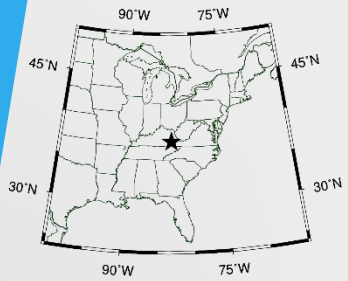
Recent Southern-Appalachian Earthquakes

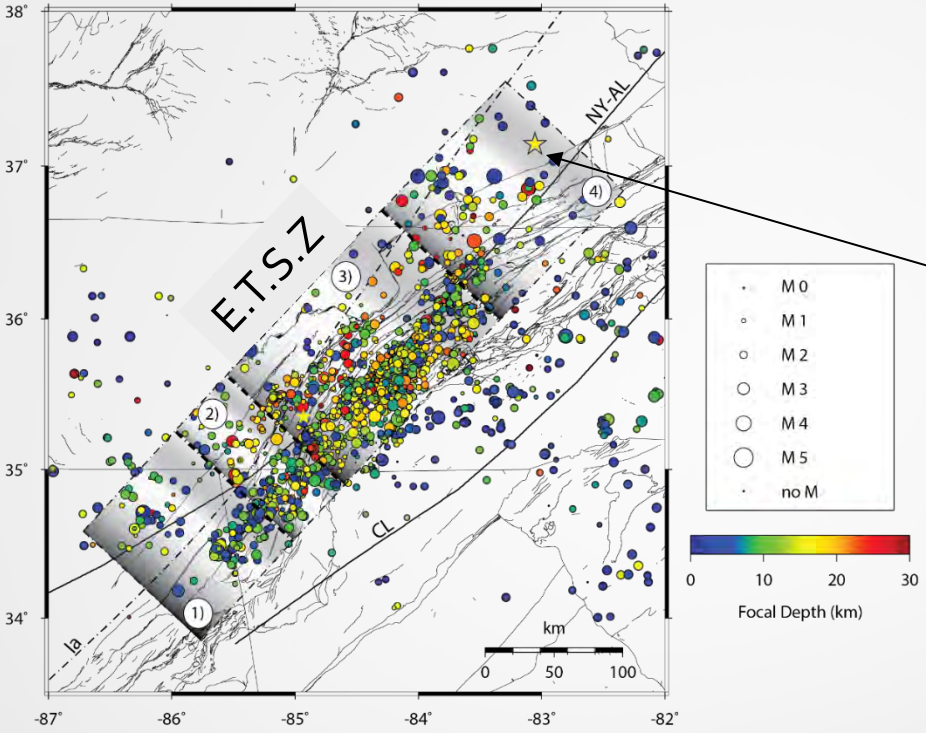




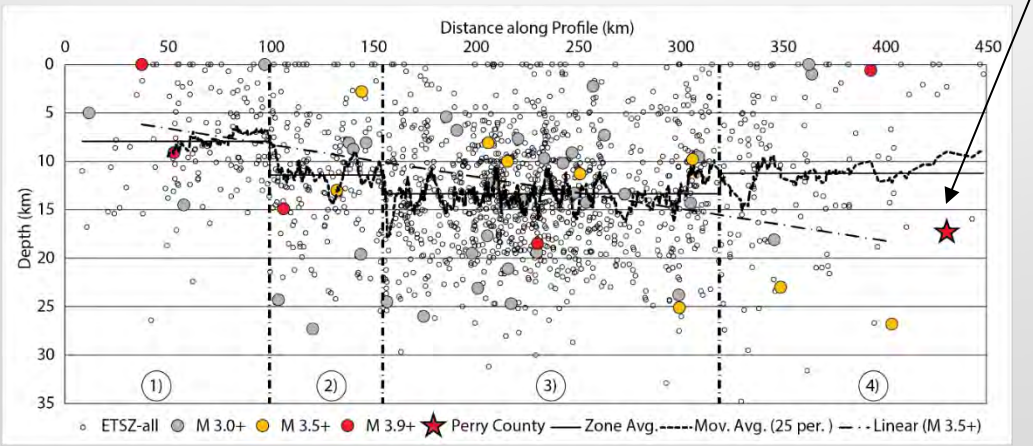
http://www.wkyt.com/wymt/home/headlines/Dam-in-Jenkins-inspected-after-earthquake-179370221.html

Eastern Tennessee Seismic Zone in SE Kentucky





2012 M 4.2



Carpenter et al., 2014

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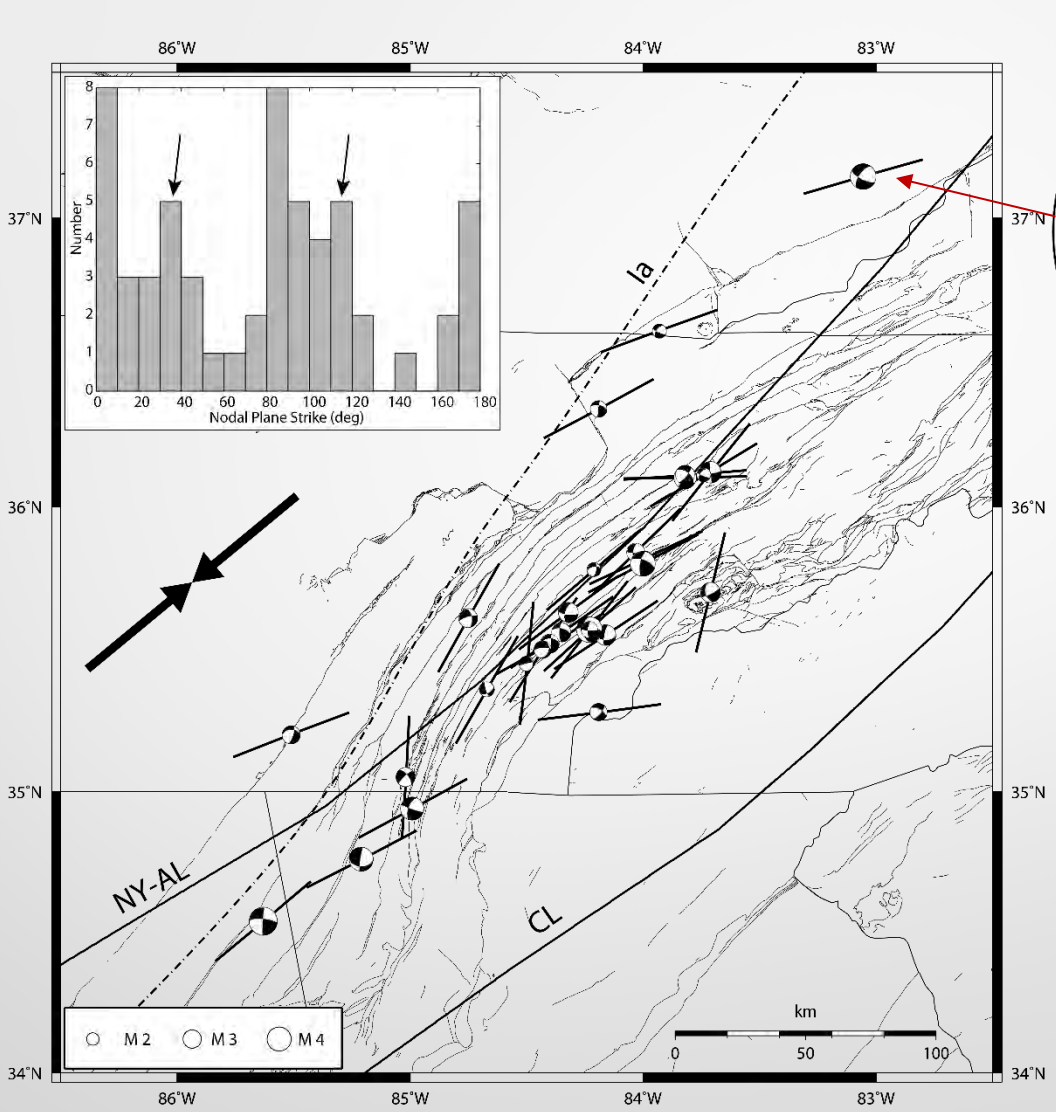
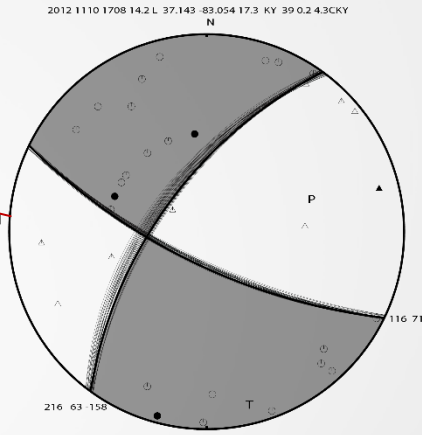
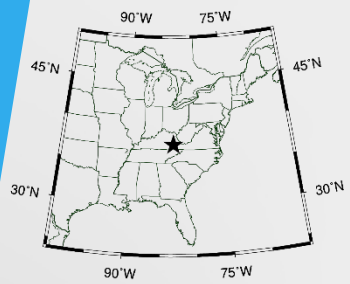
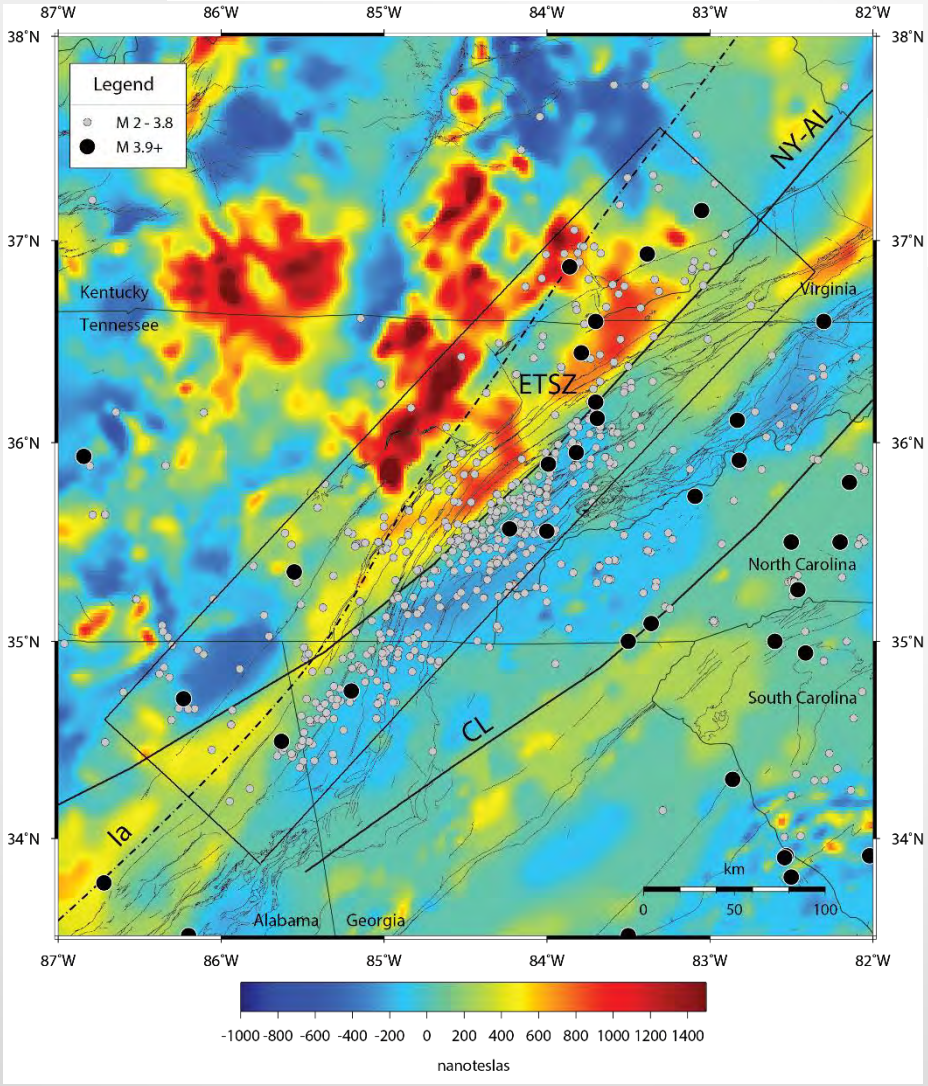




Carpenter et al., 2014

All Historical M ≥ 3.9





~25% (4 of 15) in SE Kentucky

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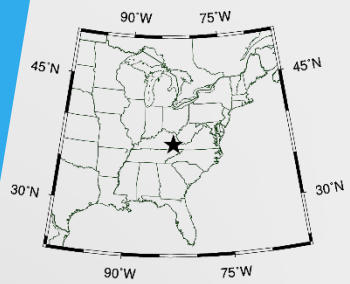

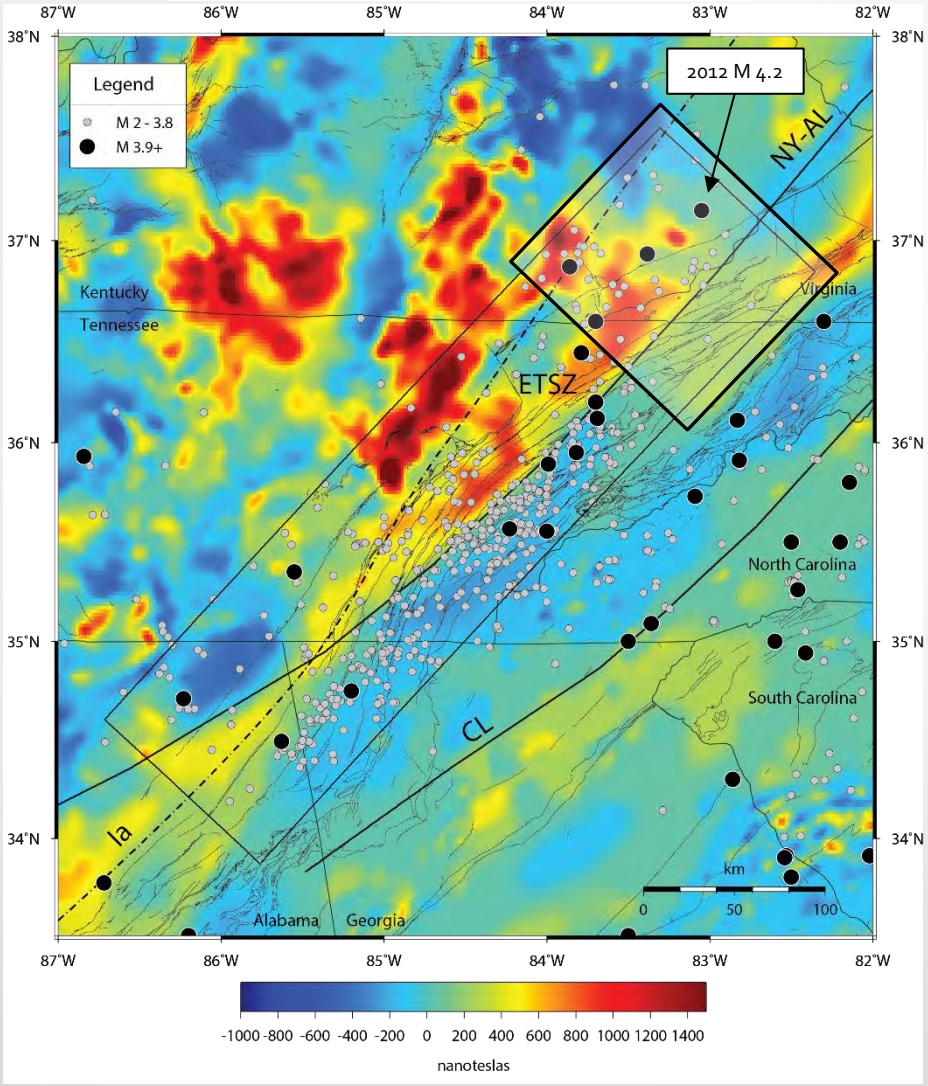

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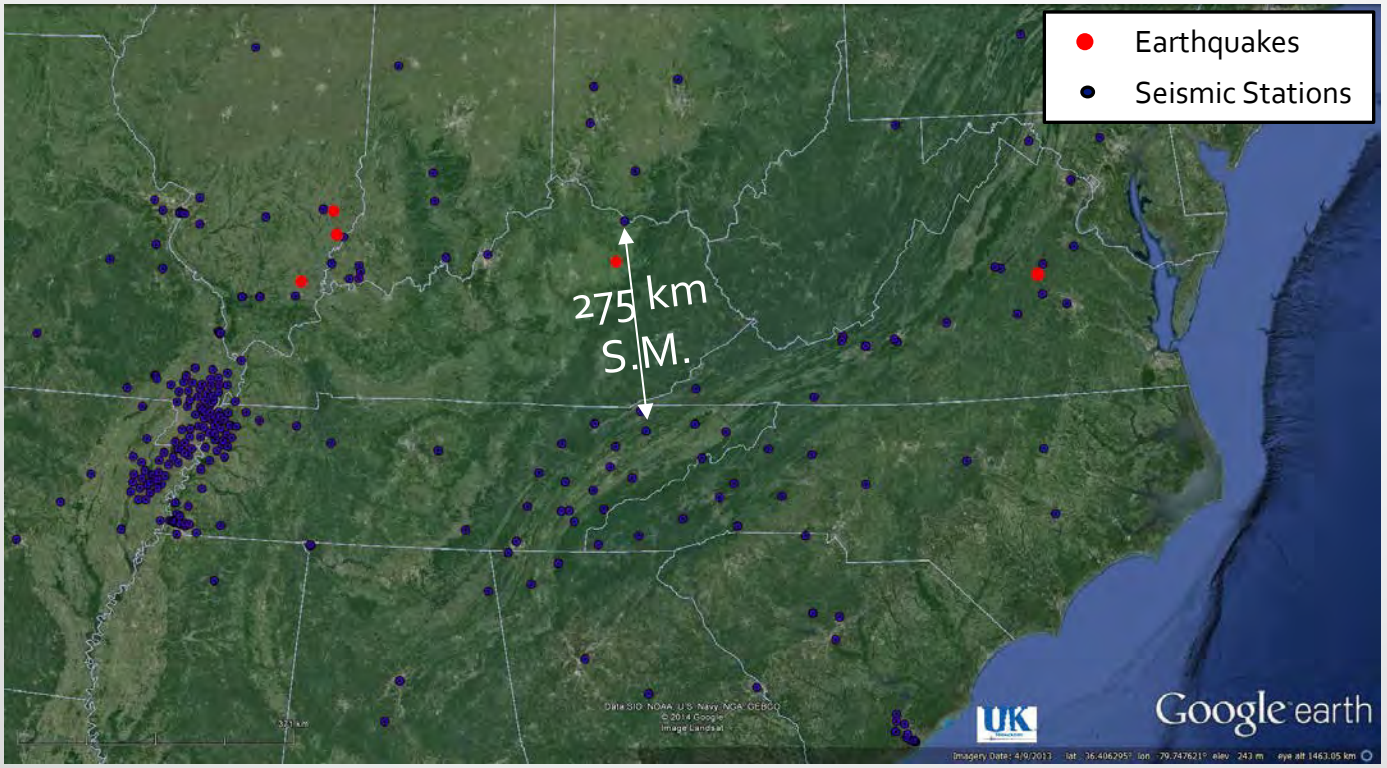
Kentucky Seismic and Strong-Motion Network

KSSMN fills an important, unmonitored area.



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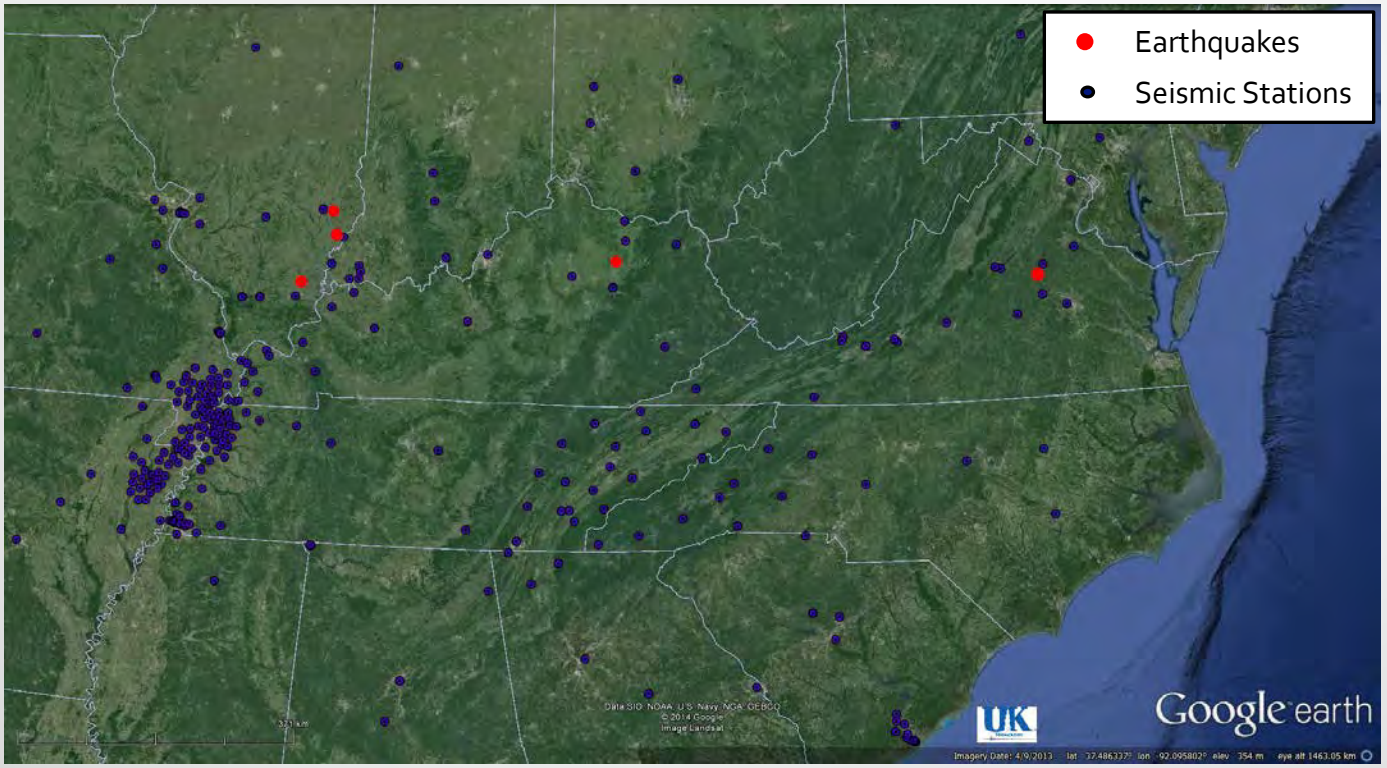

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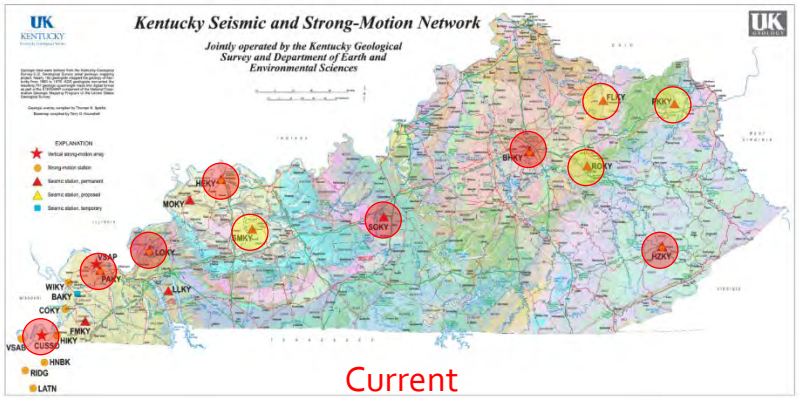
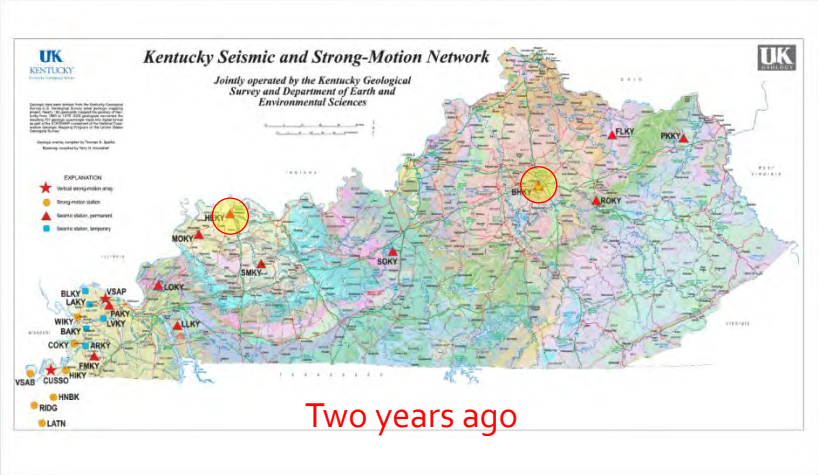
Kentucky Seismic and Strong-Motion Network

KSSMN Expansion and Upgrades



Current

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



Two years ago

Kentucky Seismic and Strong-Motion Network

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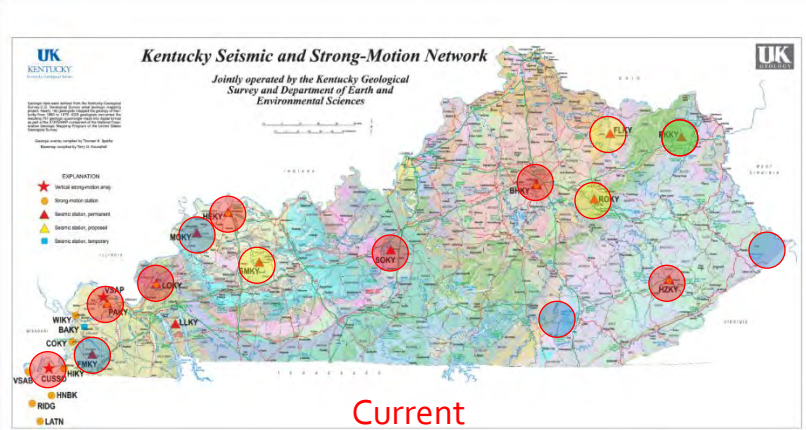
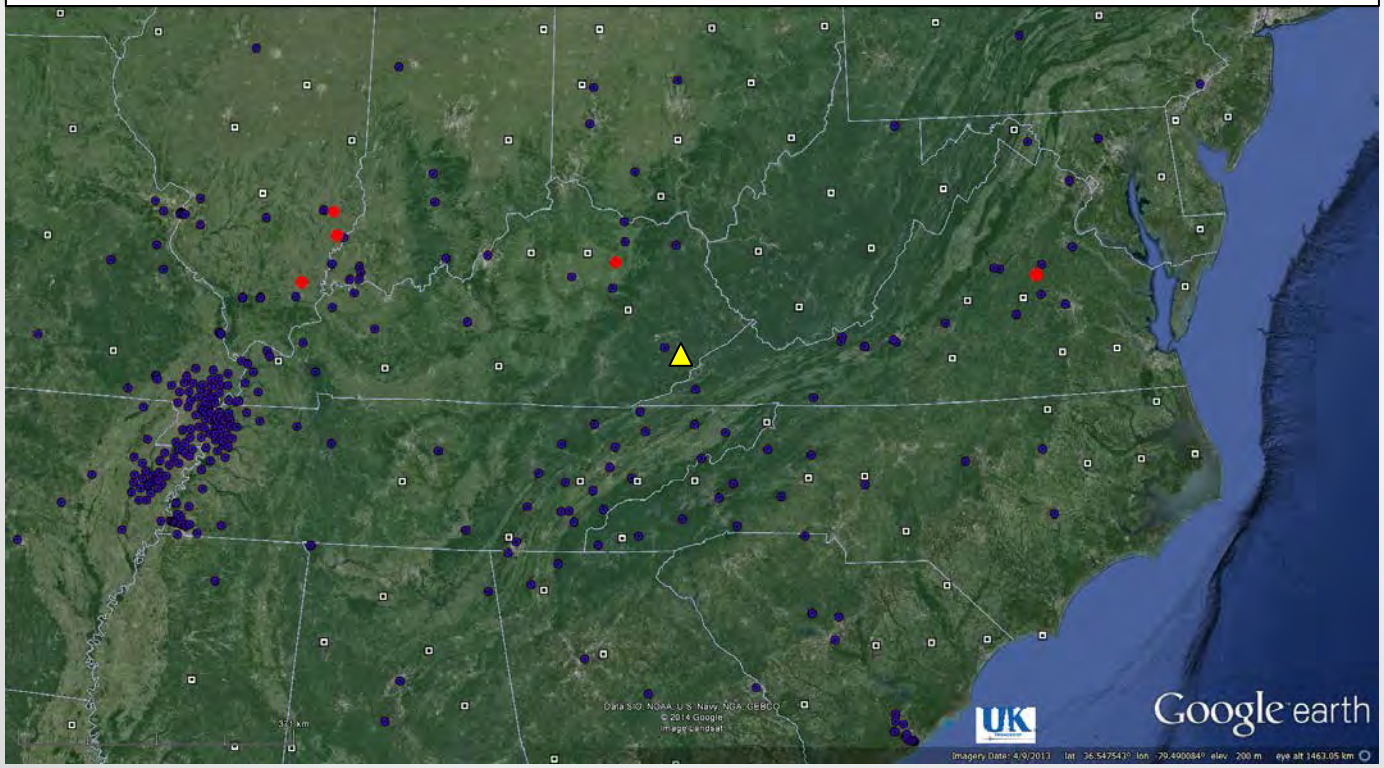


Current

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

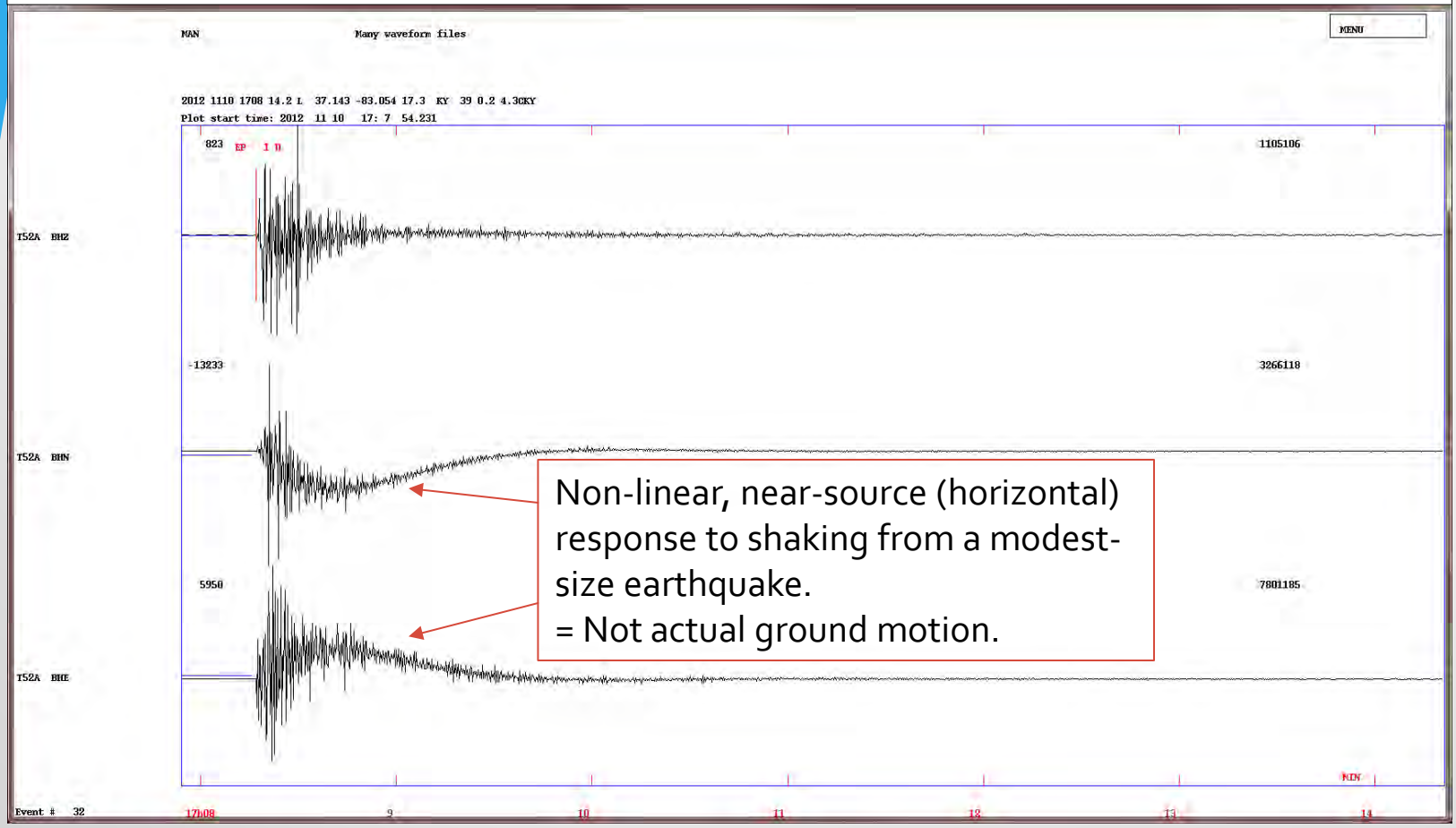
- 23 Stations - 14 Real-time
  - Data shares with CERI
  - Data to IRIS
- 7 Real-time strong-motion stations
- 1 New seismic/strong-motion station in northern ETSZ
- Record ~90 seismic events / day (almost entirely blasts)

EarthScope USArray TA Planned Adoption

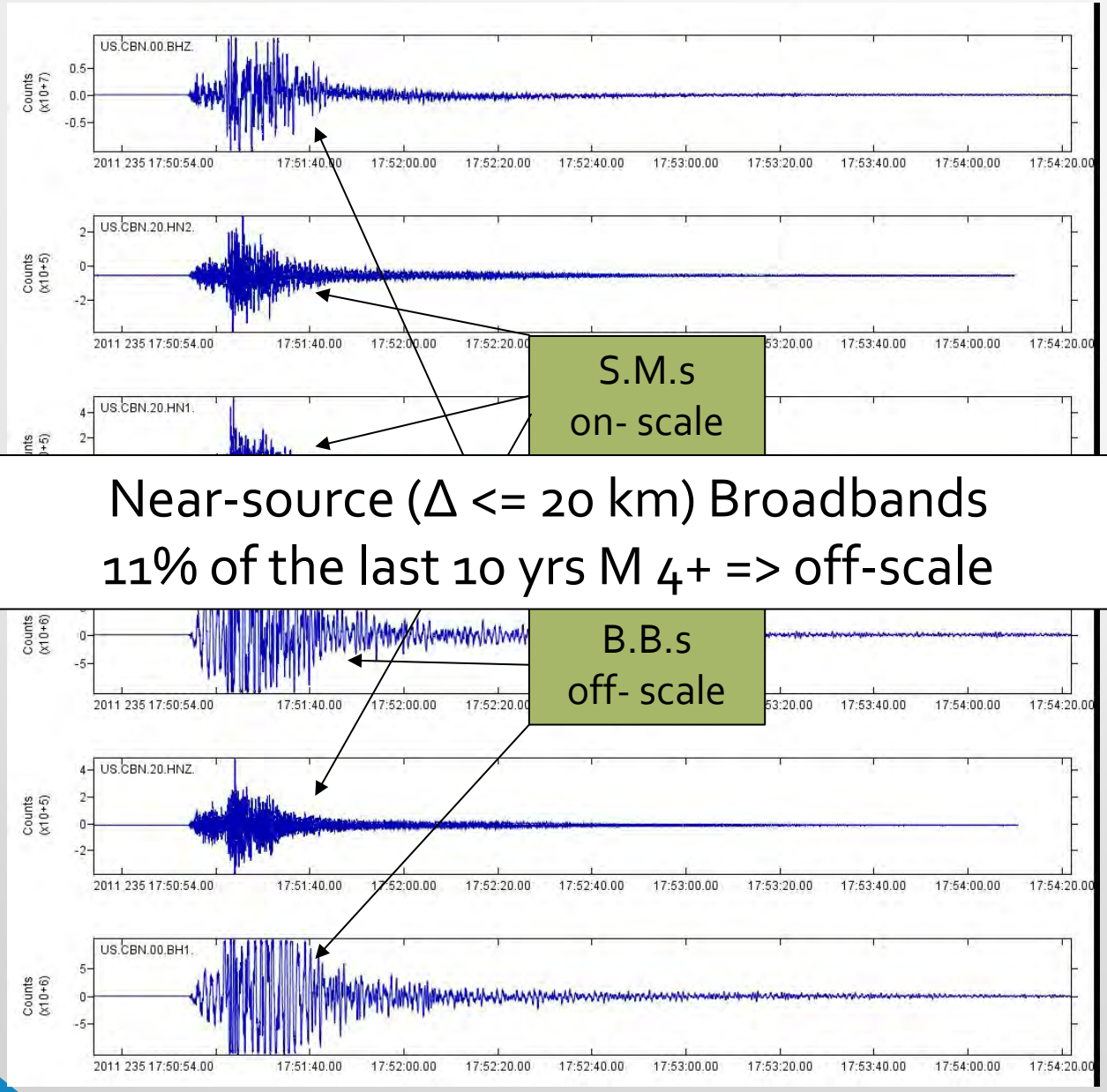


- Good for weak-motion studies
- Limited reliability for near-source and/or strong-motion observations

TA Station ~19km from source (M 4.2)



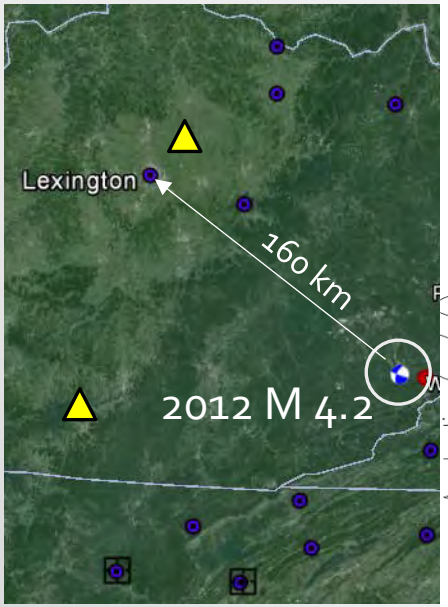
US Station ~60 km from 2011 Mineral, Va. M 5.7

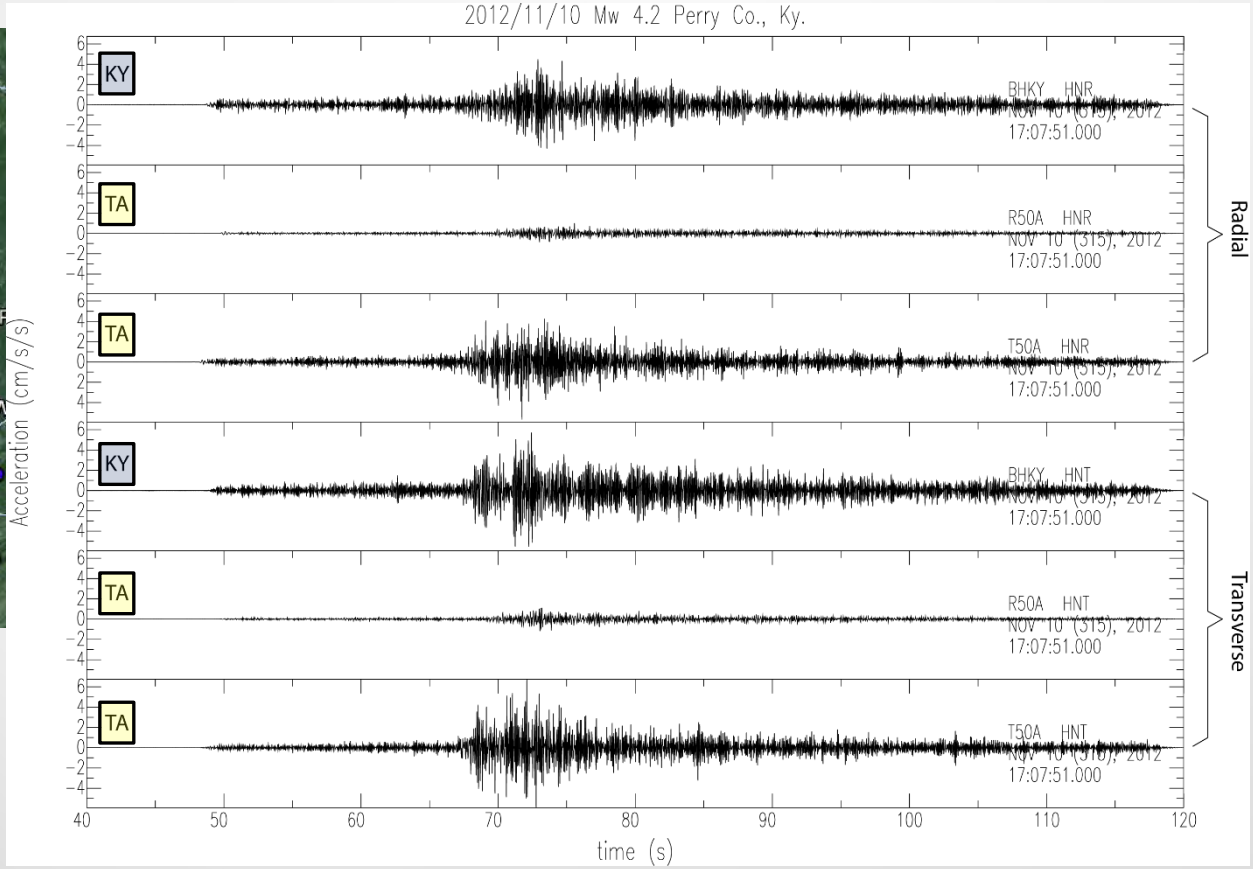


Near-source (Δ <= 20 km) Broadbands
11% of the last 10 yrs M 4+ => off-scale

KSSMN Real-time strong-motion recordings

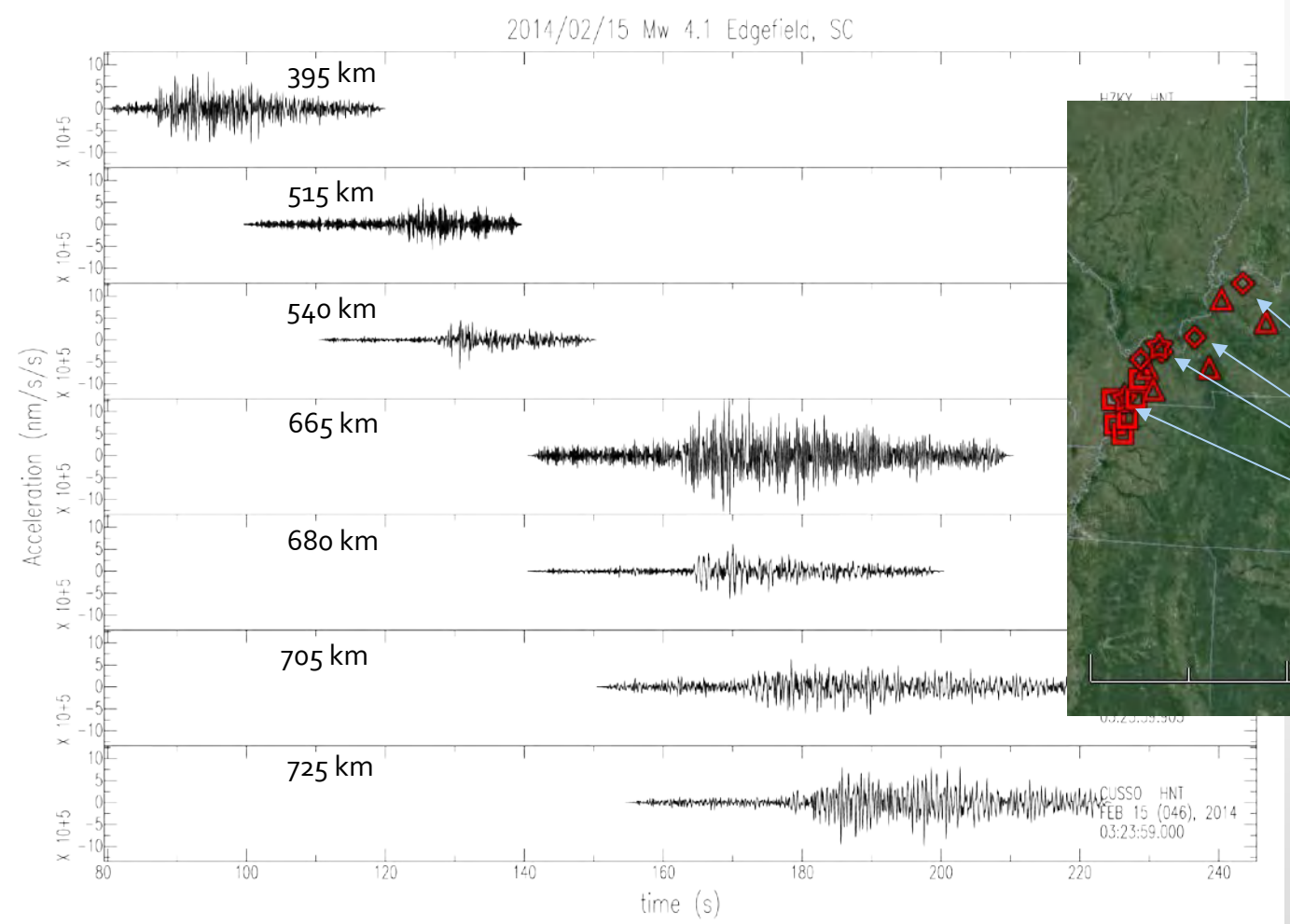
2012 M 4.2 Perry County, KY earthquake

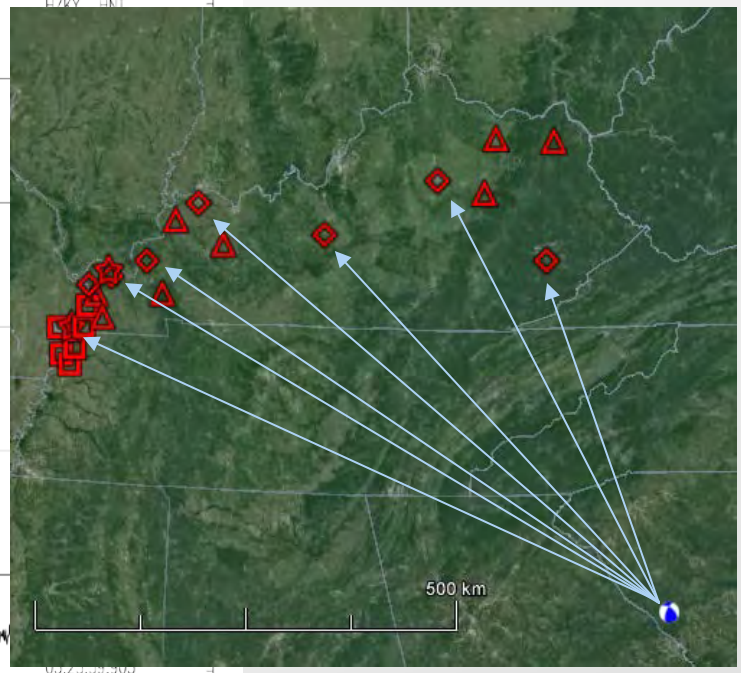




KSSMN Real-time strong-motion recordings

2014 M 4.1 Edgefield, SC earthquake





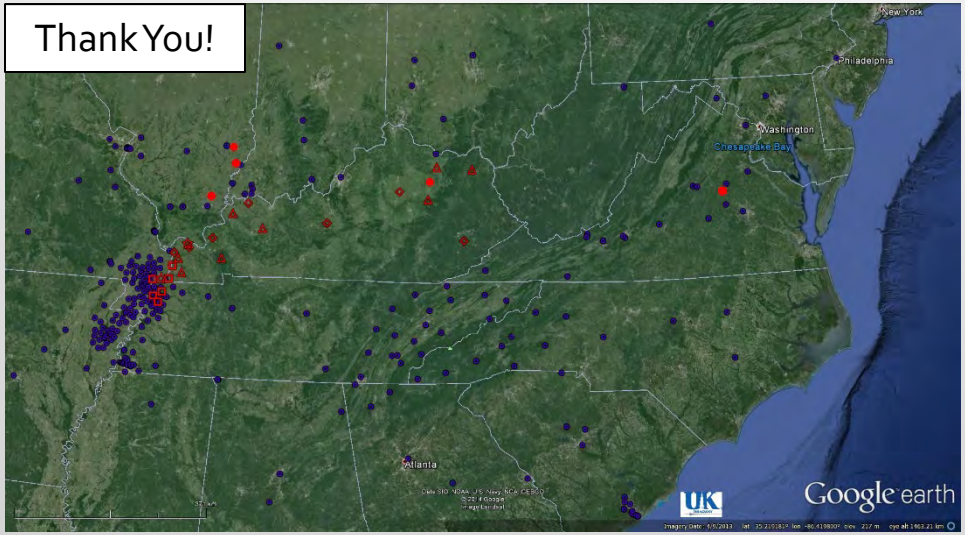
Summary

- 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.



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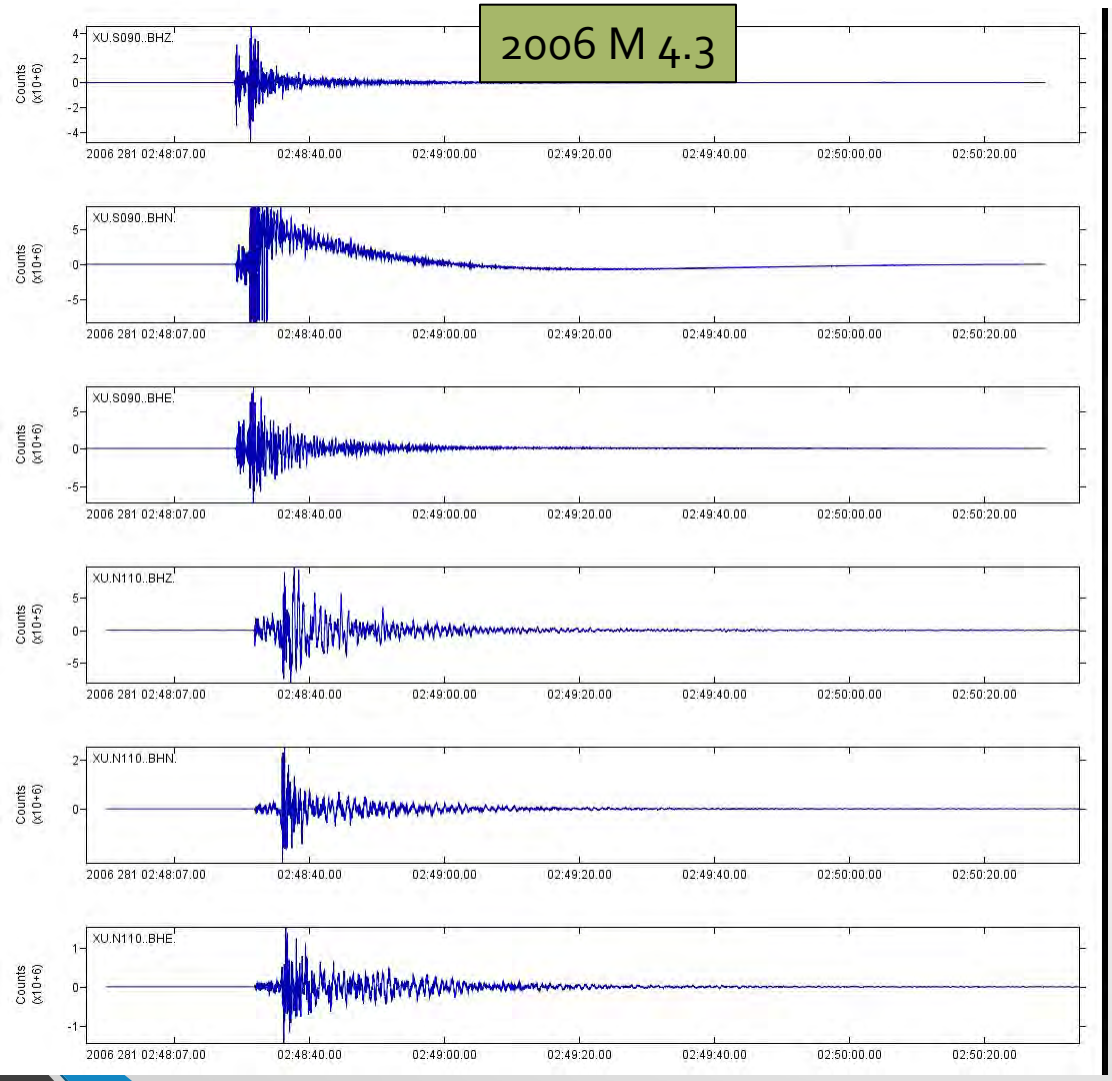
Near-source Broadbands (Δ <= 20 km) Shaken Strongly



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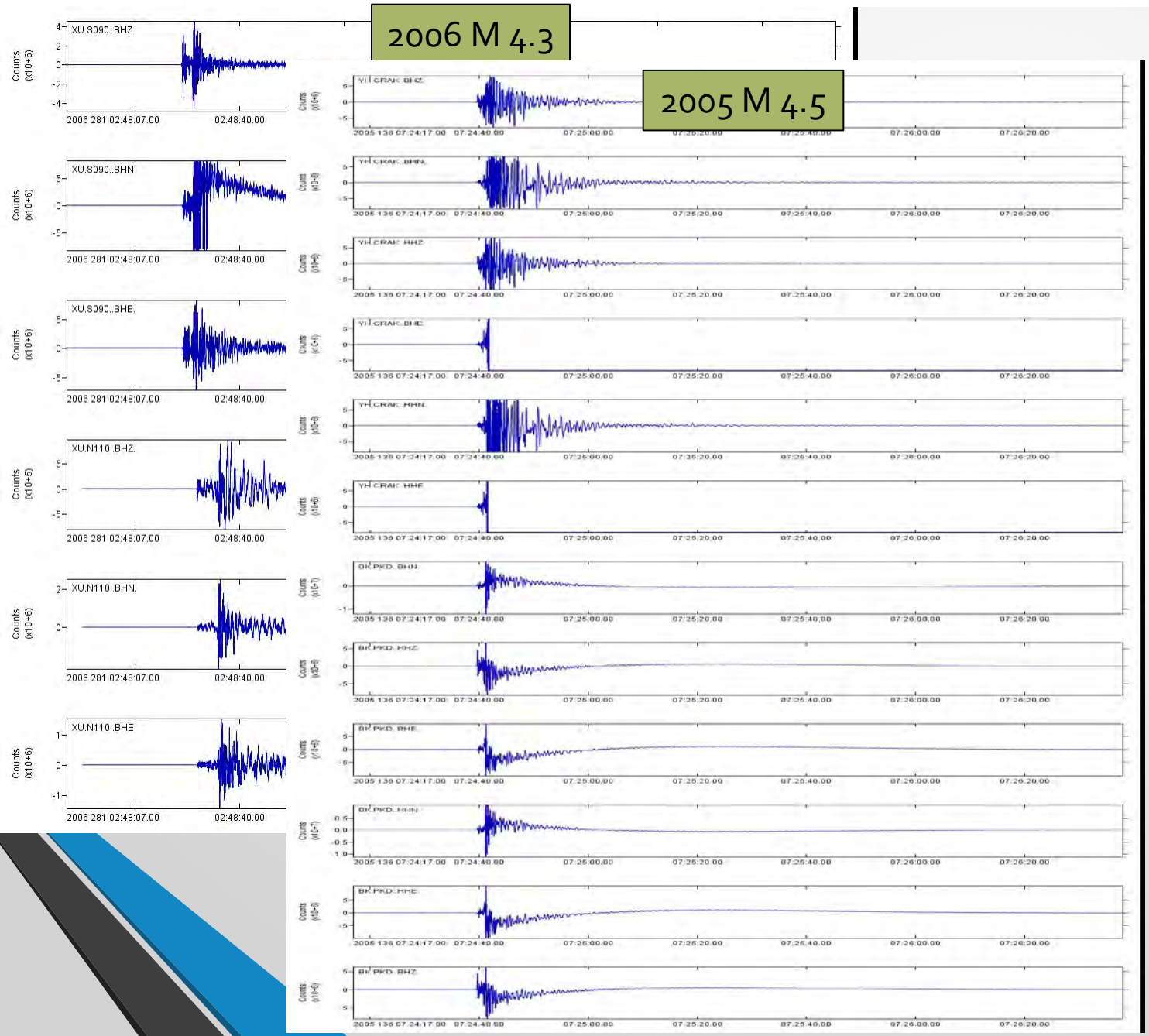

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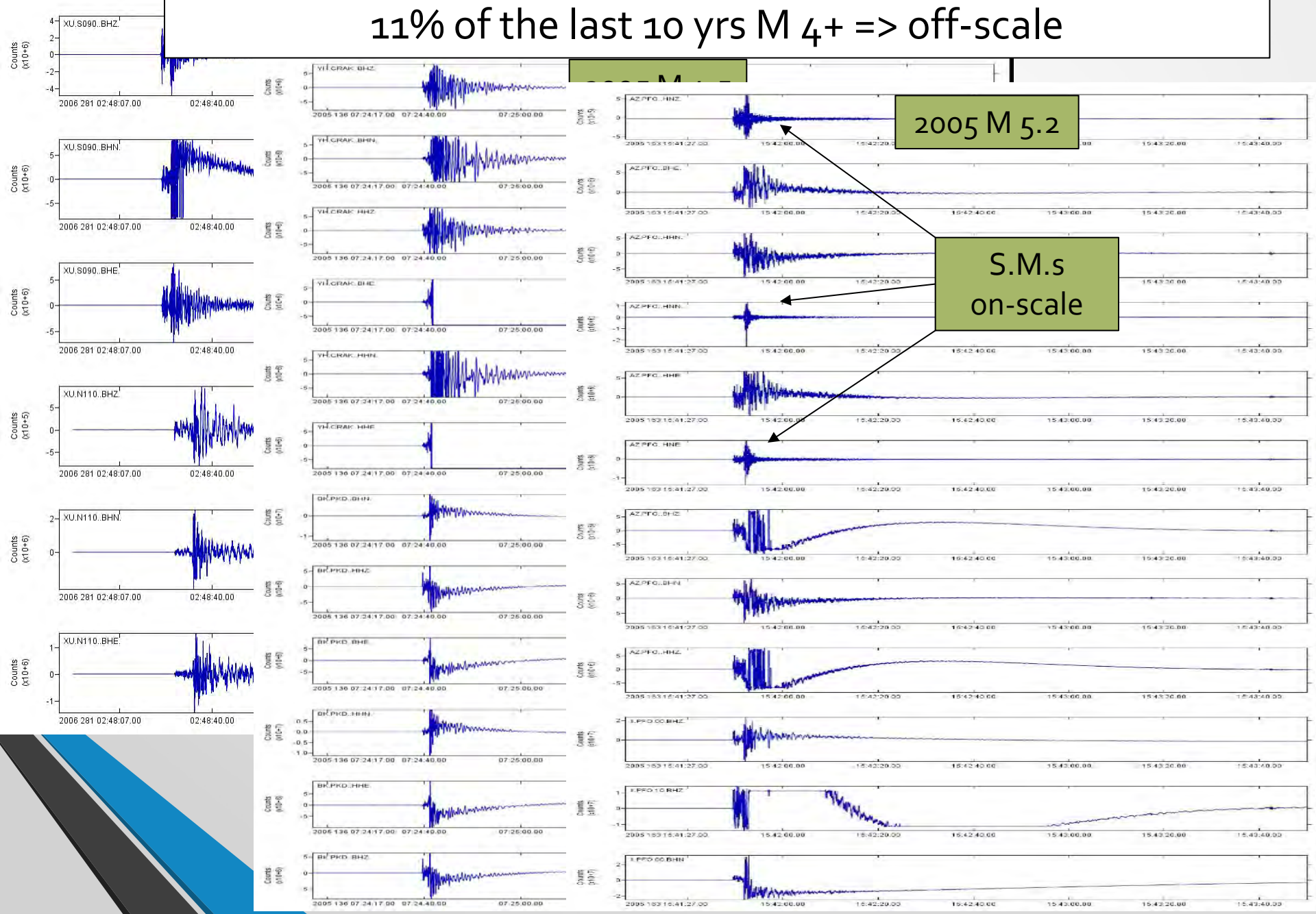

Kentucky Seismic and Strong-Motion Network

Computer Systems:

- Acquisition Systems
  - > 35 Kb/s (~3 Gb/day) real-time KSSMN data
  - Simultaneous acquisition of ~80 other stations
  - Real-time event triggering
  - Real-time data shares with the USGS

- Analysis Systems
  - Event location
  - Magnitude calculation
  - Source mechanism determination
  - Ground-motion determination

- Data Archival
  - More than 12 Tb of storage
  - Automated archival of real-time data
  - Automated real-time archival of data to IRIS