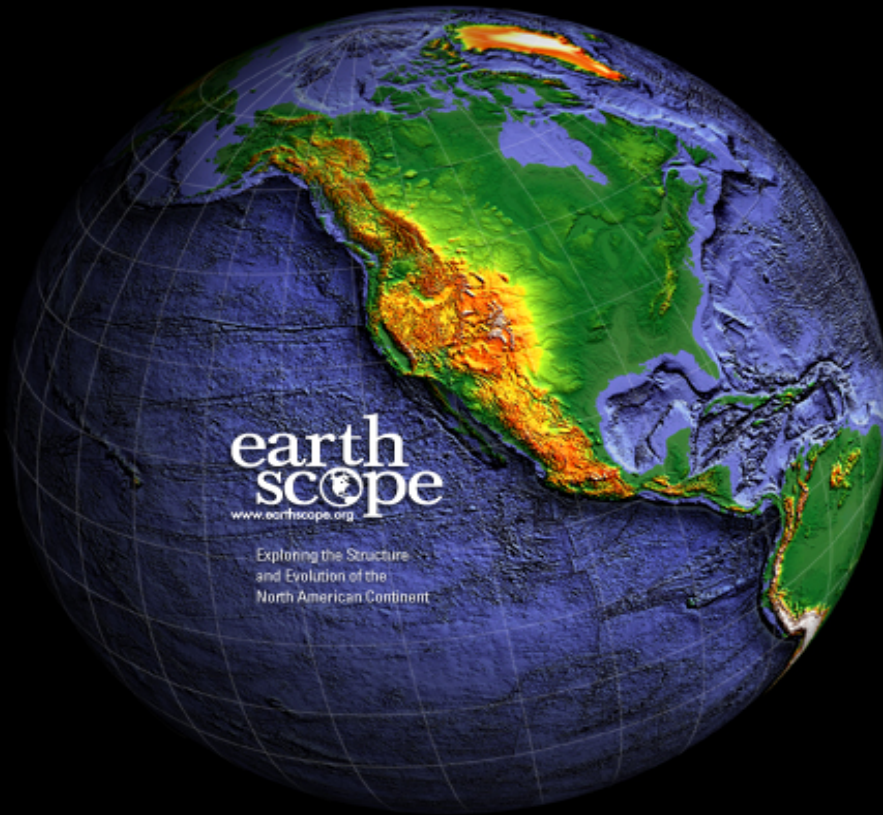
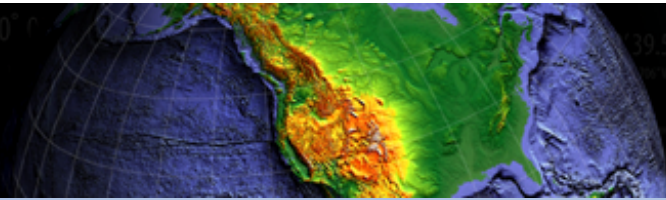


# Central and Eastern US Network: Leveraging NSF's Investment

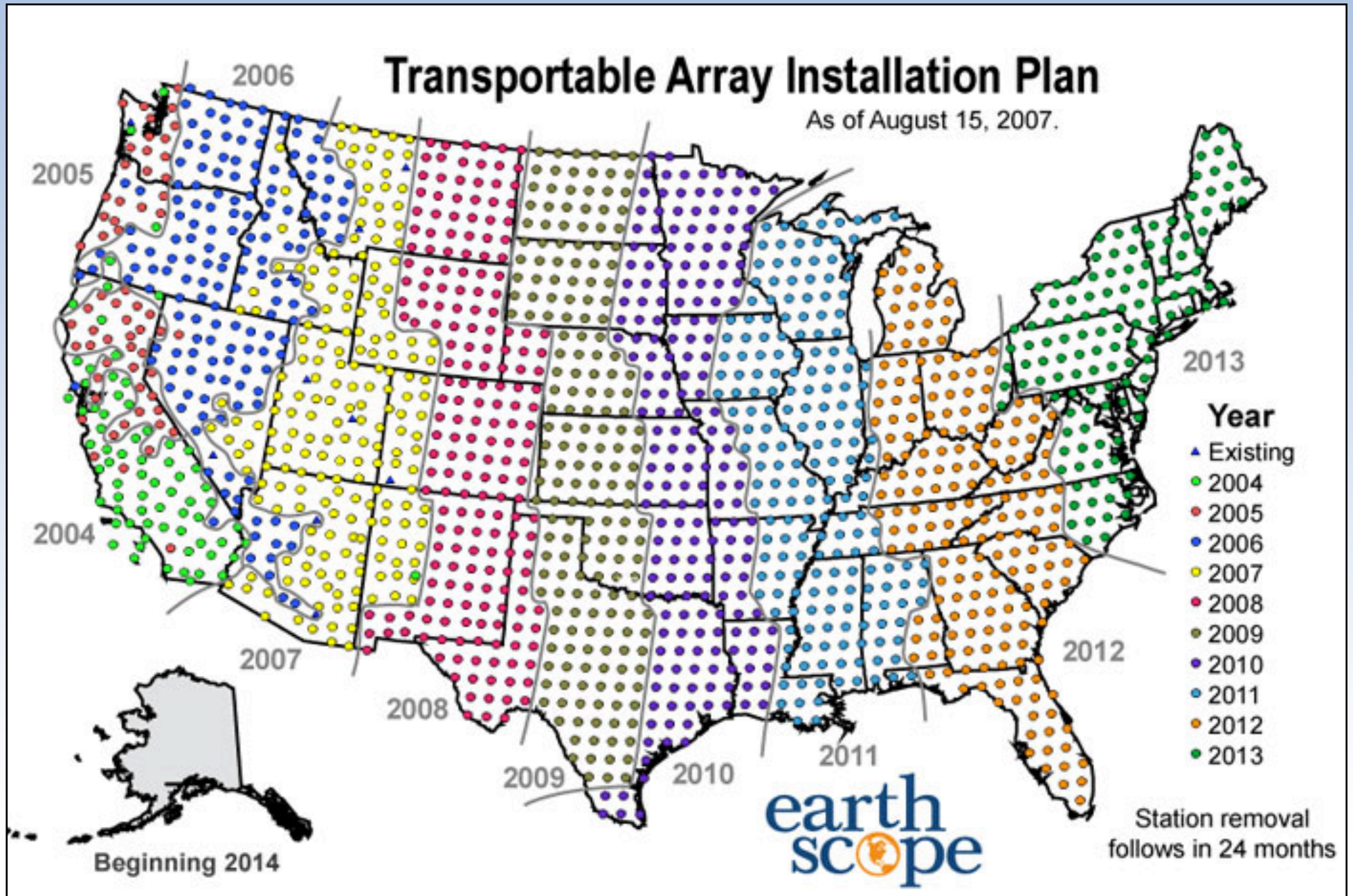


Bob Woodward  
IRIS, Director of Instrumentation  
Services

*USArray Sustainability Workshop  
Washington, DC  
November 9-10, 2016*

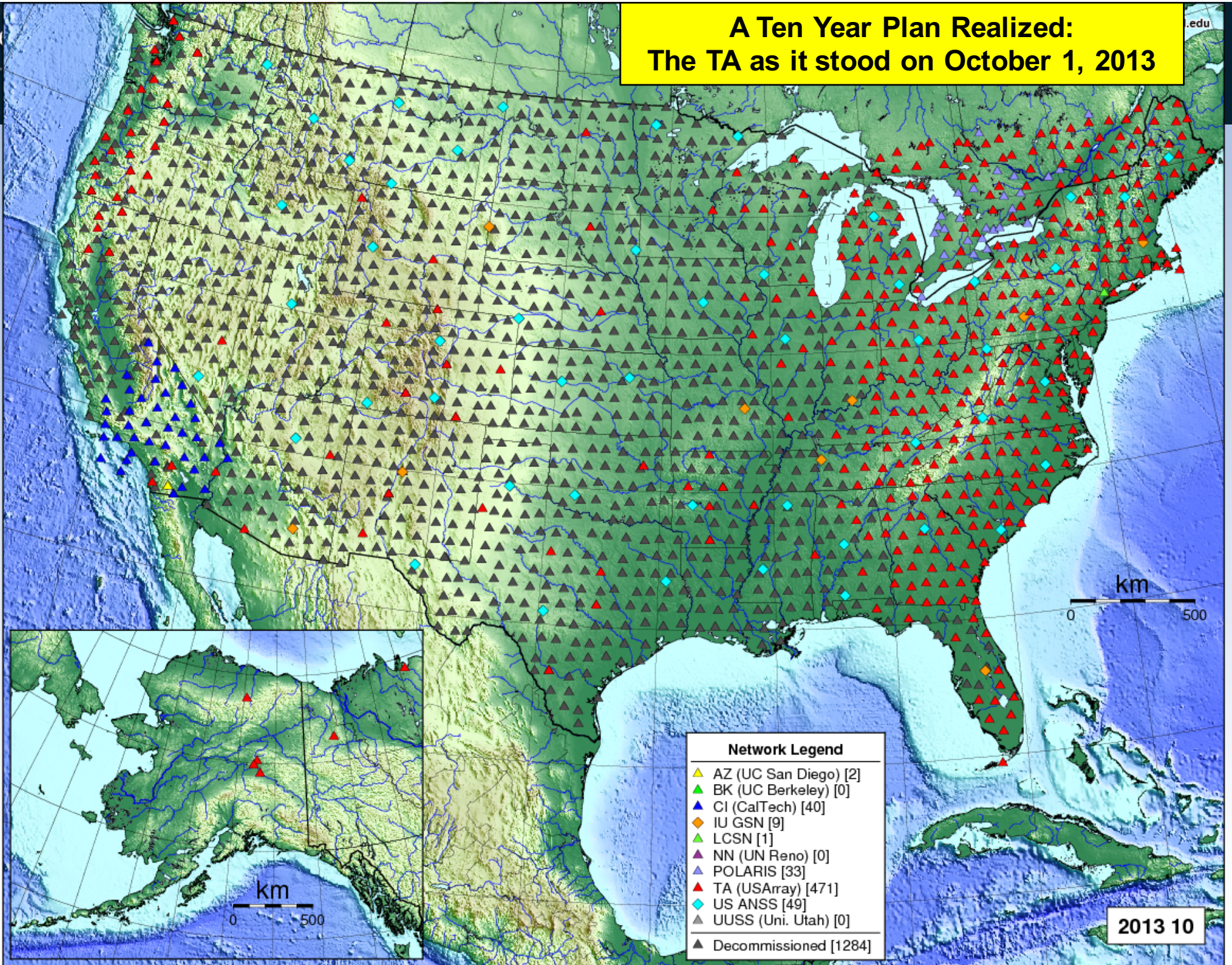


# The TA: A Ten Year Plan



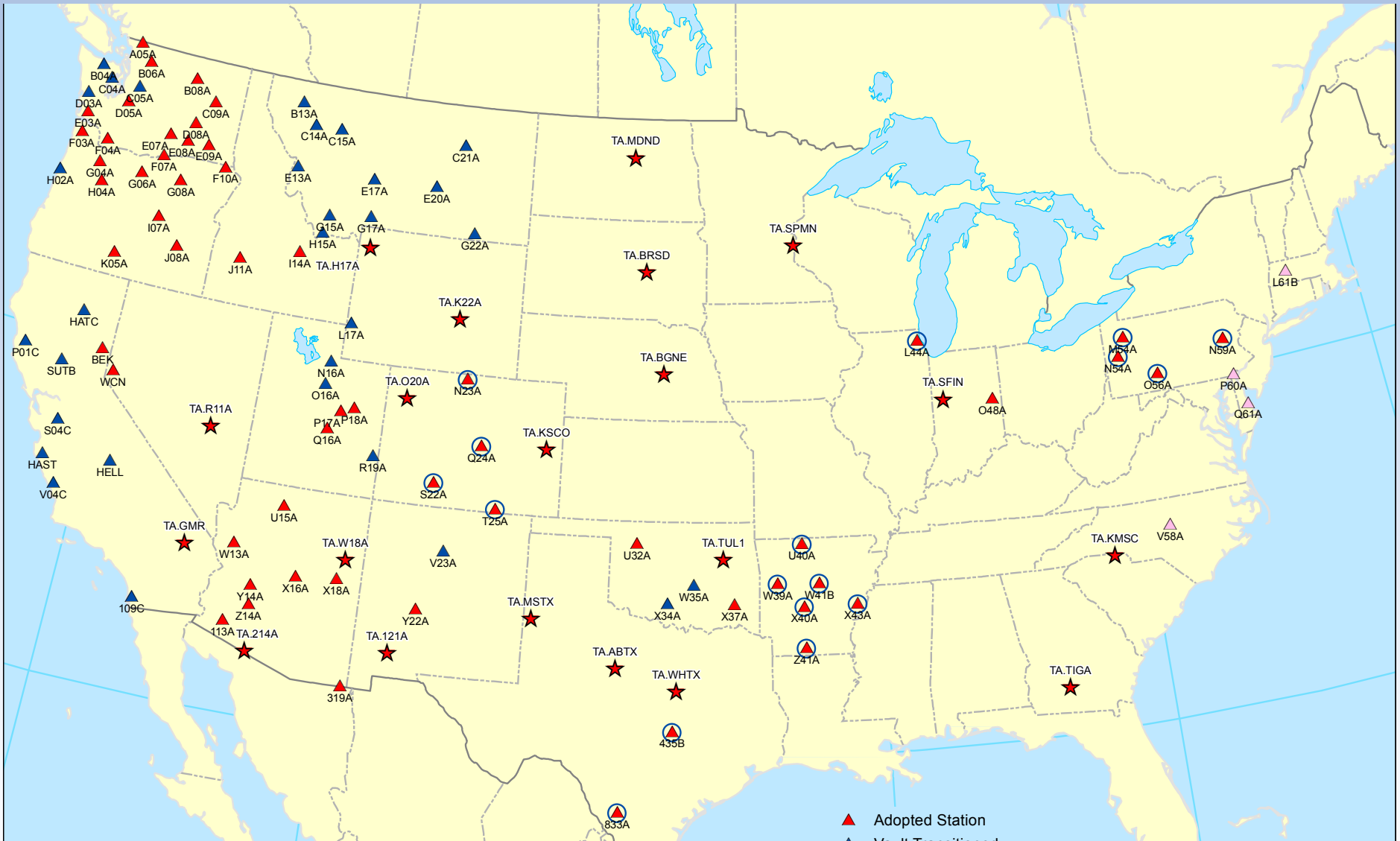


# A Ten Year Plan Realized: The TA as it stood on October 1, 2013





# The TA Created a Legacy of Permanent Stations



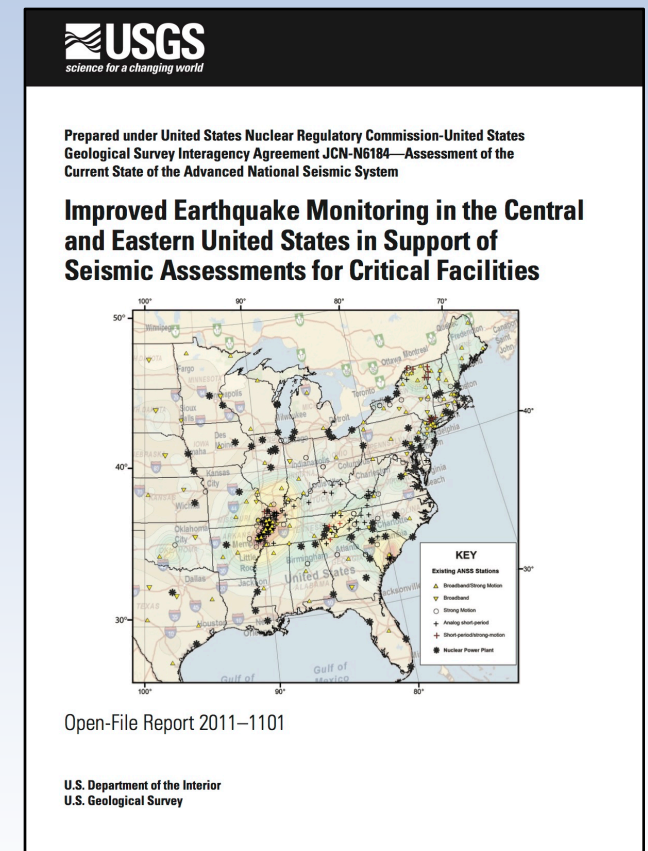
**Along the way many groups “adopted” stations to leverage NSF’s investment in site selection, permitting, construction, installation, and operation**

- ▲ Adopted Station
- ▲ Vault Transitioned
- ▲ Projected Station Adoption
- EARN Station
- ★ USArray Reference Network



# A New Concept Takes Hold . . .

- While the TA was rolling eastward . . . A new concept started to develop
- **The big idea:** Leave behind one out of every four stations in the central and eastern US
- **Motivation:** Existing coverage was sparse
  - Improved coverage would benefit numerous science and monitoring objectives
  - It would leverage the investment in the TA
- The idea was discussed in multiple forums & with multiple stakeholders
- The science and monitoring benefits were explored and enumerated
- **In parallel:** The USGS completed a report for the US NRC evaluating earthquake monitoring capabilities in the CEUS
  - Report recommended increased station coverage in the CEUS



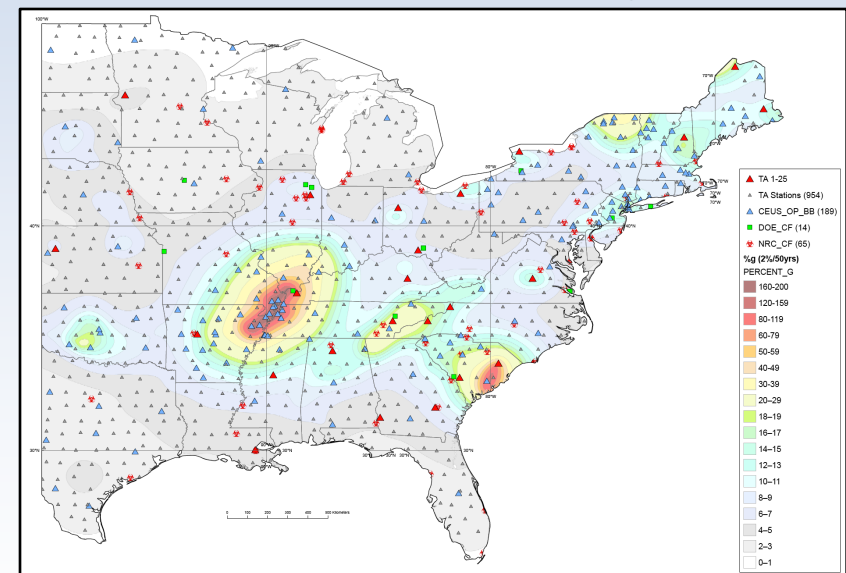


- The One-in-Four idea gained traction after a multi-agency meeting in spring 2011
- Idea gained more traction (?) after the Mineral, VA earthquake in August of 2011
  - Never underestimate the impact of a significant earthquake
- Implemented in the President's FY13 budget
  - Collaborative effort between NSF, USGS, US NRC, and DOE
  - Up to \$3 M/y for five years to adopt up to 250 TA stations
  - Example of good government
- NSF took the lead on implementing the “Central and Eastern US Network” (CEUSN)



# Implementation

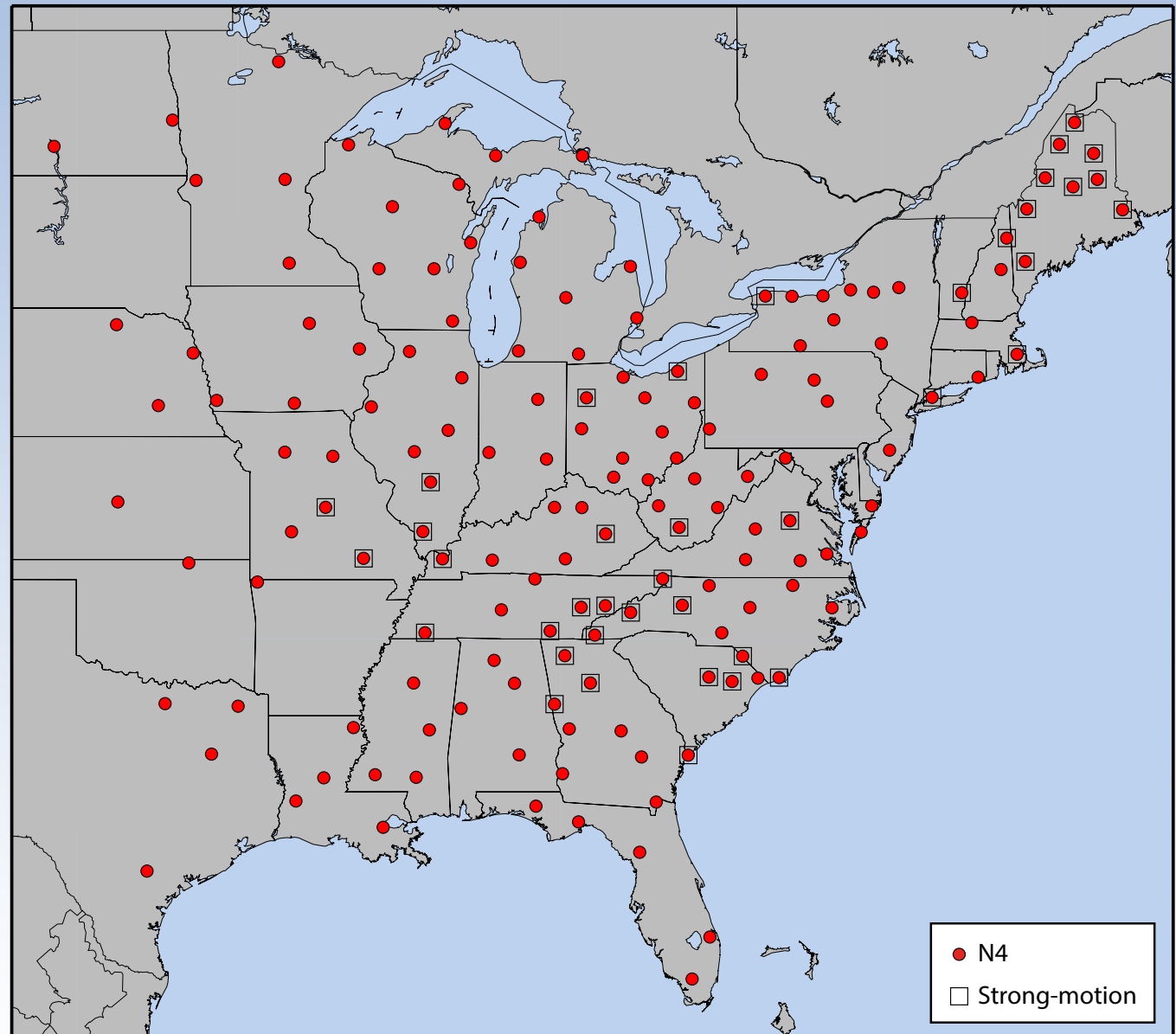
- TA Site Selection Working Group selected and prioritized target stations
  - Chaired by Harley Benz, USGS
  - Included representation of USGS, US NRC, DOE, regional network operators, state geologists, academic seismologists
- The Working Group's report prioritized 200 stations
  - Proximity to seismic hazard (and where additional coverage was required)
  - Proximity to critical infrastructure (e.g., nuclear power plants)
  - General areal coverage
- Target station configuration
  - Broadband
  - Some 3 chan strong motion
  - Sites retain atmospheric sensors (pressure, infrasound)





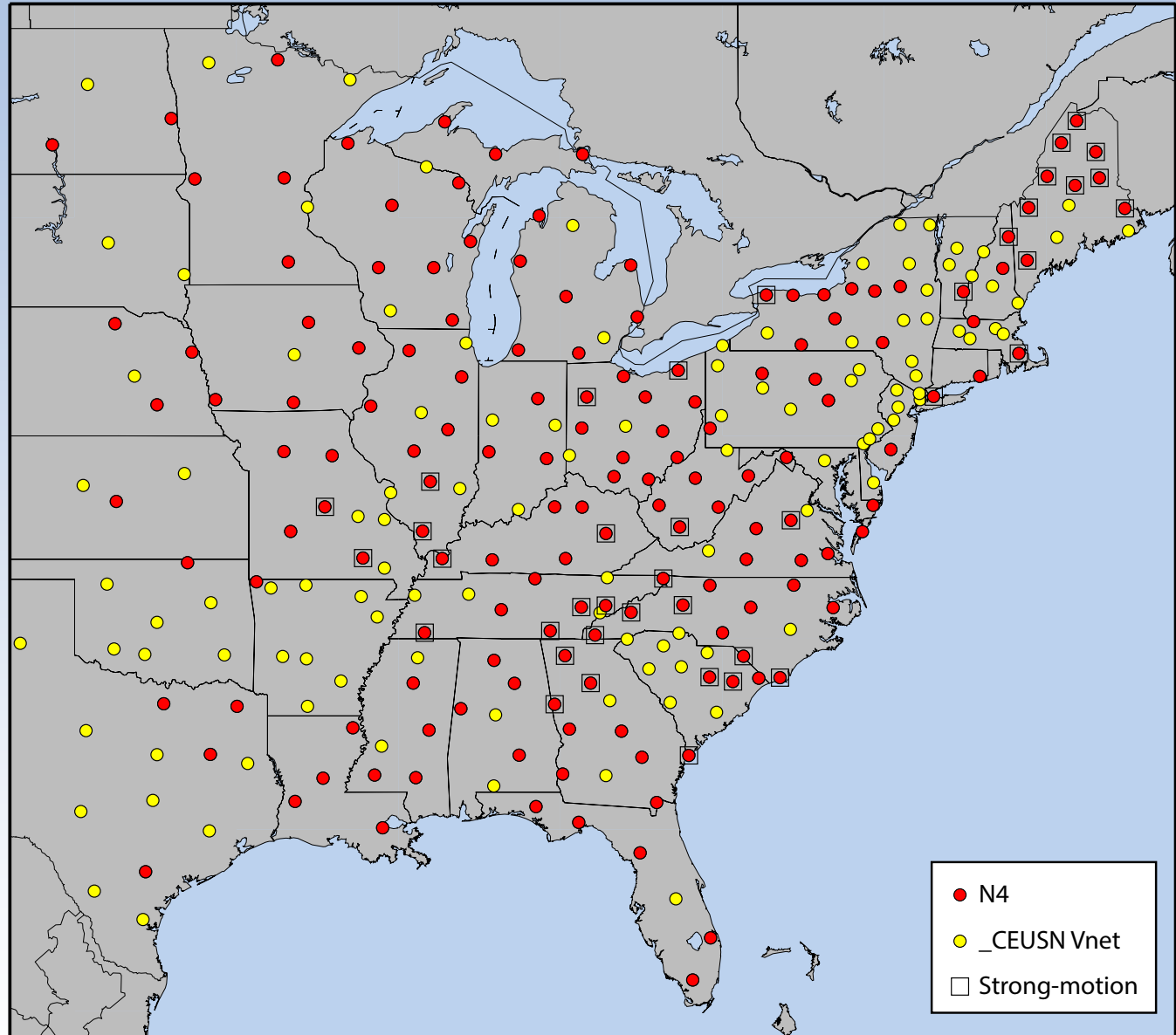
# The Adopted Stations

- Operate 158 TA seismic stations through 2017
- Multi-agency collaboration
  - NSF
  - USGS
  - US NRC
  - DOE
- Enhanced instrumentation
  - Higher sample rates (100 sps)
  - 39 new strong motion instruments



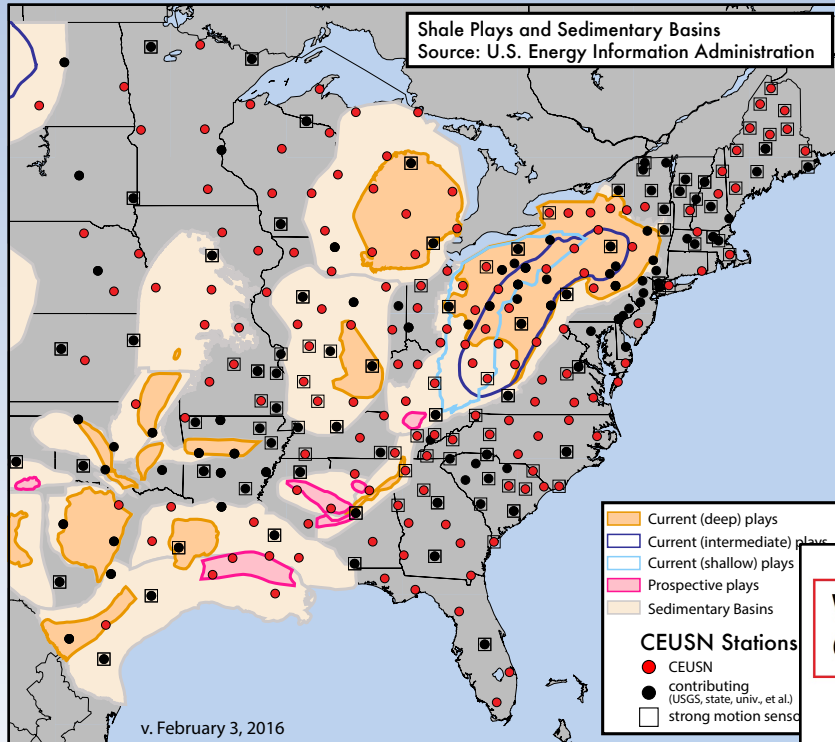
# A Broader Capability was Created

- A much broader capability was created
- Over 300 broadband stations in the CEUSN
  - The adopted TA stations filled crucial gaps within the pre-existing regional networks
- Dramatic increase in capability
  - Monitoring
  - Science
  - Coverage
  - Performance

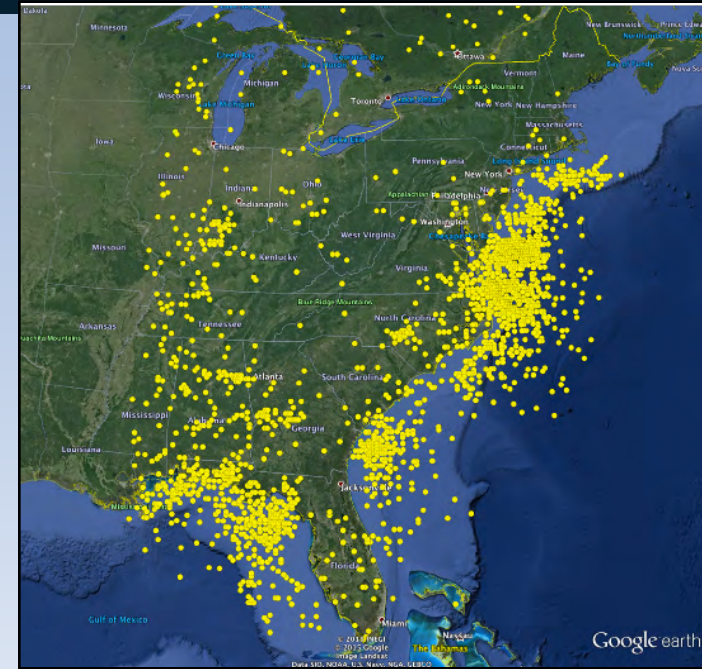




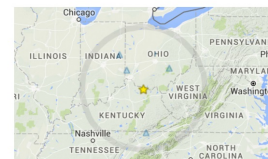
Improved proximity to natural resources –  
for characterization & monitoring



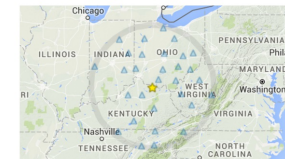
Unexpected  
science –  
infrasound events  
in the 2-8 Hz  
band



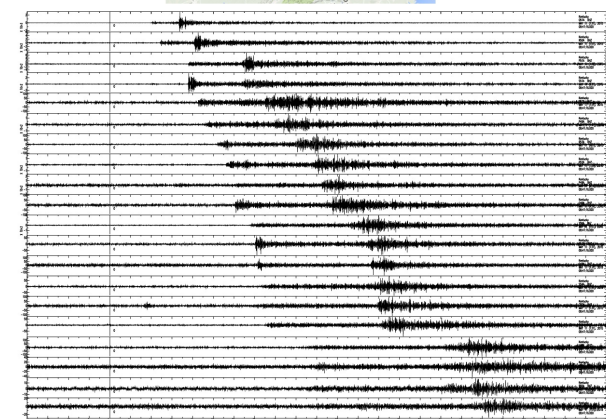
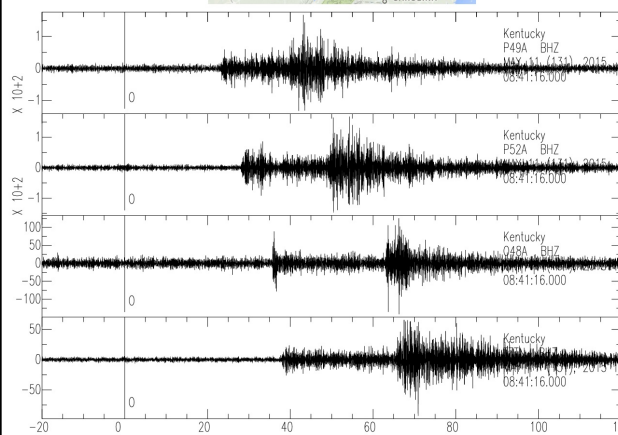
Without  
CEUSN



Magnitude 2.5  
Ohio Valley  
Earthquake



With  
CEUSN



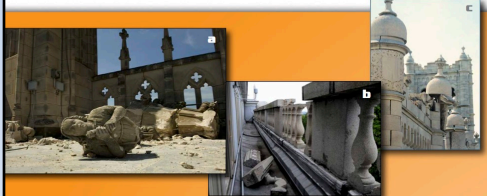
Improved monitoring for  
earthquakes of all sizes

- Start early
  - The TA is a temporary experiment
  - The CEUSN opportunity was almost missed
- Aim high
  - The CEUSN targeted \$3 M/y and up to 250 stations
  - Reality exerts downward pressure
- Engage all stakeholders
- The science will follow
  - But it needs time to blossom
  - Ongoing community engagement helps
- Plan ahead for O&M
  - O&M dollars seem to be the hardest to get into budgets
  - Requires ongoing support & advocacy

**earth scope** **CENTRAL AND EASTERN US NETWORK**  
<http://www.usarray.org/ceusn>

Large earthquakes in the central and eastern United States are relatively rare, but could have devastating consequences because many buildings and much of the infrastructure are not built with earthquakes in mind. In the past, large earthquakes occurred in New Madrid, Missouri, in the winter of 1811-1812, and near Charleston, South Carolina, in 1886. Even the moderate 2011 M5.8 Mineral, Virginia, earthquake damaged the Washington Monument, the National Cathedral, and other buildings as much as 130 km (80 miles) from the epicenter. Human industrial activity, primarily through subsurface fluid injection of wastewater, is causing the so-called "induced earthquakes" that have increased seismic hazard in some parts of the central and eastern United States.

Currently, the 158 stations of the Central and Eastern US Seismic Network (CEUSN), installed as part of the National Science Foundation (NSF) supported EarthScope project, is advancing our understanding of natural earthquakes and human-induced events in the central and eastern United States and improving the US Geological Survey (USGS) National Seismic Hazard Maps on which building codes are based. The CEUSN supplements the sparser array of the USGS and other seismic stations in the region, and almost doubles the number of seismic stations operating in the United States, east of the Rocky Mountains.

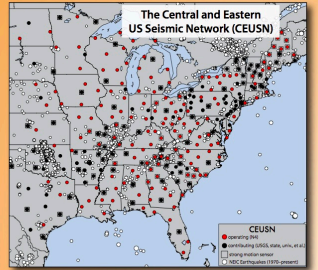


Damage in Washington, DC, caused by the 2011 Mineral, Virginia, earthquake included the (a) National Cathedral (photo credit: Nikki Kahuy/The Washington Post), (b) US Treasury building (photo credit: US Department of the Treasury), and (c) historic Sherman Building (photo credit: Armed Forces Retirement Home and PRESERVE/capex).

**2011 Mineral, Virginia Earthquake**

More people felt the August 23, 2011, M5.8 Mineral, Virginia, earthquake, which struck within the Central Virginia Seismic Zone, than any other earthquake in US history.

- The USGS received 148,628 felt reports from 31 states and four Canadian provinces.
- The Mineral, Virginia, earthquake occurred near the North Anna nuclear power plant.
- In 2011, the USGS finalized a report for the US Nuclear Regulatory Commission, and determined that at least 25 additional broadband and strong motion stations are needed to support Nuclear Regulatory Commission goals and support the agency's oversight responsibilities.
- Additional priorities for continued station coverage include regions of elevated seismic hazard to understand ground motion and characterize faults, especially near critical facilities.



**The Central and Eastern US Seismic Network (CEUSN)**

Legend:  
 ● Working site  
 ■ Working site, data only, not yet strong motion sensor  
 □ Working site, data only, not yet strong motion sensor  
 ○ Working site, data only, not yet strong motion sensor



## On the Web

- CEUSN  
[www.usarray.org/ceusn](http://www.usarray.org/ceusn)
- USArray  
[www.usarray.org](http://www.usarray.org)
- EarthScope  
[www.earthscope.org](http://www.earthscope.org)
- National Science Foundation  
[www.nsf.gov](http://www.nsf.gov)



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