

Scientific Earthquake Studies Advisory Committee

SESAC

- Research Professor Emeritus Ralph Archuleta, Chair, University of California, Santa Barbara, CA
- Prof. John Anderson, Chair, National Seismic Hazard Maps Steering Committee, University of Nevada, Reno
- Prof. Greg Beroza, Chair, Advanced National Seismic System, Stanford University, CA
- *Prof. Jeff Freymueller, University of Alaska, Fairbanks, AK
- Julie Furr, Professional Engineer, Chad Stewart and Associates Engineering, Inc., Lakeland, TN
- Dr. John Parrish, California State Geologist, Sacramento, CA
- Prof. Emeritus Terry Tullis, Chair of the National Earthquake Prediction Evaluation Council (NEPEC), Brown University, Providence, RI
- *Prof. Christine Powell, Center for Earthquake Research and Information (CERI), University of Memphis, TN
- Dr. David Simpson, Past President of the Incorporated Research Institutions for Seismology (IRIS), Washington DC

*Term ended in 2014.

SESAC: Primary Topics

- Budget—Balance between monitoring and research
- Earthquake Early Warning
- Induced Seismicity
- Earthquake Hazard Maps
- East Coast Hazards
- NEIC Products (Earthquake parameters, PAGER, ShakeMap, ShakeCast, “Did You Feel It”)
- ANSS
- Workforce (demographics, new hires, separations)
- Future EHP Initiatives (funding, associated workforce and capital expense)

SESAC: Budget

Budget—Balance between monitoring and research and hazard assessment.

- SESAC recommended that monitoring not exceed 50%. Balance between monitoring and research programs and hazard assessment.
- Major new initiatives must find 'line item' increases, e.g., EEW
- Induced seismicity is an issue that affects (or could affect) almost every state. There could be opportunities.

SESAC: Earthquake Early Warning (EEW)

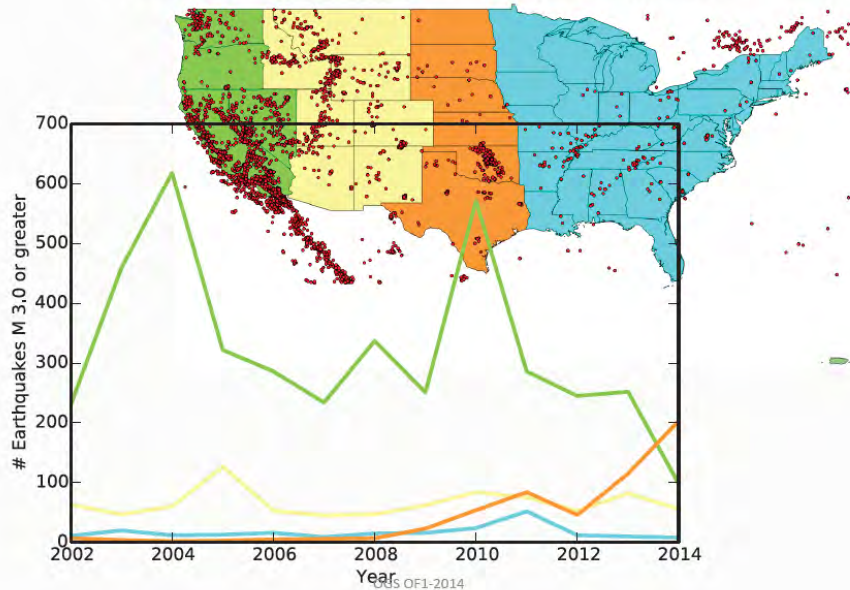
EEW is a natural outcome of a modern, dense monitoring system, but it cannot be financed within the current EHP budget

West Coast Implementation Cost	California	Pacific Northwest	West Coast (CA+PNW)
One-Time Construction costs	\$23M	\$15M	\$38M
Annual Operation and Maintenance	\$12M	\$5M	\$17M

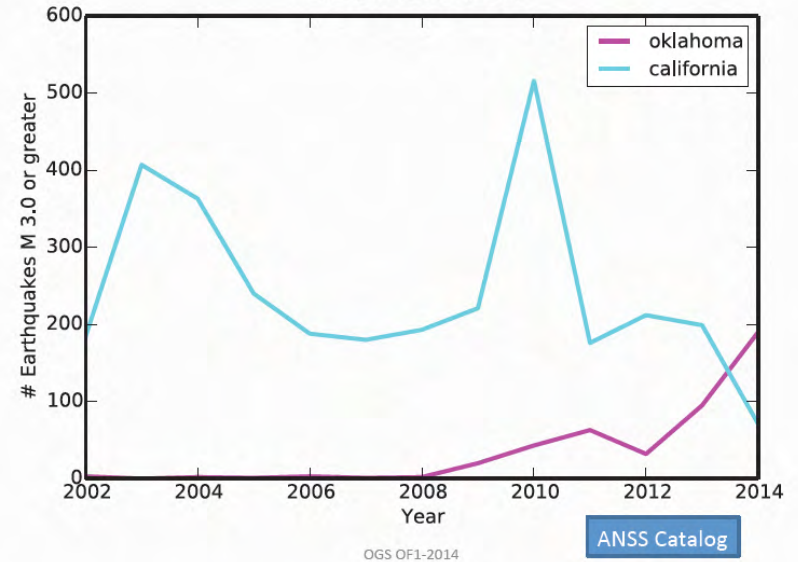
- **Includes:**
 - Infrastructure upgrades, operation and maintenance
 - Adds personnel to bring network staffing up to robust levels, operate new EEW capabilities, and test and monitor system performance
 - Support for continued R & D
- **Does not include current network funding**

SESAC: Induced Seismicity

ANSS Earthquakes by Region



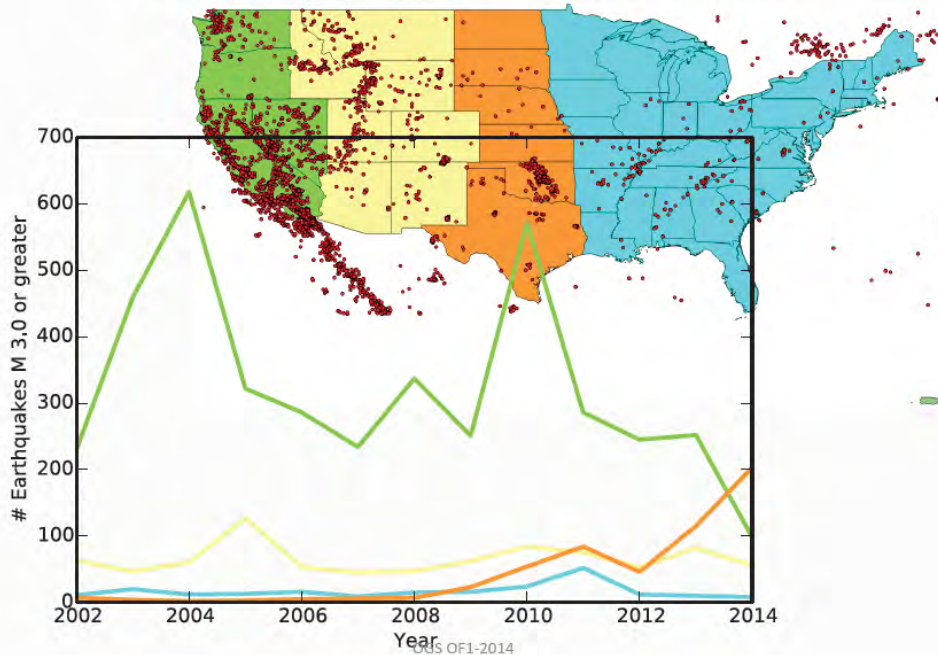
Mid-continent increase primarily in Oklahoma



Oklahoma Geological Survey OF1-2014
Recent Earthquakes: Town Hall Meeting June 26, 2014
A. Holland, A. Darold and G. R. Keller

SESAC: Induced Seismicity

ANSS Earthquakes by Region



EHP has partnered with a wide range of federal, state, university, private and international institutions in its efforts to better understand induced seismicity and its effects (8 state agencies, 6 federal agencies/labs, 9 universities, 3 international government agencies, and 8 private industries).

Oklahoma Geological Survey OF1-2014
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SESAC: Earthquake Hazard Maps

National Seismic Hazard and Risk Steering Committee 1st Meeting Held July 7-8, 2014, Golden, CO.

- John Anderson (Chair), University of Nevada, Reno, NV
- Norm Abrahamson, Pacific Gas and Electric Company, San Francisco, CA
- Ken Campbell, EQECAT, Inc., Beaverton, OR
- Martin Chapman, Virginia Polytechnic Institute and State University, Blacksburg, VA
- Michael Hamburger, Indiana University, Bloomington, IN
- Bill Lettis, Lettis Consultants International Inc., Walnut Creek, CA
- Nilesh Shome, RMS, Inc., Newark, CA
- Ray Weldon, University of Oregon, Eugene, OR
- Chris Wills, California Geological Survey, Sacramento, CA

National Seismic Hazard and Risk Steering Committee Recommendations: A Subset

- Map priorities: Discussions identified extending the maps to longer periods as the highest priority. The committee also likes the idea of incorporating the information currently presented in urban hazard maps (soil types and amplifications, basin effects, liquefaction hazards, etc.) into a map-based web site.
- The committee encouraged developing maps displaying uncertainties. Changes, and especially oscillations in mapped hazard amplitudes that are much smaller than uncertainties are problematic for engineers and might be dampened using a rigorous statistical approach. The committee supports using a rigorous approach to characterize the differences among GMPEs and to represent their center, body, and range to help to stabilize the GMPE contribution to the hazard curves.
- Induced Seismicity: Committee discussion recognized that there are enormous uncertainties. The physics of the process is not understood, the consequences of the understood branches are not known, and the needs of users for hazard maps incorporating the induced activity are not understood at this time. We do not know of any reliable proxy for locations of future activity.
 - Plan to update these maps frequently.
 - Prepare national maps following Branches 1, 2, and 3 (Rubinstein)
 - A workshop should seek to answer several questions: what is useful for the various users of the national hazard model, how should the results be delivered, and how often should results be updated?

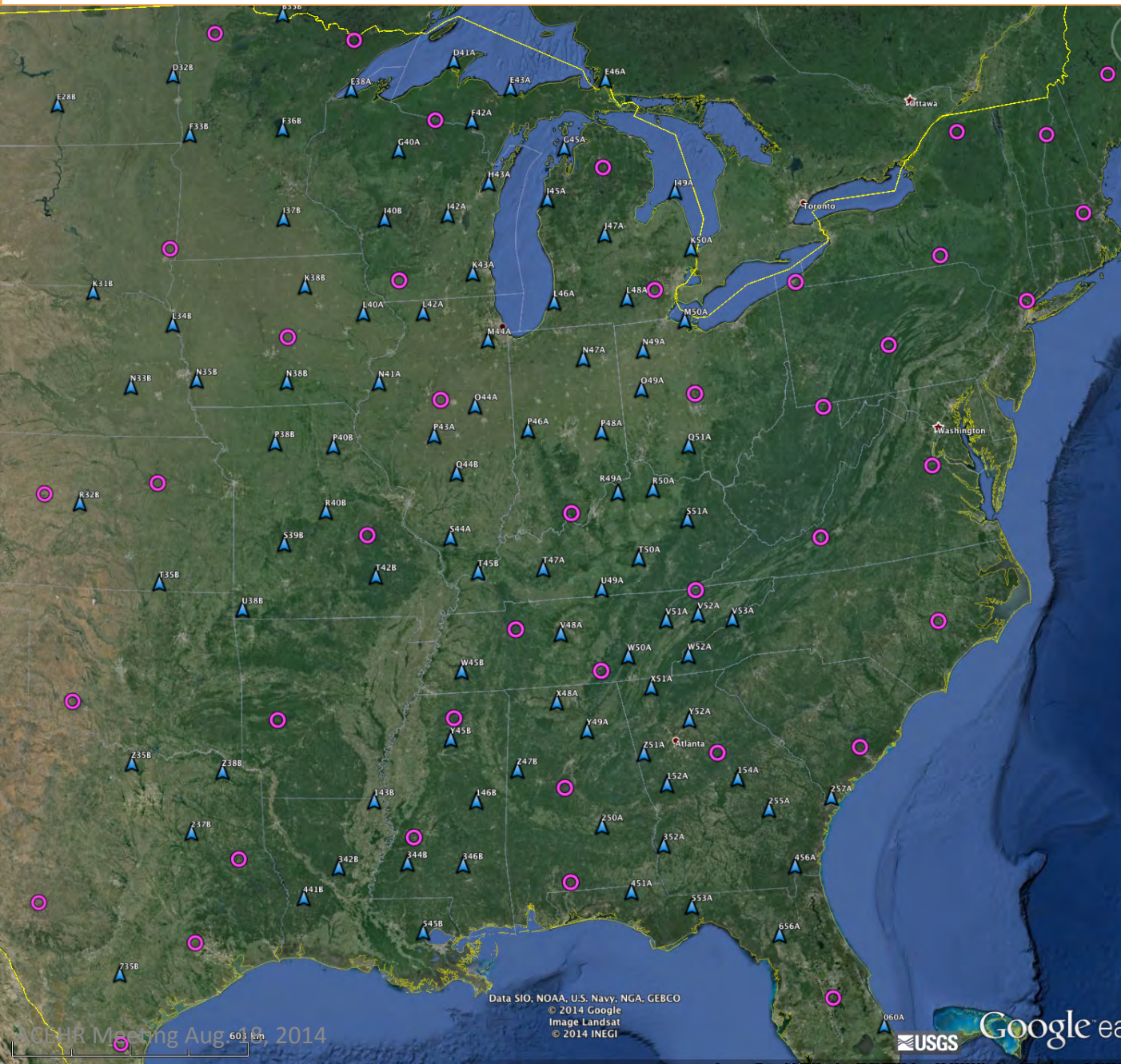
SESAC: ANSS

ANSS SC has recommended that priority be placed on a rewrite of circular 1188 (published in 1999), which defines the needs and goals for the Advanced National Seismic System

The update is a priority because: ANSS has since been (partly) built out, technologies have changed, science and engineering needs and priorities have evolved

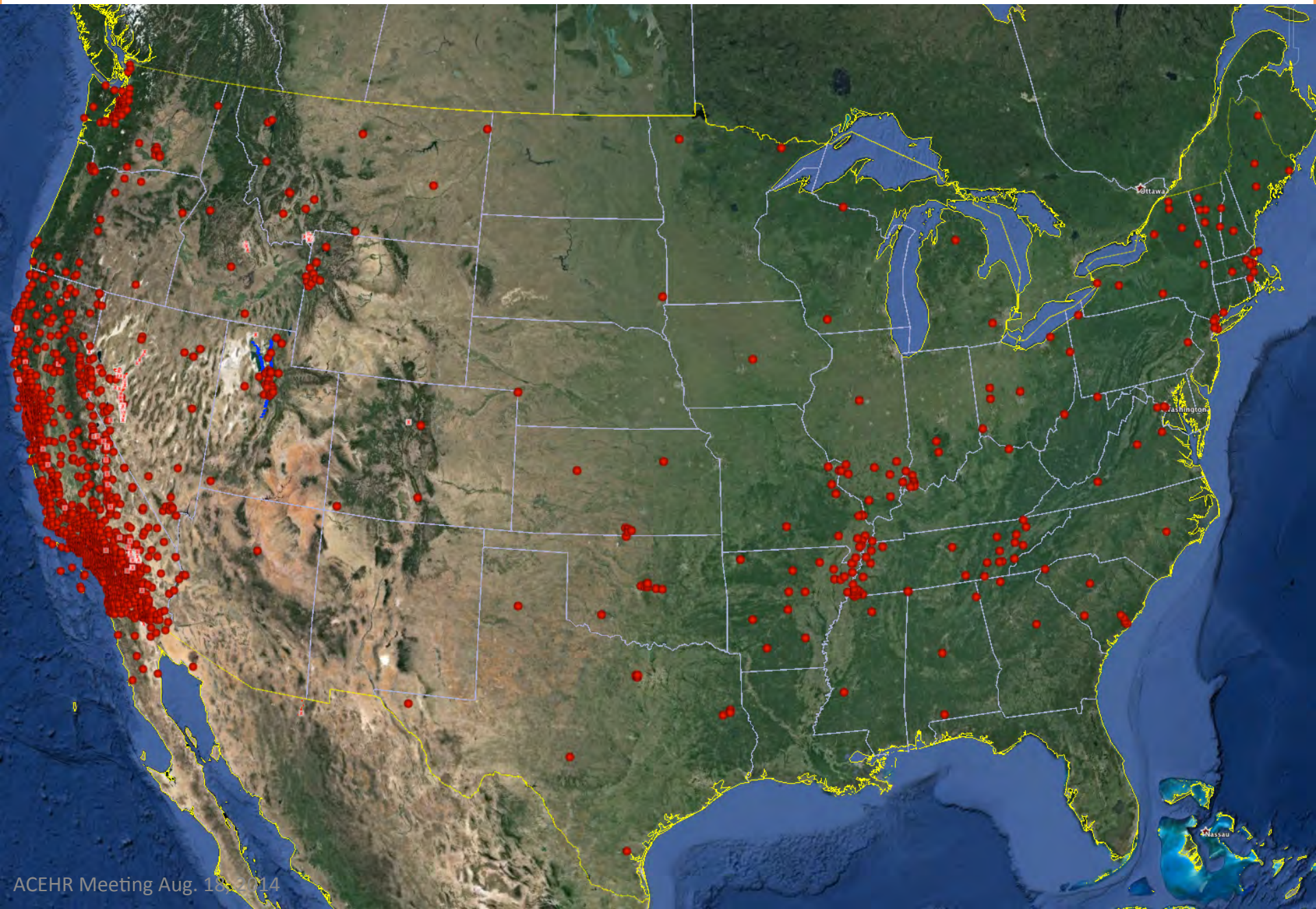
The new 1188 will be a “blue sky document” celebrating the progress of ANSS, with increased focus on the ANSS products and capabilities and including ANSS goals for new products and capabilities (EEW, Earthquake Likelihood Forecasting, RT GPS)

Added Stations to the NEIC Backbone

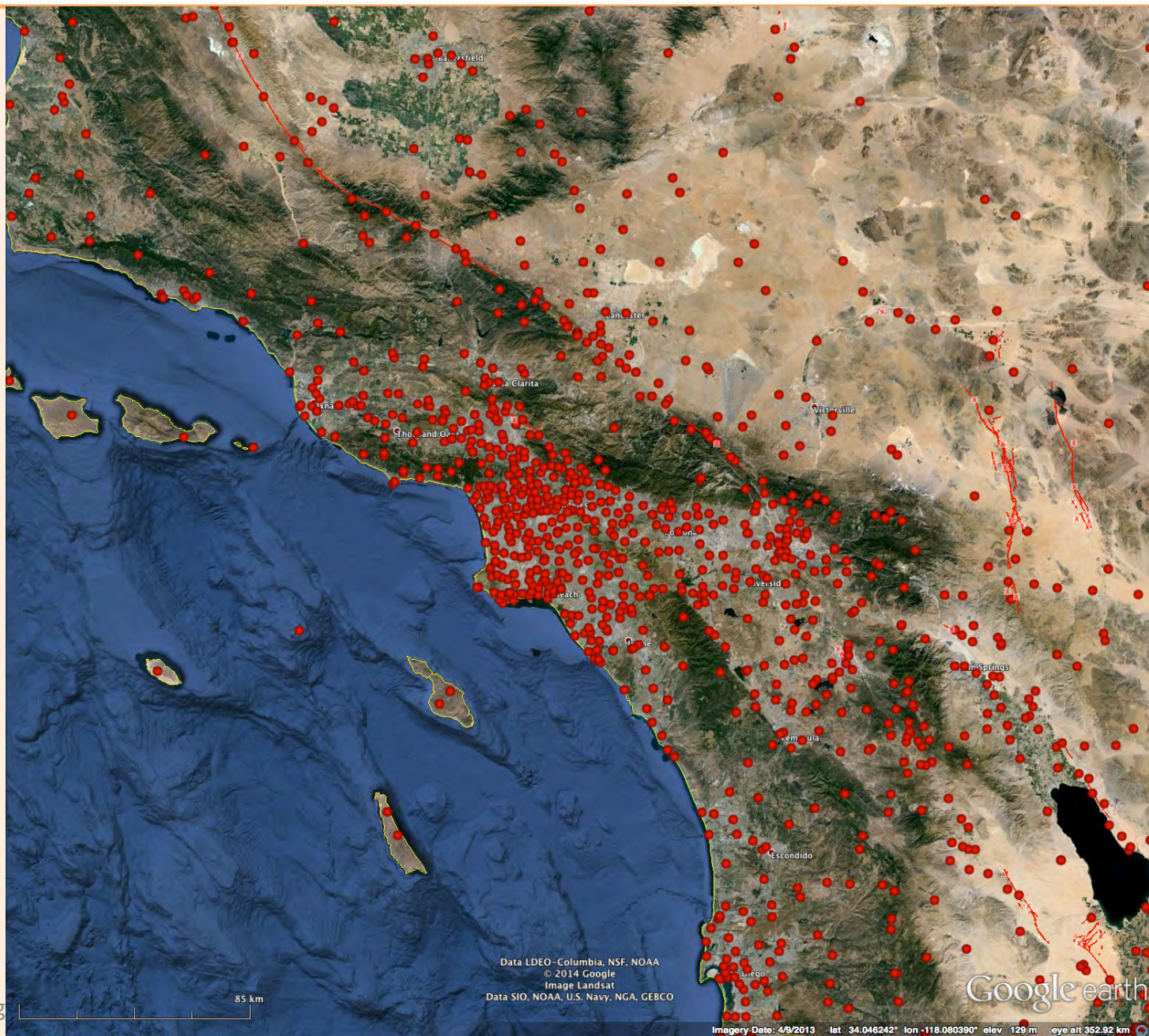


94 TA stations. 160 will be final. 17 (/94) have strong motion accelerometers.

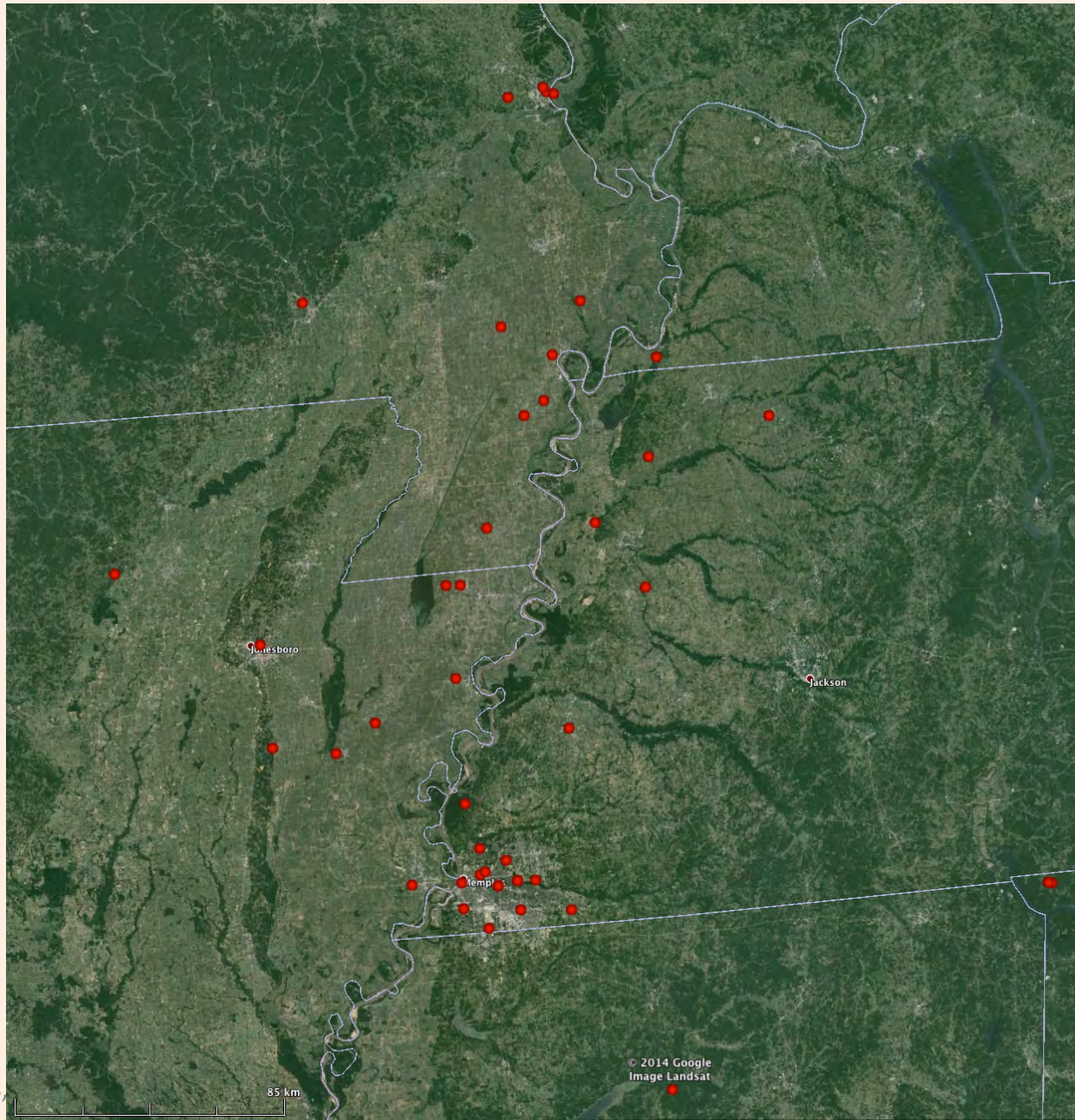
Strong Motion Stations in the Lower 48



Strong Motion Stations in Southern California



Strong Motion Stations New Madrid



SESAC: EHP Workforce and Directions

- At Menlo Park Earthquake Science Center (MESC), a large fraction of upper-grade research staff are eligible to retire.
- At Golden Hazards Science Center (GHSC), the ANSS and NEIC products (successful) now requiring more and more IT support.
- At GHSC the staff working on the NSHMP could be doubled
- At MESC 16 separations at GS 12 and above since 2008 have not been replaced.

Looking to the future

- CEUS could be a research frontier with emphasis on induced seismicity and carbon sequestration
- High density monitoring (MEMS, cell phone technology)
- LiDAR, InSAR, photogrammetry
- Expanded structural health monitoring for critical structures
- Increased seismic hazard analysis for water infrastructure, among others
- Risk and loss forecasts
- Research done as teams (earth scientists, IT, remote sensing, etc.)
- Earthquake simulators and Dynamic Earthquake Likelihood Forecasting (DELFF)—aka Operational Earthquake Forecasting
- Earthquake physics

Earthquake Hazards Program

- What is the balance between monitoring and research/hazard assessment?
- In level funding, how are new initiatives to be launched?
- What areas of research/hazard assessment cannot be sustained in the future?
- What are the new areas of research/hazard assessment?
- What are the new areas of monitoring?
- Are there partnerships within NEHRP that need to be established?
- What proposals have to be explored and ready to launch following the next damaging earthquake?
- What is the balance in effort geographically across the US?
- What is the balance between developing/continuing products versus more basic research?
- National Seismic Hazard Maps are a product that touches a trillion dollar/year activity. How can this critical product be leveraged to gain increased funding?
- What will the expertise of the workforce look like in 10-15 years?
- How much effort should the USGS in risk and loss estimates?
- Etc.

These are questions expressed by the Chair of SESAC and not yet vetted by SESAC.