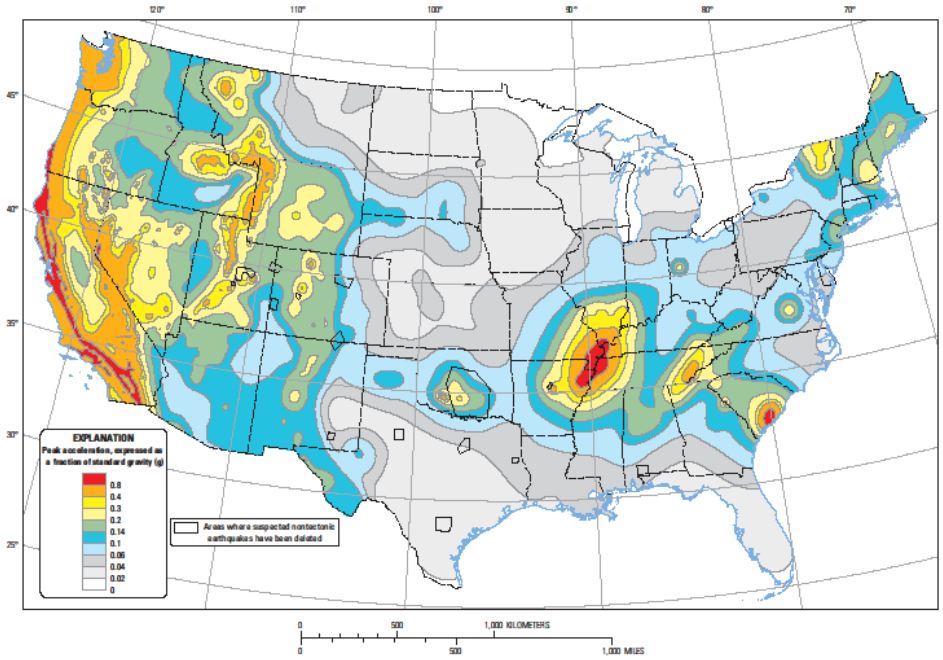
National Seismic Hazard Models for the U.S.



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

2014 model released July 2014, suspected nontectonic earthquakes deleted

Thanks for your participation and the organizers (Oklahoma Geological Survey (Randy Keller, Austin Holland, and Michelle Summers); Susan Hoover (USGS)

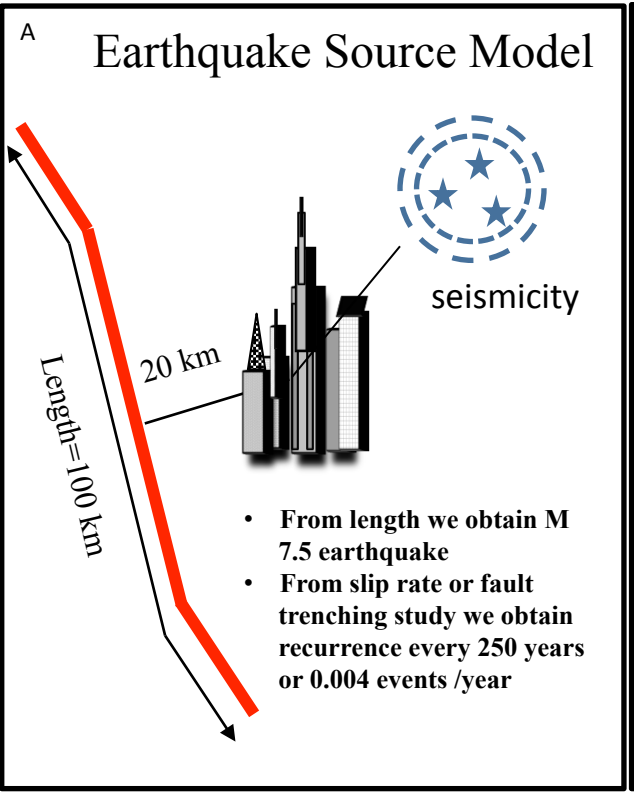
Induced seismicity: Seismicity in areas where rates have increased locally, and it has been suggested in the scientific literature that these events are related to deep injection of fluids or other man-made causes.

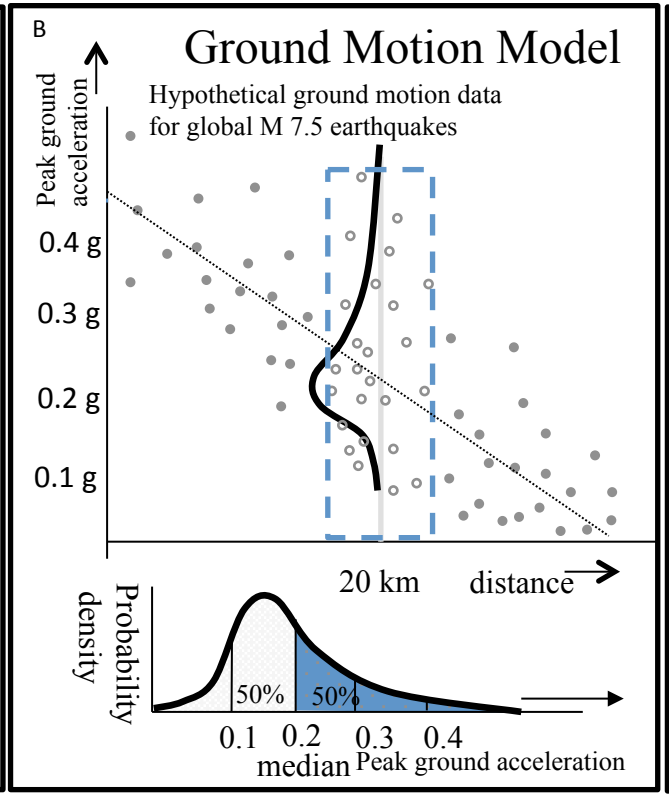
Goal: What are differences between induced and natural seismicity and shaking?

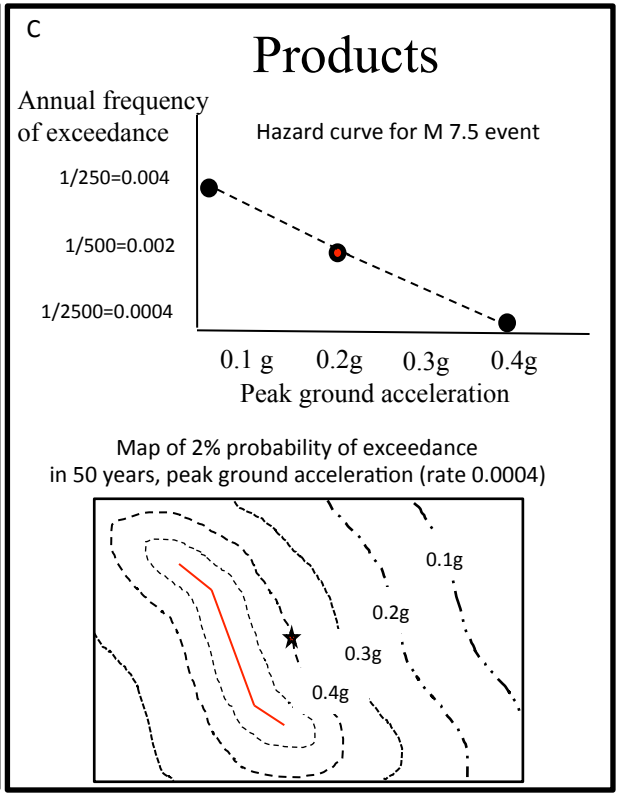
National Seismic Hazard Map workshop on Induced Seismicity

- How are the National Seismic Hazard Maps used?
  - Building codes (new and existing structures, railroads, bridges, military…),
  - insurance rates,
  - risk analyses,
  - advise Nuclear Regulatory Commission, U.S. Bureau of reclamation, consultants
- Nils Bohr- “Prediction is very difficult, especially if it’s about the future.”

What is Probabilistic seismic hazard?
Steps to generate a map:

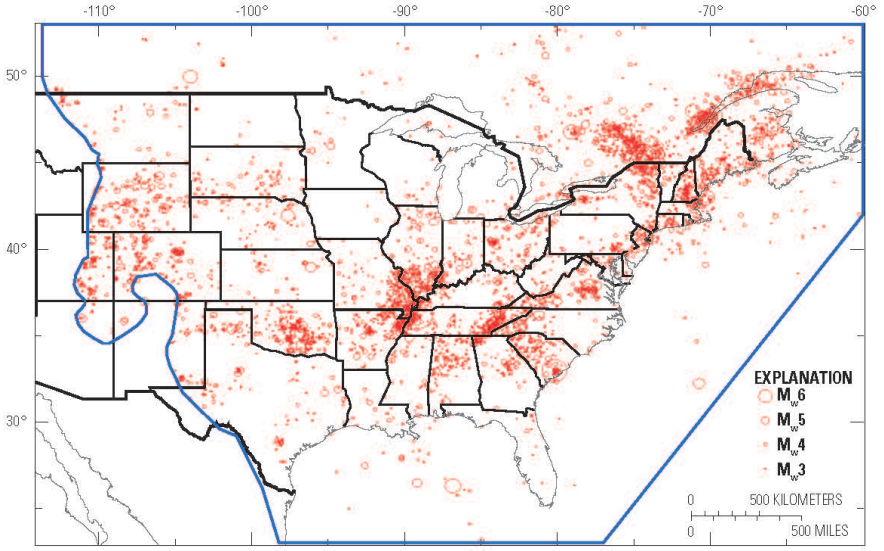


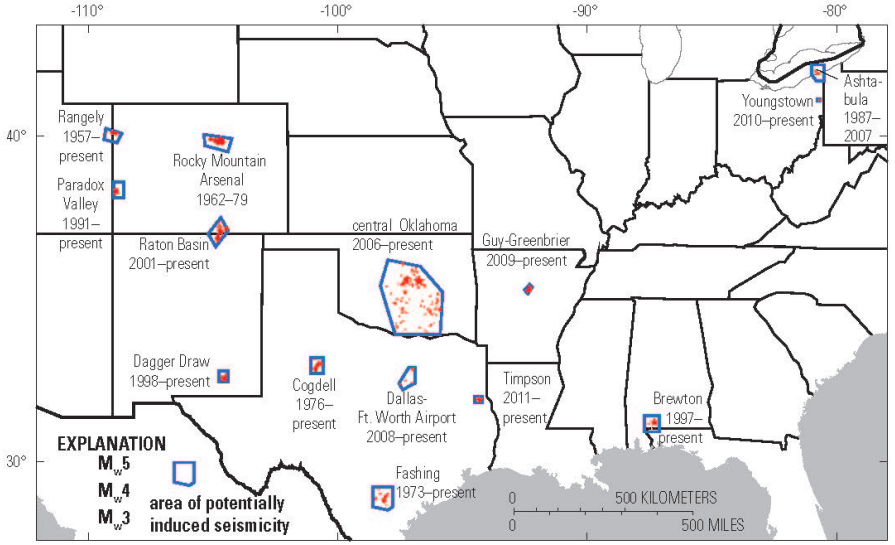




Areas of Suspected Induced Seismicity, 14 Zones

(Previously excluded from the NSHM)

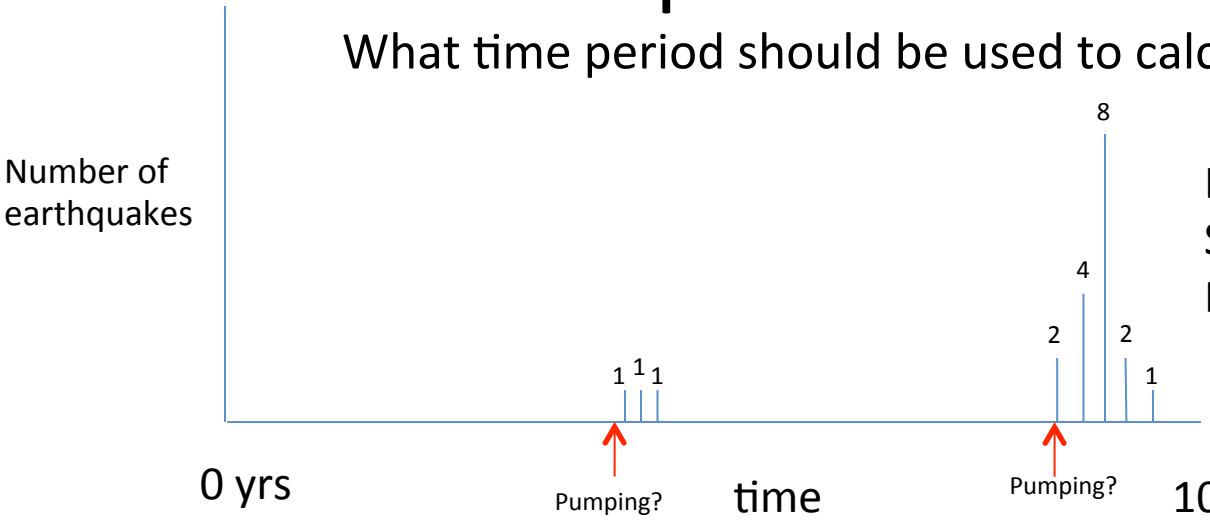




We have taken out seismicity in these areas and time windows for the 2014 maps that were released in July. We noted that we would replace the hazard from this seismicity after further research, a workshop, and discussions with experts.

Earthquake Rate Models

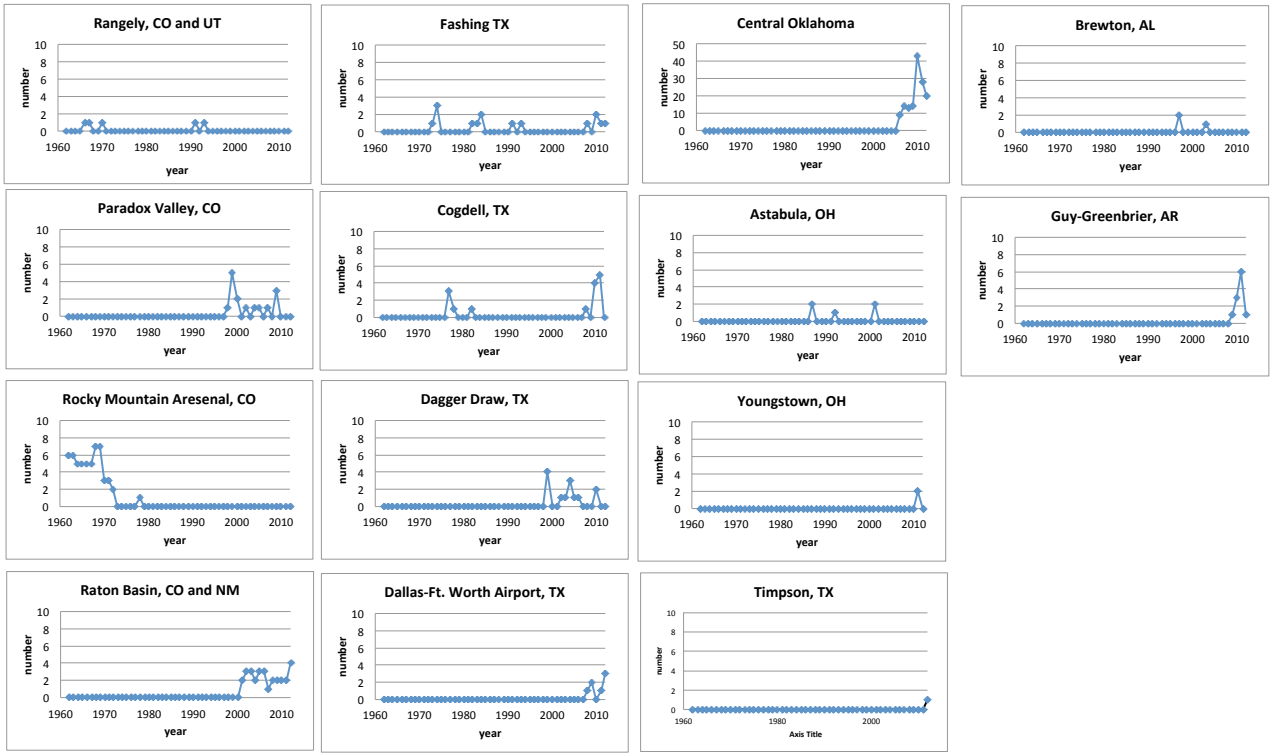
What time period should be used to calculate rate?



Long term rate:(3+17)/100 = 0.2
Short term rate:(17)/10=1.7
Decay: ? 1/10 = 1.0

Time histories for the 14 induced seismicity zones identified for the 2014 NSHM. Plots show a yearly earthquake count (1960 – present).

This is from the NSHM declustered catalog, i.e. aftershocks and foreshocks are removed.

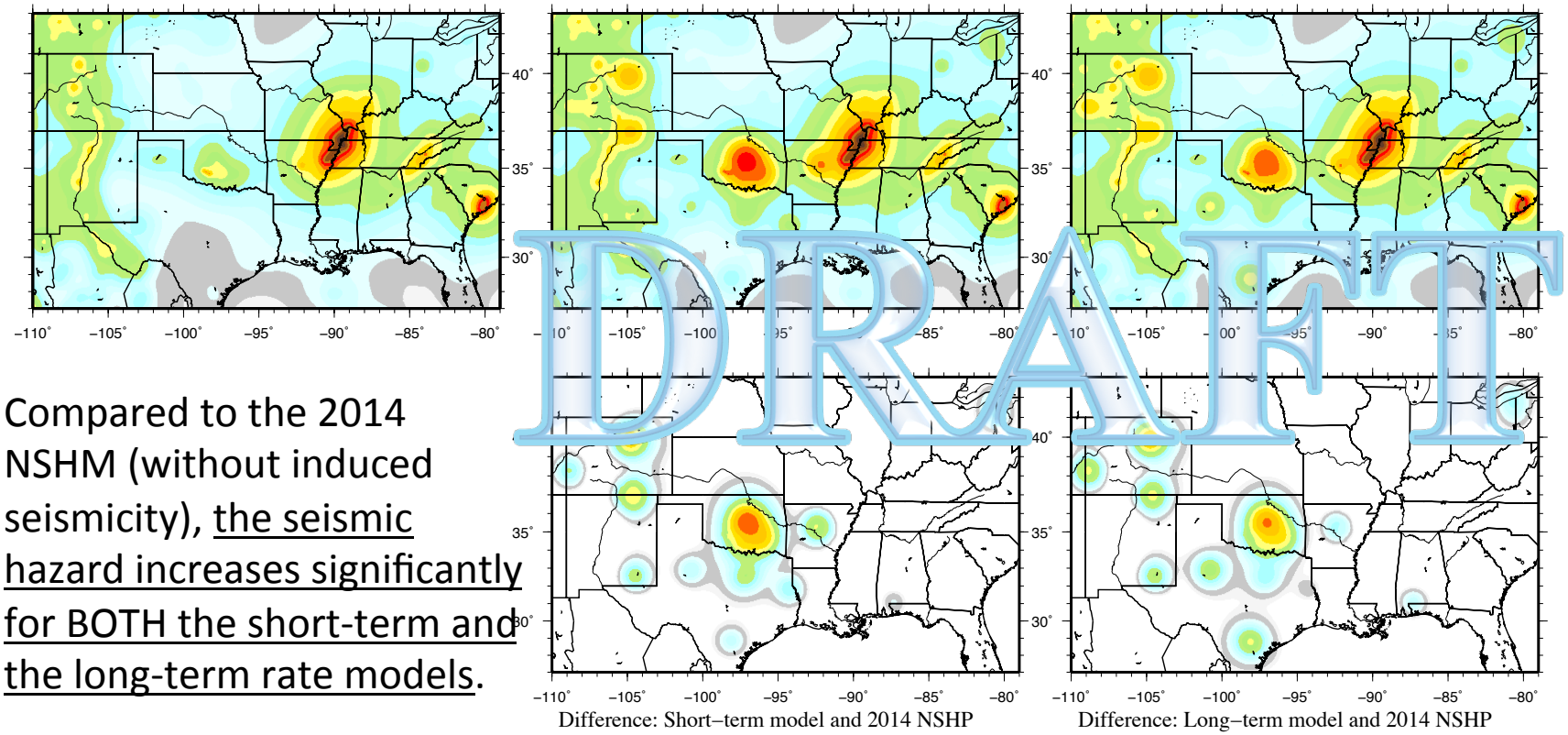


Rate Models

2014 NSHM (suspected induced events removed)

Short-term, includes induced events

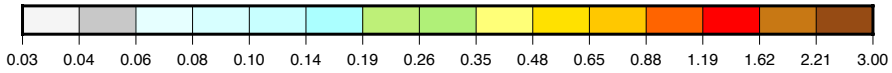
Long-term, includes induced events



Compared to the 2014 NSHM (without induced seismicity), the seismic hazard increases significantly for BOTH the short-term and the long-term rate models.

Difference: Short–term model and 2014 NSHP

Difference: Long–term model and 2014 NSHP



5 Hz, 2% probability of exceedance in 50 years (2012 and previous); Difference (bottom maps)

Maps shown in Figures are generally 2% PE of exceedance in 50 years, uniform firm rock site condition, 5 Hz spectral acceleration. Spectral acceleration is an engineering parameter that is used in building design.

What do we want to accomplish?

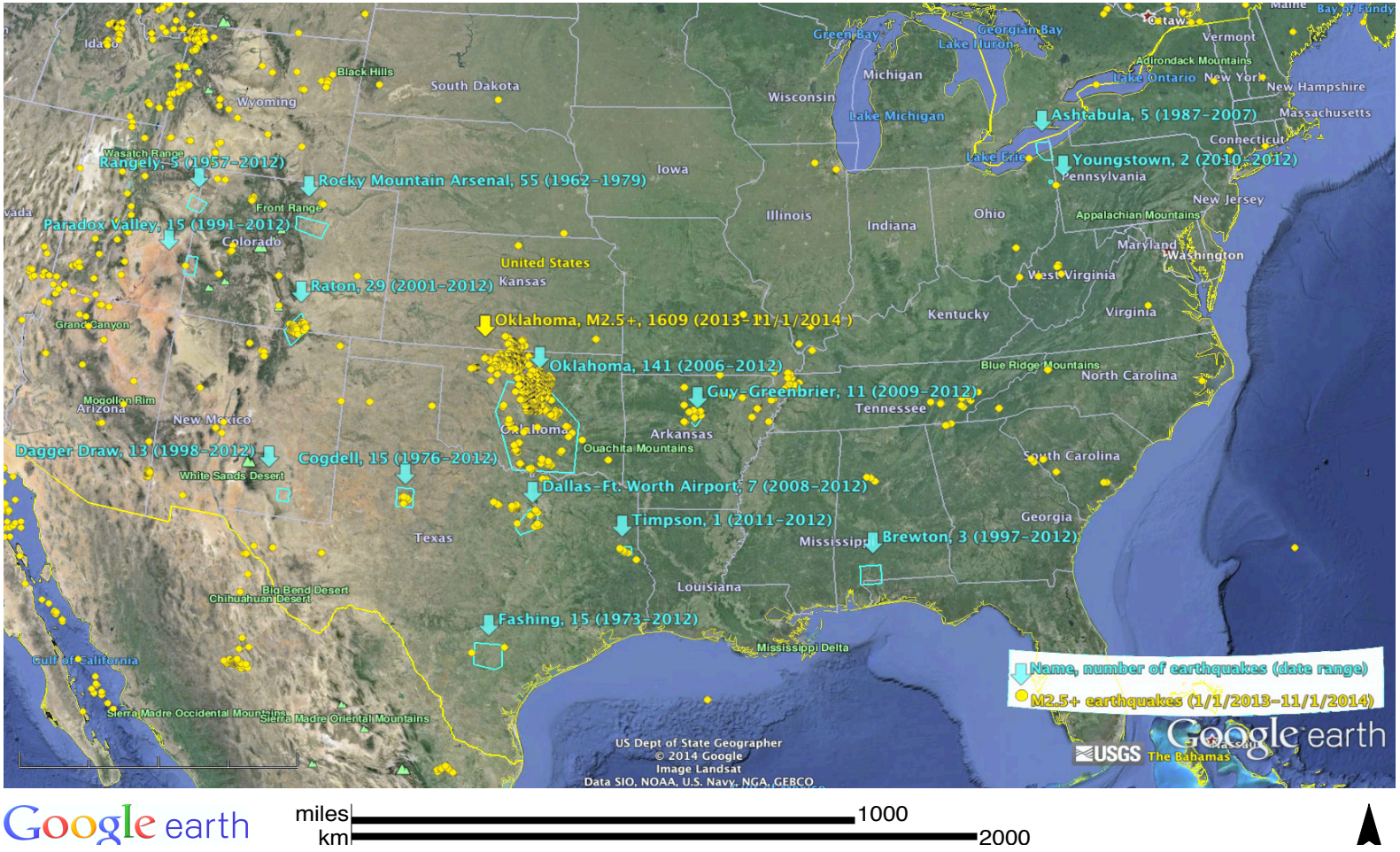
- Incorporate induced seismicity in hazard maps and assign weights to each of the following models (2014, 2015?)
  - Earthquake catalog issues: start and end times, completeness, declustering
  - Rate models: (1) long-term rates, (2) short-term rates, (3) time-dependent decay for 14 areas
  - Smoothed seismicity models
  - Maximum magnitude of induced seismicity
  - Earthquake and ground shaking characteristics

What else do we want to accomplish?

- What products do the users need?
- What data and research is needed?
- What is the future of deep injection in the U.S.?

Concerns: recent earthquakes

USGS ComCat: 1/1/2013 to 11/1/2014, M2.5+



Seismicity since 2014 maps has migrated and the rates have increased. Hazard maps need to be updated to account for changes like these. We want to update the 2014 model and think about future updates.