Combination of Observations

Jonathan Auerbach

SUSTAINABILITY

Did Fracking Cause Oklahoma's Largest Recorded Earthquake?

Probably not, as the gas drilling practice tends to be associated with minor quakes, not big ones, seismologists say

By Charles Q. Choi on November 14, 2011 18

As to whether the spike in earthquakes recently seen in the state might be due to fracking, "it is probably best not to attach much significance to perceived increases in seismic activity in Oklahoma—the occurrence of earthquakes anywhere is quite irregular," says seismologist Art McGarr with the U.S. Geological Survey. This surge in quakes might be a temporary statistical anomaly.

Humans Behind Strongest Oklahoma Quake Ever Recorded, Research Suggests

By Andrea Mustain | April 19, 2012 04:10pm ET

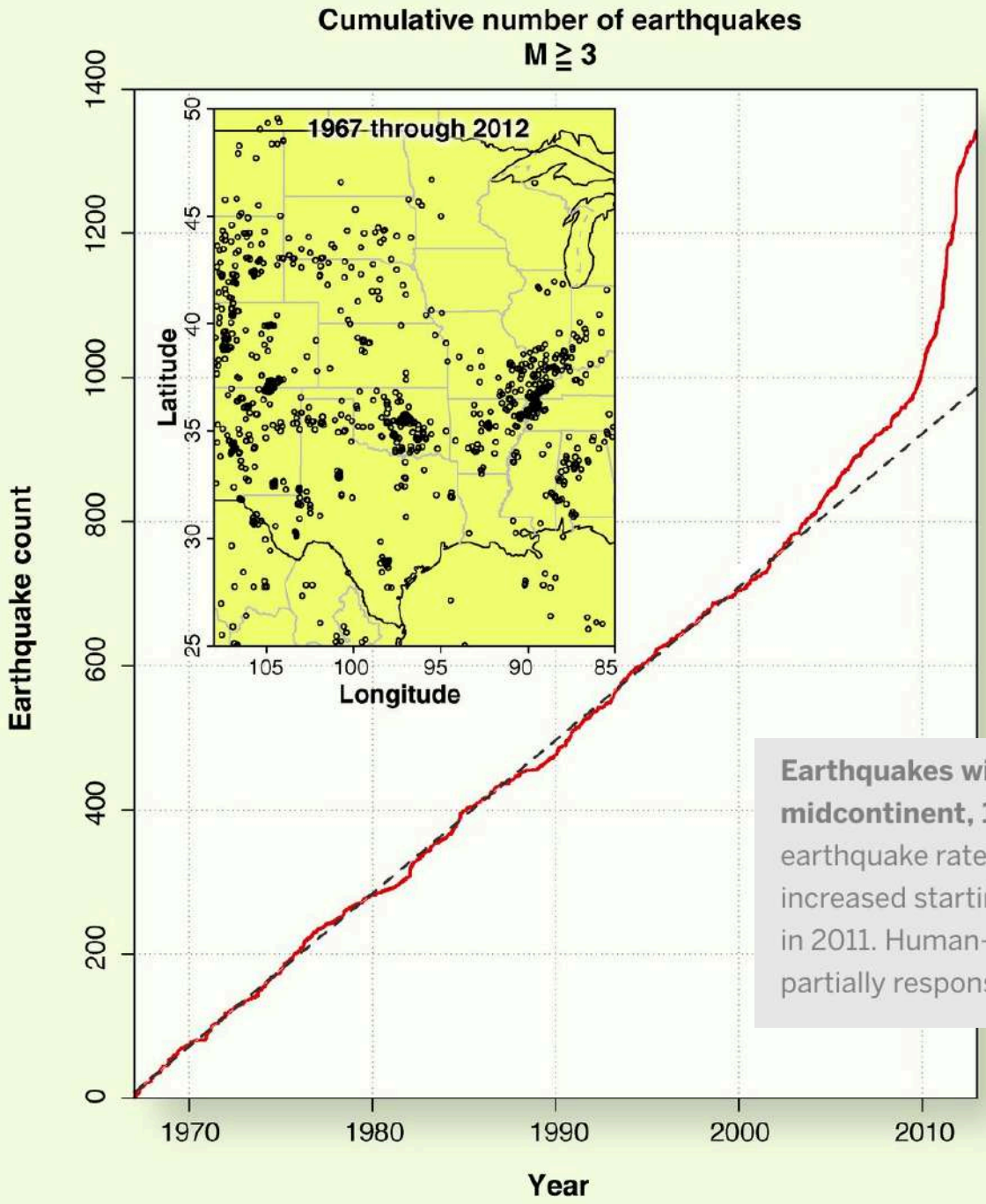
Research presented here at the annual meeting of the Seismological Society of America today (April 18) suggests the quake could be related to an industrial practice of injecting fluids deep into the Earth.

"This is part of a growing number of cases of earthquakes caused by fluid injection — and if it was found to be linked, this would be the largest," said Steve Horton, a research scientist at the University of Memphis's Center for Earthquake Research and Information.

In October, 2013, the U.S.G.S. and the O.G.S. issued a joint press release warning that the chance of an earthquake of magnitude 5.5 or higher had "significantly increased." The release quoted a statement that Oklahoma has "always been earthquake country," but no reference to Oklahoma as "earthquake country"—a consistent talking point of the O.C.C. and the O.G.S.—can be found in any database predating the recent earthquakes.

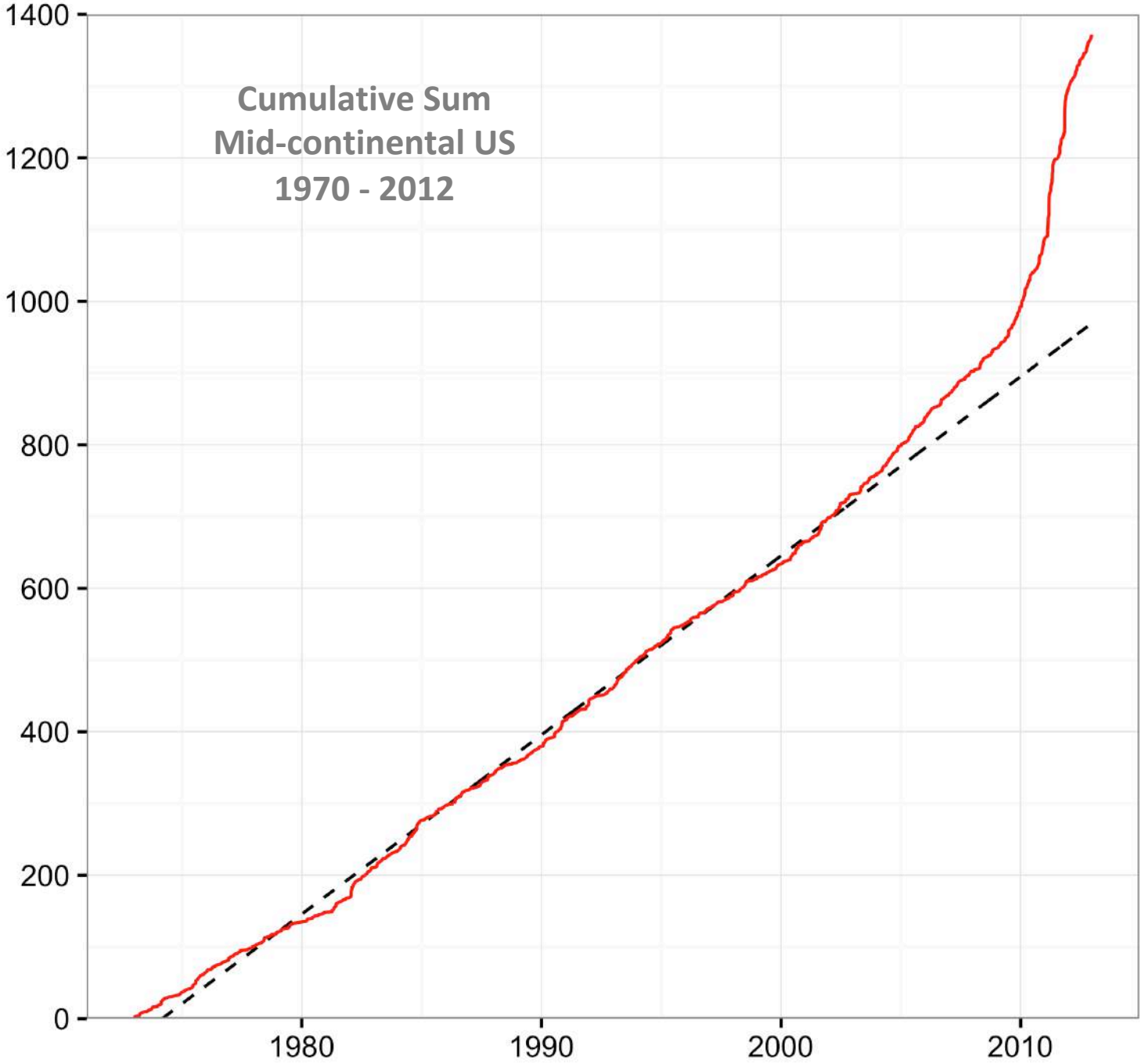
The November 2011 central Oklahoma earthquake sequence initiated very close to a pair of wastewater-injection wells where disposal operation began 18 years earlier (**16**). No unusual seismicity was detected in this historically quiet region, where only a few events of $M < 2$ were noted, until a M_w 4.1 earthquake occurred near the wells in early 2010. Aftershocks of this event continued sporadically through 2010 and into mid-2011. This decaying sequence was shattered by a M_w 5.0 earthquake on 5 November 2011, followed 20 hours later by the M_w 5.7 mainshock. With the initiating point of the November sequence within 1.5 km of the injection wells and some earthquake hypocenters at the same depth as injection, the potential for a causal connection between injection and the earthquakes is clear. The long delay between the start of injection and the earthquakes, however, deviates from the pattern seen in other documented cases of injection-induced seismicity, such as the 2011 Youngstown, Ohio, earthquake where there was, at most, a few months of delay before induced seismicity began. In the Oklahoma case, years of injection may have been needed to raise the pore pressure above the preproduction level in this depleted oil field before fault strength was exceeded (**16**).

Injection-Induced Earthquakes **by**
William Ellsworth



Earthquakes with magnitude (M) 3 in the U.S. midcontinent, 1967–2012. After decades of a steady earthquake rate (average of 21 events/year), activity increased starting in 2001 and peaked at 188 earthquakes in 2011. Human-induced earthquakes are suspected to be partially responsible for the increase.

Injection-Induced Earthquakes **by William Ellsworth**



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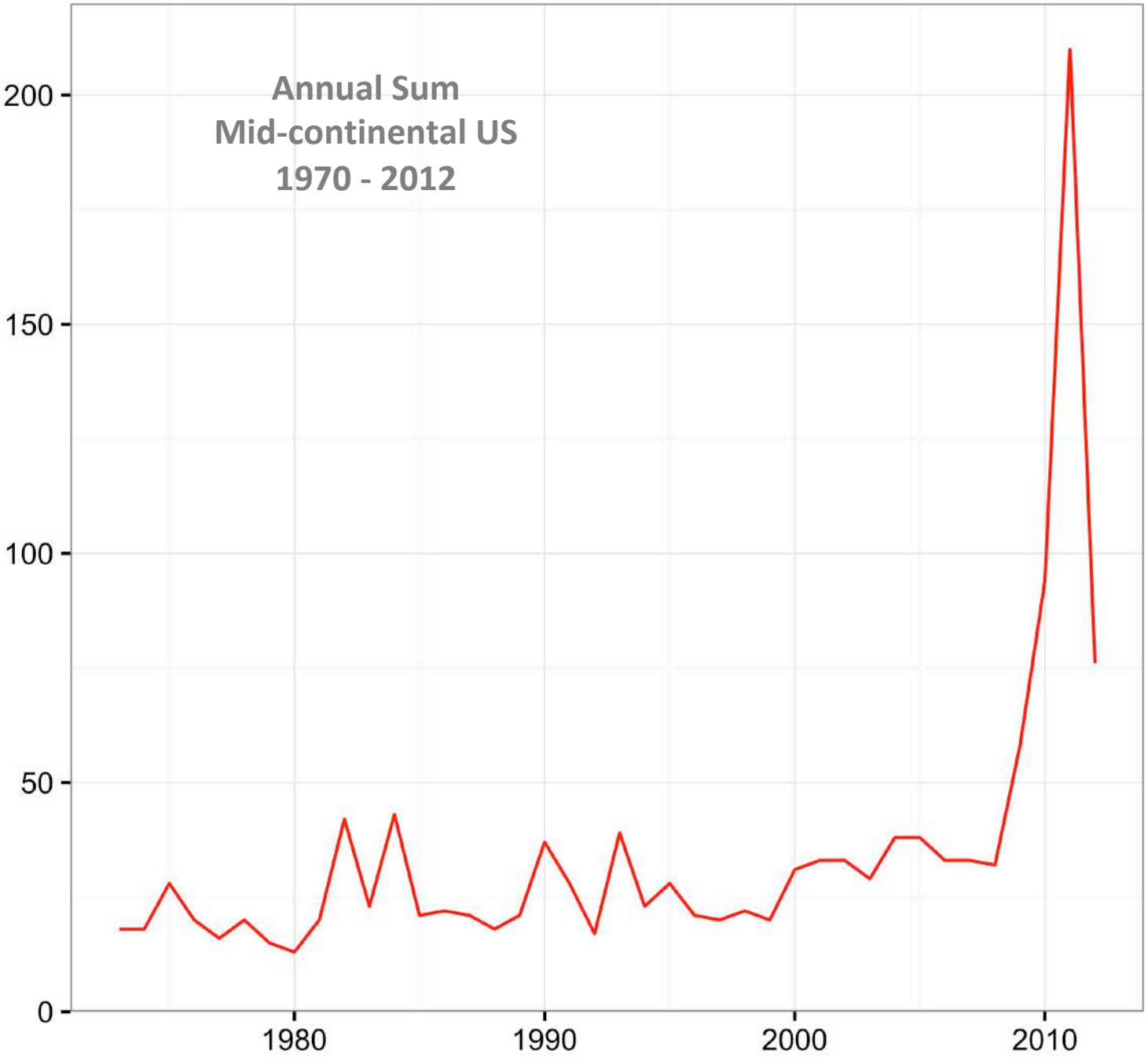

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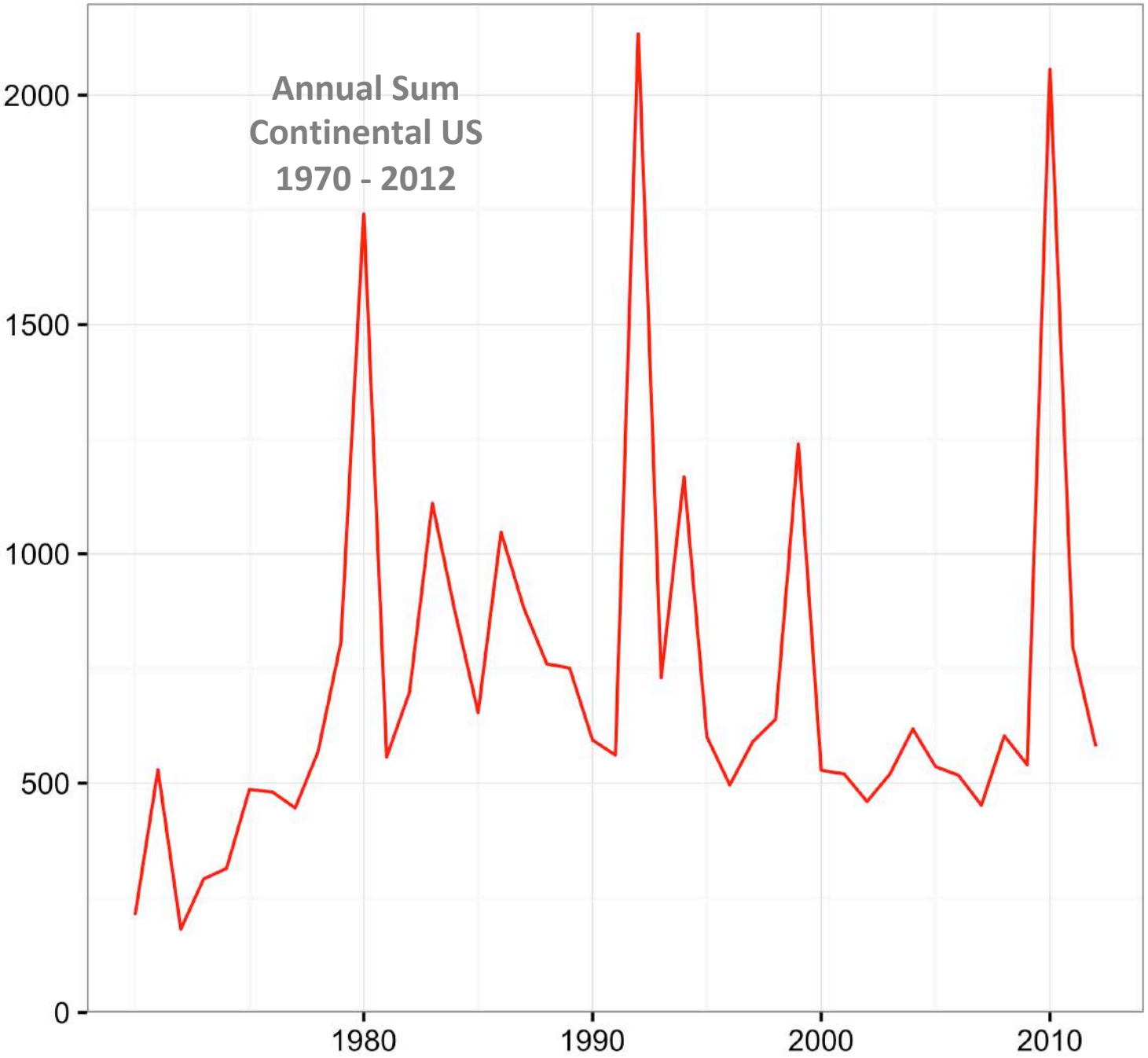

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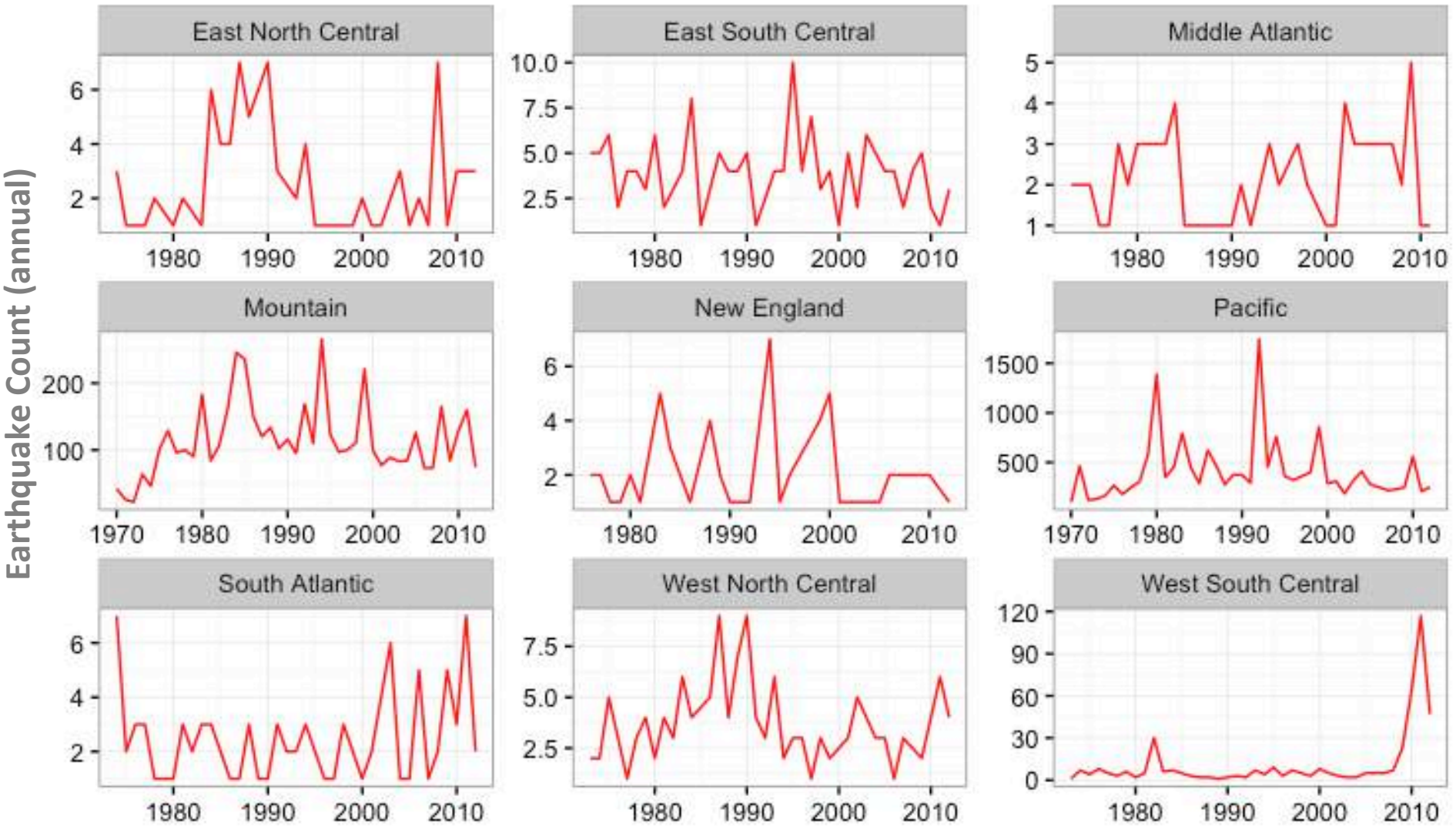
Annual Sum
US Division
1970 - 2012



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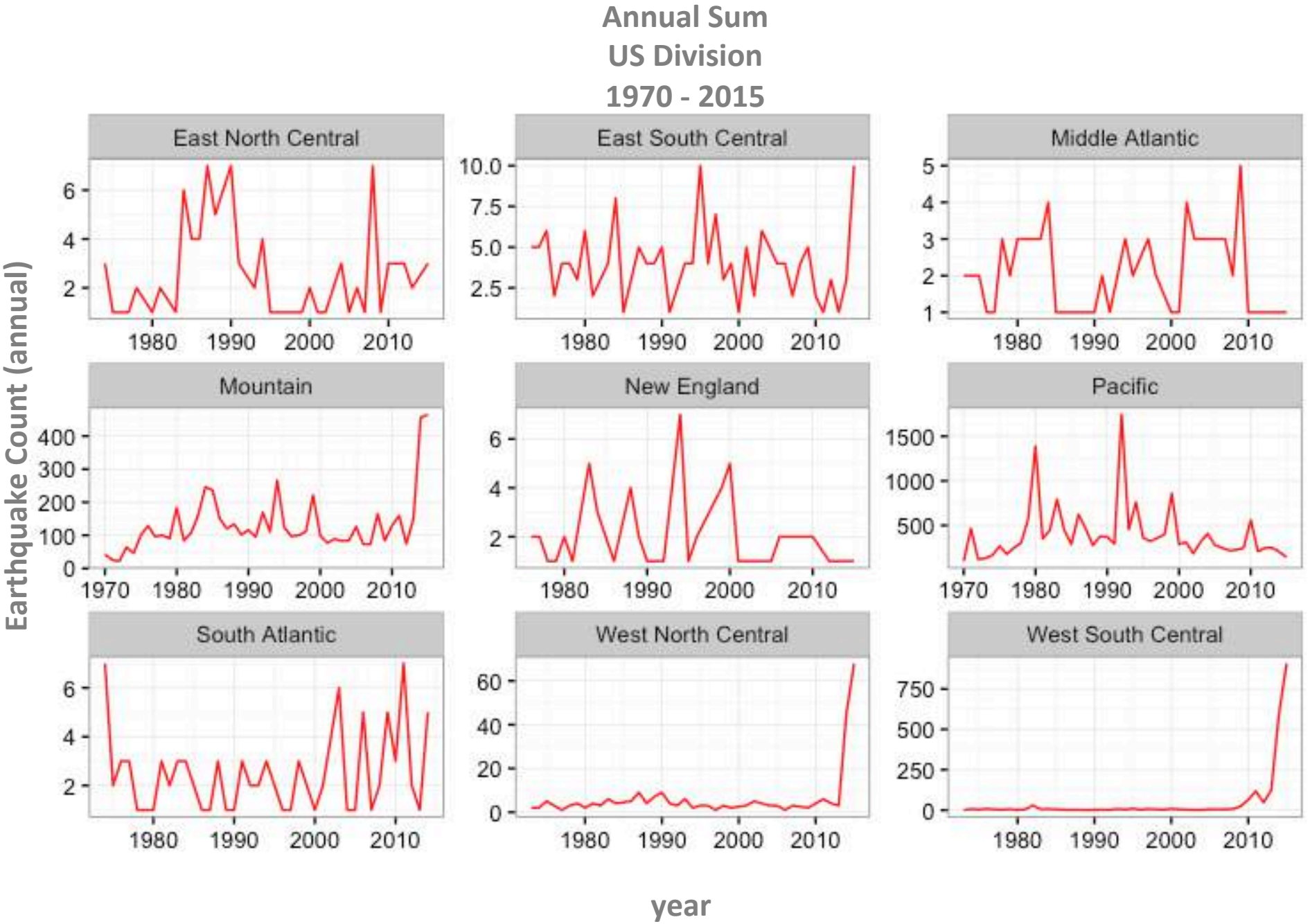

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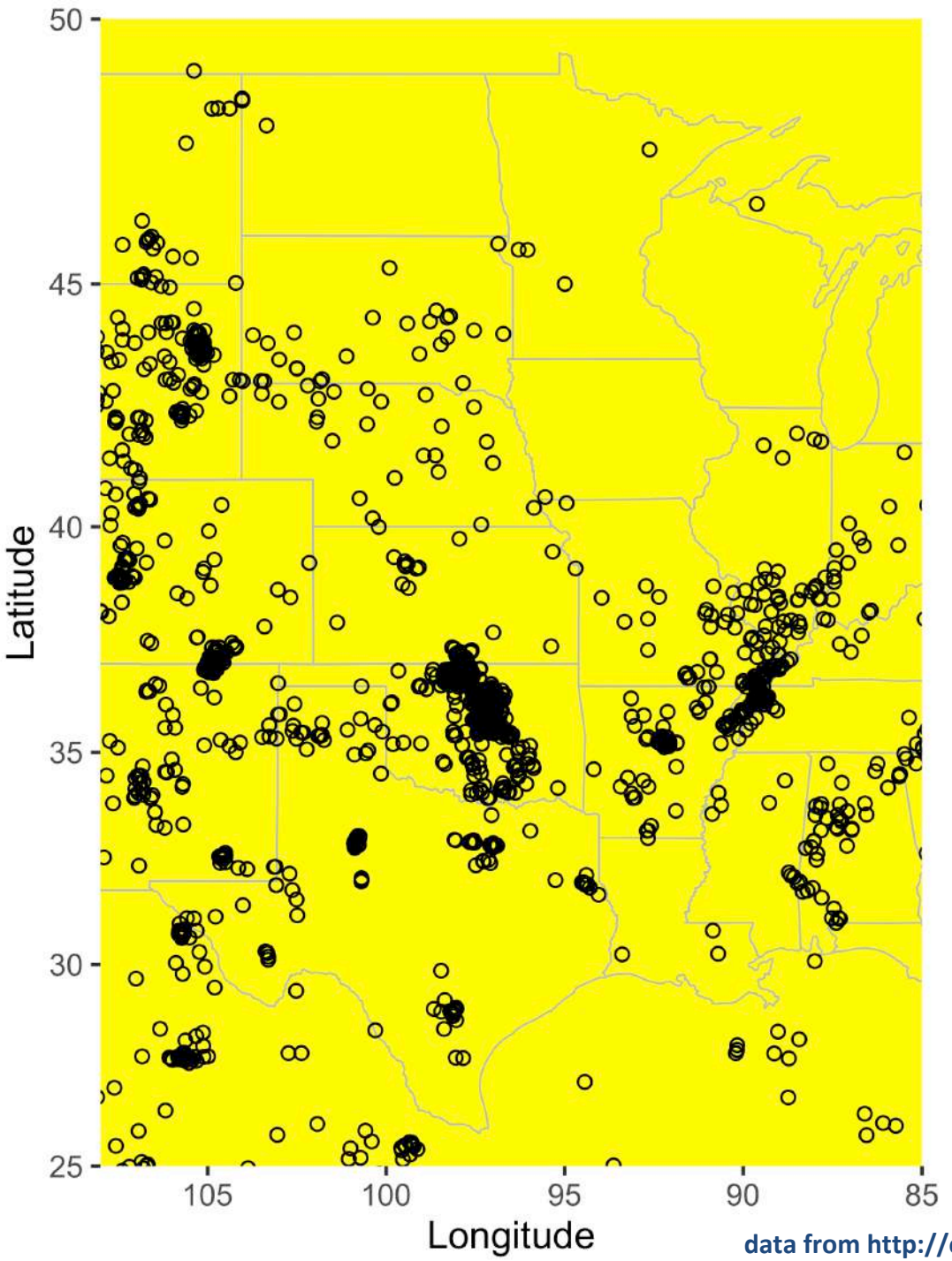
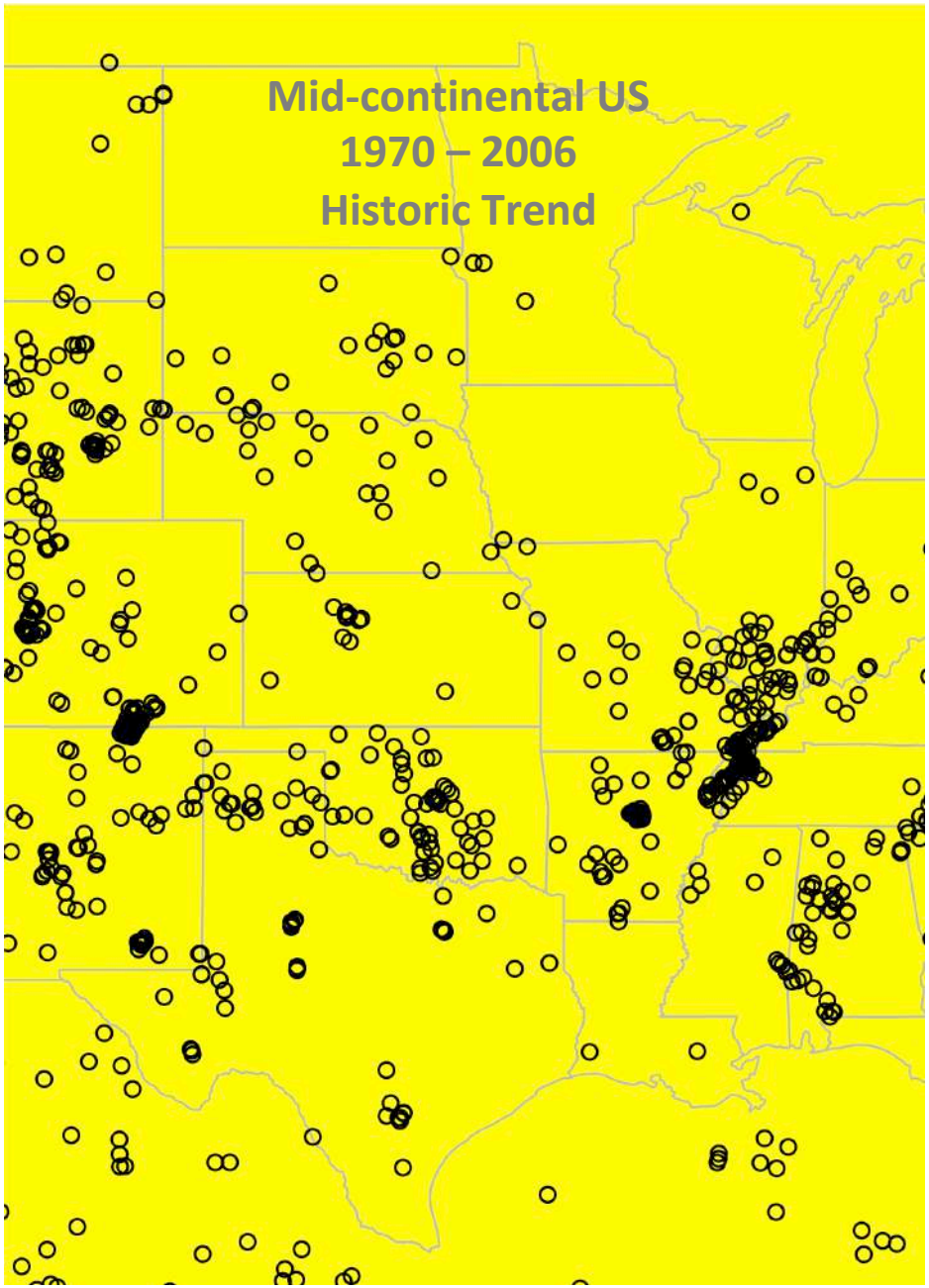
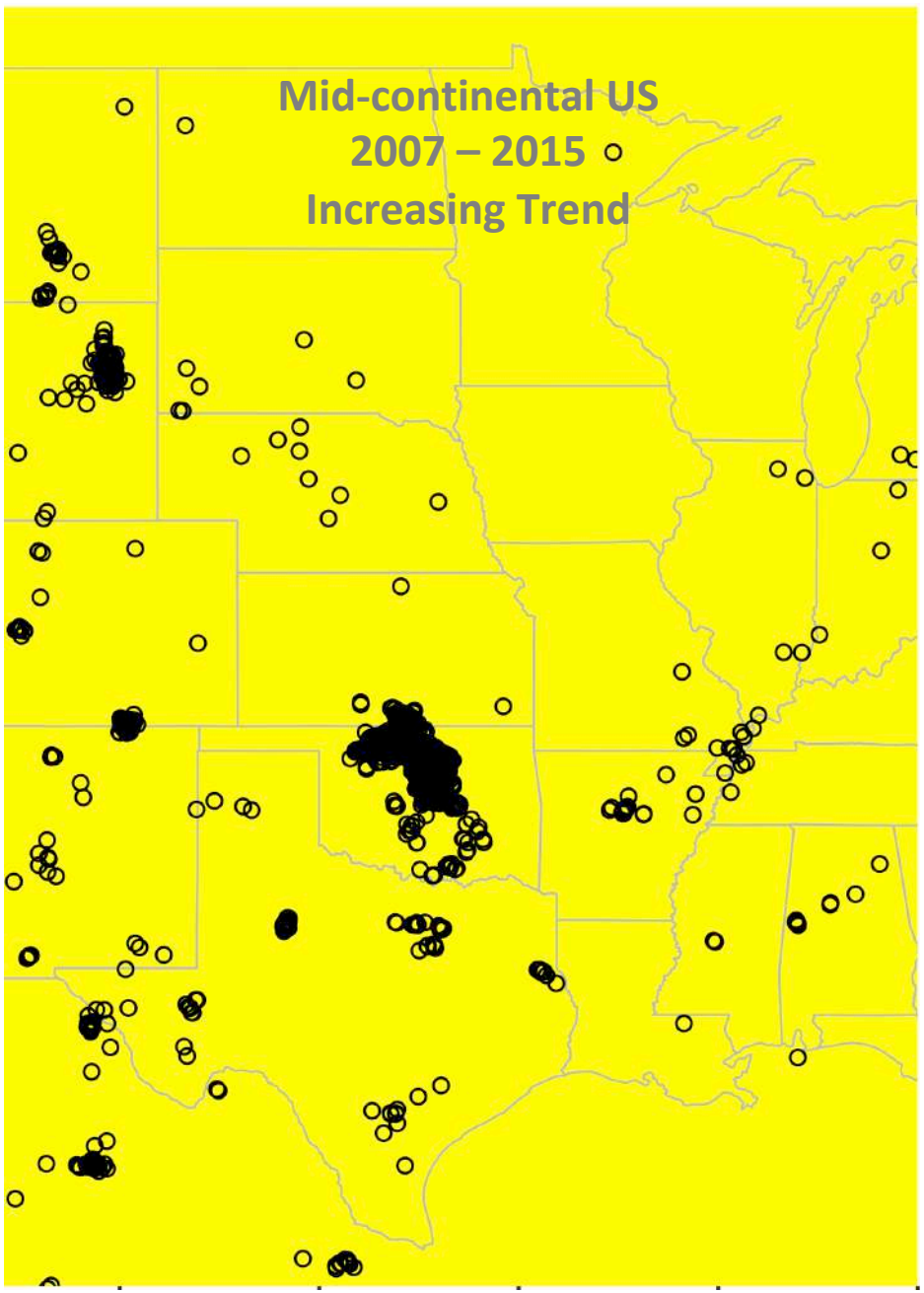


Mid-continental US
1970 - 2012

data from http://earthquake.usgs.gov/earthquakes/search/





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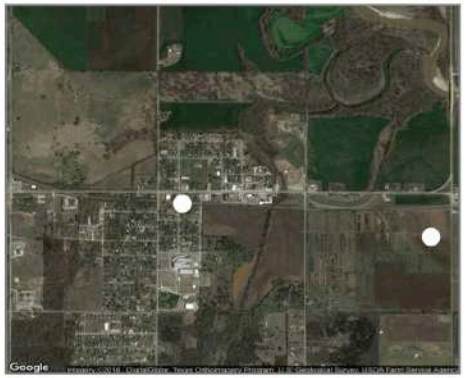
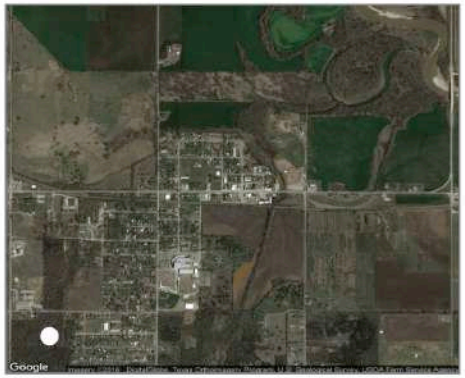
2007

2008

2009



2010



2011

2012

2013

2014

2015

Town of Jones, OK

2007

2008

2009

2010

2011

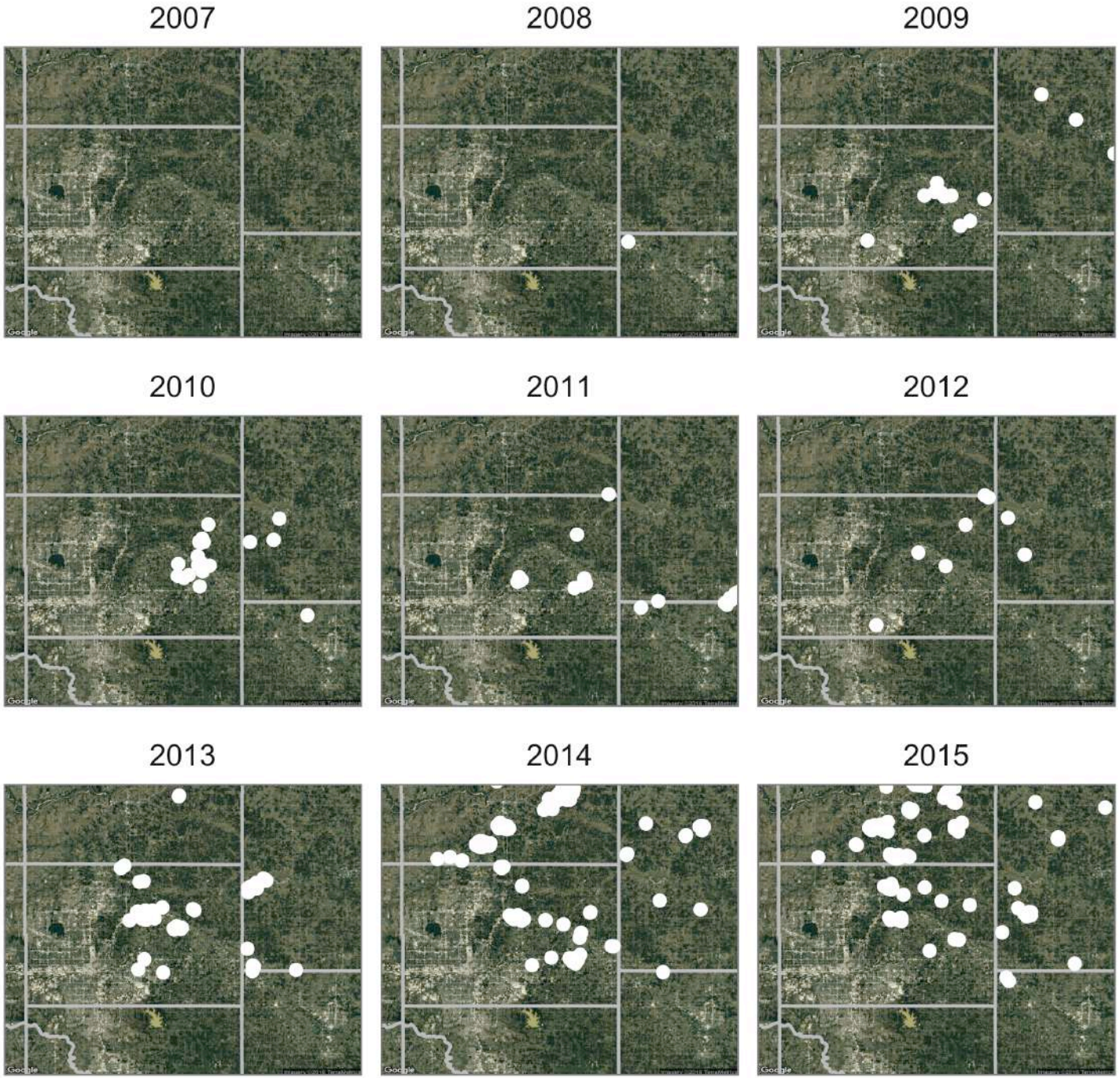
2012

2013

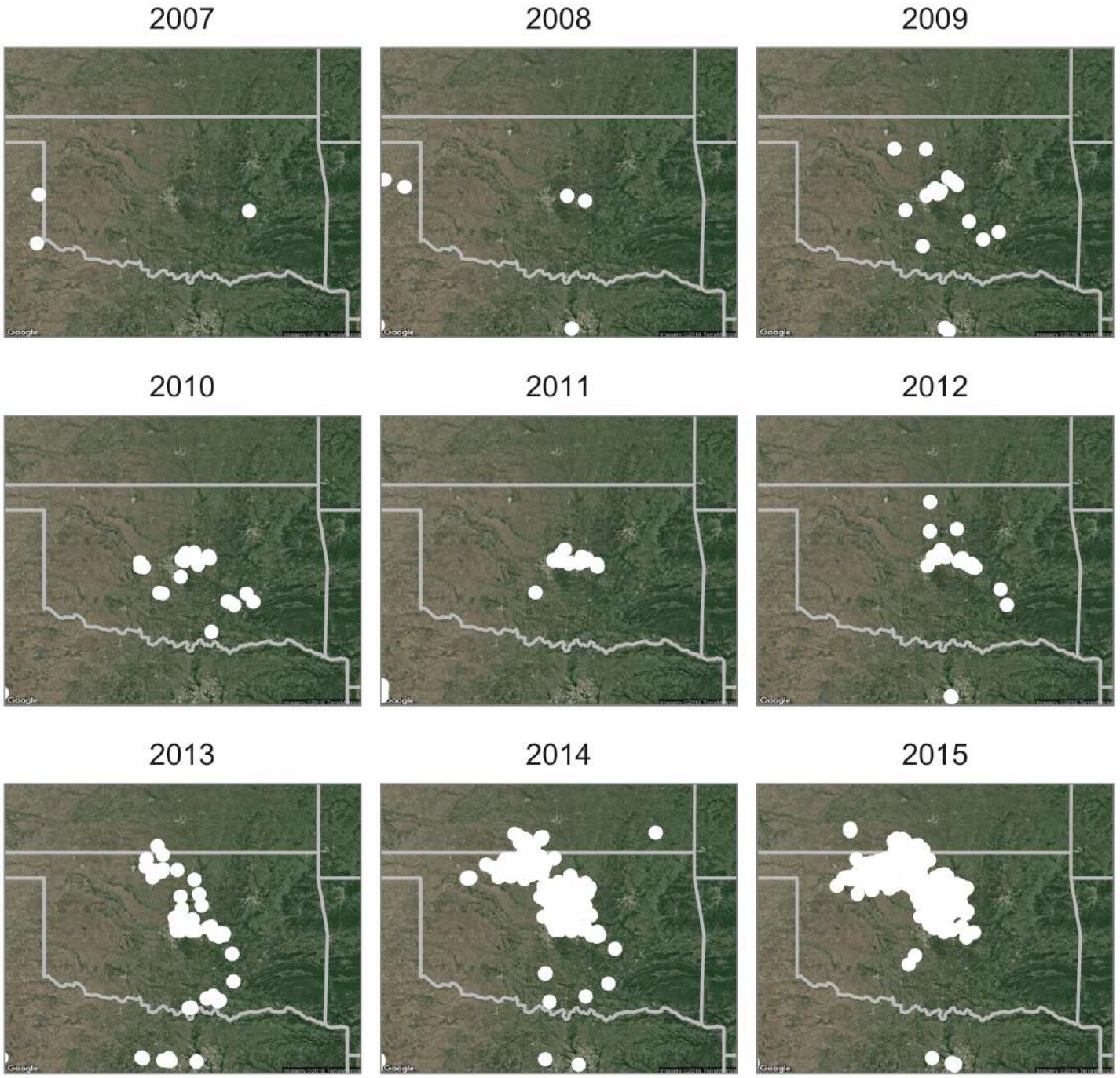
2014

2015

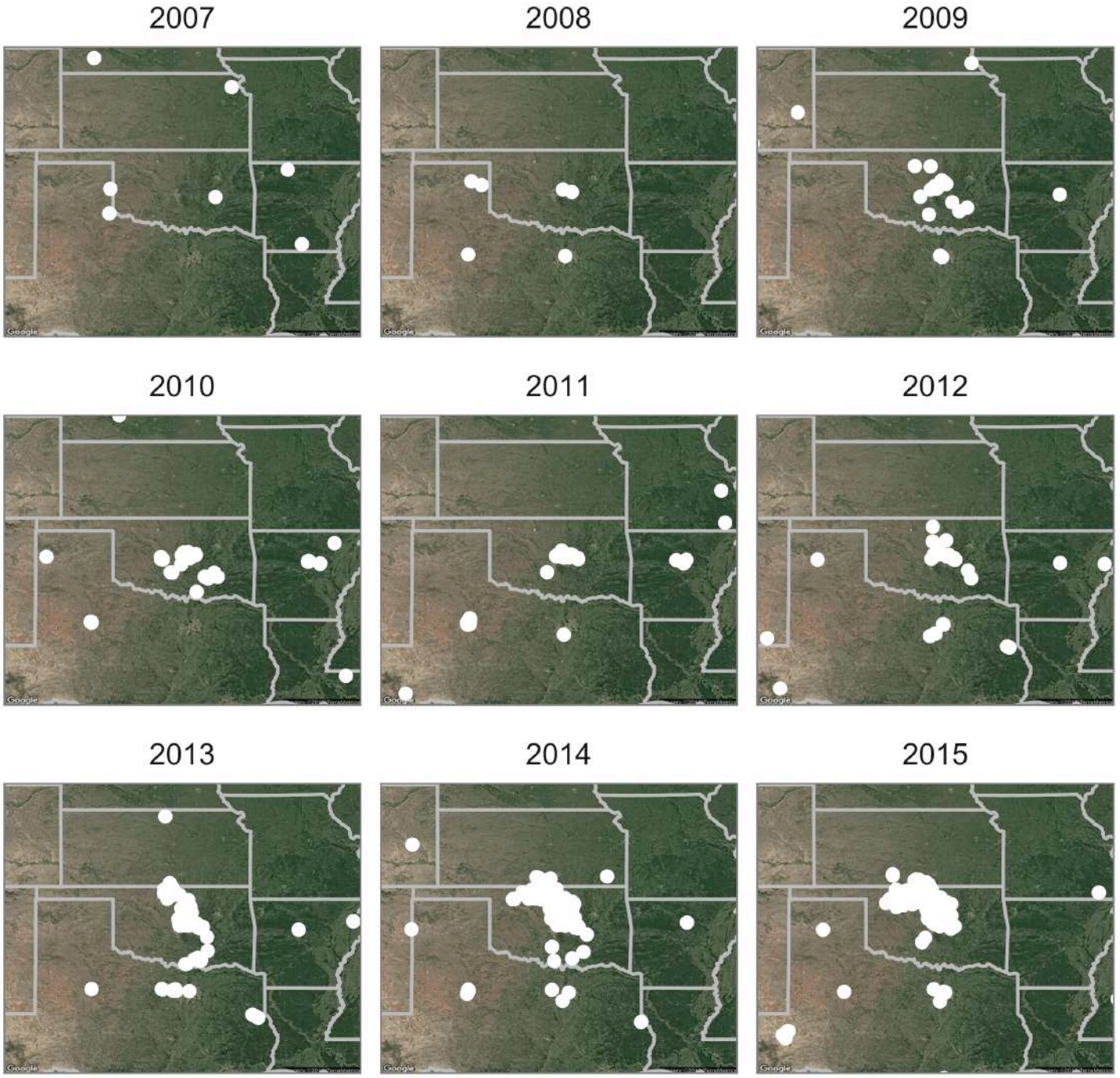
Township 13N
Range 1W



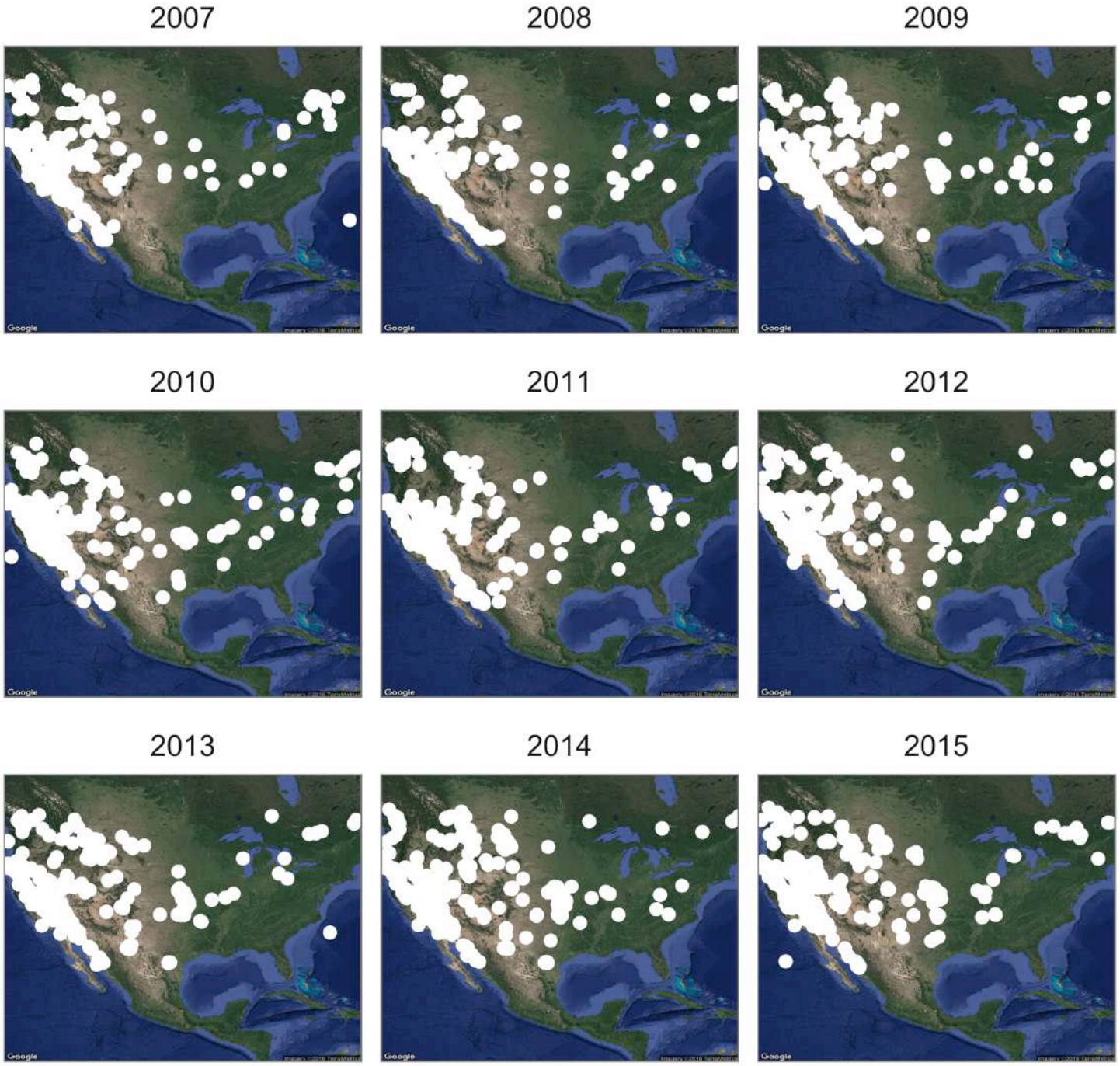
Oklahoma County

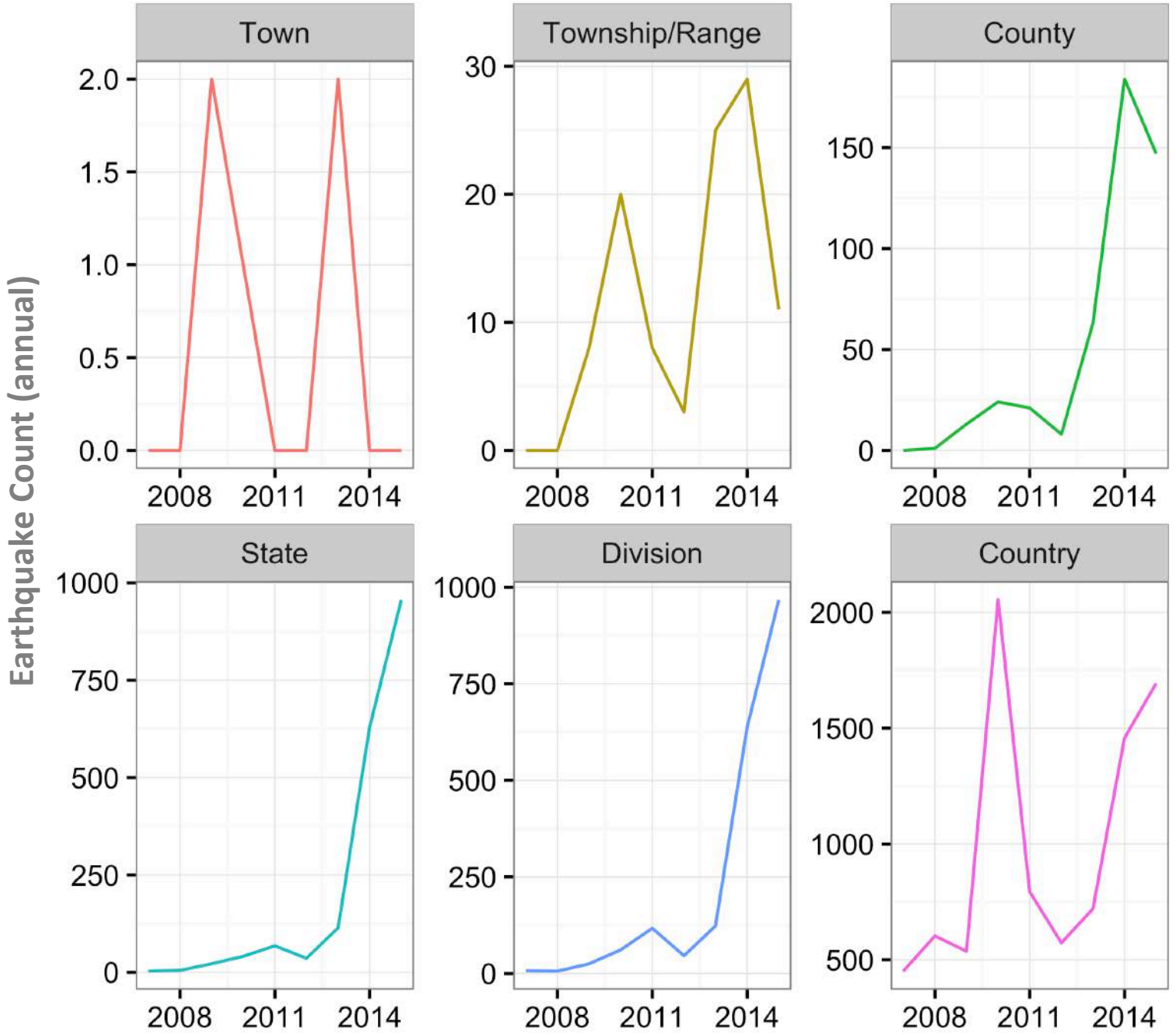


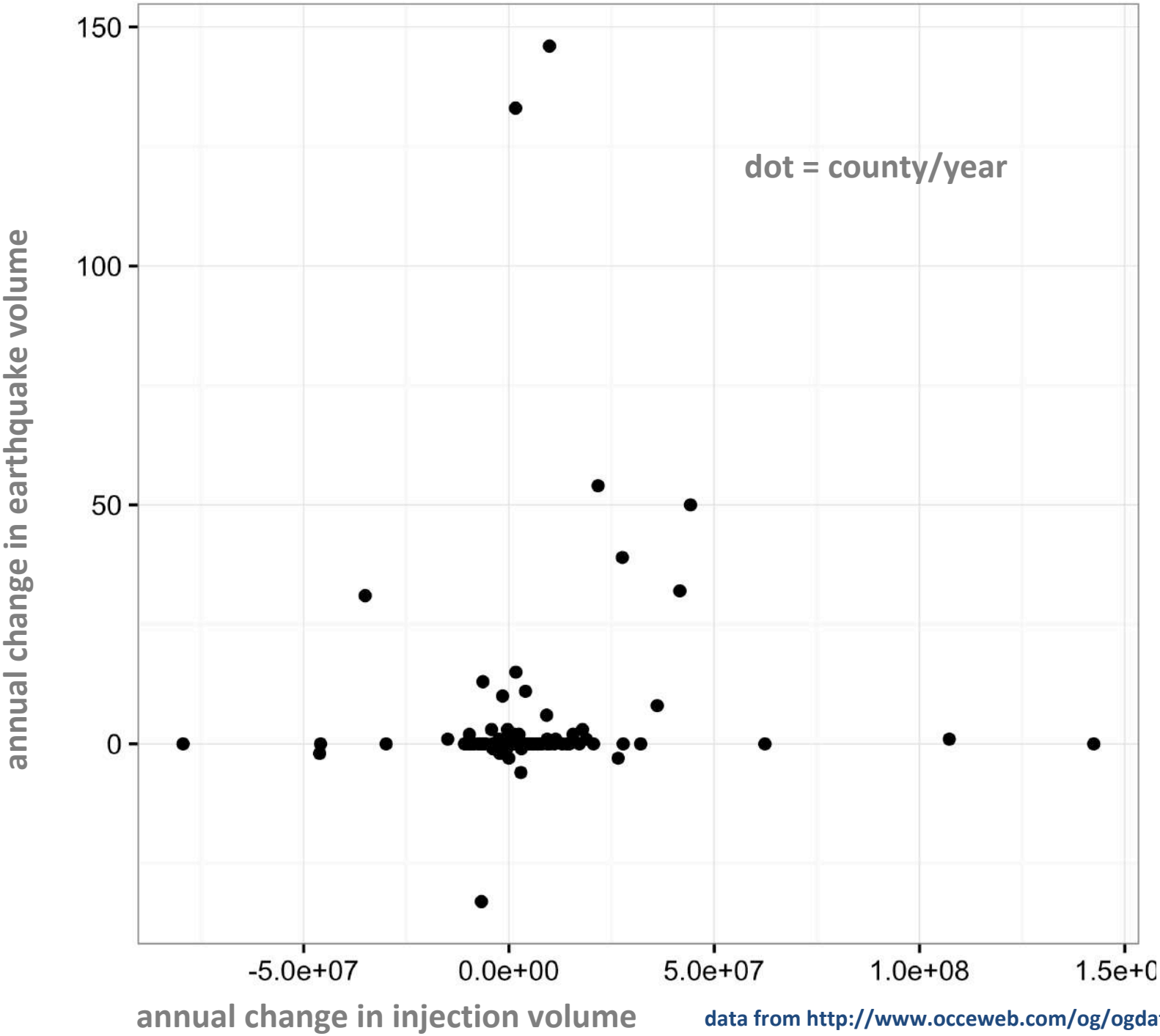
Oklahoma State



West South Central


2007
2008
2009
2010
2011
2012
2013
2014
2015
United States


Earthquake Count (annual)
Town
Township/Range
County
State
Division
Country
2008
2011
2014



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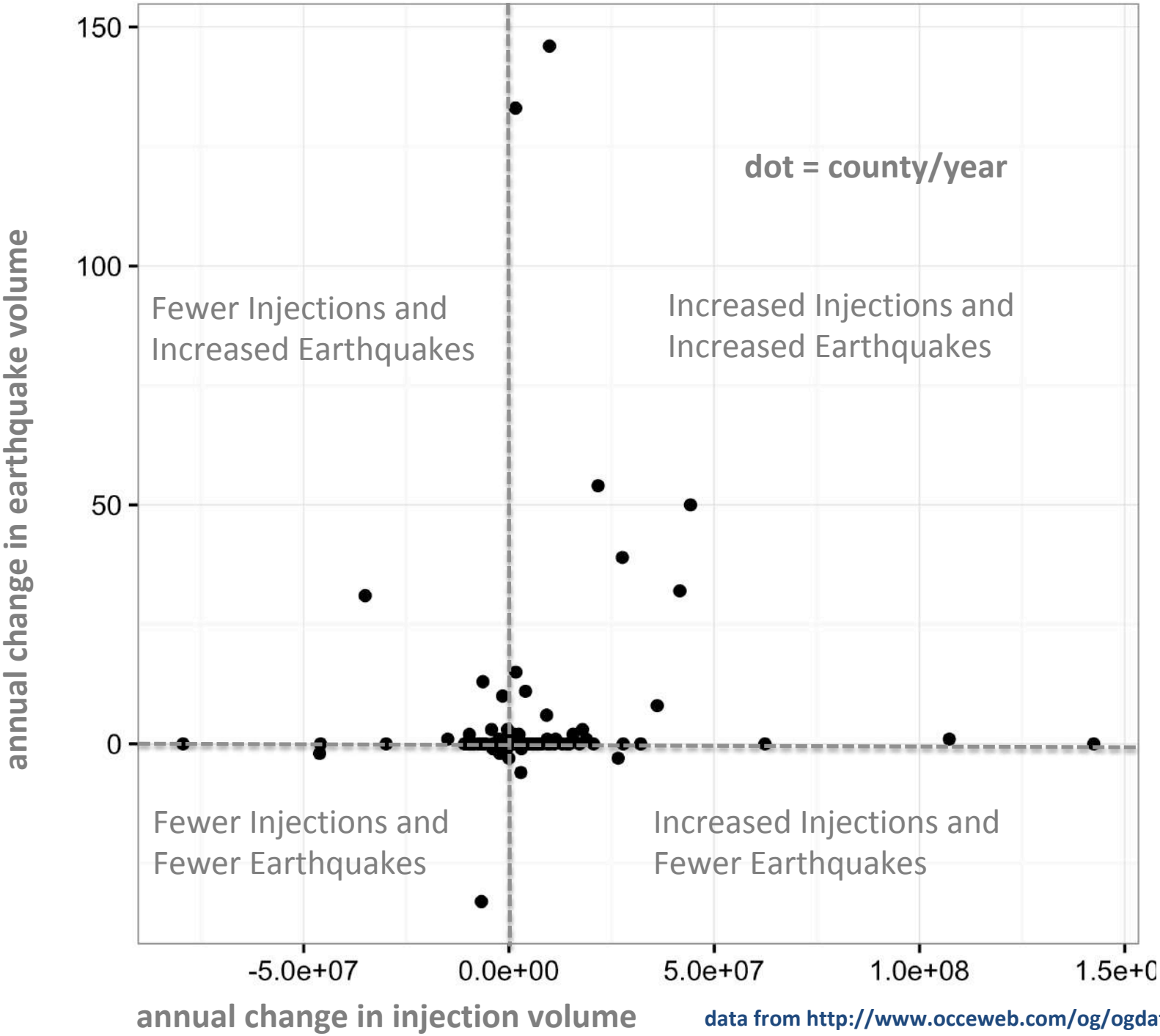

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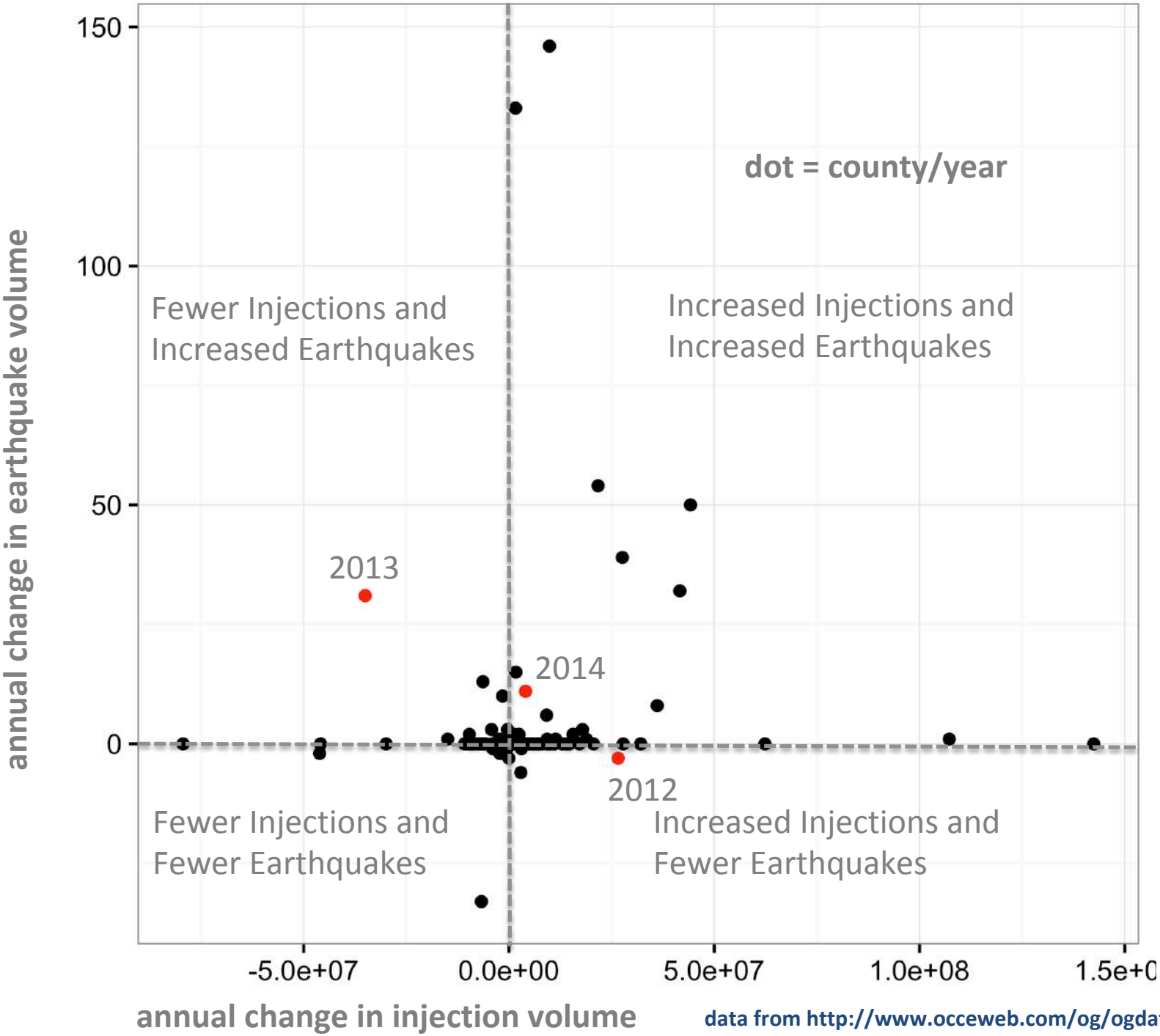

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