Hazard From Seismicity

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Organizing Principles: CEUS sources

1) Specific faults
   - New Madrid, Charleston, Meers, Cheraw
   - recurrence from paleoseismology
2) Historical seismicity (gridded & smoothed)
   - future earthquakes will occur near past earthquakes
   - alternative to source zones
   - controls hazard in much of the CEUS
3) Large background zones based on geology
   - protection in areas with little historical seismicity, but the potential for damaging earthquakes

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Implementation

- Catalog (m_b)
- Regional completeness & *b*
- Four "background" seismicity models:
  1) Model 1: rate of mag ≥ 3
  2) Model 2: rate of mag ≥ 4
  3) Model 3: rate of mag ≥ 5
  4) Model 4: regional "floor"
- Smoothing (2-D Gaussian): 50 km for M1, 75 km for M2 & M3
- Adjust rates for optimistic completeness
- Final rates: weighted sum of Models 1–4

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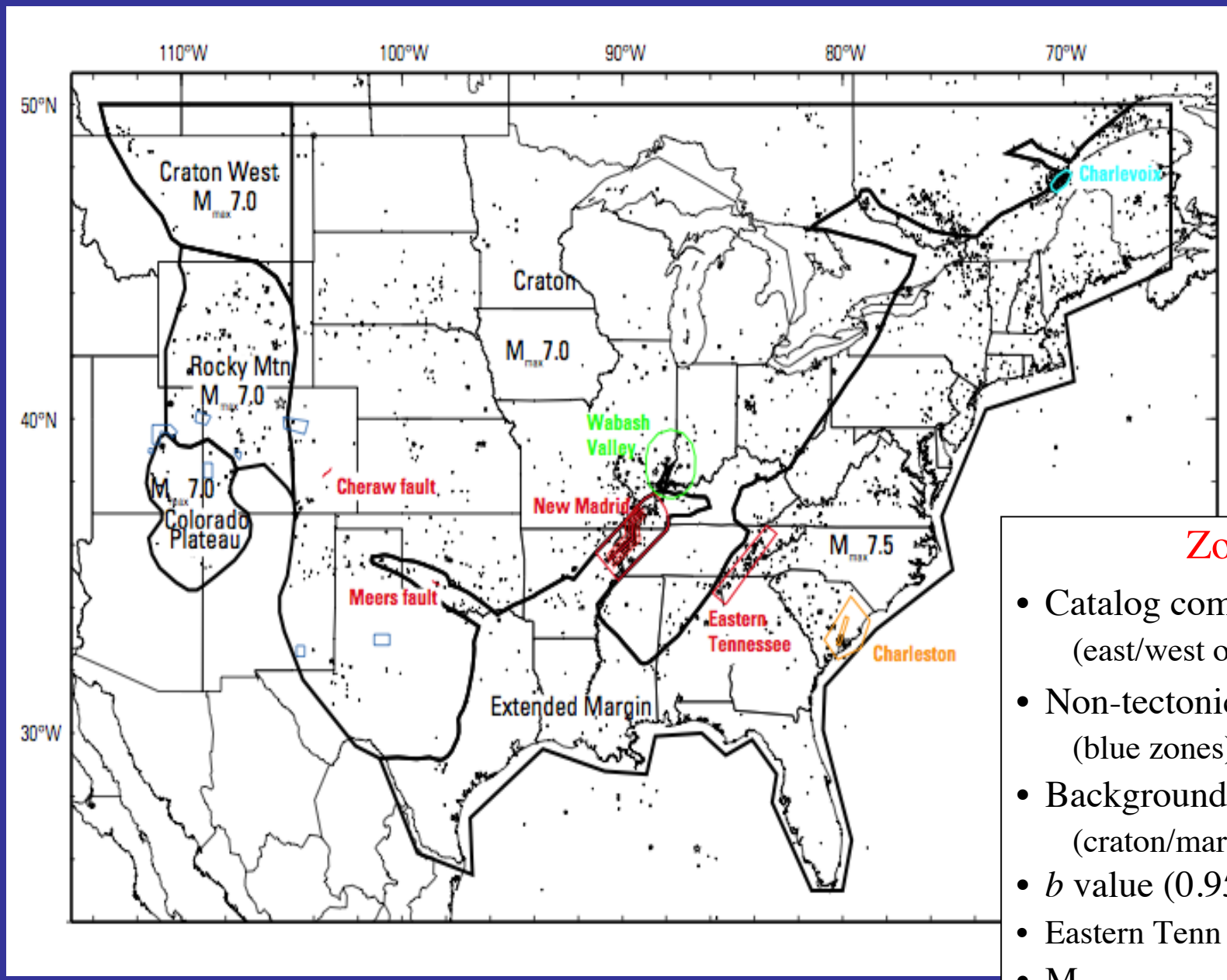

Zones

- Catalog completeness
  (east/west of longitude -105)
- Non-tectonic earthquakes
  (blue zones)
- Background rates
  (craton/margin/rm/cp)
- *b* value (0.95 & 0.76)
- Eastern Tenn & New Madrid
- M_{max}
  craton,rm,cp M_W7.0
  margin,wabash M_W7.5

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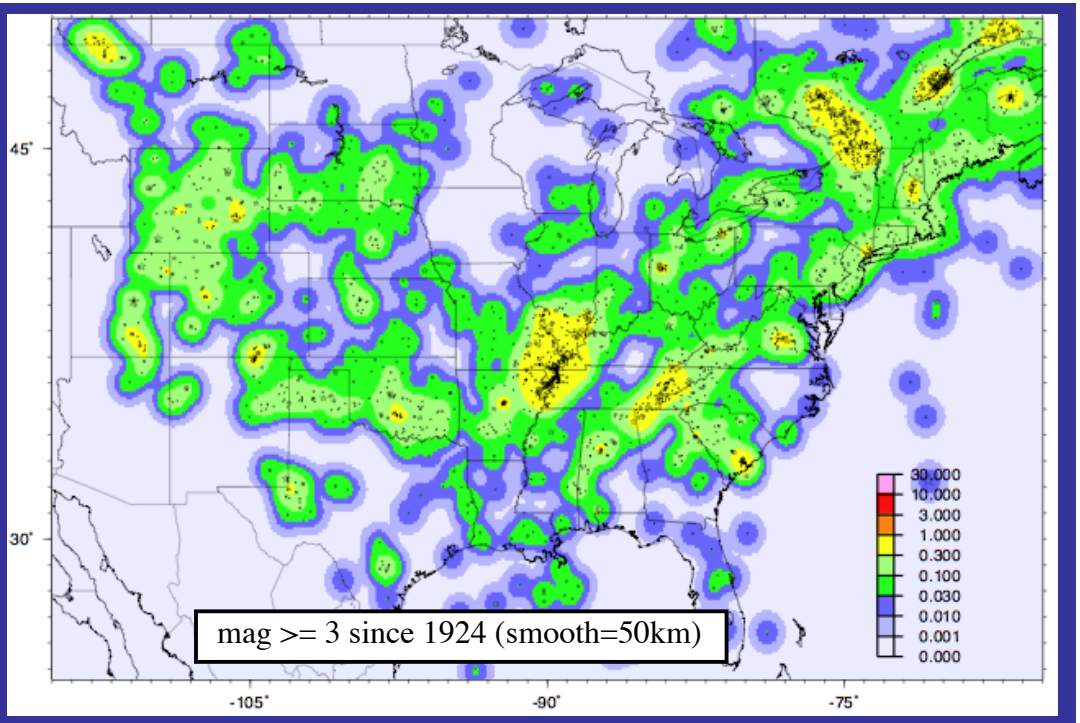
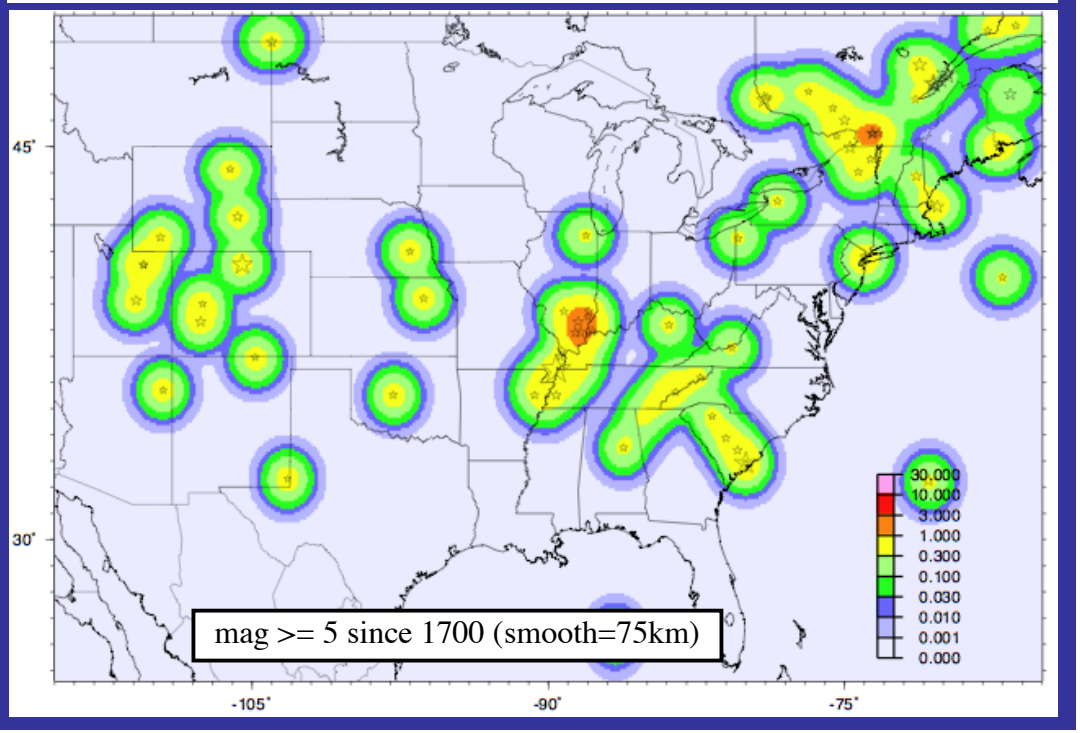
Smoothed Seismicity:

Avoid judgments about the seismogenic potential of enigmatic tectonic features

Assume that future eqks will occur near past eqks





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Why 3 Gridded Seismicity Models?

- The maximum-likelihood method counts a magnitude-5+ eqk the same as a small eqk
- In places where moderate-size eqks have occurred, but small eqks are under-represented (*e.g.,* the Nemaha Ridge), a single model may underestimate the hazard
- Can think of it like a localized, variable *b* value

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Combining rate grids ("adaptive weighting")

- Define "historical" rate =

  (Model 1 x 0.50) + (Model 2 x 0.25) + (Model 3 x 0.25)

- If historical rate > background rate: final rate = historical
- Otherwise: final rate = historical x 0.8 + background x 0.2
- Implications:
  - If historical = 0, then final = 20% of the observed regional average rate
  - Nowhere is final < historical
  - Violates the CEUS historical seismicity budget by ~ 10%

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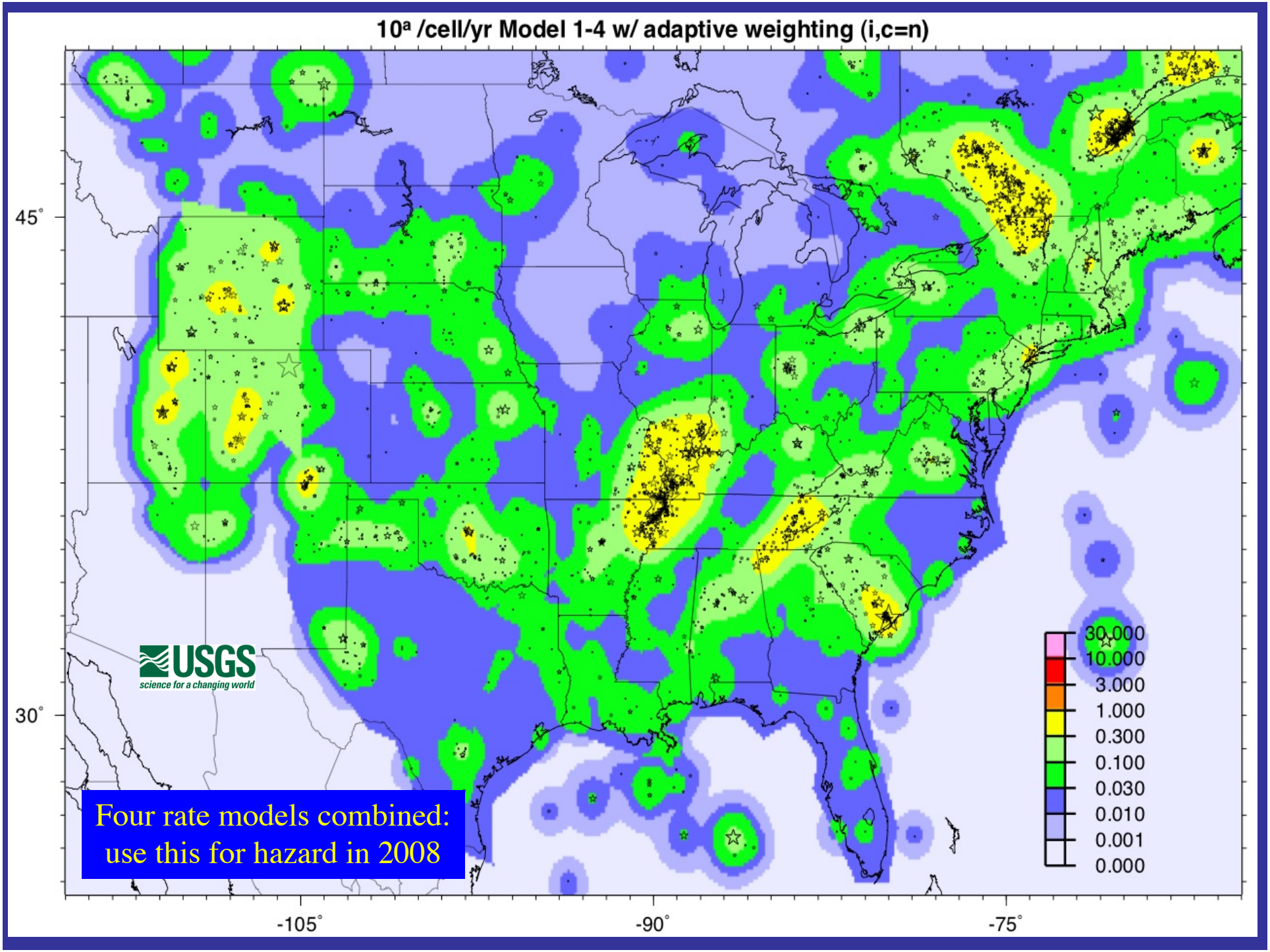
10ª /cell/yr Model 1-4 w/ adaptive weighting (i,c=n)
45°
30°
-105°
-90°
-75°
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30.000
10.000
3.000
1.000
0.300
0.100
0.030
0.010
0.001
0.000
Four rate models combined:
use this for hazard in 2008

Hazard comparisons (seismicity only)

&

Implications of possible switch to M_W

- ✓ NSHM m_b & CEUS-SSC M_W catalogs:
  - 1700-2006, Gardner & Knopoff decluster
  - Exclude Charlevoix & New Madrid
  - Get unique completeness levels & *b* values for each
- ✓ For comparisons:
  - One seismicity rate model for each catalog (*not* M1-4)
    - Use unique completeness & *b*
    - 50km smoothing
  - Mmax: use NSHM 2008
  - m_b: *b* = 0.945, $m_b$min = 5.0, "m_b" GMPEs
  - M_W: *b* = 1.069, $M_w$min = 4.7 or 5.0, M_W GMPEs

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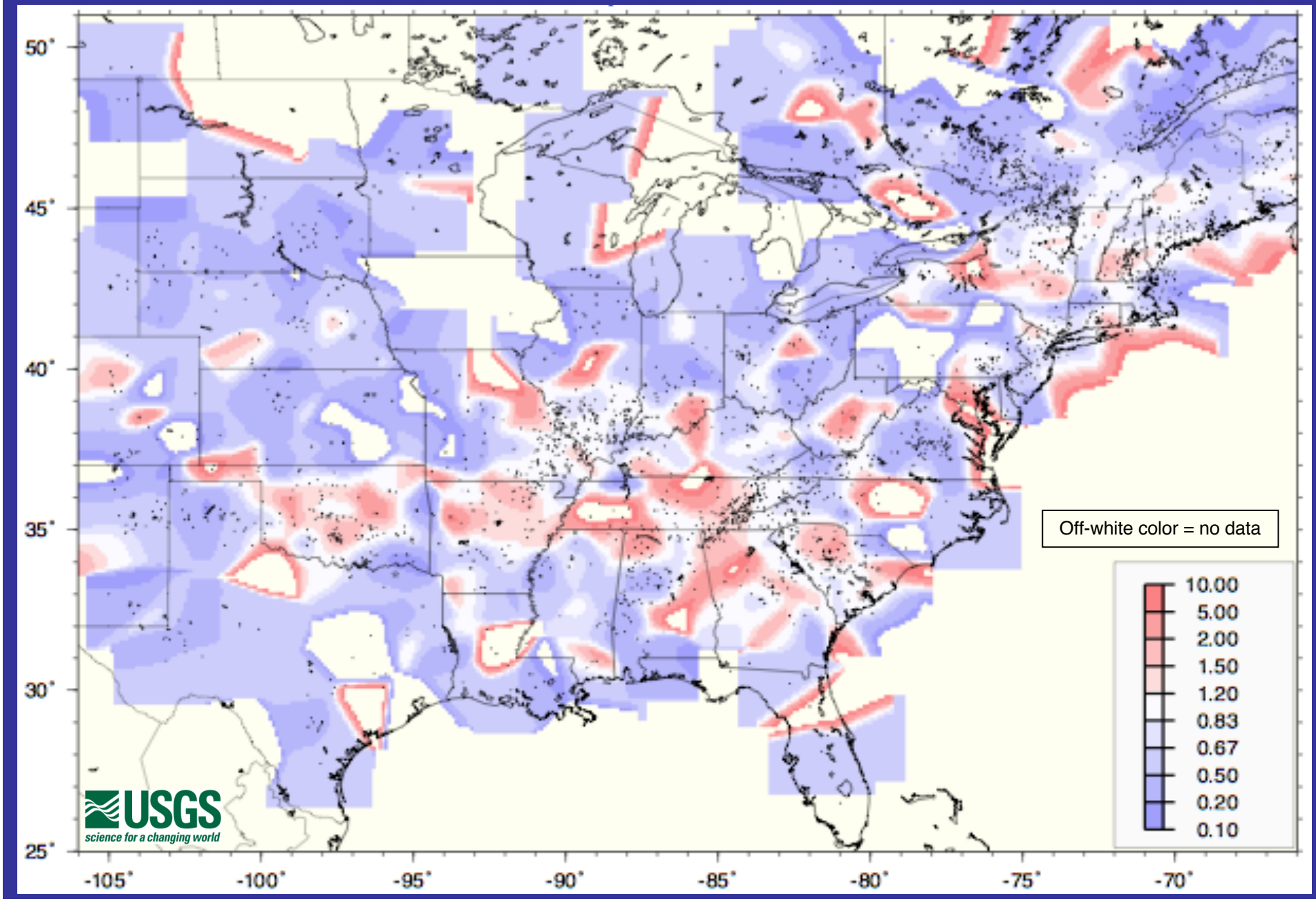
Ratio of cumulative 10[a]: CEUS-SSC@M_W4.7 / NSHM@m_b5.0



Hazard maps for PGA, 0.2sSA, 1.0sSA:

2% probability of exceedance in 50 yrs

CEUS-SSC catalog, minimum magnitude = M_w4.7

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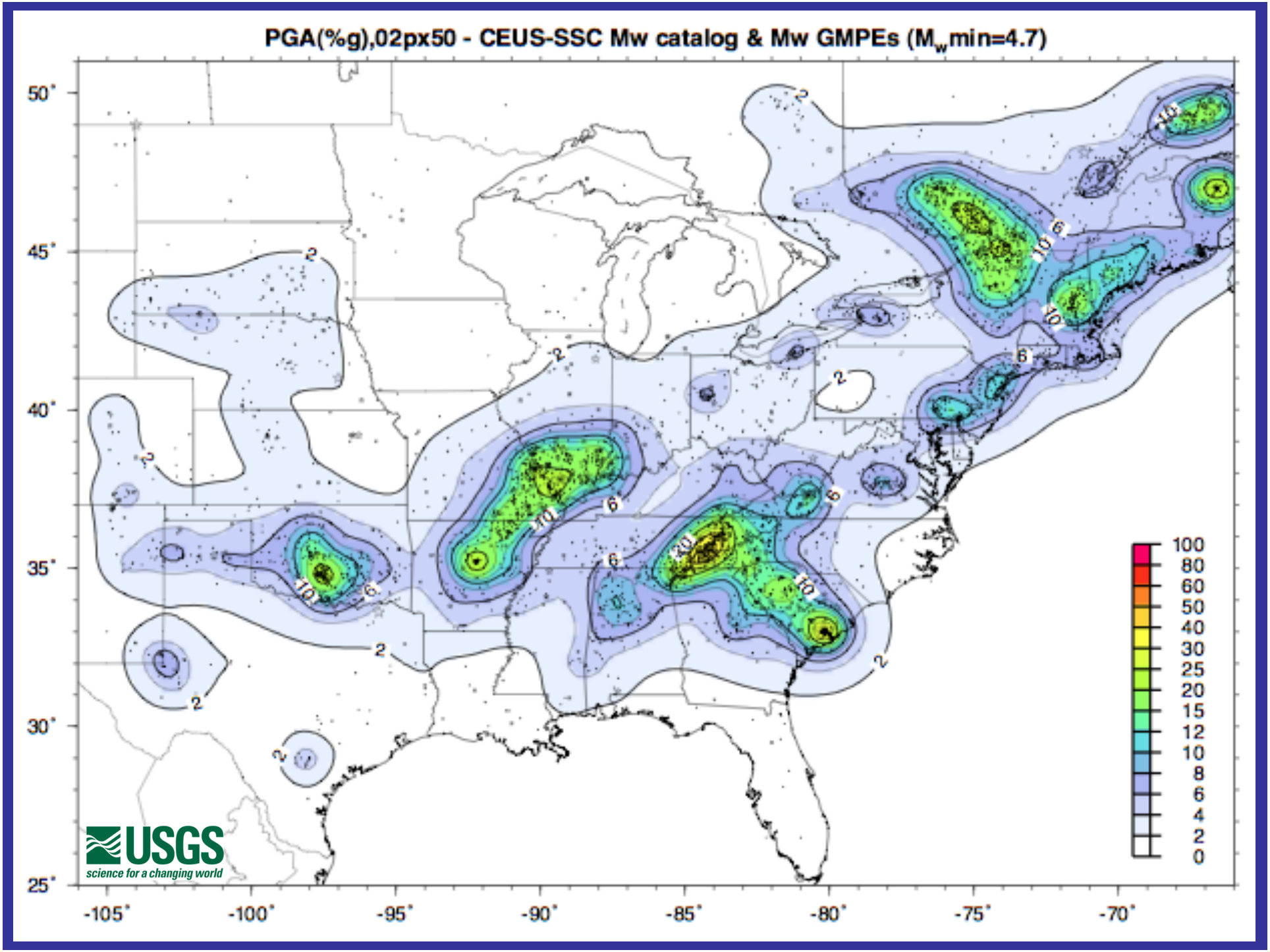
PGA(%g),02px50 - CEUS-SSC Mw catalog & Mw GMPEs (Mwmin=4.7)
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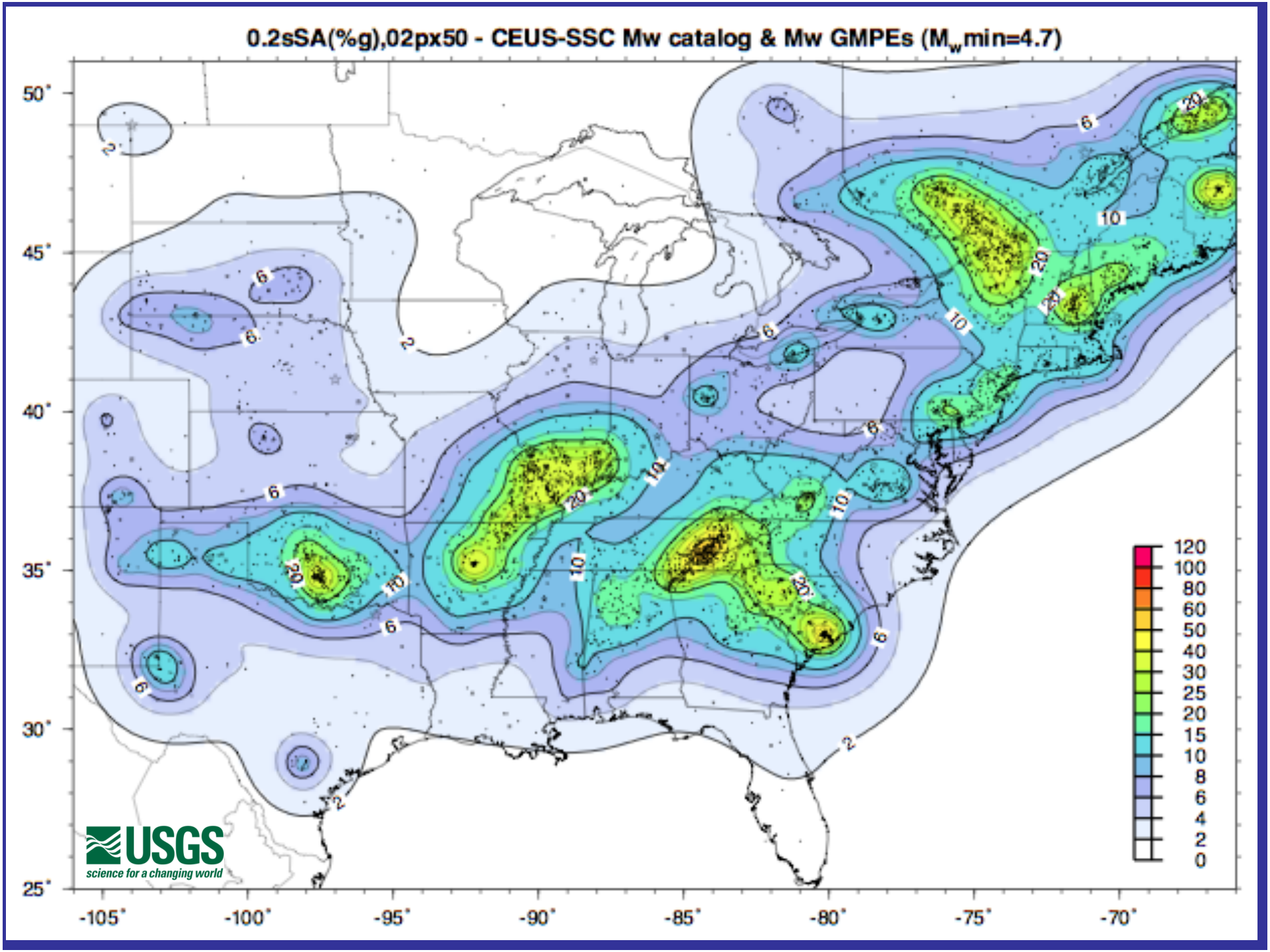
0.2sSA(%g),02px50 - CEUS-SSC Mw catalog & Mw GMPEs (Mwmin=4.7)
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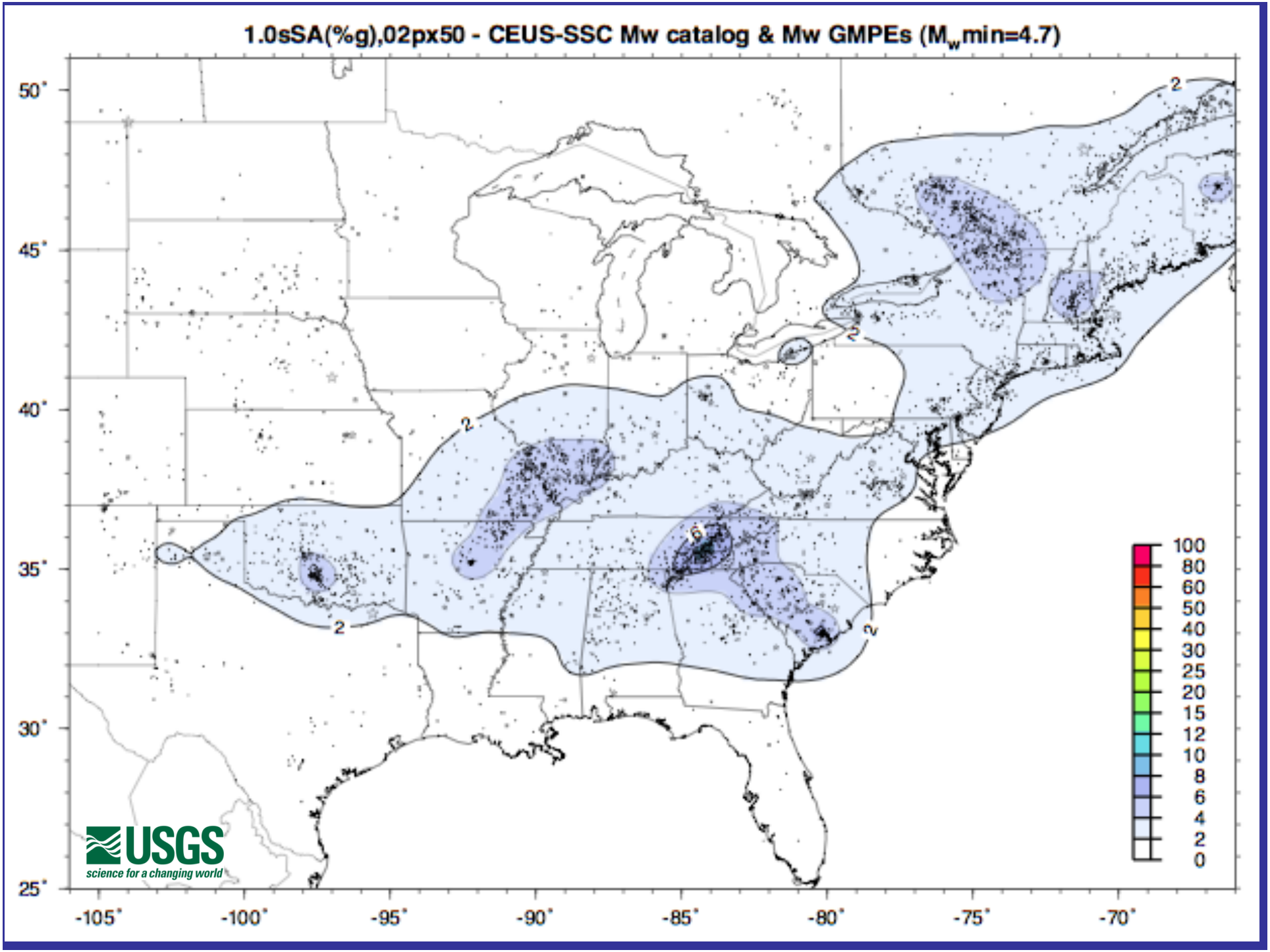
1.0sSA(%g),02px50 - CEUS-SSC Mw catalog & Mw GMPEs (Mwmin=4.7)
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Hazard ratio maps for PGA, 0.2sSA, 1.0sSA:

2% probability of exceedance in 50 yrs

CEUS-SSC $M_w$min = 4.7 / NSHM $m_b$min = 5.0

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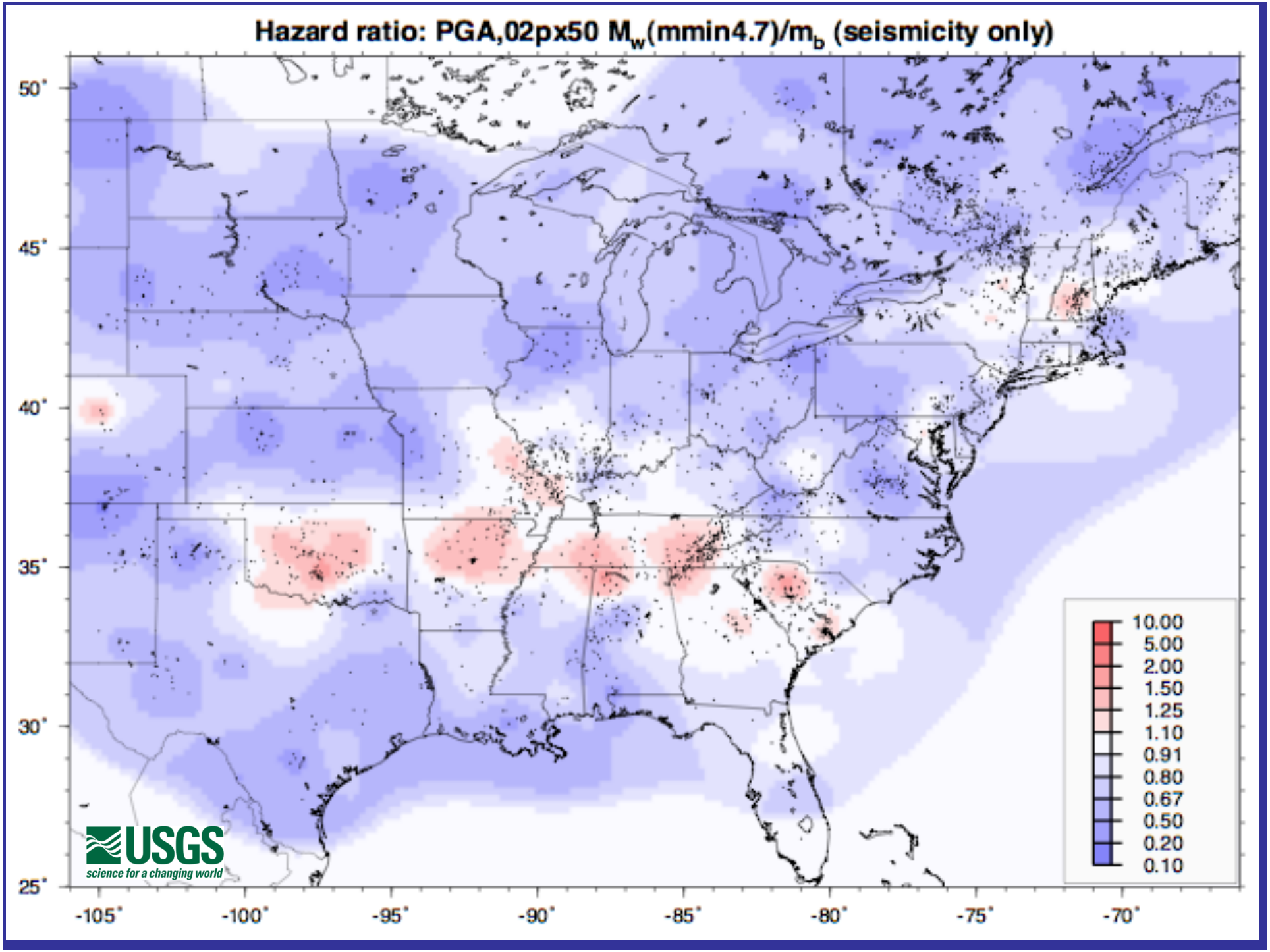
Hazard ratio: PGA,02px50 M_w(mmin4.7)/m_b (seismicity only)
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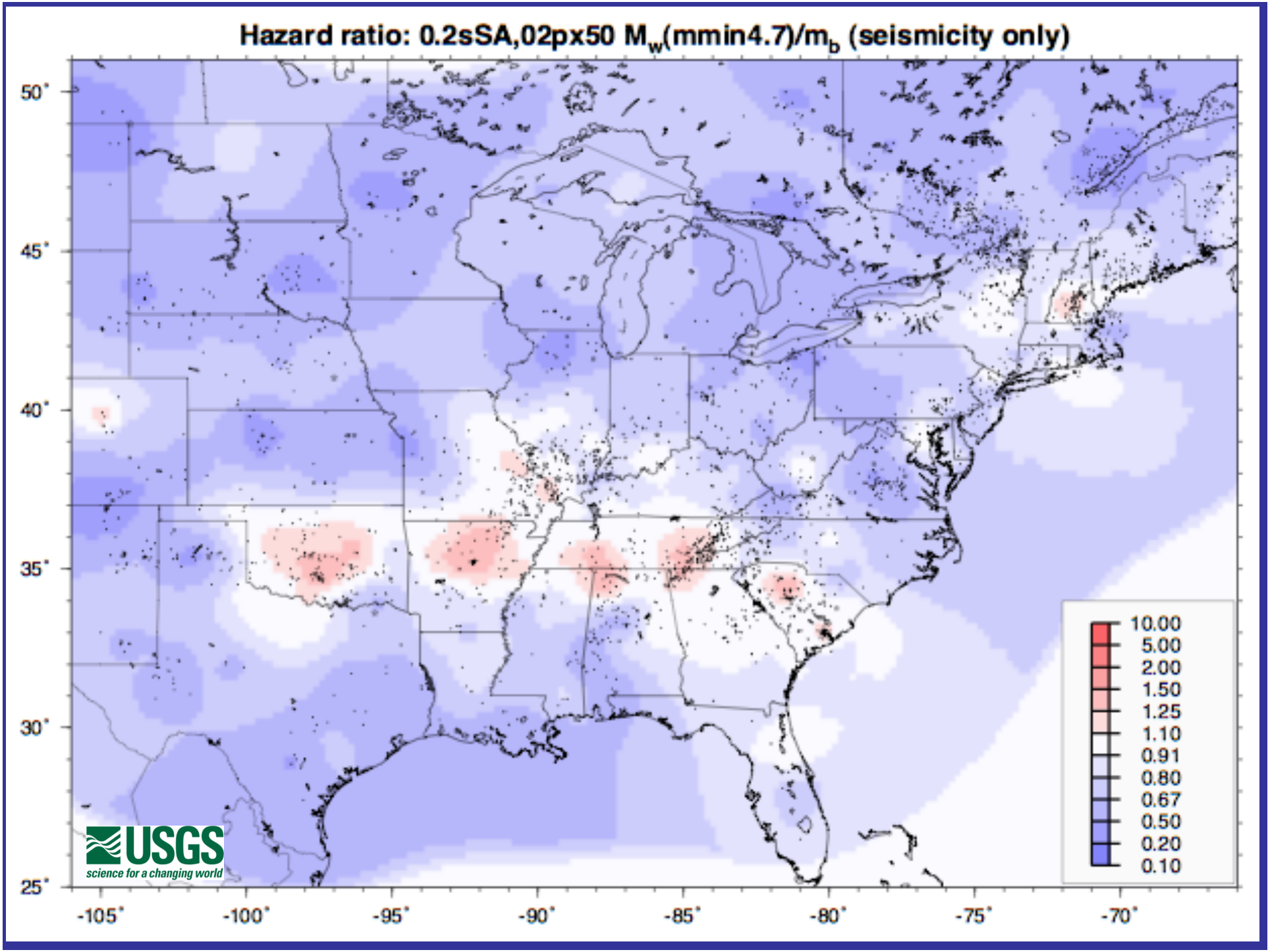
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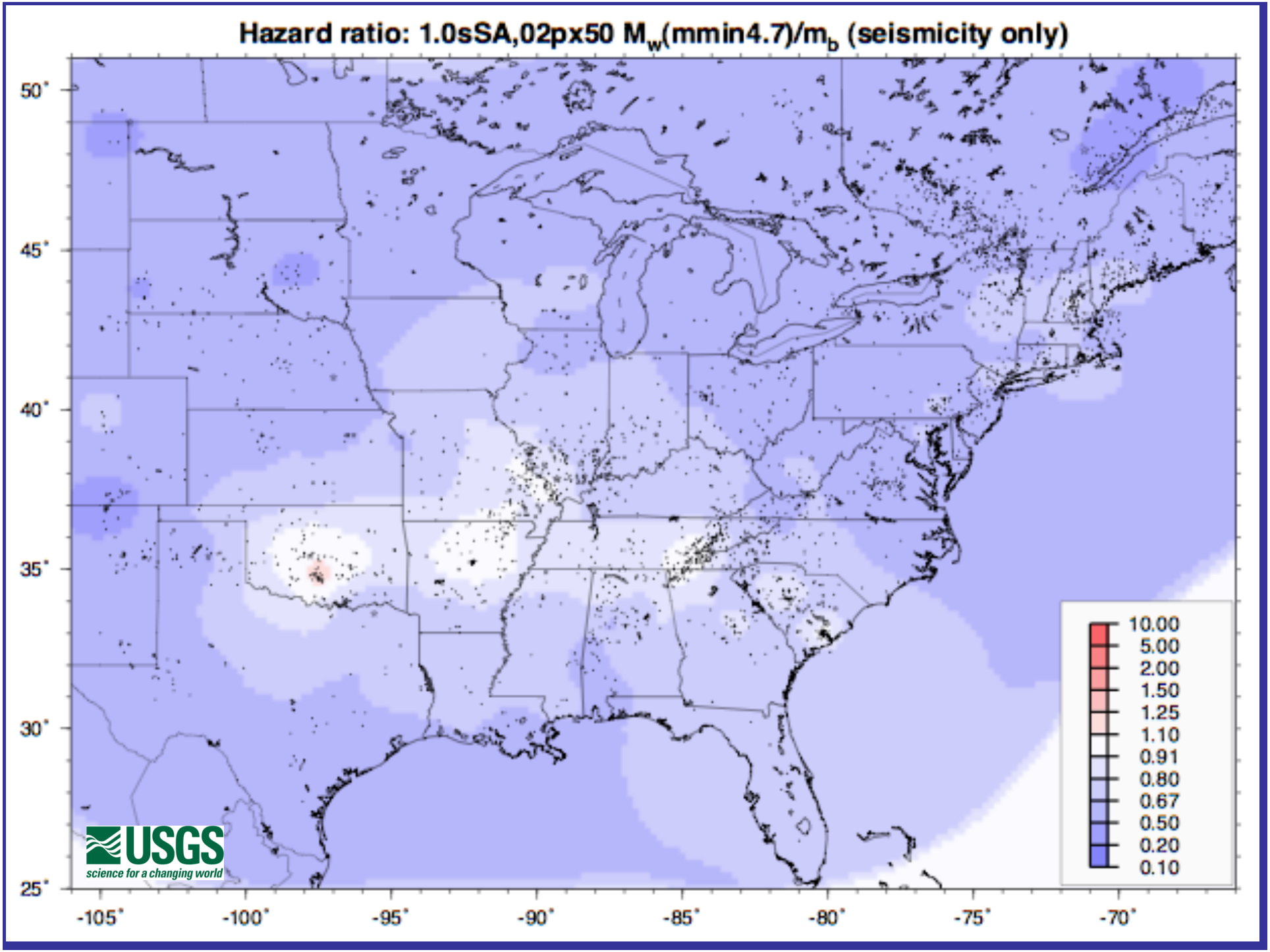
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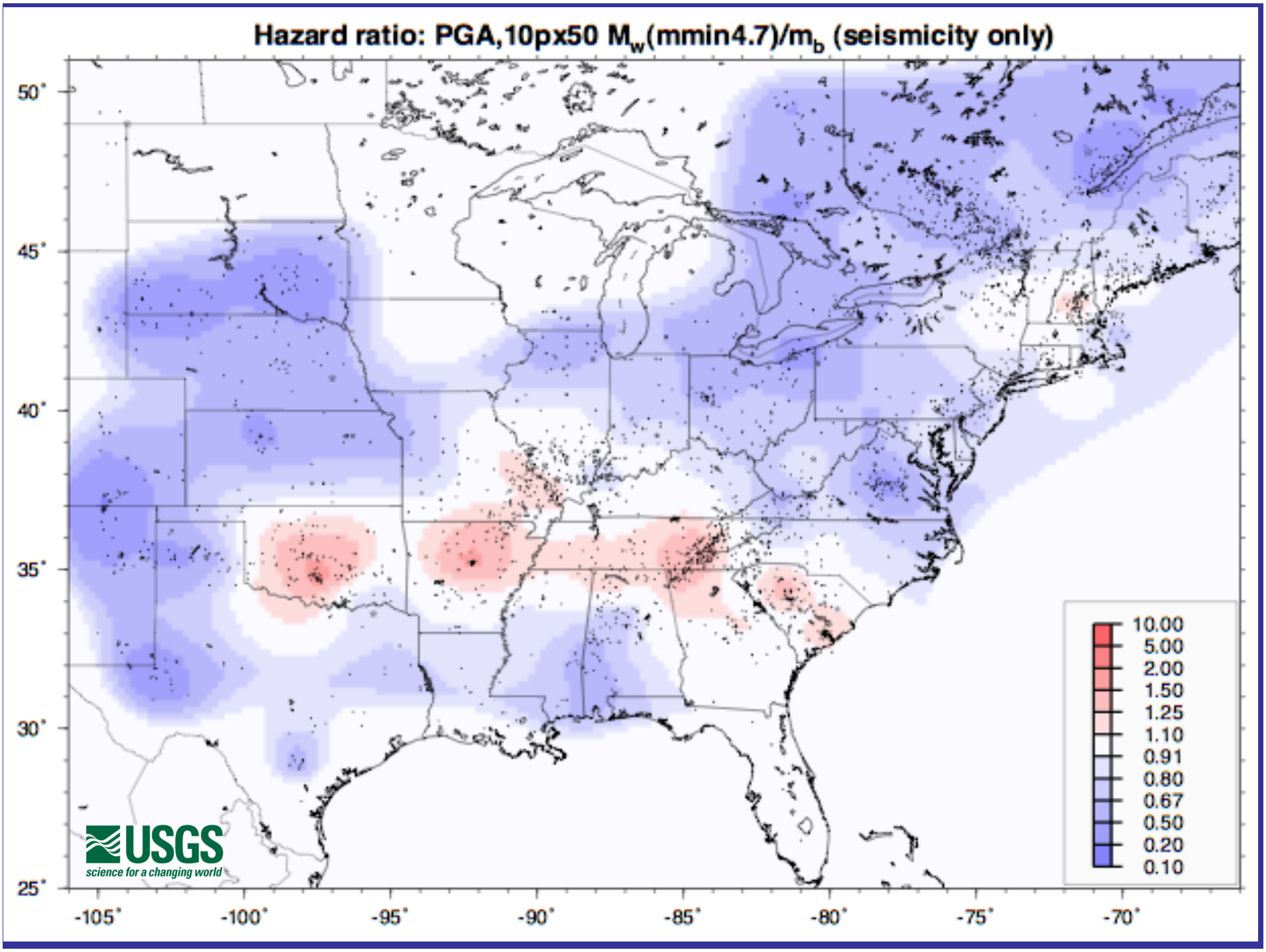
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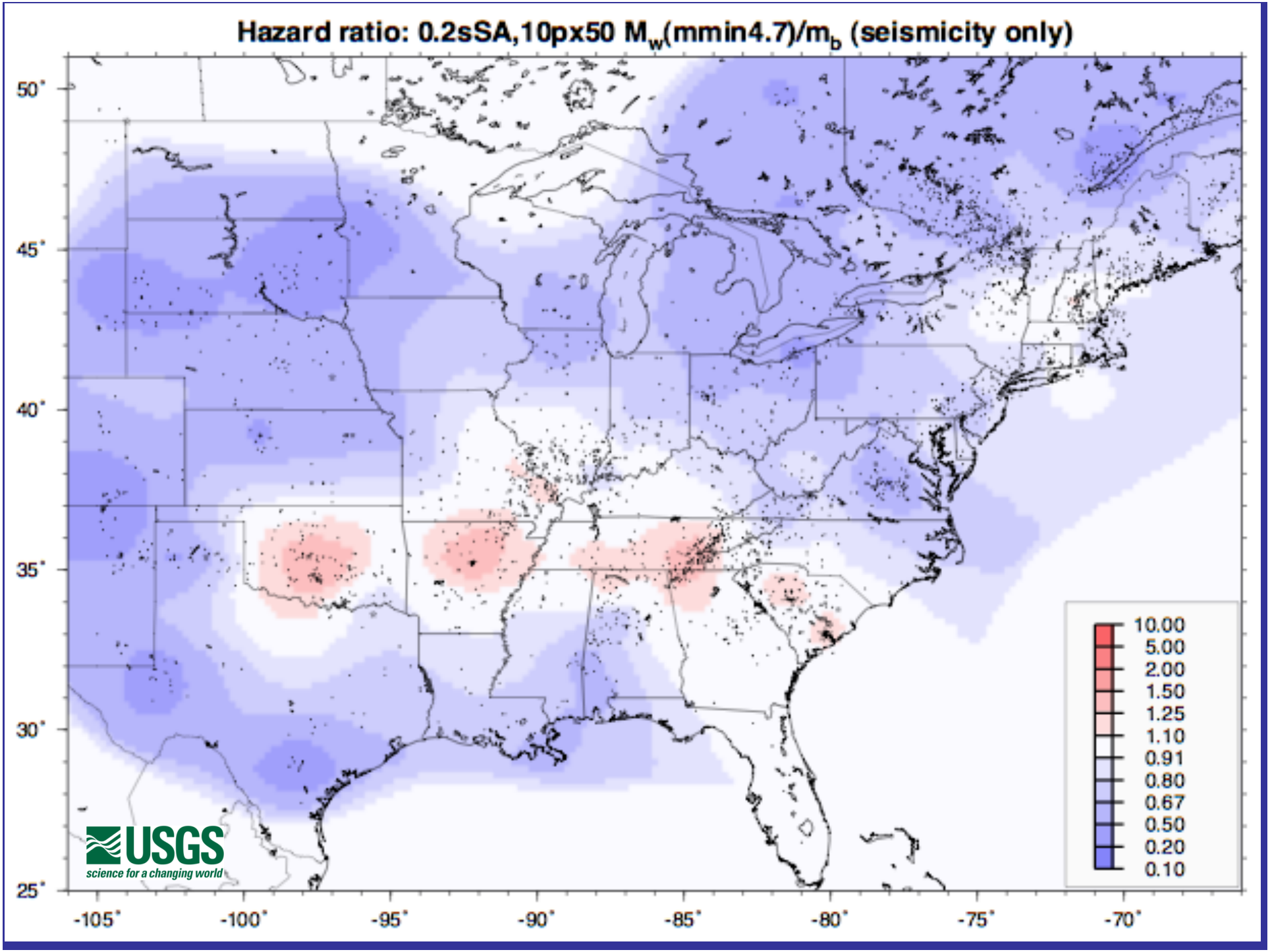
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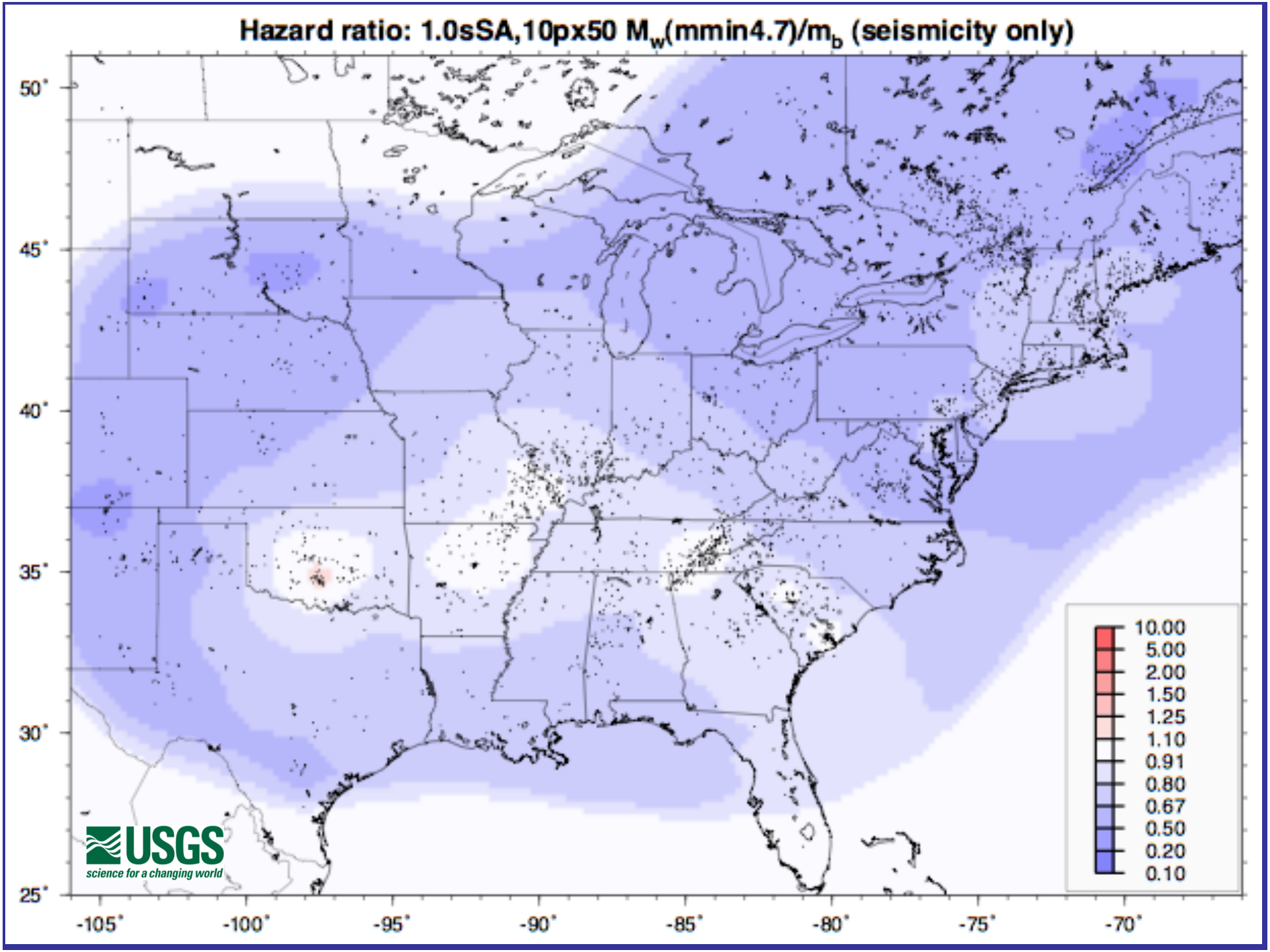
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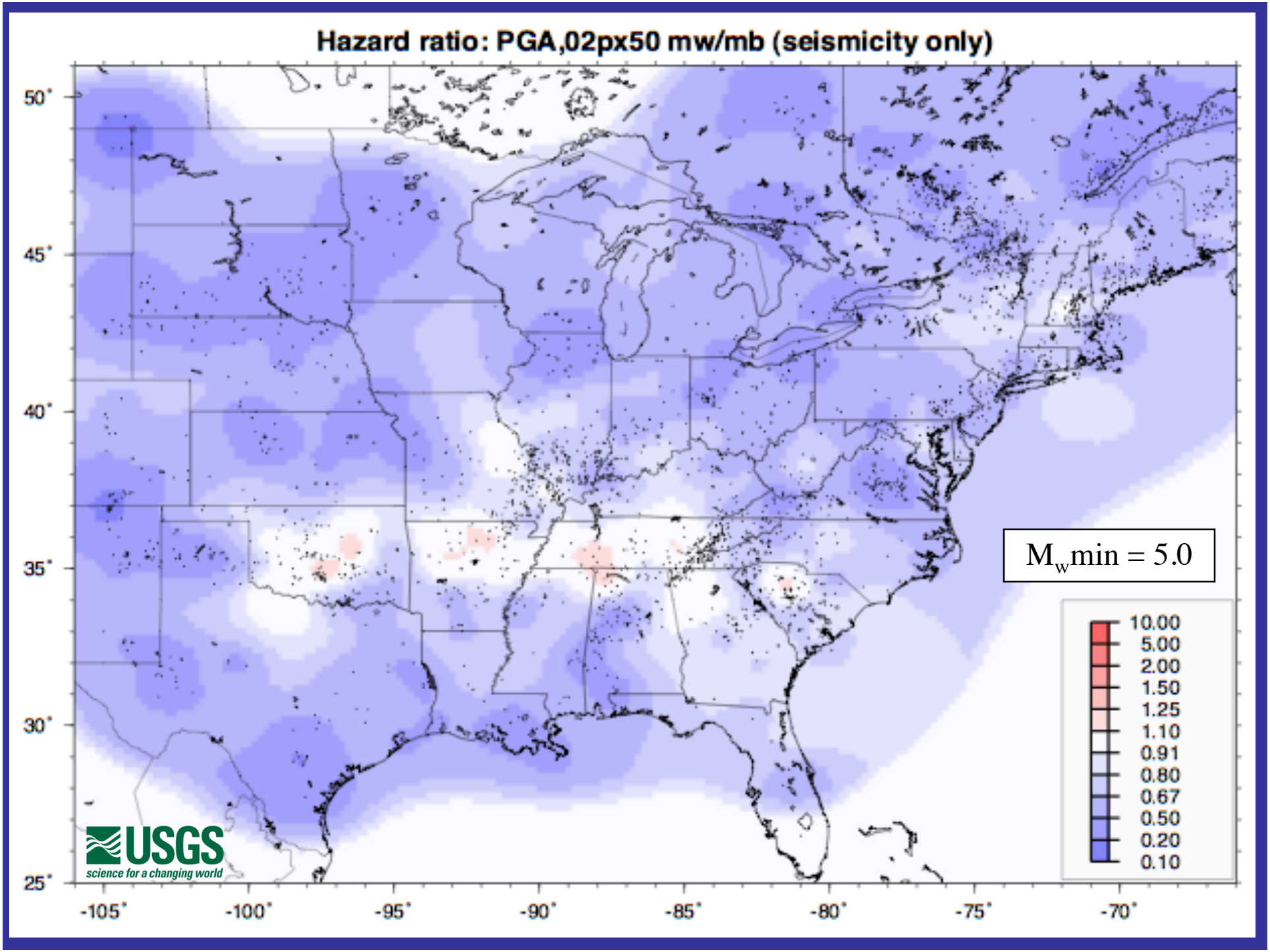
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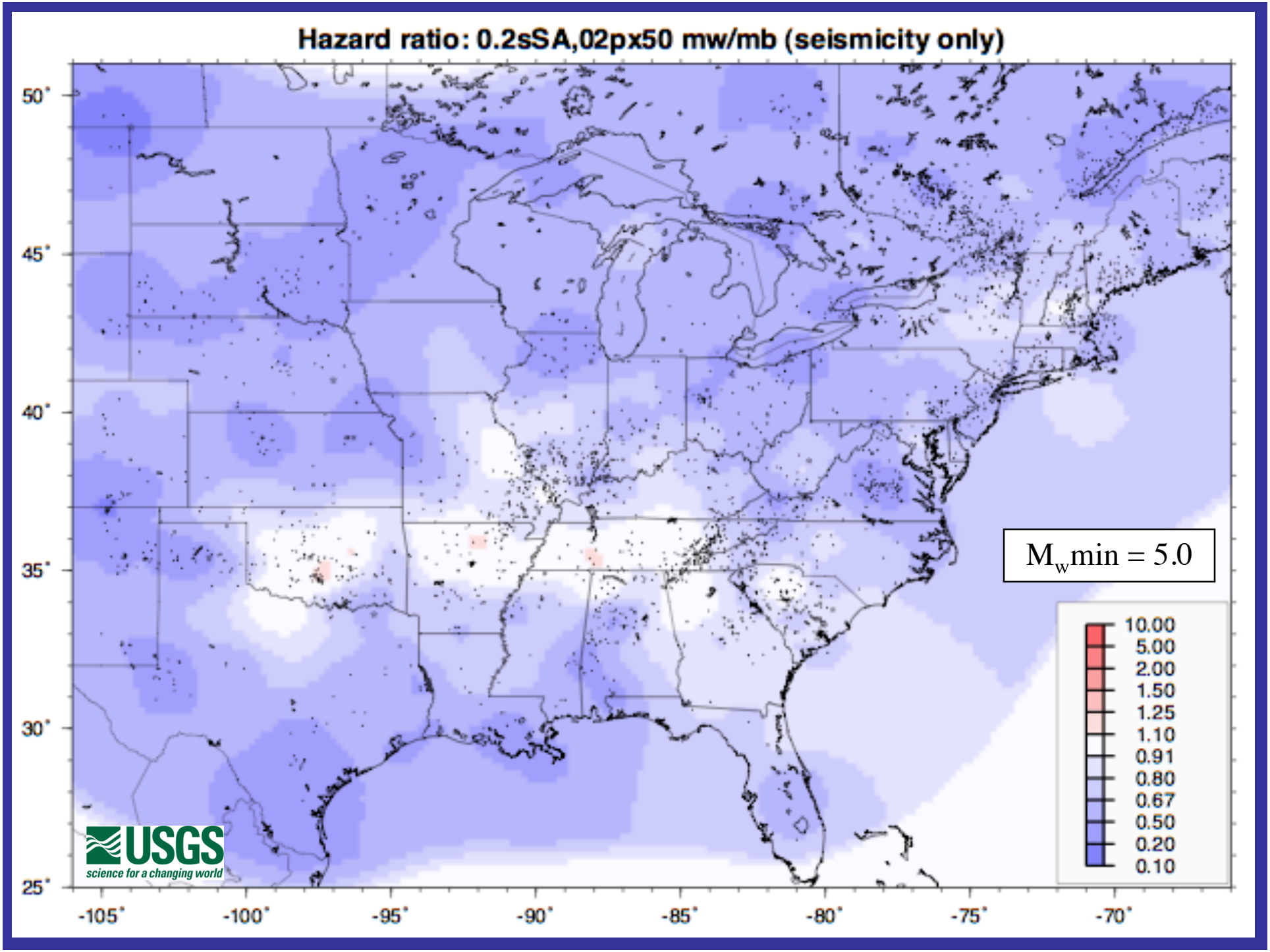
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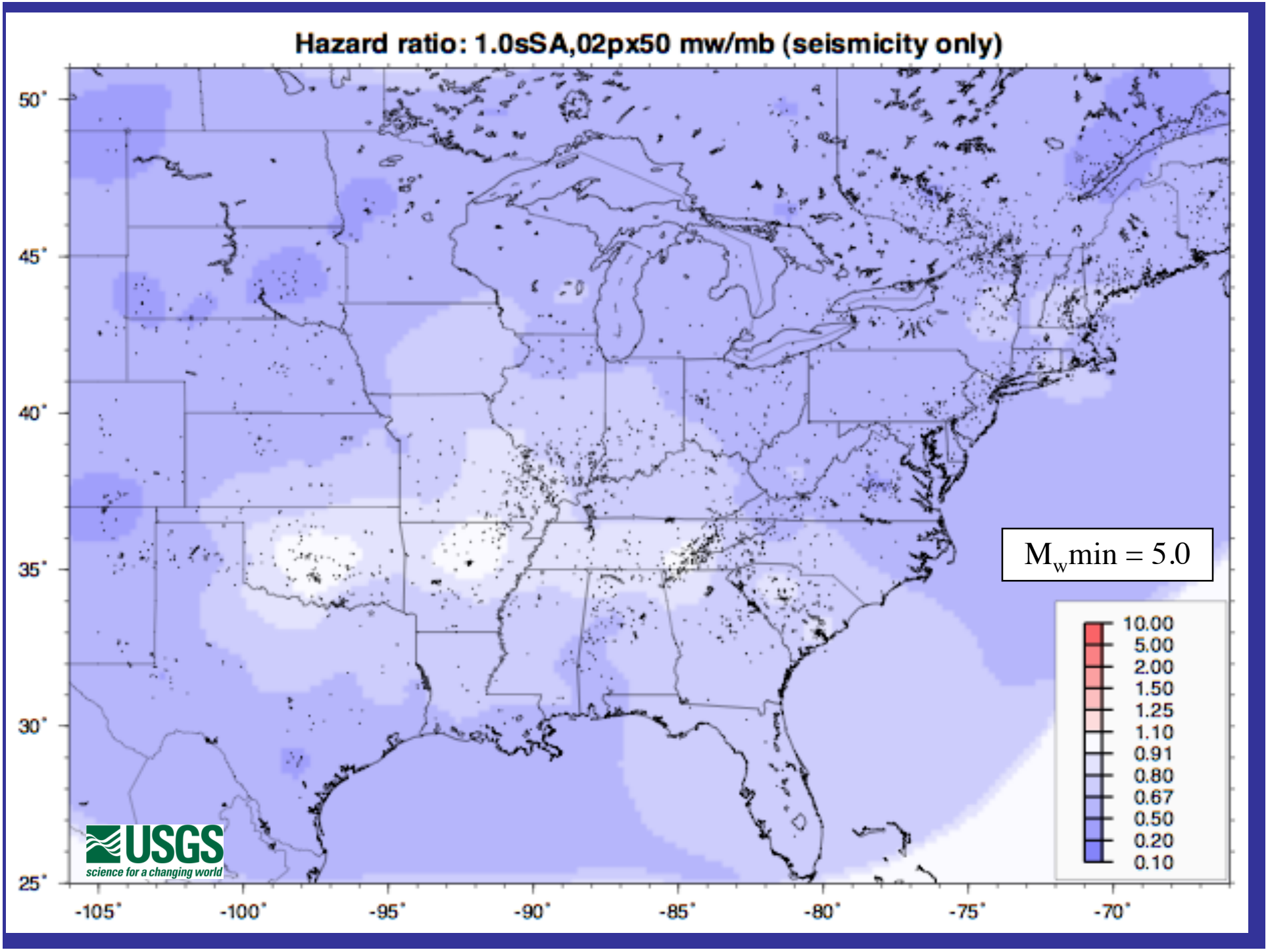
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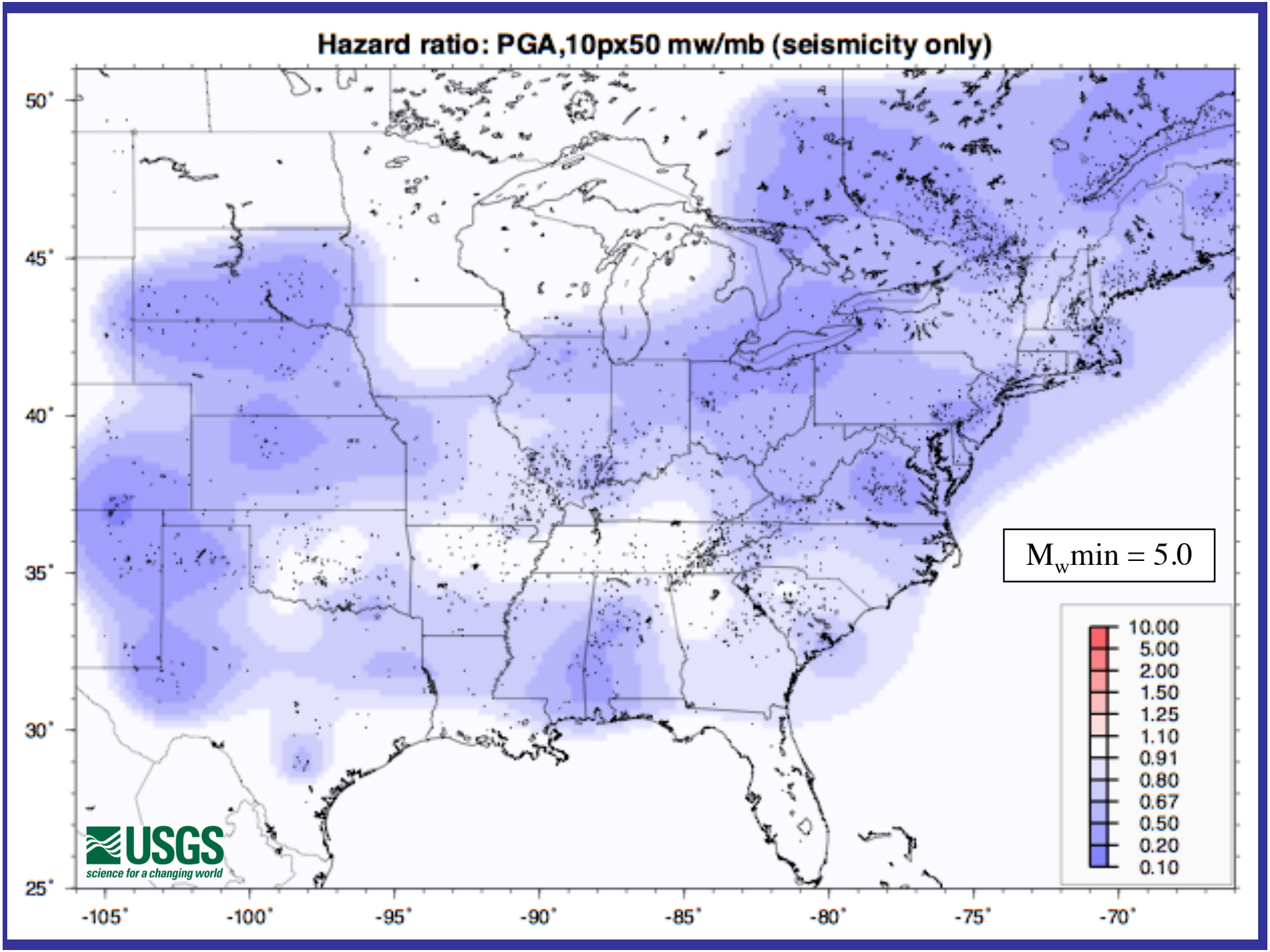
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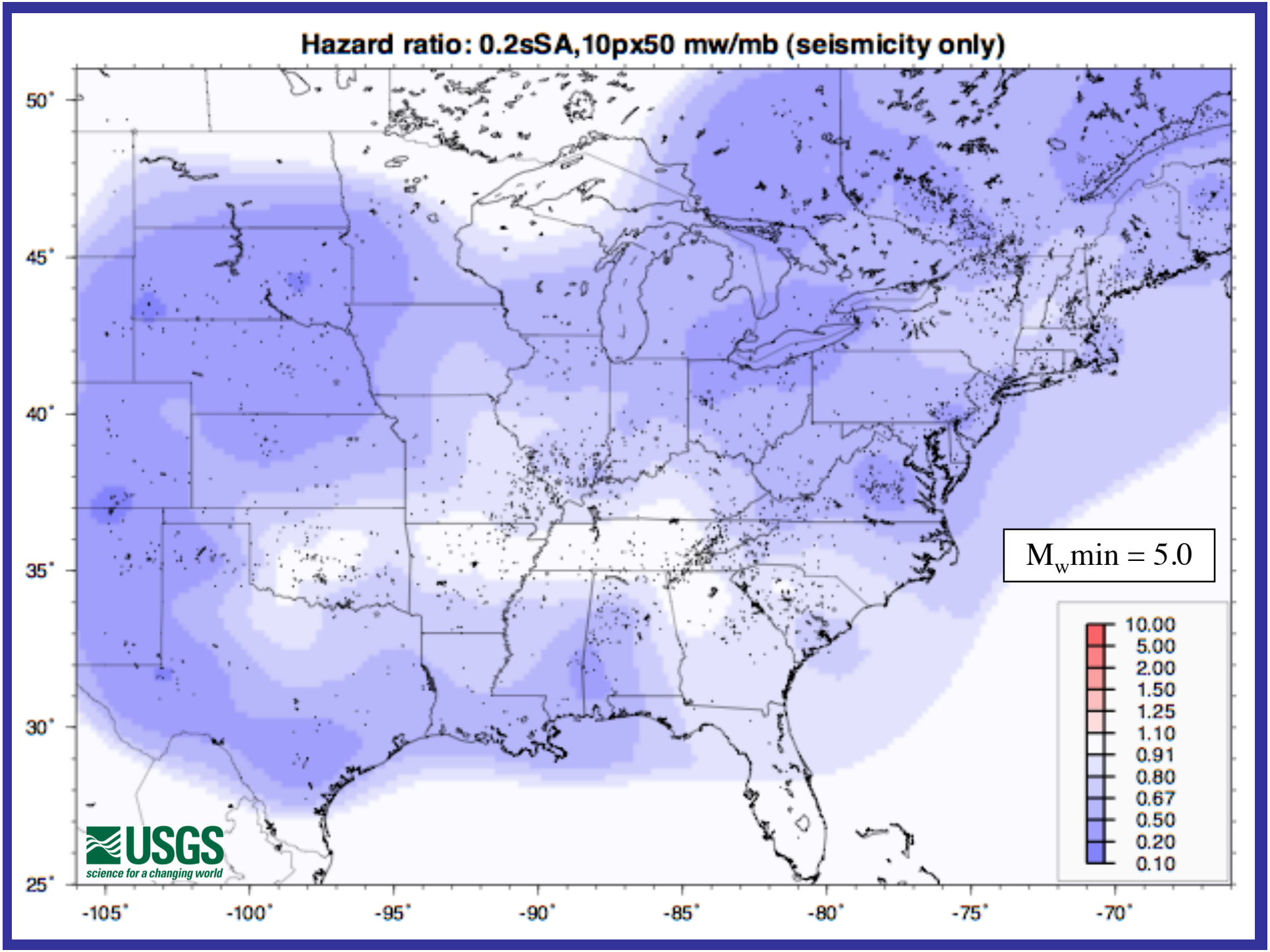
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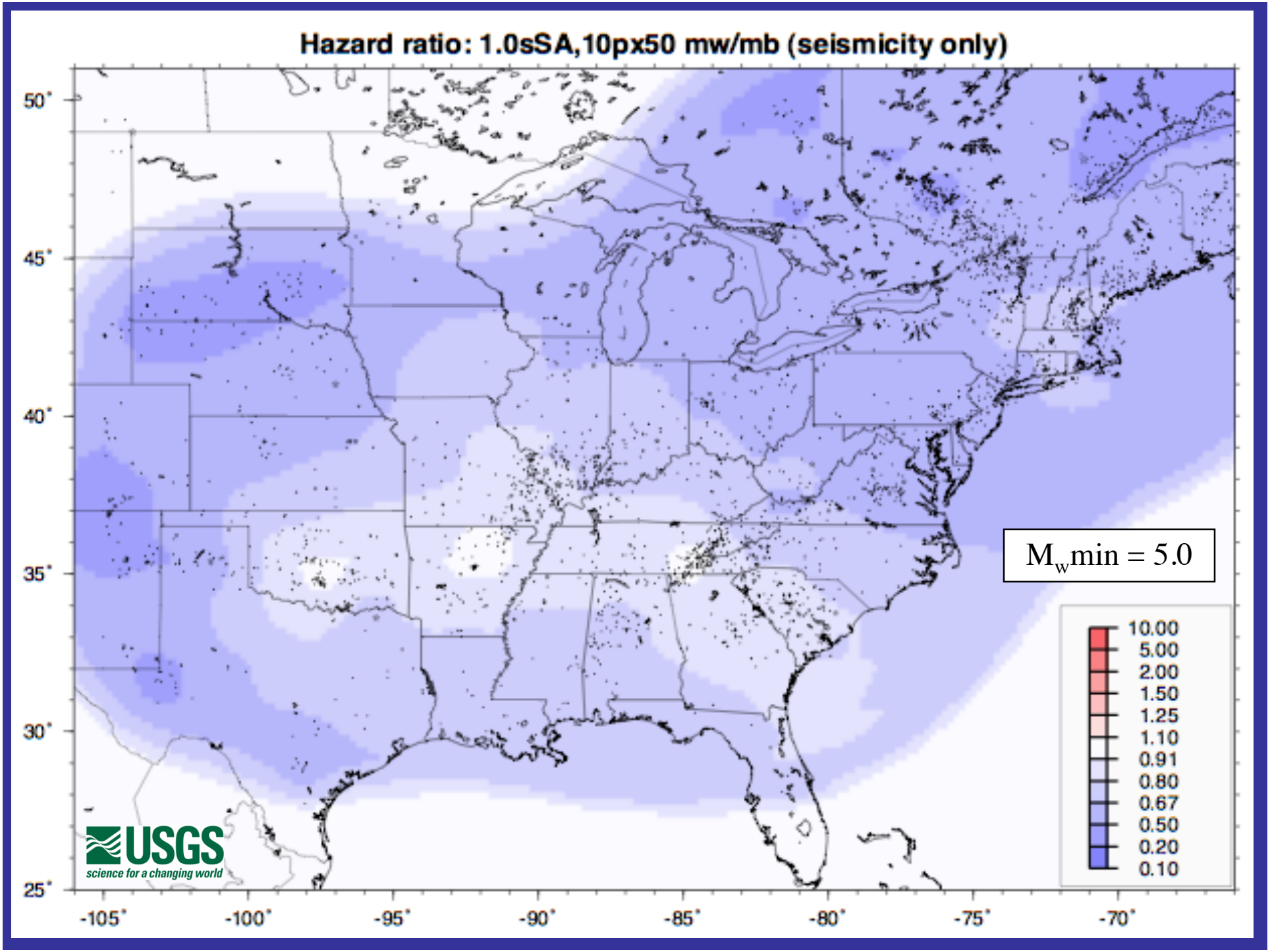
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