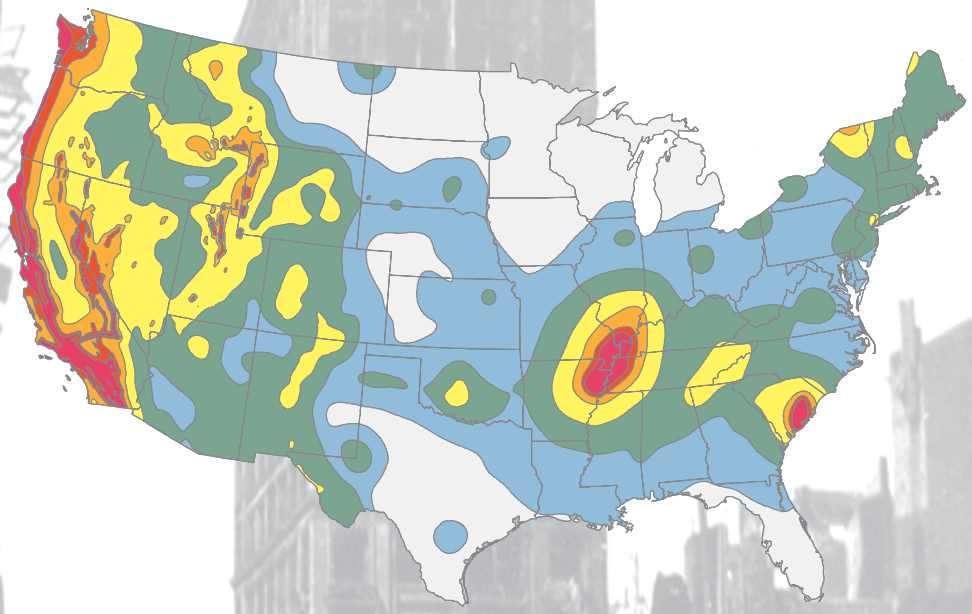
USGS
science for a changing world

nehrp

NRC032

# Documentation for the 2008 Update of the United States National Seismic Hazard Maps



Open-File Report 2008–1128

**U.S. Department of the Interior**
**U.S. Geological Survey**

by Geomatrix Consultants, Inc. (1993) with modification for depth dependence that was incorporated in the 1996 and 2002 maps. In addition, we included the Boore and Atkinson (2000) equations for intraslab earthquakes. Deep events were assumed to occur at 50-kilometer depth for the ground-motion calculations.

# Results of the Seismic Hazard Calculations

To produce the National Seismic Hazard Maps, we calculated the hazard at several spectral accelerations (SA, periods 0.2, 0.3, 0.5, 0.75, 1.0, and 2.0 s) and peak horizontal ground acceleration (PGA). The hazard curves are then interpolated at 0.00211, 0.00103, and 0.00040 annual rate of exceedance to obtain the 10-percent, 5-percent, and 2-percent probability of exceedance in 50 years, respectively. The hazard model assumes Poisson (time-independent) event occurrence. Other levels can be interpolated from the hazard curves, but we caution use of these curves at low probability levels because inclusion of some very low activity faults that are omitted from the USGS source model may cause significant differences. These maps are based on uniform firm-rock site conditions defined as a site with average shear wave velocity of 760 m/s in the upper 30 meters of the crust (Vs30).

## Central and Eastern United States Maps

The hazard at 2-percent probability of exceedance in 50 years in the CEUS is dominated by the New Madrid and Charleston seismic zones, but seismicity zones in eastern Tennessee and the northeast, as well as the two faults also contribute significantly. The hazard at the 2-percent probability of exceedance in a 50-year level is typically a factor of two to four higher than the 10 percent in 50-year values in the CEUS. Figures 28 to 30 show hazard maps for the CEUS at 2-percent probability of exceedance in 50 years for the 0.2- and 1-s SA and PGA, hazard values used in building codes. Figures 31 to 33 show hazard maps for the CEUS at 10-percent probability of exceedance in 50 years for the 0.2- and 1-s SA and PGA.

We made many comparisons of the 2008 and the 2002 hazard maps. Ratio maps can be found on the Web site: *http://earthquake.usgs.gov/research/hazmaps/*. The PGA and 0.2-s SA hazard at 2 percent in 50 years is lower by about 15–25 percent across much of the Northeastern United States. Near New Madrid the high-frequency ground motions are significantly lower within several kilometers of the fault and are typically lower by 2–15 percent at distances up to 1,000 kilometers from the fault. For the 1-s SA, the ground motions are decreased about 10–15 percent across much of the CEUS. Ground-motion hazards near the New Madrid Seismic Zone are lower than in 2002. In addition, the motions are also lower by 2–10 percent at distances up to 1,000 kilometers from sources. The cluster model causes the ground motions to be slightly elevated at sites to the northwest and southeast of the three modeled sources. Most of the decrease in ground motion in the hazard maps is caused by the new attenuation relations, changes to the New Madrid fault zone, and addition of magnitude uncertainties in the earthquake catalog.

## Western United States Maps

The hazard at 2-percent probability of exceedance in 50 years in the WUS is controlled by the major faults described earlier in the faulting sections. The hazard at the 2-percent probability of exceedance in 50-year level is typically a factor of 1.5–2 higher than the 10 percent in 50-year values in coastal California and from 2–3.5 across the rest of the WUS. Figures 34 to 36 show hazard maps for the WUS at 2-percent probability of exceedance in 50 years for the 0.2- and 1-s SA and PGA, hazard values used in building codes. Figures 37 to 39 show hazard maps for the WUS at 10-percent probability of exceedance in 50 years for the 0.2- and 1-s SA and PGA.

Comparisons of the 2008 and the 2002 hazard maps for the WUS can also be found at the USGS National Seismic Hazard Map Web site. For high-frequency ground motions (PGA and 0.2-s SA), the ground motions are mostly within about 10 percent of the 2002 maps. The ground motions in the Pacific Northwest, coastal California (figs. 40 and 41), and the Wasatch fault regions are typically 5–10 percent higher whereas the ground motions are about 10 percent lower in areas of low seismicity. However, the changes are more substantial at longer periods (1-s SA) where ground motions have decreased by 5–30 percent in many areas of the Western United States (with the exception of rates in an area adjacent to the subduction zone, which rose by 10–20 percent). These large decreases are due primarily to changes in the attenuation relations for crustal and subduction earthquakes (including better specification of the Vs30 of 760 m/s in the attenuation equations for crustal faults), reductions in the rate of earthquakes due to magnitude-uncertainty introduced in the earthquake catalog, and source model changes.

# Conclusions and Proposed Future Improvements to Maps

The 2008 National Seismic Hazard Maps represent the "best available science" based on input from scientists and engineers that participated in the update process. This does not mean that significant changes will not be made in future maps. Future earthquakes and science on earthquake recurrence and ground shaking continually improve our understanding of the seismic hazard. We plan on holding several workshops over the next several years to define uncertainties in the input parameters and to refine the methodologies used to produce

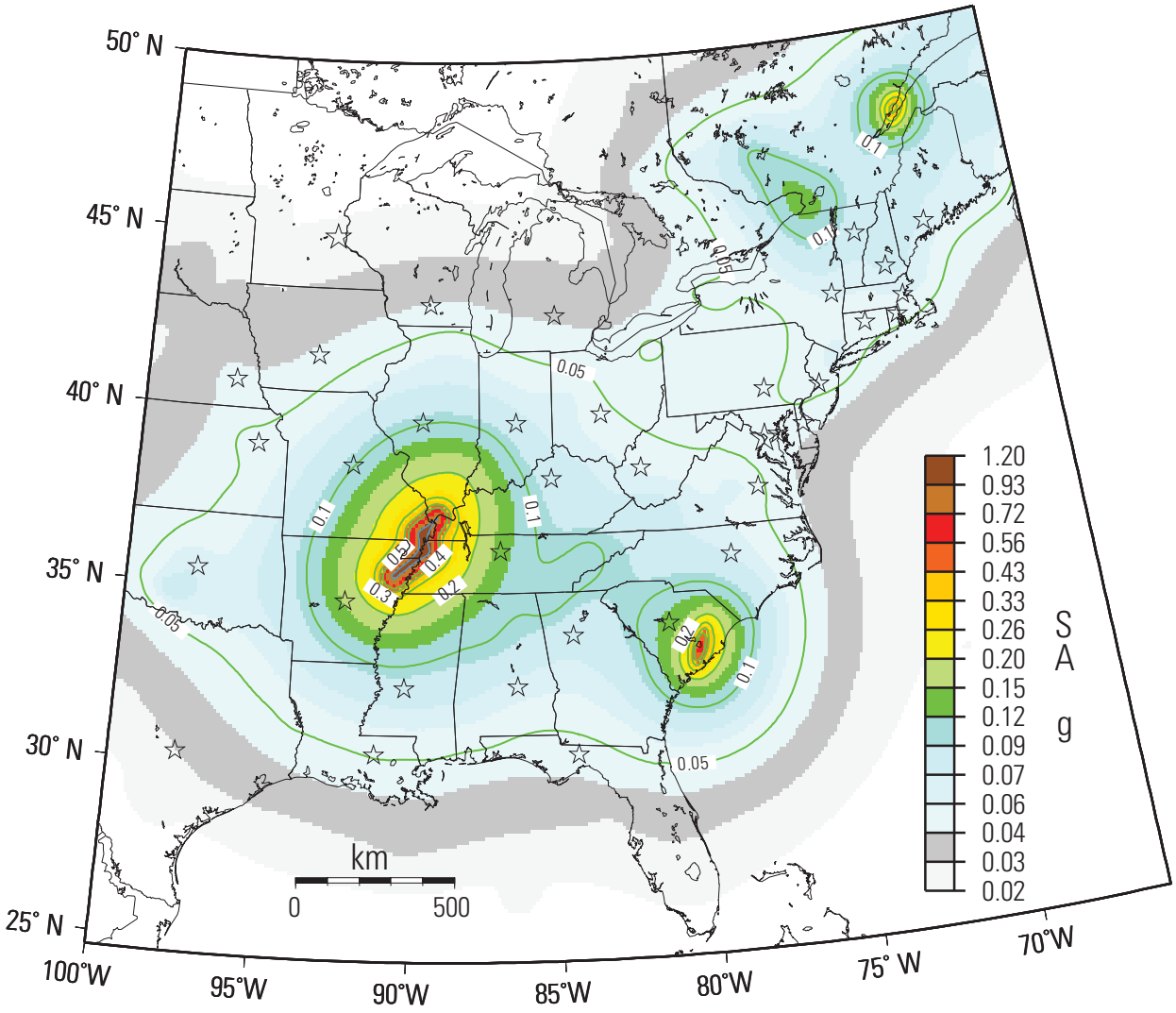



**Figure 28.** Map of 1-hertz spectral acceleration (SA) for 2-percent probability of exceedance in 50 years in the Central and Eastern United States in standard gravity (g).

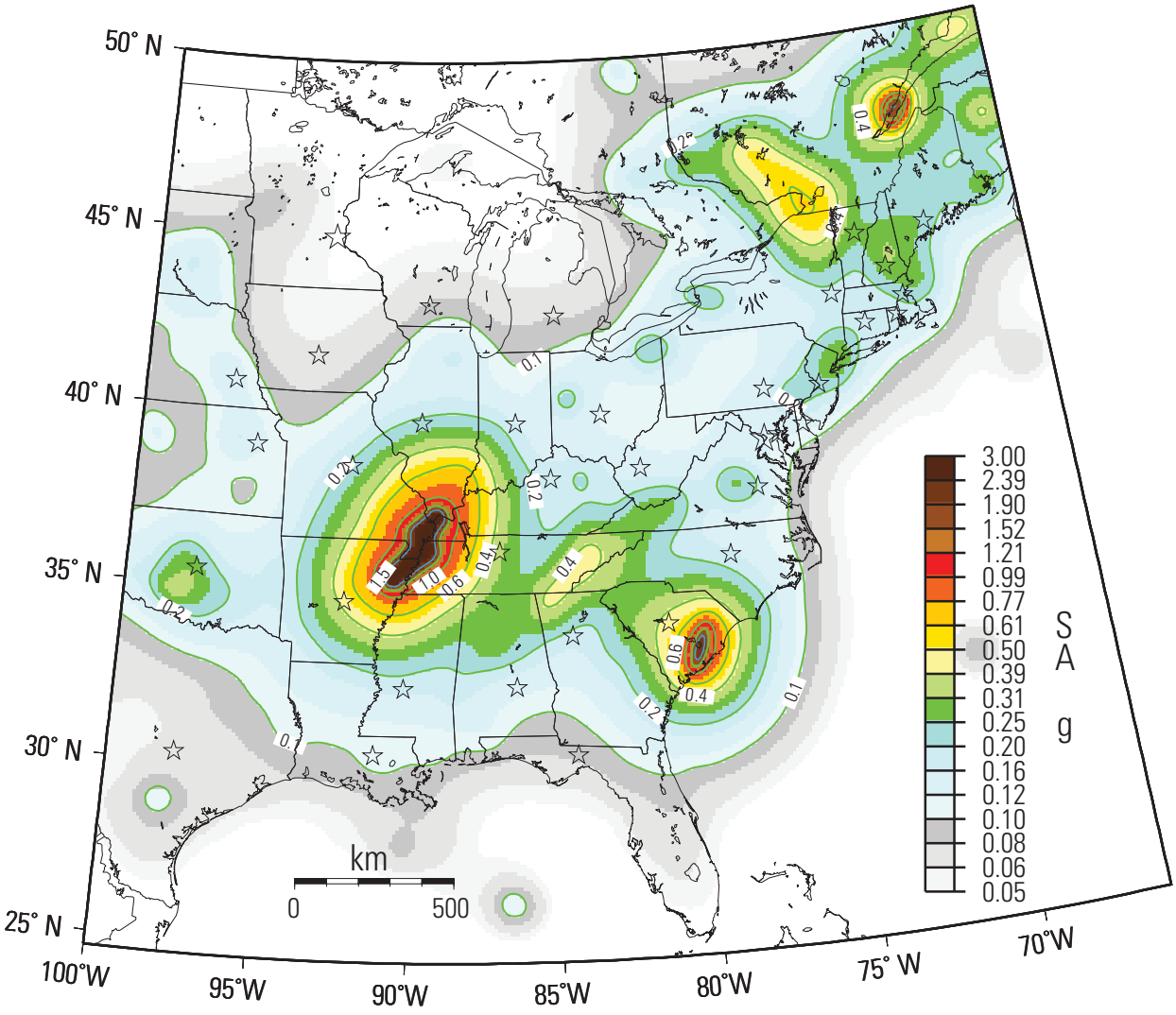



**Figure 29.** Map of 5-hertz spectral acceleration (SA) for 2-percent probability of exceedance in 50 years in the Central and Eastern United States in standard gravity (g).

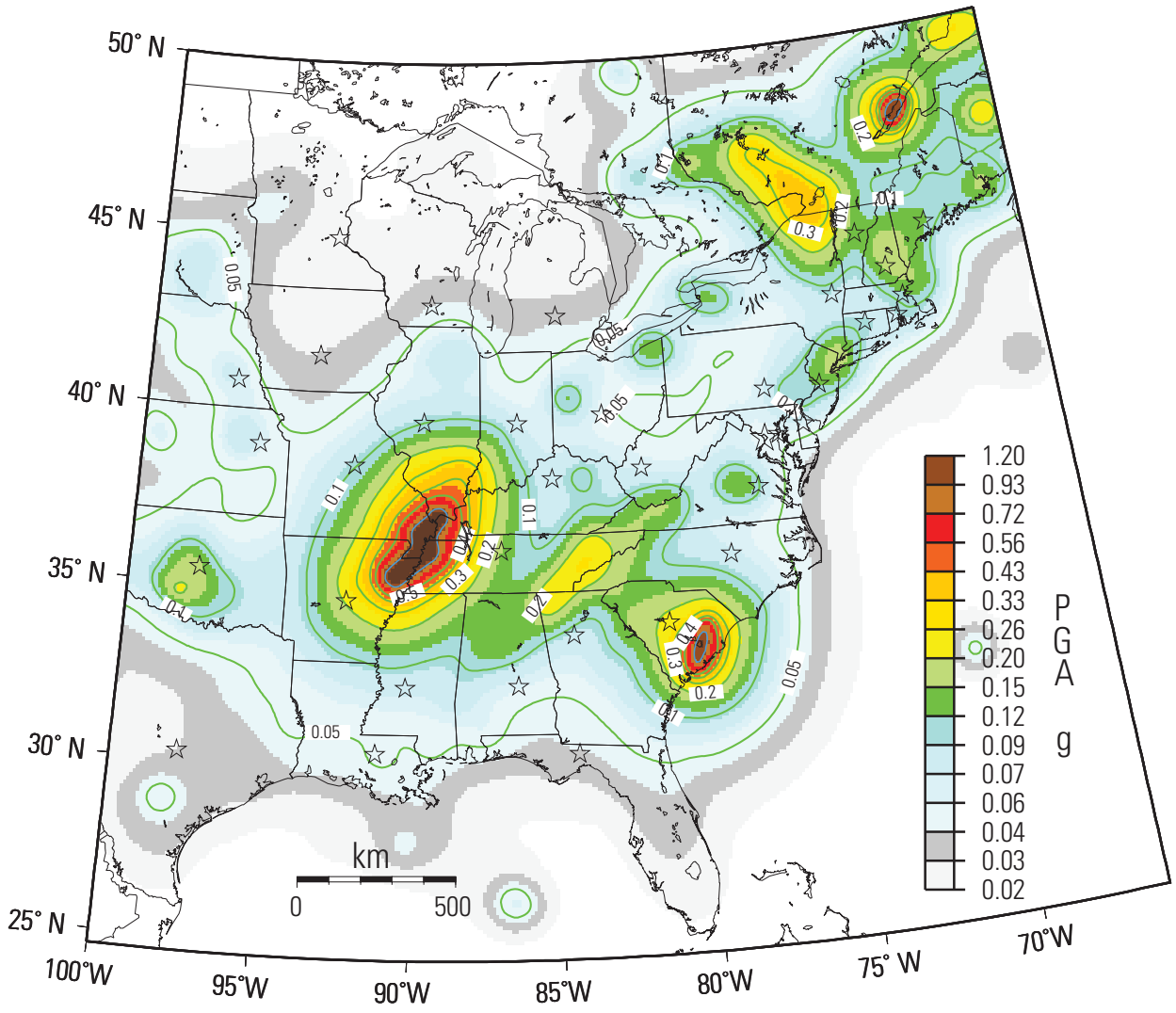



**Figure 30.** Map of peak ground acceleration (PGA) for 2-percent probability of exceedance in 50 years in the Central and Eastern United States in standard gravity (g).

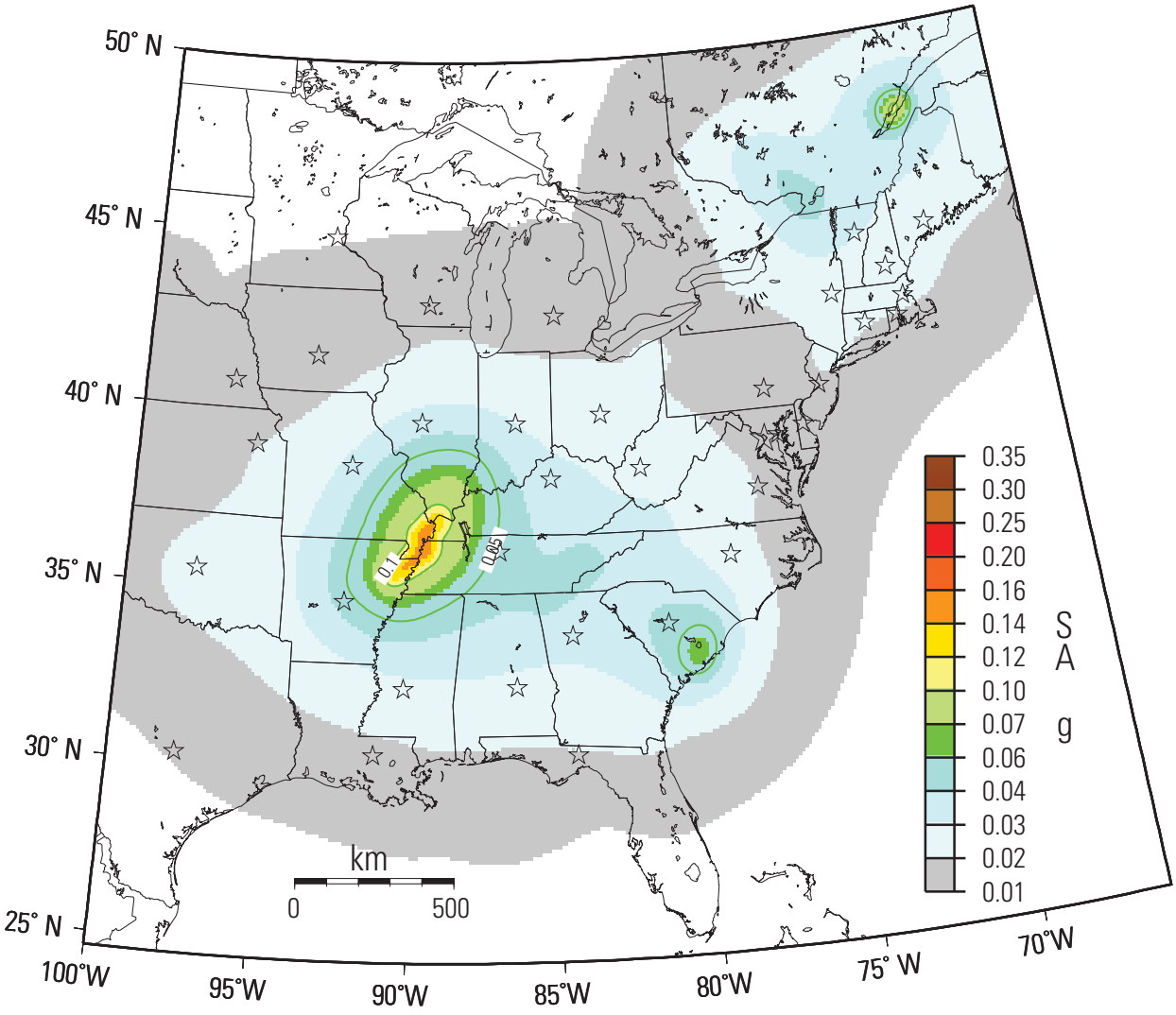



**Figure 31.** Map of 1-hertz spectral acceleration (SA) for 10-percent probability of exceedance in 50 years in the Central and Eastern United States in standard gravity (g).

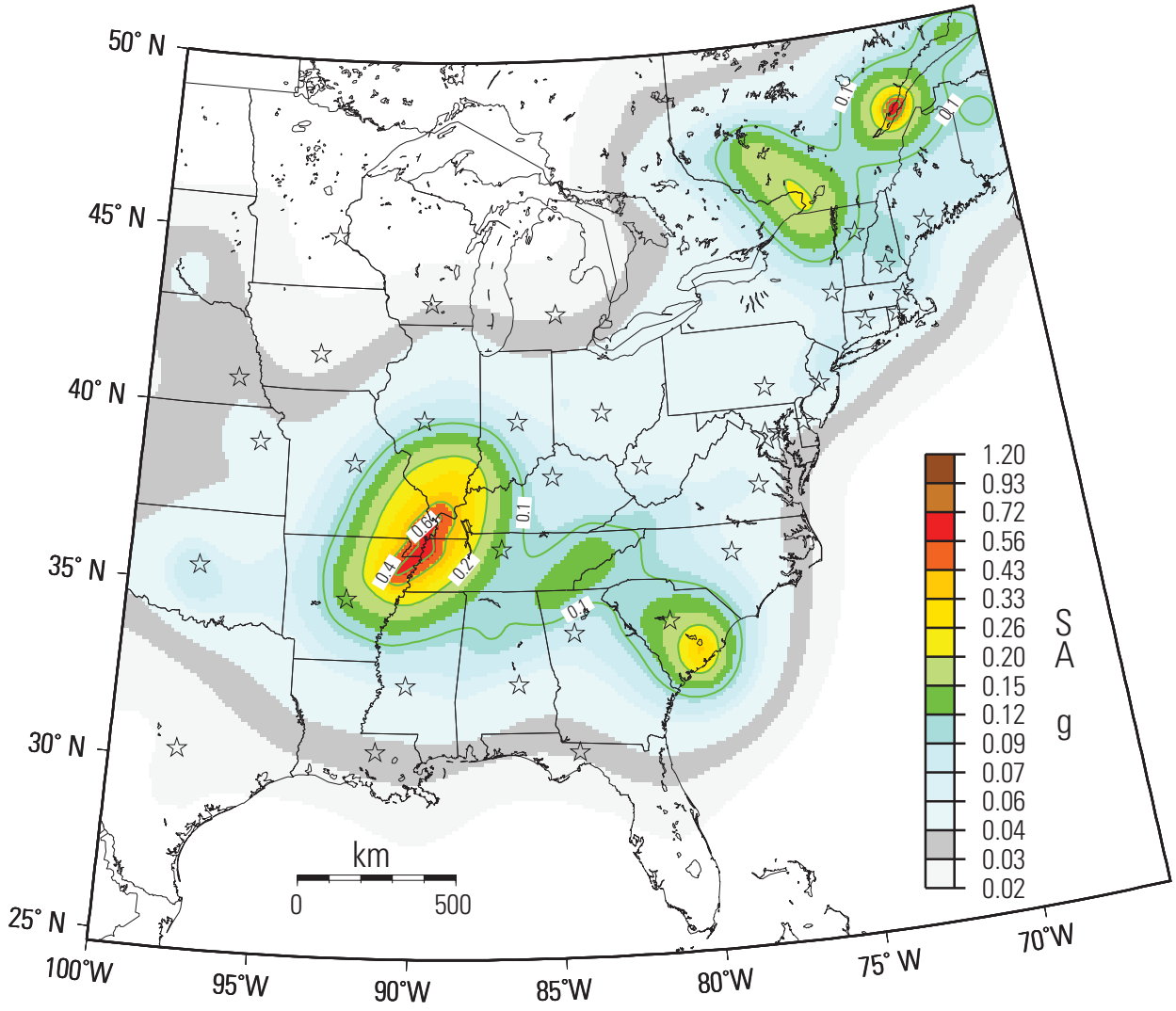



**Figure 32.** Map of 5-hertz spectral acceleration (SA) for 10-percent probability of exceedance in 50 years in the Central and Eastern United States in standard gravity (g).

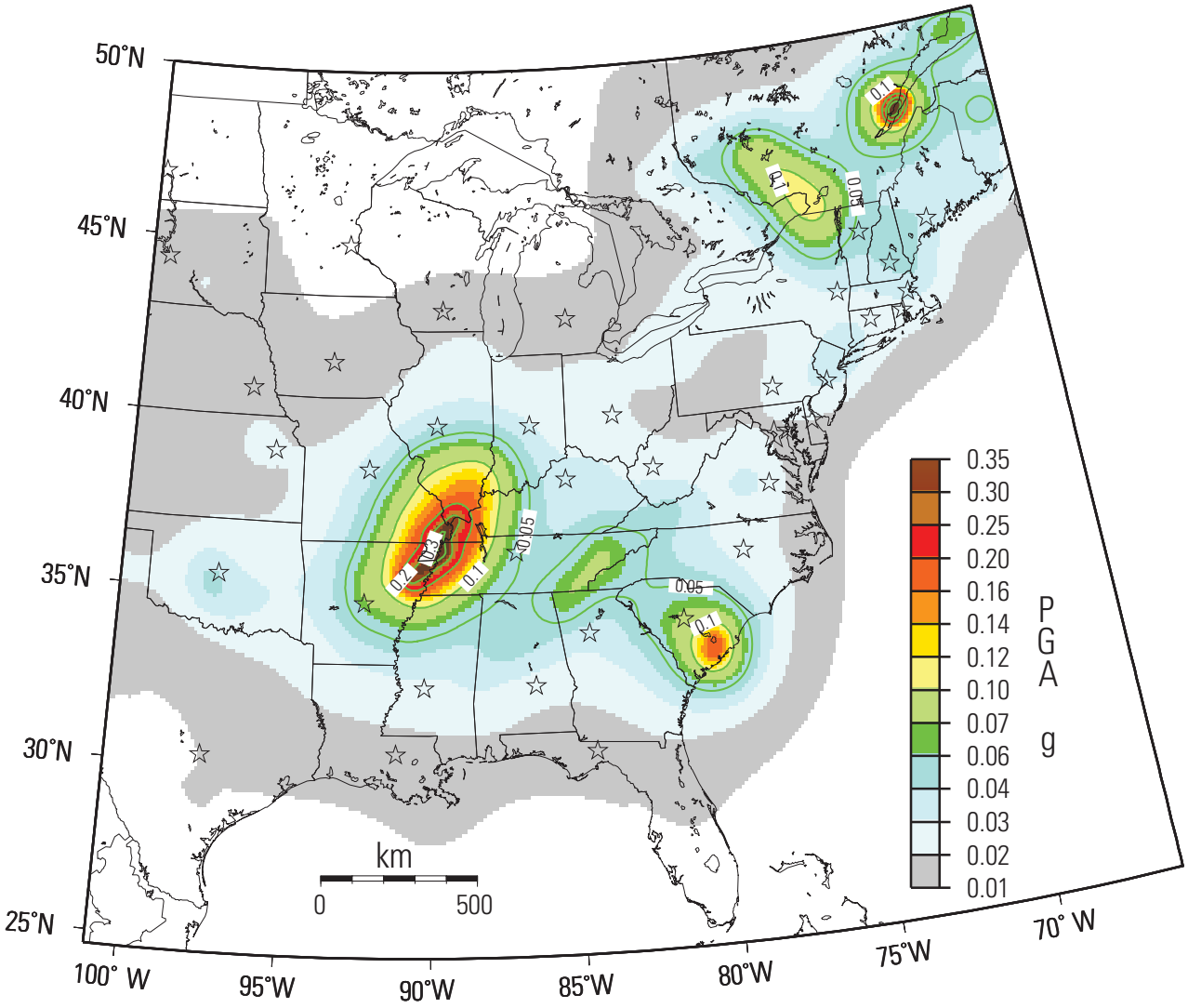



**Figure 33.** Map of peak ground acceleration (PGA) for 10 percent probability of exceedance in 50 years in the Central and Eastern United States in standard gravity (g).