USGS NEHRP Update

Activities Highlights and Agency Updates for USGS—FY24-25

Advisory Committee on Earthquake Hazards Reduction (ACEHR) Meeting #2A

June 12-13, 2024

Gavin Hayes

Senior Science Advisor for Earthquake and Geologic Hazards, USGS

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The USGS Earthquake Hazards Program

The mission of the U.S. Geological Survey Earthquake Hazards Program is to reduce losses from earthquakes in the United States and abroad.

We distribute timely notifications of the location, source characteristics, and probable impact of earthquake occurrences. We broadcast warnings of earthquake shaking, provide quantitative assessments of earthquake hazards nationwide, and advance the understanding of earthquakes and the hazards and risks they pose.



Oblique aerial view of collapsed highway overpasses and bridges at the interchange of the Foothill and Golden State Freeways after the San Fernando earthquake in February 1971 (public domain)

USGS Earthquake Hazards Program

- The USGS Earthquake Hazards Program (EHP) is the applied Earth science component of the four-Agency **National Earthquake Hazards Reduction Program (NEHRP)**, authorized in 1977, reauthorized in 2018.
- The program's components align with our NEHRP roles:
  - Assessments and characterization of earthquake hazards and risk
  - Targeted research into earthquake source processes, occurrence, and effects
  - Monitoring and reporting earthquake activity and crustal deformation, including via the Global Seismographic Network.
- The work of the EHP is carried out through regionally managed and administered Science Centers and through external grants and cooperative agreements with partners.
- External partners include university-operated Regional Seismic Networks that make up the Advanced National Seismic System (ANSS), together with USGS-managed networks and the National Earthquake Information Center.



USGS EHP & GSN Budget

	FY2020	FY2021	FY2022	FY2023	FY2024
EHP	$84,903	$85,403	$90,037	$92,651	$92,651
GSN	$7,153	$7,153	$7,212	$7,273	$7,000

Particularly within the EHP budget, USGS receives significant line-item direction (e.g., ShakeAlert and other monitoring requirements).

In FY2024, ShakeAlert budget is $28.6M. Monitoring in general makes up ~2/3 of EHP budget.

FY 2025 President's Budget Request

Natural Hazards

Natural Hazards $ in thousands	2023 Actual	2024 Annualized CR	2025 Fixed Costs	2025 Internal Transfers (+/-)	2025 Program Changes (+/-)	2025 President's Budget	Change from 2024 Annualized CR (+/-)
Earthquake Hazards Program	92,651	92,651	+1,264	0	+951	94,866	+2,215
FTE	*238*	*238*	*0*	*0*	*+3*	*241*	*+3*
Volcano Hazards Program	37,500	37,500	+801	0	+1,383	39,684	+2,184
FTE	*144*	*144*	*0*	*0*	*+0*	*144*	*+0*
Landslide Hazards Program	14,432	14,432	+253	0	-648	14,037	-395
FTE	*44*	*44*	*0*	*0*	*-1*	*43*	*-1*
Global Seismographic Network Program	7,273	7,273	+63	0	+100	7,436	+163
FTE	*12*	*12*	*0*	*0*	*+0*	*12*	*+0*
Geomagnetism Program	5,251	5,251	+74	0	+119	5,444	+193
FTE	*14*	*14*	*0*	*0*	*+0*	*14*	*+0*
Coastal/Marine Hazards and Resources Program	43,149	43,149	+1,106	0	+4,919	49,174	+6,025
FTE	*202*	*202*	*0*	*0*	*+4*	*206*	*+4*
Natural Hazards Total	200,256	200,256	+3,561	0	+6,824	210,641	+10,385
FTE	*654*	*654*	*0*	*0*	*+6*	*660*	*+6*

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FY 2025 President's Budget Request

Natural Hazards
Earthquake Hazards Program

Natural Hazards $ in thousands	2023 Actual	2024 Annualized CR	2025 Fixed Costs	2025 Internal Transfers (+/-)	2025 Program Changes (+/-)	2025 President's Budget	Change from 2024 Annualized CR (+/-)
Earthquake Hazards Program	**92,651**	**92,651**	**+1,264**	**0**	**+951**	**94,866**	**+2,215**
Subduction Zone Science	[2,700]	[2,700]	[0]	[0]	+1,500	[4,200]	[+1,500]
Earthscope Stations for Alaska	[3,000]	[3,000]	[0]	[0]	-1,463	[1,537]	[-1,463]
EEW/ShakeAlert - Geodesy	[28,600]	[28,600]	[0]	[0]	-1,500	[27,100]	[-1,500]
Baseline Capacity - 2024 Fixed Costs	[0]	[0]	[0]	[0]	+2,414	[2,414]	[+2,414]
FTE	***238***	***238***	***0***	***0***	***+3***	***241***	***+3***

- Inflationary increases (fixed costs) across all USGS programs, for both FY24 and FY25 (+3.7M).
- Increase for Subduction Zone Science (+$1.5M)
- Decrease for adopted USArray stations in Alaska (-$1.5M)
- Decrease for the Geodetic component of ShakeAlert (-$1.5M)

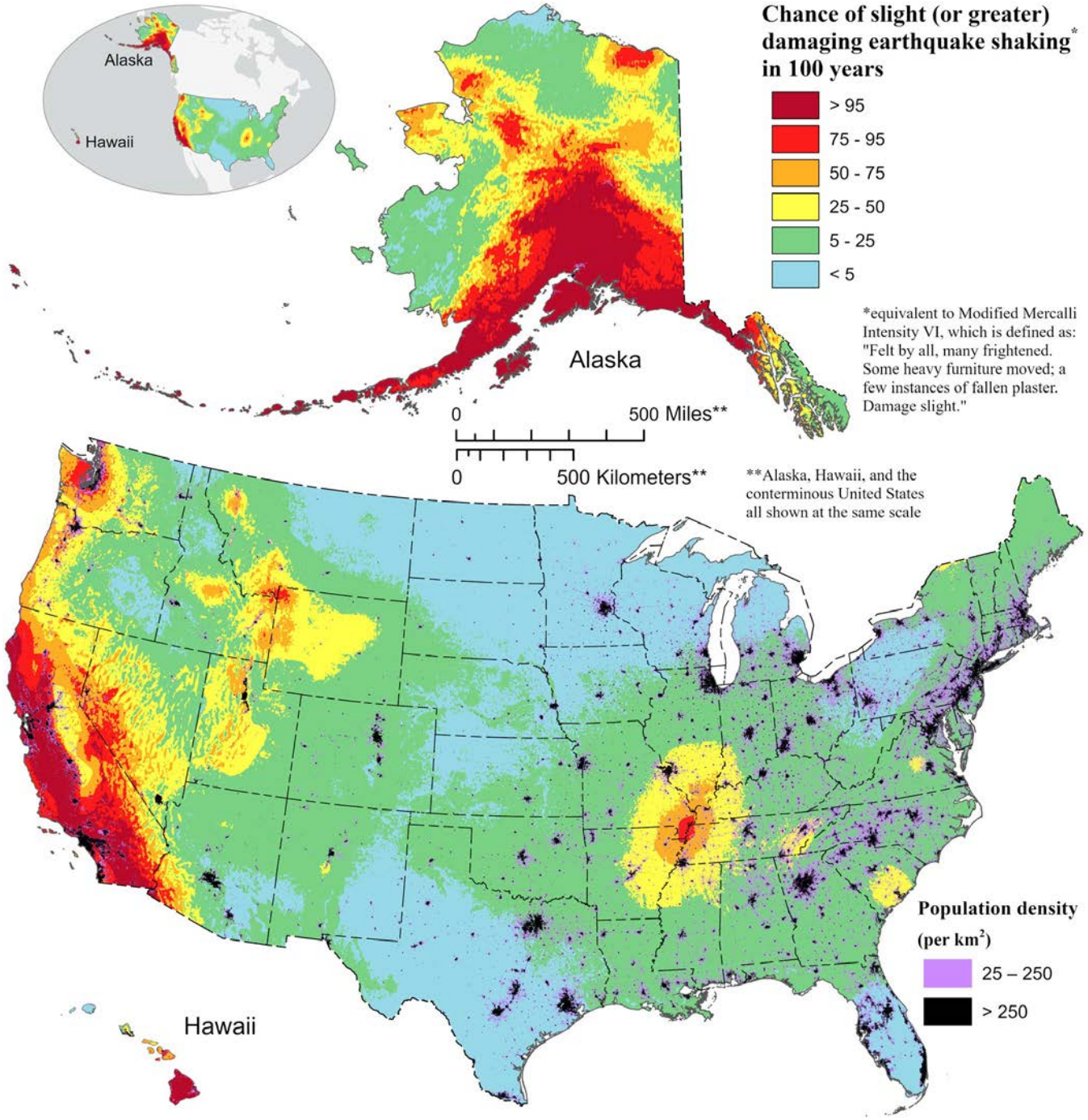
NSHM 2023 Update

Risk to People: Nearly 75% of the U.S. could experience potentially damaging earthquakes and intense ground shaking, putting hundreds of millions of people at risk.

Widespread Hazard: 37 U.S. states have experienced earthquakes exceeding magnitude 5 during the last 200 years, highlighting a long history of seismic activity across this country.

Structural Implications: The updated model will inform the future of building and structural design.

Unified Approach: This marks the first National Seismic Hazard Model to encompass all 50 states simultaneously, reflecting a massive collaborative effort with federal, state, and local partners.



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Hazard Changes in Alaska

1) New and updated fault information
2) Updated seismicity catalog to model hazard when location of faults are not known
3) New geodetic information to inform fault slip rates
4) Greater detail in modeling subduction zone geometry, depth, and segmentation
5) Addition of new NGA-Subduction GMMs specific to Alaska
6) Consideration of recent large earthquakes near Anchorage and in the Aleutians
7) Alaska experts reviewed model

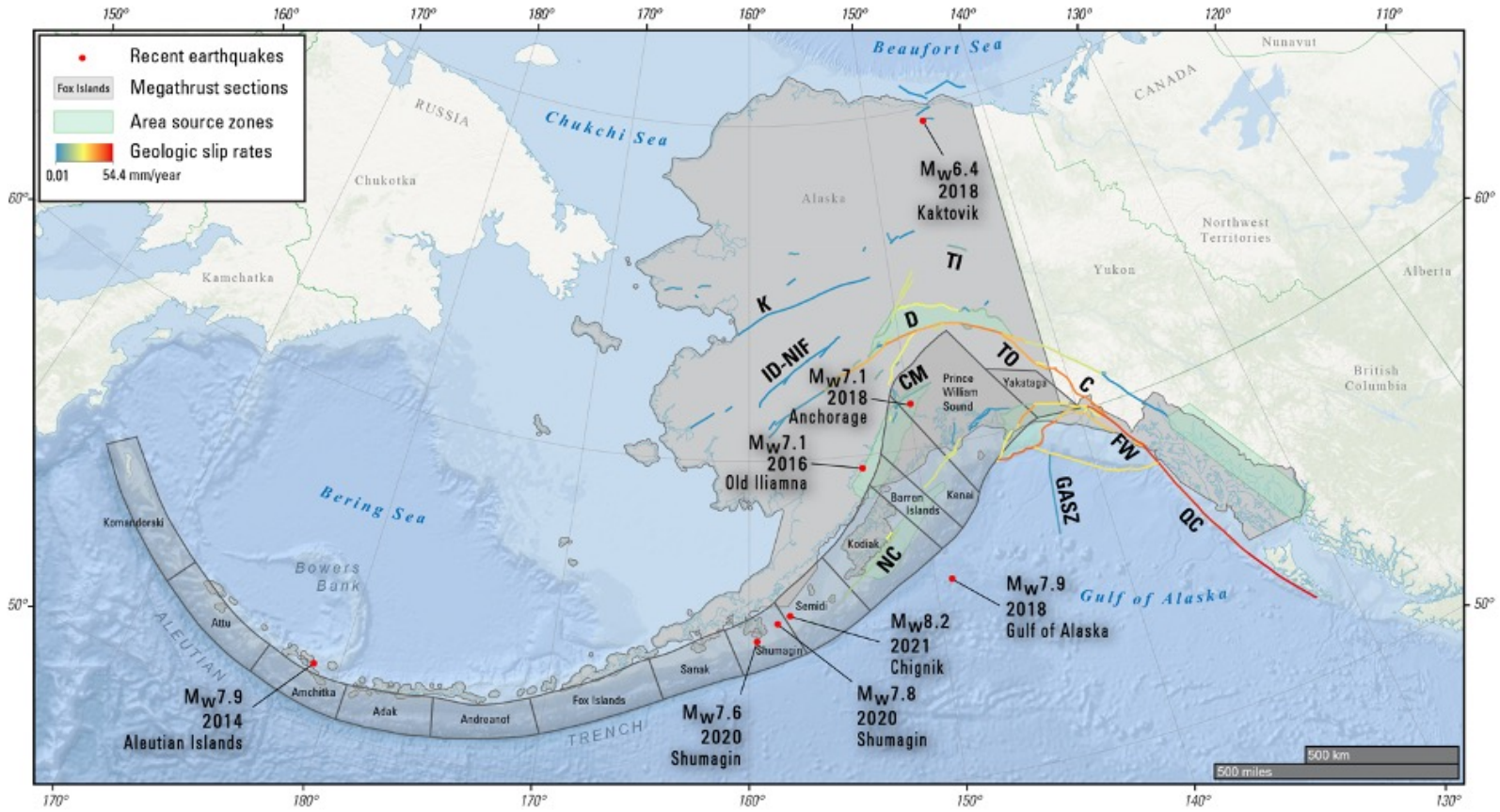

Figure 1 of Powers et al. (2024)

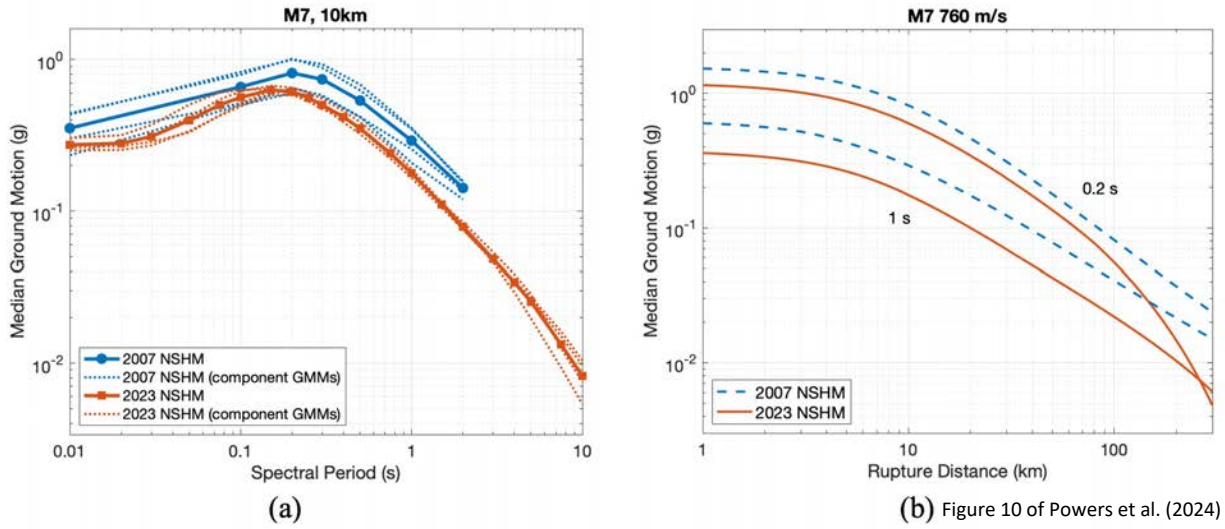

Figure 10 of Powers et al. (2024)

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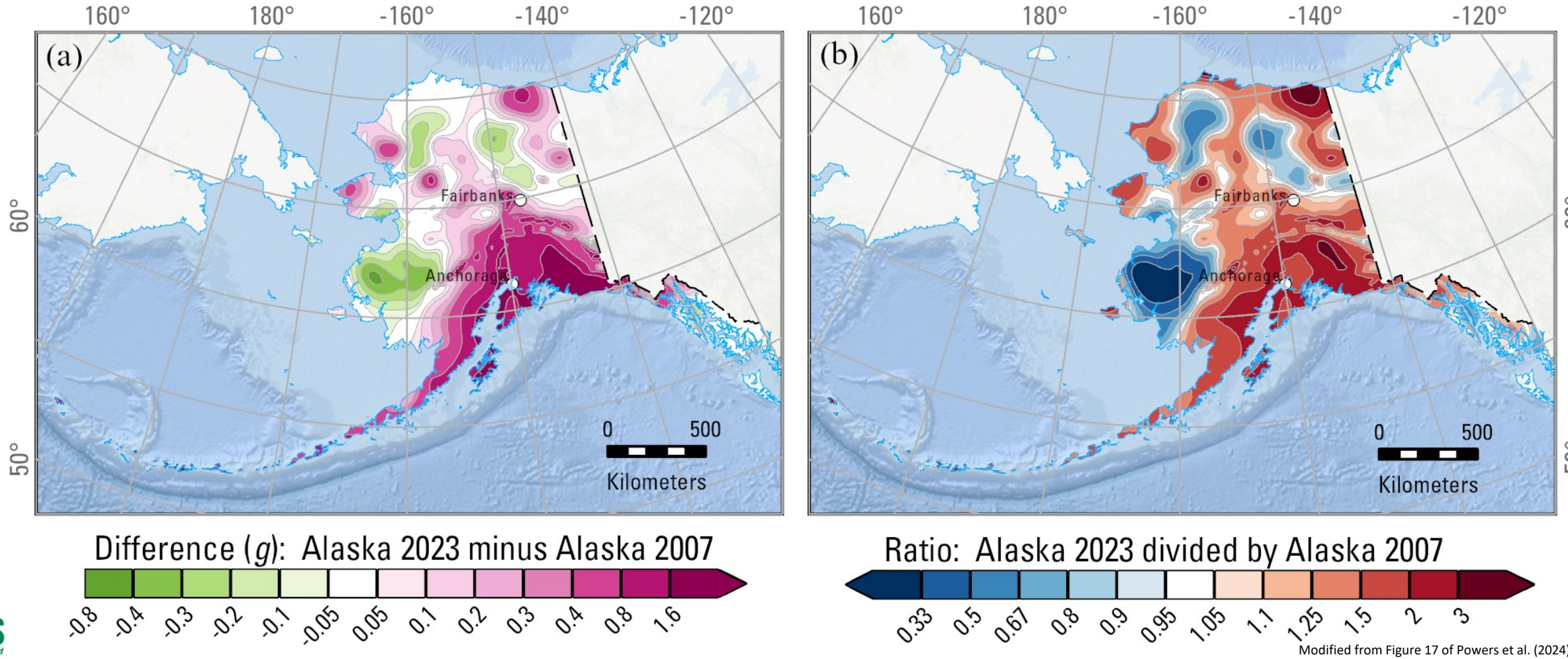
Hazard Changes in Alaska

- ERF includes data that increases hazard across the Aleutian arc
- Subduction GMMs increase hazard in the subduction zone
- Small changes in the background seismicity model causes increases and decreases in hazard in interior Alaska
- New fault and GMM information result in hazard increase for SE Alaska.



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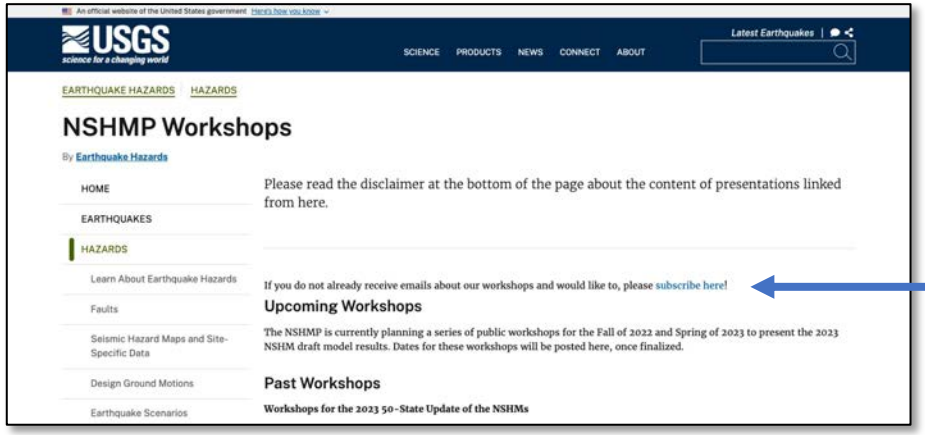
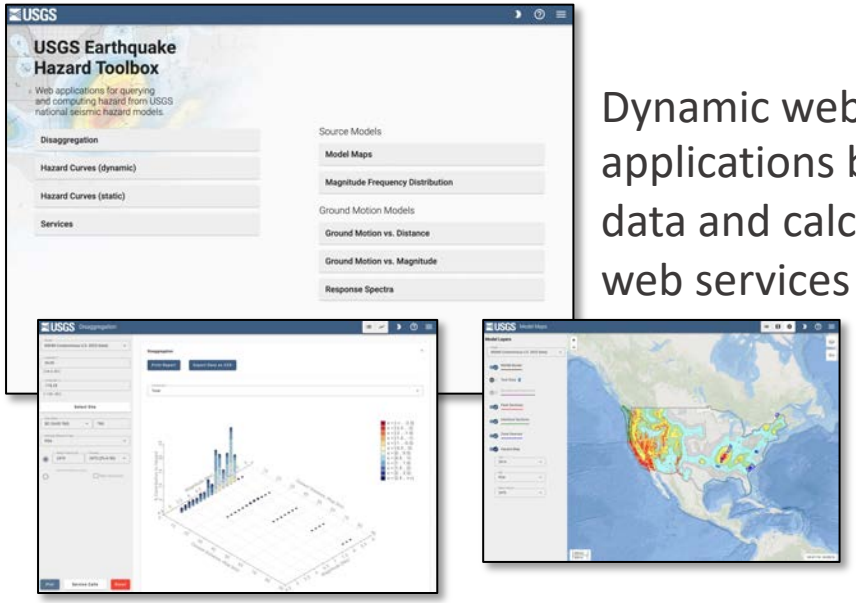
Modified from Figure 17 of Powers et al. (2024)

More Information – USGS Earthquake Hazards Website

- First published online (December 29, 2023) in the journal *Earthquake Spectra:* https://doi.org/10.1177/87552930231215428 (Open access)
- Cite article: Petersen MD, Shumway AM, Powers PM, et al. The 2023 US 50-State National Seismic Hazard Model: Overview and implications. *Earthquake Spectra*. 2023;0(0). doi:10.1177/87552930231215428

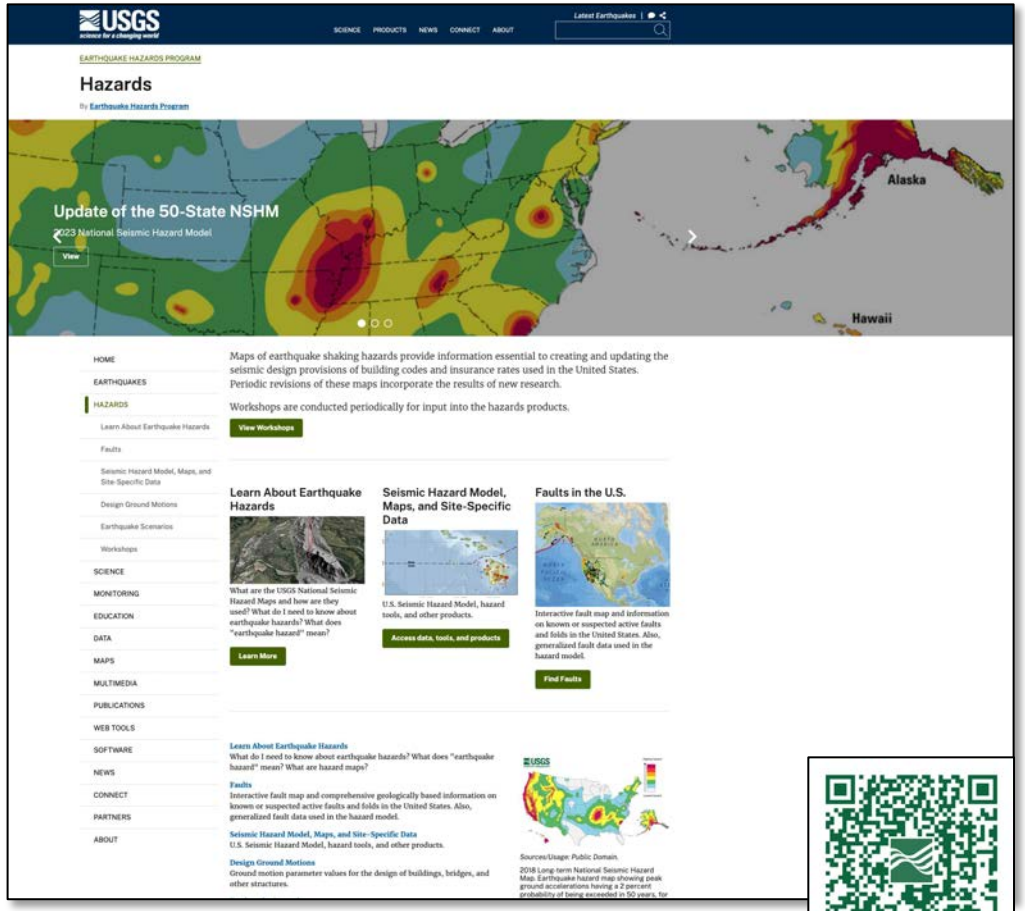


Join our email list to learn about new releases and public workshops!



Dynamic web-applications backed by data and calculation web services!

https://earthquake.usgs.gov/nshmp/



https://www.usgs.gov/programs/earthquake-hazards/hazards

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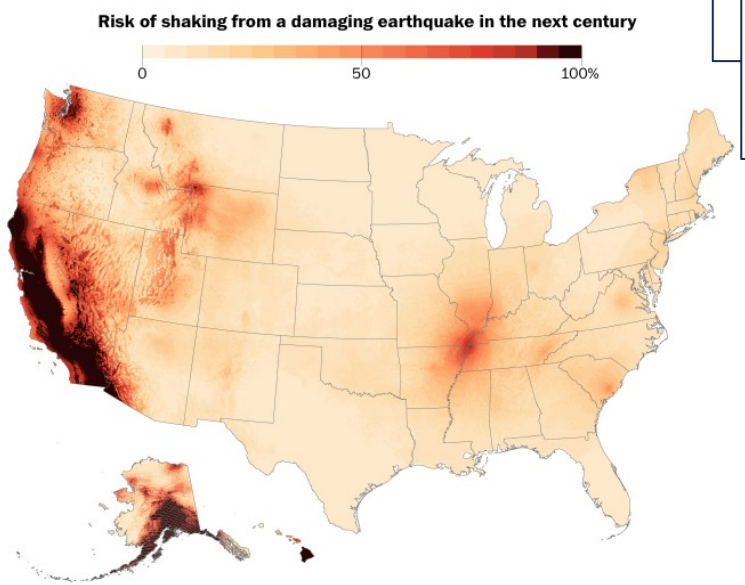
NSHM 2023 Update

The Washington Post
Democracy Dies in Darkness

Nearly three-quarters of U.S. states could experience damaging shakin from earthquakes in the next century, according to the government's latest National Seismic Hazard Model, which is used to inform policies building codes, risk assessments and earthquake preparation plans.

The greatest risks are in southern Alaska, California and Hawaii, which largely have above a 95 percent chance of feeling shakes from an earthquake in the next century. These are areas located near geologic features that can frequently trigger earthquakes, but the new model predicted more intense shaking than previous models.

Perhaps more surprising, part of the Mississippi Valley has up to a 90 percent chance of experiencing damaging shaking. Central Virginia an Charleston, S.C., have up to a 50 percent chance. Moderate to large earthquakes in these areas would reverberate to large population cente like D.C., Boston and New York City.



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Planet Earth > Earthquakes
Nearly 75% of the US is at risk from damaging earthquakes, new map reveals
News By Ben Turner published January 18, 2024
A new, ultra-detailed map sho
of damaging earthquakes, but
others.
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r damaging earthquakes
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4, 2024

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The United States Has an Updated Ma
Earthquake Hazards
The new National Seismic Hazard Model shows where damaging earthquakes are likely to occur, inform infrastructure policies.
By Caroline Hasler 14 February 2024
Alaska
Hawaii
The 2023 National Seismic Hazard Model is the first iteration to include all 50 states. Credit: USGS
Almost 15% of the U.S. population is "somewhat likely" to experience a damaging earthquake in the coming decades, according to the recently published U.S. National Seismic Hazard Model (NSHM).

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How Worried Should You Be About Earthquakes in the US?
The most recent analysis of earthquake hazards in the US reminds us that our country has a lot of potential for shaking.
Rocky Planet
By Erik Klemetti
Jan 31, 2024 8:05 AM | Last Updated Jan 31, 2024 8:10 AM
Part of the USGS map showing the chance of damaging shaking due to an earthquake in the US. Credit: USGS.
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SCIENCE SNIPPET

Earthquakes can strike faster than a New York minute – What to do when the ground shakes...

By Communications and Publishing February 12, 2024

Nearly 75 percent of the U.S. could experience damaging earthquake shaking, including the possibility of damaging earthquakes along the northeastern United States. What should residents of the Big Apple – and other major metropolitan areas -- do if they feel the ground move beneath their feet?

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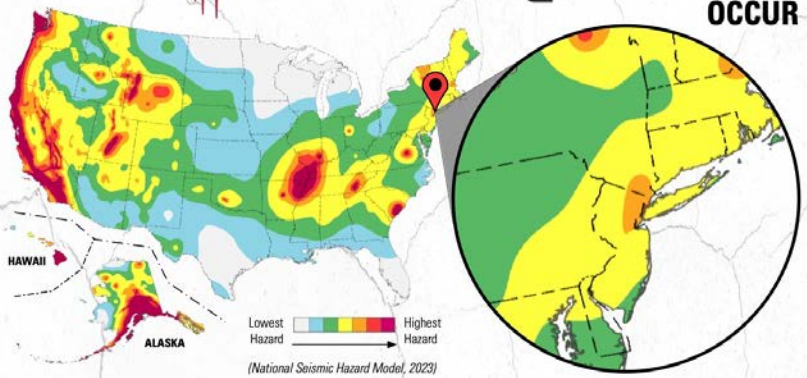
WHERE EARTHQUAKES OCCUR



(National Seismic Hazard Model, 2023)



EARTHQUAKES IN NYC

Did you know you live in "earthquake country?" It's true. Places like New York City have experienced earthquakes in the past and will again in the future. Make sure you know what to do if you feel shaking: drop, cover, and hold on!

LARGEST EARTHQUAKE
NEW YORK CITY
Aug. 10, 1884
MAGNITUDE
5.2

IF YOU FEEL THE GROUND SHAKE



DROP **COVER** **HOLD ON**

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

MORE INFORMATION
https://earthquakes.usgs.gov
www.ready.gov

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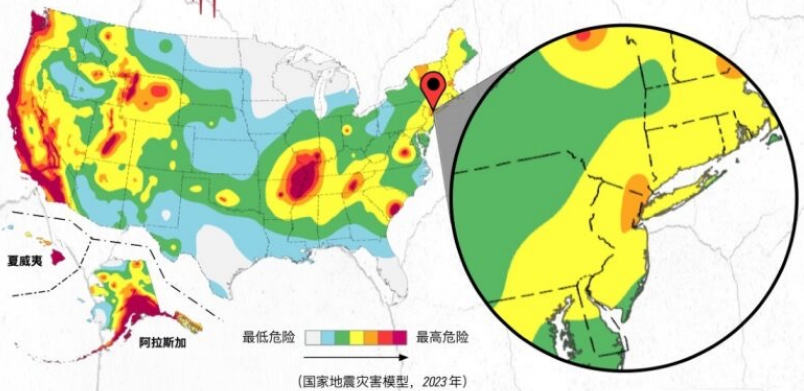
地震发生区域



（国家地震灾害模型，*2023* 年）



纽约市的地震

您知道自己生活在"地震带"吗？这是真的。纽约市等地过去曾发生过地震，将来还会发生。如果您感到地面在震动，请确保知道怎么做：趴下、掩护和稳住！

规模最大的地震
纽约市
1884 年 *8* 月 *10* 日
震级
5.2

如果您感觉到地面在震动



趴下 **掩护** **稳住**

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

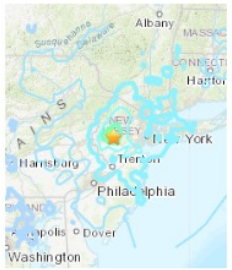
查看更多信息
https://earthquakes.usgs.gov
www.ready.gov

- Latest Earthquakes
- **Overview**
  - Interactive Map
  - Regional Information
- Impact
  - Felt Report - Tell Us!
  - Did You Feel It?
  - ShakeMap
  - PAGER
  - Ground Failure
  - Aftershock Forecast
- Technical
  - Origin
  - Moment Tensor
  - Waveforms
- Download Event KML
- View Nearby Seismicity

M 4.8 - 2024 Whitehouse Station, New Jersey Earthquake

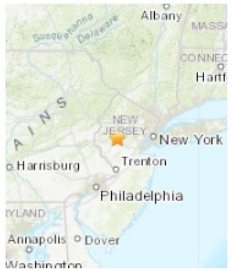
2024-04-05 14:23:20 (UTC) | 40.689°N 74.754°W | 4.7 km depth

Interactive Map



Contributed by US [3]

Regional Information



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Felt Report - Tell Us!

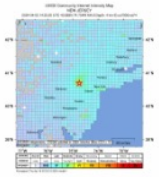
1 8 3 5 9 9

Responses

Contribute to citizen science. Please tell us about your experience.

Citizen Scientist Contributions

Did You Feel It? VI



Community Internet Intensity Map

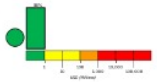
Contributed by US [3]

ShakeMap VI

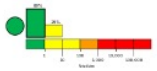
Estimated Intensity Map

Contributed by US [3]

PAGER GREEN



Estimated Economic Losses



Estimated Fatalities

Contributed by US [3]

Ground Failure

Landslide Estimate

Little or no area affected

Little or no population exposed

Liquefaction Estimate

Little or no area affected

Little or no population exposed

Contributed by US [3]

Aftershock Forecast

According to our forecast, the chance of at least one aftershock within the next **week**:

M 7+	< 1%
M 6+	< 1%
M 5+	< 1%
M 4+	< 1%
M 3+	4%

Contributed by US [3]

Origin

Review Status
REVIEWED

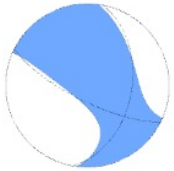
Magnitude
4.8 mwr

Depth
4.7 km

Time
2024-04-05 14:23:20 UTC

Contributed by US [3]

Moment Tensor



Fault Plane Solution

Contributed by US [3]

Tsunami

U.S. Tsunami Warning System

To view any current tsunami advisories for this and other events please visit https://www.tsunami.gov.

NOAA

View Nearby Seismicity

Time Range
± Three Weeks

Search Radius
250.0 km

Magnitude Range
≥ 1.0

ANSS Comcat

Event Sequence

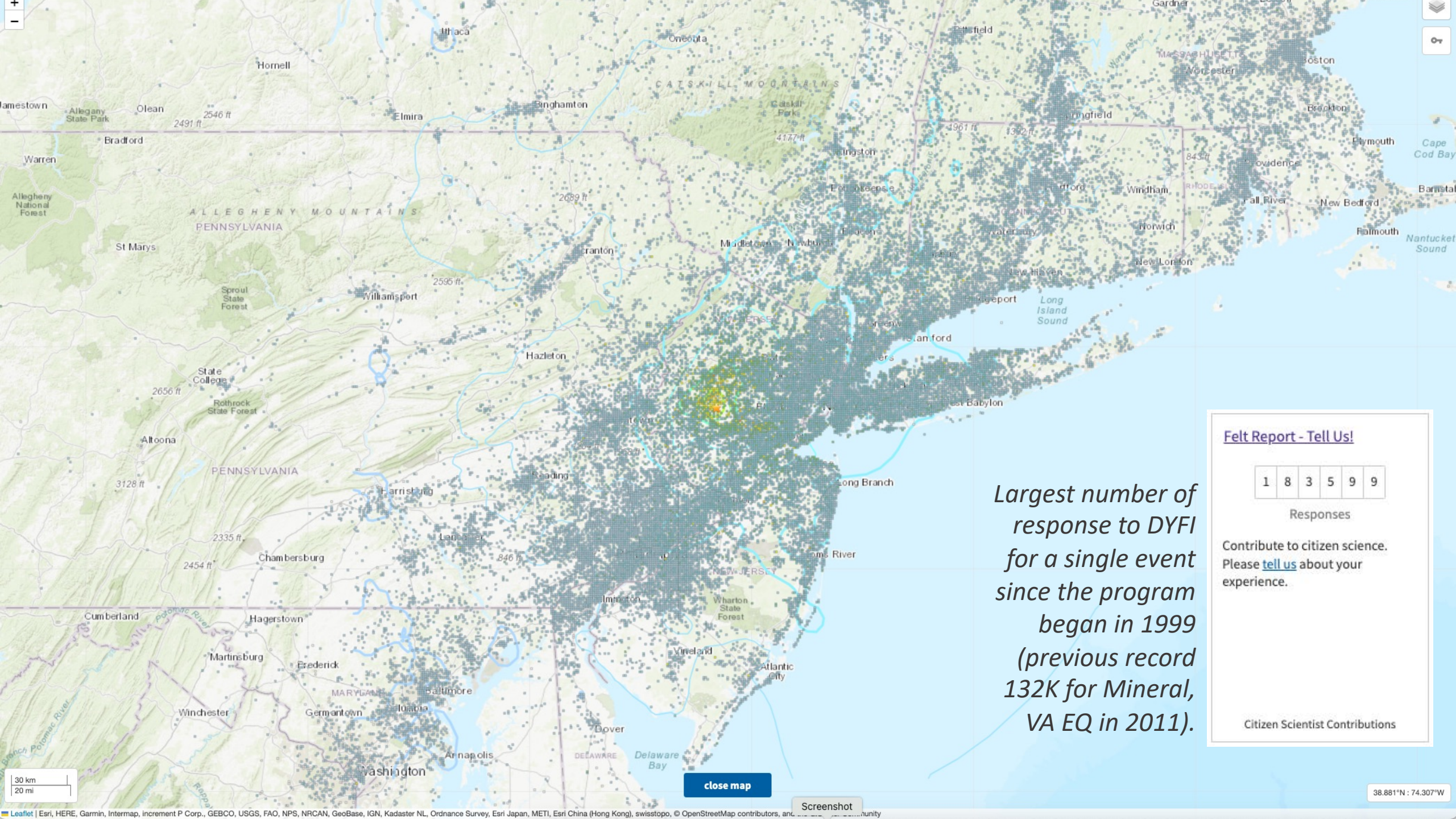
This event is identified as the potential mainshock of an earthquake sequence. View 97 events in the sequence.

Tectonic Summary

The April 5, 2024, M 4.8 earthquake near Whitehouse Station, New Jersey, occurred as a result of oblique reverse and strike-slip faulting at shallow depths in the crust. Although this event did not occur near a plate boundary, such “intraplate” earthquakes can and do occur. While this earthquake is relatively small globally, earthquakes of this magnitude are commonly widely felt in the eastern United States because of efficient seismic wave propagation in the region.

Earthquakes in the eastern US are infrequent but not unexpected. Since 1950, 40 other earthquakes of magnitude 3 and larger have occurred within 250 km of today’s earthquake. In that time range, the April 5, 2024, earthquake is the largest. Within 500 km of the April 5th earthquake, 13 earthquakes M 4.5 and larger have been recorded since 1950, the largest being the August 23, 2011, M 5.8 Mineral Virginia earthquake which caus damage and was felt throughout the eastern US. The April 5,

Screenshot



Largest number of response to DYFI for a single event since the program began in 1999 (previous record 132K for Mineral, VA EQ in 2011).

ShakeAlert – New GNSS Algorithm

“G-Fast PGD”, a peak ground displacement algorithm based on GNSS data, is now live in the operational version of ShakeAlert (v3.0.1).

G-Fast should allow ShakeAlert to reliably characterize the size of large (M~7.5+) earthquakes.

Reliable GNSS operations depend to some extent on the NSF-supported NOTA. NSF may choose to divest from, or seek joint or full support for, these stations.

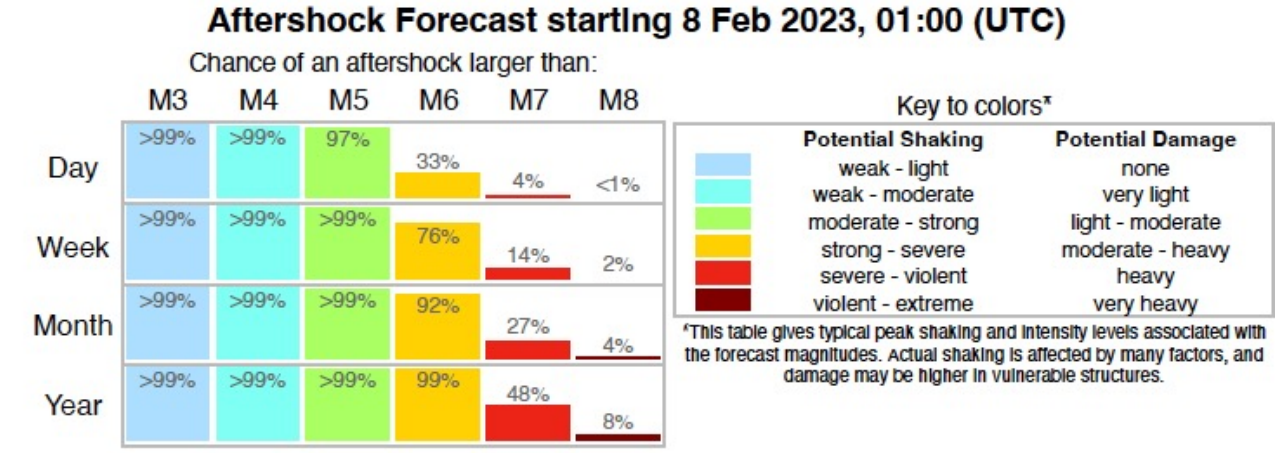


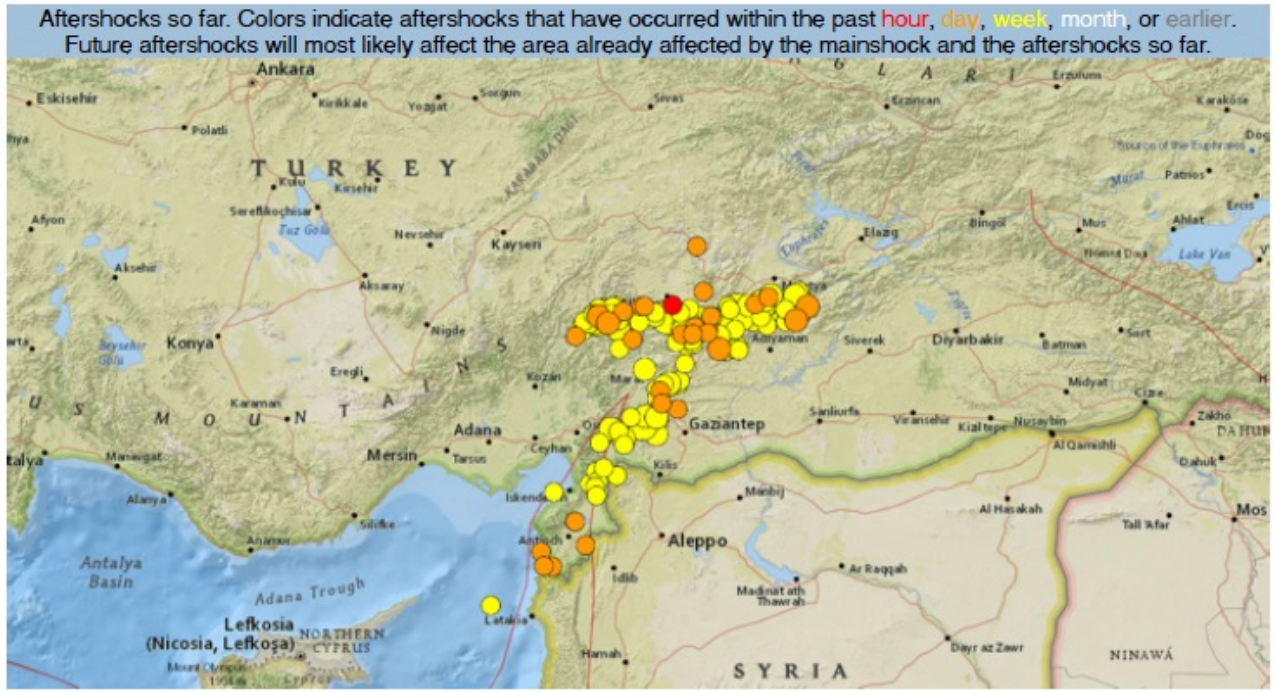
International Aftershock Forecasting

The OAF Team currently creates manual ETAS-based aftershock forecasts for PAGER-Orange+ (fatalities) earthquakes for USAID partners.

For high impact events, simplified aftershock statements have been made available on USGS event pages.

EHP intends to make quantitative forecasts publicly-available for a limited number of future impactful international earthquakes.





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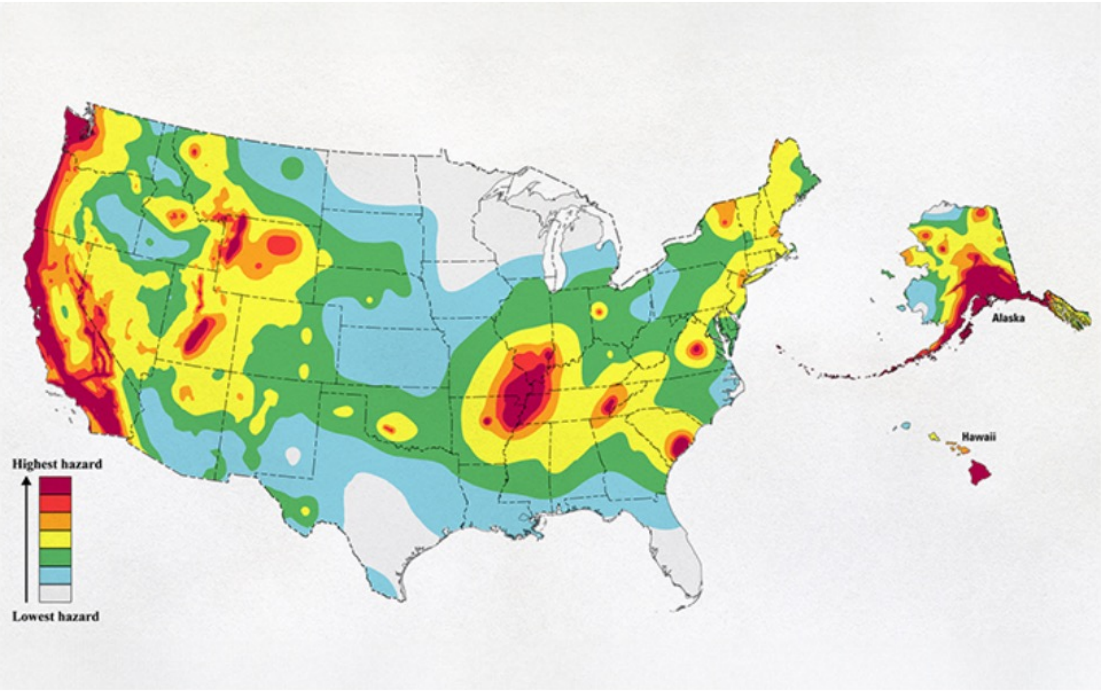
SCEC
AN NSF+USGS CENTER

Southern California Earthquake Center

Studying earthquakes and their effects in California and beyond

LOG IN REGISTER

Exciting news! We're transitioning to the **Statewide California Earthquake Center**. Our new website is under construction, but we'll continue using this website for SCEC business in the meantime. We're also archiving the Southern Center site to preserve its rich history. A new and improved platform is coming soon!



How threatened by earthquakes are US communities? New report gives answers

Researchers at USC Dornsife's Statewide California Earthquake Center contributed models that forecast earthquake ruptures for the U.S. Geological Survey's National Seismic Hazard Model.

USGS supporting SCEC via a new 2-year coop that began 02/24.

Now that SCEC is Statewide, we encourage strong participation with the group to leverage broader opportunities (and ensure activities are not redundant).

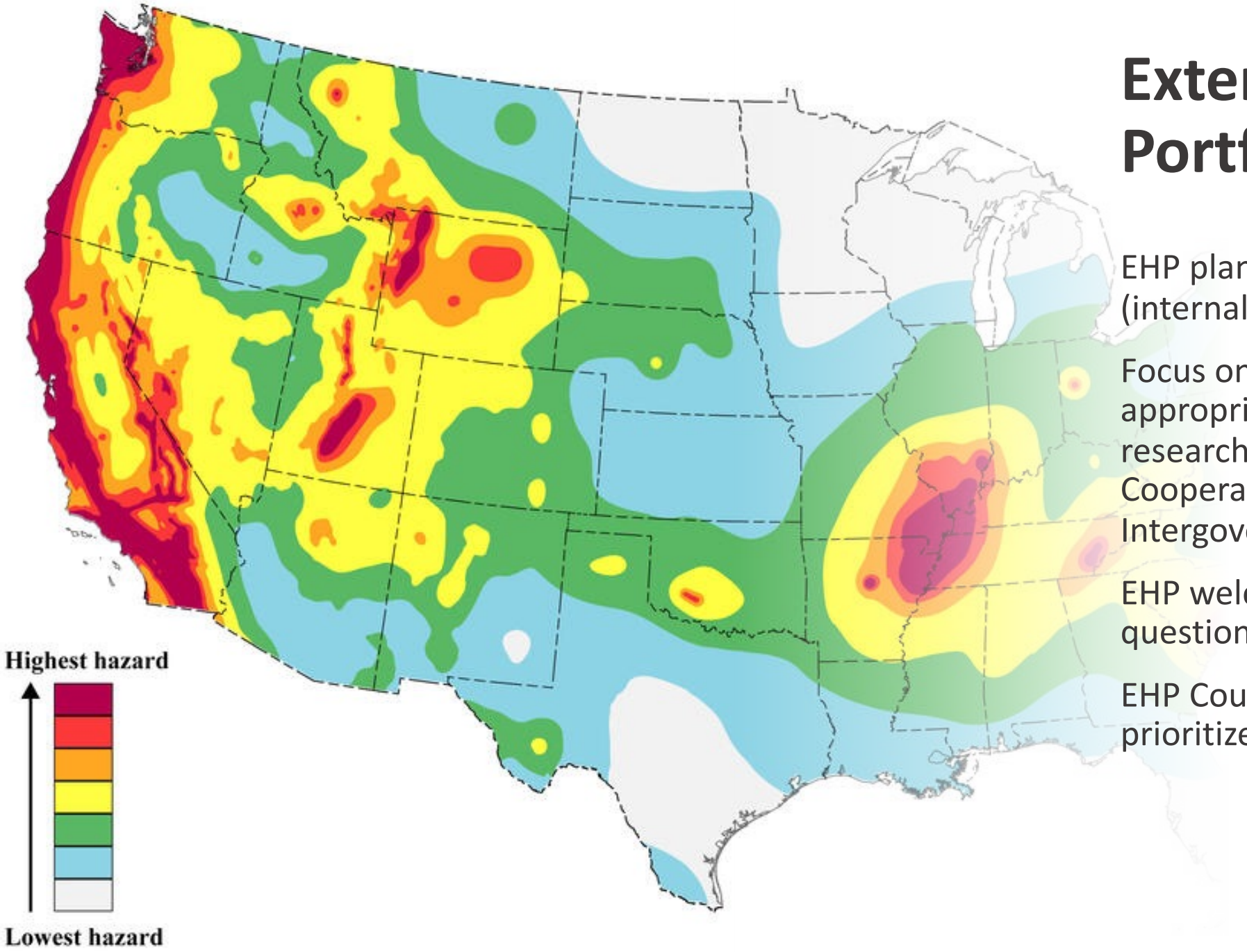
ANNOUNCEMENTS

NEWS

SCEC NEWSLETTER

SCIENCE WORKSHOPS

RECENT EARTHQUAKES



External Research Portfolio Review

EHP plans to host two expert panels (internal & external)

Focus on soliciting input on most appropriate use of limited external research funding (Grants, Cooperative Agreements, Intergovernment Personnel Act, etc.)

EHP welcomes input from ACEHR on questions/topics to present to panels

EHP Council will collate results and prioritize actions.

Earthquake Hazards Program

Looking Forward

- *NSHM '23 release – now onto PRVI model for '24-'25*
- *EHP excelling in earthquake response mode*
- *Program-wide strategic planning in final production*
- *Continued budget pressures for foreseeable future*
- *ShakeAlert nearing West Coast completion; expansion on the horizon?*
- *External Grants review process to initiate this ~Fall – input from ACEHR welcome.*



Questions?

Gavin Hayes
(ghayes@usgs.gov)
Senior Science Advisor for Earthquake and Geologic Hazards
U.S. Geological Survey