Zachary E. Ross

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Professional Appointments

2025–	Professor of Geophysics, California Institute of Technology
2021–	William H. Hurt Scholar, California Institute of Technology
2019–2025	Assistant Professor of Geophysics, California Institute of Technology
2016–2019	Postdoctoral Scholar in Geophysics, California Institute of Technology
2011–2016	Graduate Student Researcher, University of Southern California

Education

2016	Ph.D., Geophysics, University of Southern California Thesis Advisor: Prof. Yehuda Ben-Zion
2011	M.S., Civil Engineering, California Polytechnic State University, San Luis Obispo
2009	B.S., Physics, University of California, Davis

Honors and Awards

2024	Researcher profile in *National Geographic,* special vol. "The AI Revolution"
2022	Packard Fellow, David and Lucile Packard Foundation
2022	Kavli Fellow, National Academy of Sciences
2022	CAREER Award, National Science Foundation
2021	William H. Hurt Scholar (endowed professorship for junior faculty), Caltech
2019	Keiiti Aki Early Career Award, American Geophysical Union
2019	AGU Editors' Citation for Excellence in Refereeing
2019	High Performance Computing Innovation Excellence Award, Hyperion Research
2016	University Ph.D. Achievement Award, University of Southern California
2011	Graduation with Distinction, Cal Poly, San Luis Obispo

Patents

Zhu, W., Biondi, E., Li, J., Yin, J., **Ross, Z. E.**, and Z. Zhan, 2023-02-08. "Seismic Phase Arrival-Time Picking On Distributed Acoustic Sensing Data Using Semi-Supervised Learning".

Publications (Peer-Reviewed)

Legend: *Graduate Student, ^Postdoctoral Scholar, †Undergraduate Student

In Review:

[98] *Li, L., & **Ross**, **Z. E.** (n.d.). "On the Frequency and Timing of Earthquake Doublets [submitted].

[97] ^Shi, Y., **Ross**, **Z. E.**, & Yue, Y. (n.d.). Flow Annealing Posterior Sampling for Function-Space Regression and Inverse Problems [submitted].

[96] *Shi, Y., Lavrentiadis, G., Tsalouchidis, K., **Ross**, **Z. E.**, McCallen, D., Zou, C., Azizzadenesheli, K., & Asimaki, D. (n.d.). Large-Scale 3D Ground-Motion Synthesis with Physics-Inspired Latent Operator Flow Matching [submitted].

[95] Poggiali, G., Chiaraluce, L., Sugan, M., Vuan, A., **Ross**, **Z. E.**, & Marone, C. (n.d.). Spatio-temporal Evolution of Seismicity in the Northern Apennines: Insights from a High-Resolution Earthquake Catalog [submitted].

[94] *Villa, V., **Ross**, **Z. E.**, & Lapusta, N. (n.d.). Whispers of aftershocks in the seismically prolific San Jacinto Fault Zone, California [submitted].

[93] ^Guo, H., Wilding, J. D., & **Ross**, **Z. E.** (n.d.). Tidal modulation of earthquake rates in tensilely deformed environments [submitted].

[92] ^Ramirez, E. E., Stock, J. M., **Ross**, **Z. E.**, Vidal-Villegas, J. A., Núñez-Leal, M. A., & Ramírez-Hernández, J. (n.d.). Northern Baja California, Mexico, Seismicity Illuminated with Deep Learning Phase Picking and Associator [submitted].

Published:

[91] **Ross**, **Z. E.**, Wilding, J. D., Azizzadenesheli, K., & Kato, A. (2026). SPIDER: Scalable Probabilistic Inference for Differential Earthquake Relocation. *Journal of Geophysical Research: Solid Earth*, *131*(3), e2025JB032769.

[90] *Wilding, J. D., Wang, T. A., Liu, Y.-K., & **Ross**, **Z. E.** (2026). Cascading magmatic unrest and aseismic faulting in the Aegean Sea enabled by elastic stress relay [in press]. *Science Advances*.

[89] *Kong, C., Gurnis, M., & **Ross**, **Z. E.** (2026). Forward and inverse mantle convection with neural operators. *Geophysical Journal International*, *246*(3), ggag255.

[88] *Zou, C., Shi, Y., **Ross**, **Z. E.**, Clayton, R. W., & Azizzadenesheli, K. (2026). Enforcing Reciprocity in Operator Learning for Seismic Wave Propagation. *Seismological Research Letters*. https://doi.org/10.1785/0220260082

[87] *Gao, A. F., Wilding, J. D., Biondi, E., Bouman, K. L., & **Ross**, **Z. E.** (2026). High-resolution Eikonal imaging and uncertainty quantification of the Kilauea caldera. *Geophysical Journal International*, ggag179. https://doi.org/10.1093/gji/ggag179

[86] ^Chen, Z., McPhillips, D., Scharer, K., & **Ross**, **Z. E.** (2026). 3D Semantic Mapping of surface geological features. *Computers & Geosciences*, 106181.

[85] ^Ragon, T., Gao, A. F., & **Ross**, **Z. E.** (2025). DeepGEM-EGF: A Bayesian strategy for joint estimates of source-time functions and Empirical Green's functions. *Journal of Geophysical Research: Solid Earth*, *130*, e2025JB031260. https://doi.org/10.1029/2025JB031260

[84] *Shi, Y., **Ross**, **Z. E.**, Asimaki, D., & Azizzadenesheli, K. (2025a). Mesh-Informed Neural Operator: A Transformer Generative Approach. *Transactions on Machine Learning Research*. https://openreview.net/forum?id=K8qAuRfv0G

[83] *Shi, Y., **Ross**, **Z. E.**, Asimaki, D., & Azizzadenesheli, K. Stochastic Process Learning via Operator Flow Matching [Spotlight Paper]. In *Advances in neural information processing systems (neurips)*. Spotlight Paper. 2025.

[82] *Zou, C., **Ross**, **Z. E.**, Clayton, R. W., Lin, F.-C., & Azizzadenesheli, K. (2025). Ambient noise full waveform inversion with neural operators. *Journal of Geophysical Research: Solid Earth*, *130*, e2025JB031624. https://doi.org/10.1029/2025JB031624

[81] Kong, Q., Zou, C., Choi, Y., Matzel, E. M., Azizzadenesheli, K., **Ross**, **Z. E.**, Rodgers, A. J., & Clayton, R. W. (2025). Reducing Frequency Bias of Fourier Neural Operators In 3D Seismic Wavefield Simulations Through Multi-Stage Training. *Seismological Research Letters*. https://doi.org/10.1785/0220250085

[80] ^Poggiali, G., Chiaraluce, L., **Ross**, **Z. E.**, Zhu, W., & Marone, C. (2025). A High Resolution Machine-Learning Earthquake Catalog to Characterize Fault Geometry and Source Mechanics: the Altotiberina Fault Case Study. *Bulletin of the Seismological Society of America*. https://doi.org/10.1785/0120250072

[79] Zheng, H., Chu, W., Zhang, B., Wu, Z., Wang, A., Feng, B., Zou, C., Sun, Y., Kovachki, N., **Ross**, **Z. E.**, Bouman, K., & Yue, Y. InverseBench: Benchmarking Plug-and-Play Diffusion Models for Scientific Inverse Problems [Spotlight Paper]. In *International conference on learning representations (iclr)*. Spotlight Paper. 2025.

[78] *Atterholt, J., Wilding, J. D., & **Ross**, **Z. E.** (2024). The Evolution of Fault Orientation in the 2019 Ridgecrest Earthquake Sequence with a New Long-Term Catalog of Seismicity and Moment Tensors. *Geophysical Journal International*.

[77] *Shi, Y., Gao, A. F., **Ross**, **Z. E.**, & Azizzadenesheli, K. (2024a). Universal Functional Regression with Neural Operator Flows [in press]. *Transactions on Machine Learning Research*.

[76] *Wilding, J. D., & **Ross**, **Z. E.** (2024b). Rift zone architecture and inflation-driven seismicity of Mauna Loa volcano. *Journal of Geophysical Research: Solid Earth*, *129*, e2024JB029726. https://doi.org/10.1029/2024JB029726

[75] *Zou, C., Azizzadenesheli, K., **Ross**, **Z. E.**, & Clayton, R. W. (2024). Deep Neural Helmholtz Operators for 3D Elastic Wave Propagation and Inversion. *Geophysical Journal International*. https://doi.org/10.1093/gji/ggae342

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[72] *Shi, Y., Lavrentiadis, G., Asimaki, D., **Ross**, **Z. E.**, & Azizzadenesheli, K. (2024b). Broadband Ground Motion Synthesis via Generative Adversarial Neural Operators: Development and Validation. *Bulletin of the Seismological Society of America*, *114*(4), 2151–2171. https://doi.org/10.1785/0120230207

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[53] *Yang, Y., *Gao, A. F., *Castellanos, J. C., **Ross**, **Z. E.**, Azizzadenesheli, K., & Clayton, R. W. (2021). Seismic wave propagation and inversion with Neural Operators. *The Seismic Record*, *1*(3), 126–134. https://doi.org/10.1785/0320210026

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[10] **Ross**, **Z. E.**, & Ben-Zion, Y. (2016). Toward reliable automated estimates of earthquake source properties from body wave spectra. *Journal of Geophysical Research: Solid Earth*, *121*(6), 4390–4407. https://doi.org/10.1002/2016JB013003

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[8] Okaya, D., Christensen, N., **Ross**, **Z. E.**, & Wu, F. T. (2016). Terrane-controlled crustal shear wave splitting in Taiwan. *Geophysical Research Letters*, *43*(2). https://doi.org/10.1002/2015GL066446

[7] **Ross**, **Z. E.**, & Ben-Zion, Y. (2015). An algorithm for automated identification of fault zone trapped waves. *Geophysical Journal International*, *202*(2), 933–942. https://doi.org/10.1093/gji/ggv197

[6] Ben-Zion, Y., Vernon, F. L., Ozakin, Y., Zigone, D., **Ross**, **Z. E.**, Meng, H., White, M., Reyes, J., Hollis, D., & Barklage, M. (2015). Basic data features and results from a spatially-dense seismic array on the San Jacinto fault zone. *Geophysical Journal International*, *202*(1), 370–380. https://doi.org/10.1093/gji/ggv142

[5] **Ross**, **Z. E.**, Ben-Zion, Y., & Zhu, L. (2015). Isotropic source terms of San Jacinto fault zone earthquakes based on waveform inversions with a generalized CAP method. *Geophysical Journal International*, *200*(2), 1269–1280. https://doi.org/10.1093/gji/ggu460

[4] **Ross**, **Z. E.**, & Ben-Zion, Y. (2014b). Automatic picking of direct P, S seismic phases and fault zone head waves. *Geophysical Journal International*, *199*(1), 368–381. https://doi.org/10.1093/gji/ggu267

[3] **Ross**, **Z. E.**, & Ben-Zion, Y. (2014a). An Earthquake Detection Algorithm with Pseudo Probabilities of Multiple Indicators. *Geophysical Journal International*, *197*(1), 458–463. https://doi.org/10.1093/gji/ggt516

[2] **Ross**, **Z. E.**, & Ben-Zion, Y. (2013). Spatio-temporal variations of double-couple aftershock mechanisms and possible volumetric earthquake strain. *Journal of Geophysical Research: Solid Earth*, *118*(5). https://doi.org/10.1002/jgrb.50202

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Publications (Non-Refereed)

Ross, **Z. E.**, Zhu, W., & Azizzadenesheli, K. (2023). Neural mixture model association of seismic phases.

Sun, H., Yang, Y., Azizzadenesheli, K., Clayton, R. W., & **Ross**, **Z. E.** (2022). Accelerating Time-Reversal Imaging with Neural Operators for Real-time Earthquake Locations.

Hough, S. E., **Ross**, **Z. E.**, & Dawson, T. (2020). Introduction to the Special Section on the 2019 Ridgecrest, California, Earthquake Sequence. *Bulletin of the Seismological Society of America*, *110*(4), 1395–1399. https://doi.org/10.1785/0120200201

Ross, **Z. E.** (2016). Applying automated techniques to large seismic datasets for systematic analyses of phases, source, and structure [Doctoral dissertation, University of Southern California].

Ross, **Z. E.** (2011). Probabilistic Fault Displacement Hazard Analysis for Reverse Faults and Surface Rupture Scale Invariance [Master's thesis, California Polytechnic State University, San Luis Obispo].

Volumes Edited

Hough, S. E., **Ross, Z. E.**, and T. Dawson, 2020. Special Section: 2019 Ridgecrest, California, Earthquake Sequence, *Bull. Seismol. Soc. Am*, 110 (4).

Invited Presentations

[55] *USNC-TAM26: Operator Networks in Geomechanics*, April 2026.

[54] *American Geophysical Union*, December 2025.

[53] *Harvard University*, October 2025.

[52] *Earthquake Research Institute, University of Tokyo*, May 2025

[51] *Distinctive Voices Lecture, Beckman Center, National Academy of Sciences*, January 2025.

[50] *Earthquake Research Institute, University of Tokyo*, April 2024.

[49] *Machine Learning in Solid Earth Geoscience, Santa Fe, NM,* January 2024.

[48] *Committee on Seismology and Geodynamics, National Academy of Sciences*, November 2023.

[47] *University of California, Berkeley, Berkeley Seismological Laboratory Seminar*, August 2023.

[46] *American Geophysical Union*, December 2023.

[45] *ERC TECTONIC Workshop: Earthquake Physics and Applications of Machine Learning to Tectonic Faulting*, Rome, Italy, September 2023.

[44] *Earthquake Research Institute*, *University of Tokyo*, December 2022.

[43] *Seismological Laboratory Centennial Celebration*, November 2022.

[42] *Kavli Frontiers of Sciences, 3rd Japanese-American-German FOS*, *Beckman Center of the National Academies of Sciences and Engineering*, Sept 2022.

[41] *University of California, Los Angeles, Departmental Colloquium*, May 2022

[40] *American Geophysical Union, New Orleans, LA,* December 2021

[39] *Sala Baldini, Rome, Physics of Earthquake Faulting: Machine Learning to Illuminate Earthquake Precursors and Predict Laboratory Earthquakes*, September 2021.

[38] *Rice University, Earth, Environmental and Planetary Sciences Department Seminar.* November 2021.

[37] *Center for Nonlinear Studies, Los Alamos National Laboratory*, *Machine Learning in Solid Earth Geoscience,* March 2021.

[36] *University of Toronto, Geophysics seminar.* February 2021.

[35] *Michigan State University*, *Computational Mathematics, Science and Engineering Colloquium,* October 2020.

[34] *Earth2Earth UK-wide Zoom Seminar*, October 2020.

[33] *University of Utah*, *Distinguished Lecture Series,* September 2020.

[32] *Deformation and Tectonics (DeTect) Zoom Seminar series,* September 2020.

[31] *American Geophysical Union*, December 2020.

[30] *Geological Society of America*, October 2020.

[29] *Center for Nonlinear Studies, Los Alamos National Laboratory, Machine Learning in Solid Earth Geoscience*, Santa Fe, NM, March 2020. (canceled due to COVID-19).

[28] The structural architecture of fault zones and its role in earthquake physics, *University of California, Los Angeles, Tectonics Seminar,* November 2019.

[27] Searching for hidden earthquakes in Southern California, *Committee on Seismology and Geodynamics, National Academy of Sciences*, Washington DC, October 2019

[26] How deep learning is transforming earthquake seismology, *IST seminar, Dept. of Computing and Mathematical Sciences, Caltech*, October 2019.

[25] The structural architecture of fault zones at depth, *IRIS SAGE/GAGE*, Portland, October 2019

[24] The structural architecture of fault zones and its relation to earthquake physics, *Distinguished Lecturer Series, University of Utah*, October 2019.

[23] Earthquakes and the era of artificial intelligence, *Jet Propulsion Laboratory*, Pasadena, CA, September 2019.

[22] Earthquakes and the era of artificial intelligence, *Earthquake Research Institute, University of Tokyo*, Tokyo, Japan, August 2019.

[21] Earthquakes and the era of artificial intelligence, *Geological Survey of Japan, AIST*, Tsukuba, Japan, August 2019

[20] A Deep Learning Pipeline for Earthquake Detection, *StatSei11*, Hakone, Japan, August 2019.

[19] A Deep Learning Pipeline for Earthquake Detection, *Seismological Society of America Annual Meeting*, Seattle, WA, April 2019.

[18] A Deep Learning Pipeline for Earthquake Detection, *Machine Learning in Solid Earth Geoscience*, Santa Fe, NM, March 2019.

[17] A deep learning approach to seismic phase association, *American Geophysical Union*, Washington, D.C., December 2018.

[16] Detection of earthquakes, phases, and first-motion polarities with deep learning, *International Induced Seismicity Workshop*, Banff, Canada, October 2018.

[15] How big data and artificial intelligence are transforming seismology, *GPS Division Seminar, California Institute of Technology*, October 2018.

[14] Detecting millions of earthquakes in Southern California with template matching, *Southern California Earthquake Center*, Palm Springs, CA, September 2018.

[13] Earthquakes and artificial intelligence, *Berkeley Seismological Laboratory, UC Berkeley,* Berkeley, CA September 2018.

[12] Earthquakes and artificial intelligence, *United States Geological Survey, Golden*, Golden, CO, July 2018.

[11] Detecting millions of earthquakes in Southern California with template matching, *ETH Zurich*, June, 2018.

[10] Generalized seismic phase detectors with deep learning, *Seismological Society of America Annual Meeting*, Miami, FL, May, 2018.

[9] Generalized seismic phase detectors with deep learning, *Lawrence Livermore National Laboratory*, Livermore, CA, April 2018.

[8] Connecting fault zone structure and earthquake source processes, *IGPP Seminar, Scripps Institution of Oceanography*, San Diego, CA, January 2018.

[7] Aftershocks driven by afterslip and fluid pressure sweeping through a fault-fracture mesh. *American Geophysical Union*, New Orleans, LA, December 2017.

[6] Connecting fault zone structure and earthquake source processes, *University of California, Los Angeles,* Los Angeles, CA, October 2017.

[5] Using GPU clusters to detect millions of earthquakes in southern California with template matching. *Stanford University*, Stanford, CA, February 2017.

[4] Toward reliable automated estimates of earthquake source properties of body wave spectra. *American Geophysical Union*, San Francisco, CA, December 2016.

[3] Applying automatic techniques to large seismic datasets for comprehensive studies of regional and fault zone environments. Department of Earth and Planetary Sciences, *University of California, Santa Cruz*, Santa Cruz, CA, October 2015.

[2] Applying automatic techniques to large seismic datasets for comprehensive studies of regional and fault zone environments. Seismolab Seminar*, California Institute of Technology*, Pasadena, CA, April 2015.

[1] Automatic detection and picking of direct P, S and fault zone head & trapped waves. Tectonics Seminar, *Department of Earth and Space Sciences, UCLA*, Los Angeles, CA, January 2015.

Courses Taught

Ge165 Geophysical Inverse Theory
Ge166 Machine Learning in Geophysics
Ge271 Dynamics of Seismicity

Ph.D. students

Manuela Hurtado Betancur (2026-present; GPS)
Siavash Rahimi (2025-present; CMS)
Soyeon Park (2024-present; GPS)
Chenxi Kong (2023-present; GPS)
Rajani Shrestha (2023-present; GPS)
Caifeng Zou (2022-present; GPS)
Yaozhong Shi (2022-2026; MCE, joint with D. Asimaki)
Valeria Villa (2021-present; GPS)
Yan Yang (2021-2023; GPS), Postdoc, Scripps Institution of Oceanography, UCSD
John Wilding (2020-2026; GPS), Postdoc, The University of Texas at Austin
James Atterholt (2019-2024; GPS), Assistant Professor, University of Arizona
Angela Gao (2019-2025; main advisor K. Bouman in CMS)
Ben Strozewski (2019-2022; GPS)
Yuan-Kai Liu (2019-2022; GPS), Postdoc, Stanford University

Postdoctoral Scholars

Quentin Higueret (2026-present)
Shaked Engelberg (2026-present)
Huiyun Guo (2024-present)
Taiyi Wang (2024-2026), Assistant Professor, The University of Texas at Austin
Zhi-ang Chen (2023-2025), Postdoc, Arizona State University
Hongyu Sun (2022-2024), Assistant Professor, University of Texas, El Paso
Greg Lavrentiadis (2022-2025), Assistant Professor of Civil Engineering, SUNY Buffalo. (Co-advised w/ D. Asimaki)
Weiqiang Zhu (2021-2023), Assistant Professor, University of California, Berkeley
Manuel Florez-Torres (2019-2022) Assistant Professor, Universidad Industrial de Santander
Erik Ramirez (2021-2022), Researcher, Universidad Autónoma de Baja California
Jonathan Smith (2019-2021), Principal Research Scientist, British Antarctic Survey
Bing Li (2019-2021), Assistant Professor, University of Western Ontario

Visiting Scholars

Shinya Katoh (2024), Earthquake Research Institute, University of Tokyo
Hiromichi Nagao (2023), Earthquake Research Institute, University of Tokyo
Giulio Poggiali (2022), INGV, Roma, Italy

Service to the Profession

Member, California Earthquake Prediction Evaluation Council (CEPEC), 2025-present
Board Officer, Statewide California Earthquake Center, 2025-present
Member, Board of Directors, Statewide California Earthquake Center, 2024-present

Member, Board of Directors, Southern California Earthquake Center, 2021-2024

Associate Editor, *The Seismic Record*, 2020-present

SCEC Standing Committee for Research Computing and Cyberinfrastructure, 2021-2023

Member of NSF EAR Review Panel

Member of USGS NEHRP External Grant Review Panel

Member of Dept. of Energy Review Panel, *Los Alamos National Laboratory*, January 2019.

Scientific organizing committee for StatSei12 workshop in Carges, Corsica, October 2022.

SCEC Task Force on Research Computing and Cyberinfrastructure, 2021.

Keiiti Aki Early Career Award Selection Committee, AGU Seismology Section, 2021-2022.

Instructor for AGU Seismology Summer School on Machine Learning, August 2020.

Guest editor at *Bulletin of the Seismological Society of America* for the Ridgecrest earthquake special issue, 2019-2020.

Session convener on "The 2019 M6.4 Searles Valley and M7.1 Ridgecrest Earthquakes", *American Geophysical Union*, 2019.

Session convener on "How do earthquakes start?", *American Geophysical Union*, 2019.

Invited speaker at *National Academy of Sciences,* Committee on Seismology and Geodynamics, "Searching for hidden earthquakes in southern California", October 2019.

Congressional Briefing on "Machine Learning in Seismology: Using AI to Improve Earthquake Monitoring", *United States Senate*, February 2019.

Reviewer for *Bulletin of the Seismological Society of America*; 2016, 2017, 2018, 2019, 2020

Reviewer for *Department of Energy*; 2019, 2020, 2021, 2022

Reviewer for *European Research Council*; 2018, 2021

Reviewer for *G3*; 2018, 2021

Reviewer for *Geophysical Journal International*; 2017, 2018, 2021

Reviewer for *Geophysical Research Letters*; 2017, 2018, 2019, 2024

Reviewer for *IEEE Transactions on Geoscience and Remote Sensing*; 2018, 2019, 2020, 2021

Reviewer for *Israeli Science Foundation*; 2022, 2024

Reviewer for *Journal of Geophysical Research – Solid Earth*; 2016, 2017, 2019, 2021, 2022, 2023

Reviewer for *National Science Foundation*; 2018, 2019, 2020, 2021, 2023, 2024

Reviewer for *Nature*; 2022

Reviewer for *Nature Communications*; 2019, 2020, 2023,

Reviewer for *Nature Geoscience*; 2021, 2022

Reviewer for *Physics of the Earth and Planetary Interior*; 2018

Reviewer for *Pure and Applied Geophysics*; 2018

Reviewer for *Rock Mechanics and Rock Engineering*; 2019

Reviewer for *Science*; 2021, 2022

Reviewer for *Science Advances*; 2018, 2019, 2020, 2024

Reviewer for *Scientific Reports*; 2019

Reviewer for *Seismological Research Letters*; 2018, 2020, 2023

Reviewer for *Singapore National Research Foundation*; 2020.

Reviewer for *Tectonophysics*; 2016, 2020

Professional Associations

Member, American Association for the Advancement of Science (AAAS)
Member, American Geophysical Union