

Eric M. Dunham

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EDUCATION

2005 Ph.D. Physics, Dept. of Physics, U. of California, Santa Barbara
2000 B.S. Physics with Highest Distinction, Dept. of Physics, U. of Virginia

APPOINTMENTS

2015–present Associate Professor
 Department of Geophysics, Stanford University
2011–present Affiliated Faculty Member
 Institute for Computational and Mathematical Engineering, Stanford
2009–2015 Assistant Professor
 Department of Geophysics, Stanford University
2008–2009 Lecturer on Applied Mathematics
 School of Engineering and Applied Sciences, Harvard University
2007–2009 Research Associate in Geophysics
 Department of Earth and Planetary Sciences, Harvard University
2005–2007 Reginald A. Daly Postdoctoral Fellow
 Department of Earth and Planetary Sciences, Harvard University

HONORS AND AWARDS

2014 School of Earth Sciences Excellence in Teaching Award, Stanford
 (one award annually to a faculty member in Stanford’s School of Earth
 Sciences for excellence in teaching)
2013 National Science Foundation CAREER Award
 (“The Faculty Early Career Development (CAREER) Program is a
 Foundation-wide activity that offers the National Science Foundation's
 most prestigious awards in support of junior faculty who exemplify the
 role of teacher-scholars through outstanding research, excellent education
 and the integration of education and research within the context of the
 mission of their organizations.”)
2012 Alfred P. Sloan Foundation Fellow
 (“The Sloan Research Fellowships seek to stimulate fundamental research
 by early-career scientists and scholars of outstanding promise. These two-
 year fellowships are awarded yearly to 126 researchers in recognition of
 distinguished performance and a unique potential to make substantial
 contributions to their field.”)
2011 Best Poster Award, Society of Industrial and Applied Mathematics
 (SIAM) Geosciences Conference

2009–2012	Frederick E. Terman Fellow, Stanford (awarded to promising young faculty in science and engineering)
2008	Certificate for Distinction in Teaching, Harvard (given to instructors achieving overall course evaluations of 4.5 or above on 5-point scale)
2008	Nominee for Joseph R. Levenson Memorial Teaching Prize, Harvard (approximately 30 instructors nominated annually by former students)
2007	Editors' Citation for Excellence in Refereeing for Geophysical Research Letters
2001–2005	National Defense Science and Engineering Graduate Fellowship
2004	Outstanding Student Paper, American Geophysical Union
2004	UCSB Affiliates Graduate Dissertation Fellowship, UCSB
2004	Student Presentation Award, Seismological Society of America
2002	Outstanding Student Paper, American Geophysical Union
2001	John Cardy Award for strongest academic performance in core first-year graduate classes, UCSB Physics
2000	Parsons Fellowship for outstanding promise in computational science, UCSB Physics
2000	James W. Elkins Award for graduate with most outstanding academic record in physics, UVA Physics
1996–2000	Jefferson Scholar: full academic scholarship for leadership, citizenship, and scholarship, University of Virginia
1999	Phi Beta Kappa

RESEARCH EXPERIENCE

My research focuses on mechanics and physics of natural hazards:

- Dynamics of earthquake rupture propagation along faults
 - Characterization of strong ground motion and seismic hazard
 - Evolution of fault strength during frictional sliding
 - Stress levels on active faults
- Subduction zone hazards
 - Megathrust earthquake rupture dynamics
 - Tsunami generation
- Physical volcanology and volcano seismology
 - Fluid dynamics of magma flow
 - Waves in fluid-filled cracks and conduits
 - Repeating earthquakes model of volcanic tremor
- Numerical methods for earthquakes, volcanoes, and tsunamis
 - High-order accurate finite difference and finite volume methods
 - Provably stable enforcement of nonlinear interface conditions across frictional faults and fluid-filled cracks
 - Fluid-solid coupling for volcanoes and tsunamis
 - Implementation in scalable parallelized codes

ADVISING

Postdoctoral Fellows

- 2012–present Kenneth Duru, Numerical methods for 3D seismic wave propagation and earthquake rupture dynamics
- 2012–2014 Leif Karlstrom, NSF Earth Sciences postdoctoral fellow, Waves in volcanic conduits (currently Assistant Professor, Geological Sciences, University of Oregon)
- 2010–2012 Brittany Erickson, NSF Earth Sciences postdoctoral fellow, Algorithms for earthquake cycles in sedimentary basins (currently Assistant Professor, Mathematics, Portland State University)
- 2010–2011 Zijun Fang, Dynamics of geometrically complex faults (currently Geomechanicist, ConocoPhillips)
- 2009–2012 Jeremy E. Kozdon, NSF Transformative Computational Science using CyberInfrastructure (CI TraCS) postdoctoral fellow, Numerical methods for seismic wave propagation and earthquake ruptures (currently Assistant Professor, Applied Mathematics, Naval Postgraduate School)

Graduate Students

- 2015–present Bo Prochnow, MS Geophysics expected 2016
- 2015–present Chao Liang, PhD Geophysics expected 2019
- 2014–present Leighton Watson, PhD Geophysics expected 2019
- 2014–present Gabriel Lotto, Generation of tsunamis in a compressible ocean by offshore earthquakes, PhD Geophysics expected 2017
- 2013–2014 Paul Summers, Volcanic conduit flow models and connection to volcanic tremor, MS Geophysics 2014
- 2012–present Kali Allison, Efficient parallel simulations of earthquake cycles, PhD Geophysics expected 2017
- 2012–2014 Gabriel Lotto, Seismic and ocean acoustic waves and tsunamis from megathrust ruptures, MS Computational Geosciences
- 2011–present Samuel Bydlon, Seismic scattering, source complexity, and earthquakes in heterogeneous media, PhD Geophysics expected 2016
- 2011–present Brad Lipovsky, Source processes of volcanic and glacial tremor, PhD Geophysics expected 2016
- 2011–present Ossian O’Reilly, Numerical simulation of wave propagation along fluid-filled cracks, PhD Geophysics expected 2016
- 2010–2011 Ossian O’Reilly, Visiting Masters Student from Uppsala University, Sweden, Finite volume methods for seismic waves in complex geometries

Graduate Students (departmental “second projects”)

- 2015 Guillaume Barnier, Tsunami wavefield reconstruction
- 2014 Lucile Bruhat, Supershear transition on nonplanar faults
- 2012 Kevin Seats, Frequency-dependent radiation patterns observed in K-NET and KiK-net data
- 2012 Ksenia Dmitrieva, Physical models of harmonic tremor at Redoubt Volcano, Alaska
- 2011 Ali Almomin, Constraining earthquake dynamic source parameters from strong motion records

Undergraduate Students (summer interns and academic year research)

- 2010–present Summer interns working with my group: Hoon Cho, A.J. Delauder, Sebastian Soto, Francisco Nunez (principal advisor: postdoc Jeremy E. Kozdon), Lay Kuan Loh (principal advisor: postdoc Leif Karlstrom), Alex Kinsella, Paul Summers, Gina Belair, Dilia Olivo (principal advisor: PhD student Brad Lipovsky), Ferdinand Harerimana (principal advisor: PhD student Sam Bydlon)
- 2013–present Alex Kinsella, Approximate source descriptions of complex ruptures on nonplanar faults
- 2012–2013 Daniel Trugman, Kinematic earthquake descriptions based on dynamic rupture simulations (Honors Thesis, recipient of Kennedy Prize for best honors thesis at Stanford in Natural Sciences)
- 2010–2011 Hoon Cho, Far-field radiation from complex earthquake ruptures
- 2008–2009 Lin Cong, Numerical methods for dynamic elastoplasticity (at Harvard)
- 2007–2009 David Belanger, Numerical methods for modeling earthquake ruptures on nonplanar faults (at Harvard)

PROFESSIONAL ACTIVITIES

- 2013 Co-organizer for Seismological Society of America annual meeting special session on Earthquake Source Physics
- 2012 Chair of National Academy of Sciences, 15th Chinese-American Kavli Frontiers of Science Symposium, Earthquake Mechanics and Forecasting
- 2011–present Co-leader of Southern California Earthquake Center Computational Science disciplinary group and member of Planning Committee
- 2011 Co-organizer for Seismological Society of America annual meeting special session on Seismicity in Volcanic Environments
- 2011 Co-organizer for Society of Industrial and Applied Mathematics (SIAM) Geosciences Minisymposium on Computational Challenges in Earthquake Simulation
- 2010 Delegate for U.S.-Japan Natural Resources Panel on Earthquake Research
- 2010 Co-convener for International Workshop on Multiscale and Multiphysics Processes in Geomechanics
- 2009 Co-convener for Southern California Earthquake Center Dynamic Weakening Mechanisms workshop
- 2003–present Collaborator in Southern California Earthquake Center rupture dynamics code verification project

PROFESSIONAL SERVICE

- 2014 United States Geological Survey Review Panelist
- 2013 United States Geological Survey Review Panelist
- 2010 United States Geological Survey Review Panelist
- 2005–2008 Associate Editor, Journal of Geophysical Research
- 2005–present Reviewer for National Science Foundation and 20+ journals

PROFESSIONAL SOCIETIES

- 2010–present Society for Industrial and Applied Mathematics, member

2002–present American Geophysical Union, member
2002–present Seismological Society of America, member

UNIVERSITY AND DEPARTMENTAL SERVICE

2015 Invited speaker for Stanford Club of Marin
2015 Invited speaker for Stanford Admit Weekend (Academic Expo lecture series)
2014–2015 Geophysics faculty search committee
2014 Invited speaker for Stanford Admit Weekend (Academic Expo lecture series)
2014 Invited speaker for Stanford Alumni Club of the Desert
2013–2014 Department of Geophysics, Admissions Committee
2013–2014 School of Earth Sciences Teaching Task Force
2013 Invited speaker at New Student Orientation (Engaging with Faculty lecture series) for incoming Stanford freshmen
2013 Invited speaker for Stanford Admit Weekend (Academic Expo lecture series)
2012 Invited speaker at New Student Orientation (Engaging with Faculty lecture series) for incoming Stanford freshmen
2012–present Advisory Board, Computational Geosciences MS Program, Institute for Computational and Mathematical Engineering
2011–present School of Earth Sciences Council
2011–2012 Department of Geophysics, seminar series organizer
2011 Invited speaker at New Student Orientation (Engaging with Faculty lecture series) for incoming Stanford freshmen
2010–present Pre-major advisor to 20 undergraduates
2009–2010 Geophysics undergraduate curriculum committee

TEACHING

CME 108: Introduction to Scientific Computing (spring 2012, winter 2013)
GEOPHYS 287: Earthquake Seismology (spring 2011, spring 2013, spring 2015)
GEOPHYS 229: Earthquake Rupture Dynamics (autumn 2014)
GEOPHYS 120/220: Ice, Water, Fire (winter 2011, winter 2012, winter 2013, spring 2014, winter 2015)
GEOPHYS 385D: Theoretical Geophysics seminar (various topics: Earthquake Rupture Dynamics, autumn, 2011; Fluid Dynamics in Volcanic Eruptions, spring, 2010; Strong Ground Motion and Seismic Hazard, winter 2010)
GEOPHYS 385L: Earthquake Seismology, Deformation, and Stress seminar (every quarter, 2009–present)
AM 202: Physical Mathematics II (spring 2008 at Harvard)

INVITED TALKS (since 2009)

2015 Symposium on the Application of Mechanics to Geophysics
2014 American Geophysical Union Fall Meeting (two invited talks)
2014 Southern California Earthquake Center Annual Meeting (plenary lecture)

- 2014 Shell Technology Centre, Amsterdam, Rock and Fluid Physics: Academic and Industrial Perspectives Conference
- 2014 Computational Infrastructure for Geodynamics Crustal Deformation Modeling Workshop
- 2014 Incorporated Research Institutions for Seismology, Grand Challenges in Faulting and Deformation Processes (plenary lecture)
- 2014 Seismological Society of America Annual Meeting
- 2014 Penn State
- 2014 Caltech
- 2013 Lockheed Martin Advanced Technology Center
- 2013 University of British Columbia, Earth and Ocean Sciences
- 2013 King Abdullah University of Science and Technology
- 2012 American Geophysical Union Fall Meeting
- 2012 International Workshop of Special Project for Reducing Vulnerability for Urban Mega Earthquake Disasters, Matsushima, Japan
- 2012 University of California, Berkeley, Earth and Planetary Sciences
- 2012 U.S. Geological Survey, Earthquake Science Seminar
- 2012 International Conference on a New Perspective on Great Earthquakes Along Subduction Zones, Kochi, Japan
- 2011 American Geophysical Union Fall Meeting
- 2011 University of California, Santa Cruz
- 2010 U.S.-Japan Natural Resources Panel on Earthquake Research, Nagaoka, Japan
- 2010 U.S. Geological Survey, Earthquake Science Seminar
- 2010 University of California, Berkeley, Berkeley Seismological Laboratory
- 2010 University of Oregon
- 2010 Lawrence Livermore National Laboratory
- 2010 University of California, Berkeley, Applied Mathematics
- 2010 Lockheed Martin Advanced Technology Center
- 2009 U.S. Geological Survey, Earthquake Science Seminar

PUBLICATIONS

(available at <http://pangea.stanford.edu/~edunham/publications/publications.html>)

- Duru, K., and E. M. Dunham (2015), Dynamic earthquake rupture simulations on nonplanar faults embedded in 3D geometrically complex, heterogeneous elastic solids, *Journal of Computational Physics*, submitted
- Bydlon, S. A., and E. M. Dunham (2015), Rupture dynamics and ground motions from earthquakes in 2-D heterogeneous media, *Geophysical Research Letters*, doi:10.1002/2014GL062982.
- Lipovsky, B. P., and E. M. Dunham (2015), Vibrational modes of hydraulic fractures: Inference of fracture geometry from resonant frequencies and attenuation, *Journal of Geophysical Research*, **120**(2), 1080-1107, doi:10.1002/2014JB011286.
- Lotto, G. C., and E. M. Dunham (2015), High-order finite difference modeling of tsunami generation in a compressible ocean from offshore earthquakes, *Computational Geosciences*, doi:10.1007/s10596-015-9472-0.

- O'Reilly, O., J. Nordstrom, J. E. Kozdon, and E. M. Dunham (2015), Simulation of earthquake rupture dynamics in complex geometries using coupled finite difference and finite volume methods, *Communications in Computational Physics*, **17**(2), 337-370, doi:10.4208/cicp.111013.120914a.
- Kozdon, J. E., and E. M. Dunham (2014), Constraining shallow slip and tsunami excitation in megathrust ruptures using seismic and ocean acoustic waves recorded on ocean-bottom sensor networks, *Earth and Planetary Science Letters*, **396**, 56-65, doi:10.1016/j.epsl.2014.04.001.
- Erickson, B. A., and E. M. Dunham (2014), An efficient numerical method for earthquake cycles in heterogeneous media: Alternating sub-basin and surface-rupturing events on faults crossing a sedimentary basin, *Journal of Geophysical Research*, **119**(4), 3290-3316, doi:10.1002/2013JB010614.
- Johri, M., E. M. Dunham, M. D. Zoback, and Z. Fang (2014), Predicting fault damage zones by modeling dynamic rupture propagation and comparison with field observations, *Journal of Geophysical Research*, **119**(2), 1251-1272, doi:10.1002/2013JB010335.
- Trugman, D. T., and E. M. Dunham (2014), A 2D pseudo-dynamic rupture model generator for earthquakes on geometrically complex faults, *Bulletin of the Seismological Society of America*, **104**(1), doi:10.1785/0120130138.
- Denolle, M. A., E. M. Dunham, G. A. Prieto, and G. C. Beroza (2014), Strong ground motion prediction using virtual earthquakes, *Science*, **343**(6169), 399-403, doi:10.1126/science.1245678.
- Fang, Z., and E. M. Dunham (2013), Additional shear resistance from fault roughness and stress levels on geometrically complex faults, *Journal of Geophysical Research*, **118**(7), 3642-3654, doi:10.1002/jgrb.50262.
- Dmitrieva, K., A. J. Hotovec-Ellis, S. Prejean, and E. M. Dunham (2013), Frictional-faulting model for harmonic tremor before Redoubt Volcano eruptions, *Nature Geoscience*, **6**, 652-656, doi:10.1038/ngeo1879.
- Kozdon, J. E., and E. M. Dunham (2013), Rupture to the trench: Dynamic rupture simulations of the 11 March 2011 Tohoku earthquake, *Bulletin of the Seismological Society of America*, **103**(2B), 1275-1289; doi:10.1785/0120120136.
- Denolle, M. A., E. M. Dunham, G. A. Prieto, and G. C. Beroza (2013), Ground motion prediction of realistic earthquake sources using the ambient seismic field, *Journal of Geophysical Research*, **118**, 1-17, doi:10.1029/2012JB009603.
- Kozdon, J. E., E. M. Dunham, and J. Nordstrom (2013), Simulation of dynamic earthquake ruptures in complex geometries using high-order finite difference methods, *Journal of Scientific Computing*, **55**(1), 92-124, doi:10.1007/s10915-012-9624-5.
- Denolle, M. A., E. M. Dunham, and G. C. Beroza (2012) Solving the surface-wave eigenproblem with Chebyshev spectral collocation, *Bulletin of the Seismological Society of America*, **102**(3), 1214-1223, doi:10.1785/0120110183.
- Vallee, M., and E. M. Dunham (2012), Observation of far-field Mach waves generated by the 2001 Kokoxili supershear earthquake, *Geophysical Research Letters*, **39**, L05311, doi:10.1029/2011GL050725.

- Dunham, E. M. and D. E. Ogden (2012) Guided waves along fluid-filled cracks in elastic solids and instability at high flow rates, *Journal of Applied Mechanics*, **79**(3), 031020, doi:10.1115/1.4005961.
- Dunham, E. M., D. Belanger, L. Cong, and J. E. Kozdon (2011), Earthquake ruptures with strongly rate-weakening friction and off-fault plasticity, 1: Planar faults, *Bulletin of the Seismological Society of America*, **101**(5), 2296–2307, doi:10.1785/0120100075.
- Dunham, E. M., D. Belanger, L. Cong, and J. E. Kozdon (2011), Earthquake ruptures with strongly rate-weakening friction and off-fault plasticity, 2: Nonplanar faults, *Bulletin of the Seismological Society of America*, **101**(5), 2308–2322, doi:10.1785/0120100076.
- Harris, R. A., M. Barall, D. J. Andrews, B. Duan, S. Ma, E. M. Dunham, A.-A. Gabriel, Y. Kaneko, Y. Kase, B. Aagaard, D. D. Oglesby, J.-P. Ampuero, T. C. Hanks, and N. Abrahamson (2011) Verifying a computational method for predicting extreme ground motion, *Seismological Research Letters*, **82**(5), 638–644, doi:10.1785/gssrl.82.5.638.
- Kozdon, J. E., E. M. Dunham, and J. Nordstrom (2011), Interaction of waves with frictional interfaces using summation-by-parts difference operators: Weak enforcement of nonlinear boundary conditions, *Journal of Scientific Computing*, **50**(2), 341–367, doi:10.1007/s10915-011-9485-3.
- Dunham, E. M., D. Belanger, L. Cong, and J. E. Kozdon (2011), Earthquake ruptures on rough faults, in *Multiscale and Multiphysics Processes in Geomechanics (results of workshop at Stanford Univ., June, 2010)*, Springer Series in Geomechanics and Geoengineering, edited by Ronaldo I. Borja, ISBN 978-3-642-19629-4, pp. 145–148.
- Bizzarri, A., E. M. Dunham, and P. Spudich (2010), Coherence of Mach fronts during heterogeneous supershear earthquake rupture propagation: simulations and comparison with observations, *Journal of Geophysical Research*, **115**, B08301, doi:10.1029/2009JB006819.
- Hetland, E. A., M. Simons, and E. M. Dunham (2010), Postseismic and interseismic fault creep I: Model description, *Geophysical Journal International*, **181**(1), 81–98, doi:10.1111/j.1365-246X.2010.04522.x
- Rice, J. R., E. M. Dunham, and H. Noda (2010), Thermo- and hydro-mechanical processes along faults during rapid slip, in *Meso-Scale Shear Physics in Earthquake and Landslide Mechanics*, edited by Y. Hatzor, J. Sulem, and I. Vardoulakis, CRC Press, pp. 3–16.
- Rojas, O., E. M. Dunham, S. M. Day, L. A. Dalguer, and J. E. Castillo (2009), Finite difference modeling of rupture propagation with strong velocity-weakening friction, *Geophysical Journal International*, **179**(3), 1831–1858, doi:10.1111/j.1365-246X.2009.04387.x.
- Noda, H., E. M. Dunham, and J. R. Rice (2009), Earthquake ruptures with thermal weakening and the operation of major faults at low overall stress levels, *Journal of Geophysical Research*, **114**, B07302, doi:10.1029/2008JB006143.
- Harris, R. A., M. Barall, R. Archuleta, E. M. Dunham, B. Aagaard, J. P. Ampuero, H. Bhat, V. Cruz-Atienza, L. Dalguer, P. Dawson, S. Day, B. Duan, G. Ely, Y. Kaneko, Y. Kase, N. Lapusta, Y. Liu, S. Ma, D. Oglesby, K. Olsen, A. Pitarka, S. Song, and E. Templeton (2009), The SCEC/USGS dynamic earthquake-rupture code verification

- exercise, *Seismological Research Letters*, **80**(1), 119–126, doi:10.1785/gssrl.80.1.119.
- Dunham, E. M., and J. R. Rice (2008), Earthquake slip between dissimilar poroelastic materials, *Journal of Geophysical Research*, **113**, B09304, doi:10.1029/2007JB005405.
- Dunham, E. M., and H. S. Bhat (2008), Attenuation of radiated ground motion and stresses from three-dimensional supershear ruptures, *Journal of Geophysical Research*, **113**, B08319, doi:10.1029/2007JB005182.
- Dunham, E. M. (2007), Conditions governing the occurrence of supershear ruptures under slip-weakening friction, *Journal of Geophysical Research*, **112**, B07302, doi:10.1029/2006JB004717.
- Page, M. T., E. M. Dunham, and J. M. Carlson (2005), Distinguishing barriers and asperities in near-source ground motion, *Journal of Geophysical Research*, **110**, B11302, doi:10.08029/2005JB00373.
- Dunham, E. M., and R. J. Archuleta (2005), Near-source ground motion from steady state dynamic rupture pulses, *Geophysical Research Letters*, **32**, L03302, doi:10.08029/2004GL021793.
- Dunham, E. M. (2005), Dissipative interface waves and the transient response of a three dimensional sliding interface with Coulomb friction, *Journal of Mechanics and Physics of Solids*, **53**, 327–357, doi:10.1016/j.jmps.2004.07.003.
- Dunham, E. M., and R. J. Archuleta (2004), Evidence for a supershear transient during the 2002 Denali Fault earthquake, *Bulletin of the Seismological Society of America*, **94**, S256–S268, doi:10.1785/0120040616.
- Dunham, E. M., P. Favreau, and J. M. Carlson (2003), A supershear transition mechanism for cracks. *Science*, **299**, 1557–1559, doi:10.1126/science.1080650.