Jeremy Edward Kozdon

Associate Professor

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Research Interests

Stable and accurate numerical methods for partial differential equations

Numerical methods for coupled multiphysics problems

Coupling of different classes of numerical methods

Development of high-performance computational codes

Computational geosciences

Education

2009 Ph.D.: Computational and Mathematical Engineering, Institute for Computational and Mathematical Engineering (ICME), Stanford University
Dissertation: Numerical Methods with Reduced Grid Dependency for Enhanced Oil Recovery
Advisor: Prof. Margot Gerritsen

2006 M.S.: Computational and Mathematical Engineering, ICME, Stanford University

2004 B.S.: Physics with honors, minor in Computer Science with high honors, University of California Santa Cruz

Professional Experience

2019–present	Associate Professor, Department of Applied Mathematics, Naval Postgraduate School, Monterey, CA
2012–2019	Assistant Professor, Department of Applied Mathematics, Naval Postgraduate School, Monterey, CA
2011–2012	NSF Fellow for Transformative Computational Science using CyberInfrastructure (CI TraCS), Department of Geophysics, Stanford University
2009–2011	Postdoctoral Scholar, Department of Geophysics, Stanford University (with Prof. Eric M. Dunham)
2009	(spring) Research Staff, Center of Excellence for Simulation of In-situ Combustion, Department of Energy Resources Engineering, Stanford University

2006–2008	(summers) Professional Intern, Reservoir Simulation Research, Chevron Energy Technology Company (with Dr. Bradley Mallison)
2005	(summer) Graduate Research Intern, Theoretical Biology, Los Alamos National Laboratory (with Dr. James Faeder, now at University of Pittsburgh)
2003	(summer) Physics Research Experience for Undergrads, University of Washington (with Prof. John J. Rehr)
2002	(summer) Physics Research Experience for Undergrads, Los Alamos National Laboratory (with Dr. James Faeder, now at University of Pittsburgh)

Publications

Submitted

Sridhar, A., Y. Tissaoui, S. Marras, Z. Shen, C. Kawczynski, S. Byrne, K. Pamnany, M. Waruszewski, T. H. Gibson, J. E. Kozdon, V. Churavy, L. C. Wilcox, F. X. Giraldo, and T. Schneider (2021), Large-eddy simulations with climatemachine: a new open-source code for atmospheric simulations on gpus and cpus, arXiv: TBD.

Kozdon, J. E., B. A. Erickson, and T. Harvey (2021), A non-stiff summation-by-parts finite difference method for the wave equation in second order form: Characteristic boundary conditions and nonlinear interfaces, arXiv: `https://arxiv.org/abs/2106.00706`.

Peer-Reviewed

22) Kozdon, J. E., B. A. Erickson, and L. C. Wilcox (2021), Hybridized summation-by-parts finite difference methods, *Journal of Scientific Computing*, *87*, 85, doi: 10.1007/s10915-021-01448-5.

21) Erickson, B. A., J. Jiang, M. Barall, N. Lapusta, E. M. Dunham, R. Harris, L. S. Abrahams, K. L. Allison, J.-P. Ampuero, S. B. andC. Cattania, A. Elbanna, Y. Fialko, B. Idini, J. E. Kozdon, V. Lambert, Y. Liu, Y. Luo, X. Ma, M. B. McKay, P. Segall, P. Shi, M. van den Ende, and M. Wei (2020), The community code verification exercise for simulating sequences of earthquakes and aseismic slip (seas), *Seismological Research Letters*, *91*(2A), 874–890, doi: 10.1785/0220190248.

20) Mckay, M. B., B. A. Erickson, and J. E. Kozdon (2019), A computational method for earthquake cycles within anisotropic media, *Geophysical Journal International*, *219*(2), 816–833, doi: doi.org/10.1093/gji/ggz320.

19) Kozdon, J. E., L. C. Wilcox, T. Hagstrom, and J. W. Banks (2019), Robust approaches to handling complex geometries with Galerkin difference methods, *Journal of Computational Physics*, *392*, 483–510, doi: 10.1016/j.jcp.2019.04.031.

18) Harris, R. A., M. Barall, B. Aagaard, S. Ma, D. Roten, K. Olsen, B. Duan, D. Liu, B. Luo, K. Bai, J. P. Ampuero, Y. Kaneko, A. Gabriel, K. Duru, T. Ulrich, S. Wollherr, Z. Shi, E. Dunham, Z. Zhang, X. Chen, S. N. Somala, C. Pelties, J. Tago, V. Cruz-Atienza, J. Kozdon, E. Daub, K. Aslam, Y. Kase, K. Withers,

and L. Dalguer (2018), A suite of exercises for verifying dynamic earthquake rupture codes, *Seismological Research Letters*, *89*(3), 1146–1162, doi: 10.1785/0220170222.

17) Kozdon, J. E., and L. C. Wilcox (2018), An energy stable approach for discretizing hyperbolic equations with nonconforming discontinuous Galerkin methods, *Journal of Scientific Computing*, *76*(3), 1742–1784, doi: 10.1007/s10915-018-0682-1.

16) Kozdon, J. E., and L. C. Wilcox (2016), Stable coupling of nonconforming, high-order finite difference methods, *SIAM Journal on Scientific Computing*, *38*(2), A923–A952, doi: 10.1137/15M1022823.

15) Duru, K., J. E. Kozdon, and G. Kreiss (2015), Boundary conditions and stability of a perfectly matched layer for the elastic wave equation in first order form, *Journal of Computational Physics*, *303*, 372–395, doi: 10.1016/j.jcp.2015.09.048.

14) O'Reilly, O., J. Nordström, 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.

13) 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.

12) Chun, C., B. Neta, J. E. Kozdon, and M. Scott (2014), Choosing weight functions in iterative methods for simple roots, *Applied Mathematics and Computation*, *227*, 788–800, doi: 10.1016/j.amc.2013.11.084.

11) 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.

10) Kozdon, J. E., E. M. Dunham, and J. Nordström (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.

9) Keilegavlen, E., J. E. Kozdon, and B. T. Mallison (2012), Multidimensional upstream weighting for multi-phase transport on general grids, *Computational Geosciences*, *16*, 1021–1042, doi: 10.1007/s10596-012-9301-7.

8) Kozdon, J. E., E. M. Dunham, and J. Nordström (2012), 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.

7) Dunham, E. M., D. Belanger, L. Cong, and J. E. Kozdon (2011), Earthquake ruptures with strongly rate-weakening friction and off-fault plasticity, Part 1: Planar faults, *Bulletin of the Seismological Society of America*, *101*(5), 2296–2307, doi: 10.1785/0120100075.

6) Dunham, E. M., D. Belanger, L. Cong, and J. E. Kozdon (2011), Earthquake ruptures with strongly rate-weakening friction and off-fault plasticity, Part 2: Nonplanar faults, *Bulletin of the Seismological Society of America*, *101*(5), 2308–2322, doi: 10.1785/0120100076.

5) Kozdon, J. E., B. T. Mallison, and M. G. Gerritsen (2011), Multidimensional upstream weighting for multiphase transport in porous media, *Computational Geosciences*, *15*(3), 399–419, doi: 10.1007/s10596-010-9211-5.

4) Kozdon, J. E., B. T. Mallison, M. G. Gerritsen, and W. Chen (2011), Multi-D upwinding for multi phase transport in porous media, *SPE Journal*, *16*(2), 263–272, doi: 10.2118/119190-PA.

3) Kozdon, J. E., B. T. Mallison, and M. G. Gerritsen (2009), Robust Multi-D transport schemes with reduced grid orientation effects, *Transport in Porous Media*, *78*(1), 47–75, doi: 10.1007/s11242-008-9281-1.

2) Kozdon, J. E., M. G. Gerritsen, and M. Christie (2008), Grid orientation revisited: Near-well, early-time effects and solution coupling methods, *Transport in Porous Media*, *73*, 255–277, doi: 10.1007/s11242-007-9188-2.

1) Rehr, J. J., J. Kozdon, J. Kas, H. Krappe, , and M. Rossner (2005), Bayes-Turchin approach to XAS analysis, *Journal of Synchrotron Radiation*, *12*, 70–74, doi: 10.1107/S0909049504027876.

Major Code Contributions

2021–present PETSc.jl: Julia wrappers for the PETSc library (contributor: architect of major package reworking)
Available at `https://github.com/JuliaParallel/PETSc.jl`

2019–present CLIMA: The Climate Modelling Alliance CLImate MAchine (contributor: discontinuous Galerkin discretization, time stepping support, GPU support, general framework support)
Available at `https://github.com/climate-machine/CLIMA`

2016–present NUMA: The Nonhydrostatic Unified Model of the Atmosphere (contributor: dynamic and static mesh adaptivity for discontinuous and continuous Galerkin methods)
Project information at `http://frankgiraldo.wixsite.com/mysite/numa`

2012–2018 `bfam`: toolkit for coupled multiphysics PDE applications with dynamically adapted meshes (co-developer with Lucas Wilox).
Available at `https://github.com/bfam/bfam`

`beard` & `beardo`: discontinuous Galerkin solver for elasticity and (earthquake) rupture dynamics built on the `bfam` toolkit.

2010–2012 Tetemoko: adaptive mesh solver for dynamic rupture simulations in simple geometries using block structure adaptive meshes with finite volume methods (developer).

Available at `https://github.com/jkozdon/tetemoko`

2009–2012 FDMAP: Finite Difference with MAPped grids for earthquake rupture dynamics (co-developer with Eric Dunham).
Available at `https://pangea.stanford.edu/~edunham/codes/fdmap`

Grants

06/2021–05/2024 "Collaborative Research: Exploring System-Wide Events on Complex Fault Networks using Fully-Dynamic 3D Earthquake Cycle Simulations"
National Science Foundation EAR-2053405 (Principal Investigator)

02/2019–09/2021 "Next Generation Earth System Model" (via NCRADA-NPS-19–0226)
Caltech (Co-Principal Investigator)

08/2018–10/2023 "Collaborative Research: HDR: Data-Driven Earth System Modeling"
National Science Foundation AGR-1835881 (Senior Personnel)

07/2016–06/2017 "CI TraCS Research Starter Supplement: Utilizing Graphics Processing Units for Dynamic Rupture Earthquake Simulations"

National Science Foundation OAC-1403203 (Principal Investigator)

03/2016–02/2020 "Collaborative Research: From Loading to Dynamic Rupture — How do fault geometry and material heterogeneity affect the earthquake cycle?"
National Science Foundation EAR-1547596 (Principal Investigator)

01/2016–12/2018 "An Adaptive and Scalable Unified CG/DG Nonhydrostatic Atmospheric Model"
Office of Naval Research (Co-Principal Investigator)

02/2014–01/2015 "A Collaborative Project: Rupture Dynamics, Validation of the Numerical Simulation Method" (via NCRADA-NPS–14–0200)
NSF/USGS Southern California Earthquake Center (Co-Investigator)

02/2014–01/2015 "Multiscale Dynamic Rupture Simulations using Adaptive Mesh Refinement" (via NCRADA-NPS–14–0200)
NSF/USGS Southern California Earthquake Center (Principal Investigator)

02/2012–01/2013 "Adaptive Mesh Refinement Simulations for Earthquake Scaling Laws"
NSF/USGS Southern California Earthquake Center (Postdoctoral Co-Investigator)

08/2011–07/2014 "High Performance Computing for Geoscience Problems"
National Sciences Foundation Ci TraCS Postdoctoral Fellowship OAC-1122734 (Principal Investigator)

02/2010–01/2011 "Advanced Numerical Techniques for Dynamic Rupture Simulations"
NSF/USGS Southern California Earthquake Center (Postdoctoral Co-Investigator)

02/2009–01/2010 "Adaptive Mesh Refinement for Dynamic Rupture Simulation"
NSF/USGS Southern California Earthquake Center (Postdoctoral Co-Investigator)

Invited Talks

04/2018 Kozdon, J. E.. "Discontinuous Galerkin methods for earthquake cycle simulations", SCEC Workshop on Rupture Dynamics Code Validation and Comparing Simulations of Earthquake Sequences and Aseismic Slip, Cal Poly Pomona

03/2017 Kozdon, J. E.., and L. C. Wilcox "On the Stability of Mesh Adaptivity for Discontinuous Galerkin Methods", SIAM Conference on Computational Science and Engineering, Atlanta, GA

01/2017 Kozdon, J. E.. "Making it All Work: Some Practical Observations on Implementing DG Schemes", Applied & Computational Mathematics Seminar, Portland State University, Portland, OR

07/2015 Kozdon, J. E.., and L. C. Wilcox "Adaptive Mesh Refinement for Dynamic Rupture Simulations in Complex Geometries", SIAM Conference on Mathematical and Computational Issues in the Geosciences, Stanford, CA

05/2015 Kozdon, J. E.. "Earthquake Rupture Dynamics: an ideal application of high-order, adaptive numerical methods for waves", Applied & Computational Mathematics Seminar, Portland State University, Portland, OR

06/2014 Kozdon, J. E.., and L. C. Wilcox "Provably Stable Coupling of High Order Finite Difference Methods and Unstructured Discontinuous Galerkin Methods", International Conference on Spectral and High Order Methods, Salt Lake City, UT

03/2014 Kozdon, J. E.. "Earthquake Rupture Dynamics: an ideal app for high-order, adaptive numerical methods for waves", Applied Mathematics and Statistics Department, UC Santa Cruz, CA

12/2012 Kozdon, J. E.. "Development of Stable and Accurate Methods for Earthquake Simulations", Bay Area Scientific Computing Day, Stanford University/SLAC, CA

12/2012 Kozdon, J. E., and E. M. Dunham. "Dynamic Rupture Simulations of 11 March 2011 Tohoku Earthquake", American Geological Union Annual Meeting, San Francisco, CA

10/2012 Kozdon, J. E.. "Understand earthquakes using finite difference Methods, Adaptive Mesh Refinement, and Parallel Computing", Center for Computational Earth and Environmental Science, Stanford Unverisity, CA

09/2012 Kozdon, J. E.. "Understanding Earthquake Source Physics through Computation", Southern California Earthquake Center, Palm Springs, CA

04/2012 Kozdon, J. E.. "Rupture to the Trench: Dynamic Rupture Simulations of the 11 March 2011 Tohoku Earthquake", IGPP Seminar, UC Santa Cruz, CA

02/2012 Kozdon, J. E.. "Computational Methods for Understanding the 2011 Great East Japan Earthquake and Tsunami", ICME Colloquium, Stanford University

01/2012 Kozdon, J. E.. "Computational Methods for Understanding the 2011 Great East Japan Earthquake and Tsunami", Naval Postgraduate School, Monterey, CA

01/2012 Kozdon, J. E.. "Computational Methods for Understanding the 2011 Great East Japan Earthquake and Tsunami", UC Merced

12/2011 Dunham, E. M., and J. E. Kozdon (speaker). "Rupture Dynamics of Subduction Megathrust Earthquakes", American Geological Union Annual Meeting, San Francisco, CA

10/2011 Kozdon, J. E.. "Computational Issues in the Geosciences", Introduction to ICME Research, Stanford University

10/2011 Kozdon, J. E., E. M. Dunham, B. Erickson, and J. Nordström. "Computational Models of Earthquake Ruptures and Volcanic Eruptions", Mathematics Department Seminar, Linköping University

02/2011 Kozdon, J. E. and E. M. Dunham, "Tetemoko: Adaptive Mesh Refinement for Dynamic Rupture Simulation", Southern California Earthquake Center Code Validation Workshop, Cal Poly Pomona

02/2011 Dunham, E. M. and J. E. Kozdon (joint speaker), "How We May Improve Our Method: Some Thoughts on Addressing Branching Fault Difficulties", Southern California Earthquake Center Code Validation Workshop, Cal Poly Pomona

01/2011 Kozdon, J. E., E. M. Dunham, and J. Nordström. "Numerical Methods for Earthquake Rupture Dynamics", Geophysics Department Seminar, Stanford University

04/2008 Kozdon, J. E., M. Gerritsen, B. Mallison, and M. Christie. "Giving the physics a chance: how to reduce the impact of numerical errors on solutions for flow and transport in porous media" ICME Colloquium, Stanford University

05/2007 Kozdon, J. E., B. Mallison, and M. Gerritsen. "Simulating Gas Injection into a Porous Medium" Symposium on Current Research in Engineering and Applied Mathematics, Stanford University (SIAM student chapter)

Professional Service

2021	DOE INCITE reviewer
2019	Mentor for Hartnell/NPS Community College Catalyst (3C)
2018–present	Member of Southern California Earthquake Center Code Verification Exercise for Simulating Sequences of Earthquakes and Aseismic Slip
2017	Mentor for Hartnell/NPS Community College Catalyst (3C)
2016	NSF Ad hoc reviewer, Division of Earth Sciences (EAR)
2015	NSF Ad hoc reviewer, Division of Earth Sciences (EAR)
2015	Mentor for Hartnell/NPS Community College Catalyst (3C)
2014	Mentor for Hartnell/NPS Community College Catalyst (3C)
2012	NSF panel member, Office of Cyberinfrastructure (OCI)
2012	Mentor for Stanford Summer Undergraduate Research in Geoscience and Engineering
2011	Co-organizer for minisymposium on Computational Challenges in Earthquake Simulation, SIAM Conference on the Mathematical and Computational Issues in the Geosciences, Long Beach, CA

2009–present	Member of Southern California Earthquake Center Dynamic Rupture Code Validation project
2005–2009	Founding member of the Stanford Computational Consulting group, ICME, Stanford University
2007–2009	Founding member of Computational Approaches to Digital Stewardship: A research collaboration between Stanford University and Library of Congress, ICME, Stanford University

University Service

2021	Selection committee for Carl E. and Jesse W. Menneken Annual Faculty Award for Excellence in Scientific Research
2020–present	NPS Department of Applied Mathematics Data Science Committee
2020	NPS Department of Applied Mathematics Faculty Chair Selection Committee
2018–present	NPS Department of Applied Mathematics Seminar Coordinator
2017	NPS Department of Applied Mathematics Faculty Chair Selection Committee
2017	NPS Department of Applied Mathematics Future Hiring Planning Committee
2016	NPS Department of Applied Mathematics Faculty Chair Selection Committee
2014–2017	NPS Math Club Faculty Sponsor
2013–present	NPS HPC Advisory Committee
2013	NPS Department of Applied Mathematics Faculty Chair Selection Committee

Awards

2019	Carl E. and Jesse W. Menneken Annual Faculty Award for Excellence in Scientific Research – Highly Meritorious Research Award
2011	Travel award to attend SIAM Conference on the Mathematical and Computational Issues in the Geosciences, Long Beach, CA
2006	(Winter Quarter) Computational Earth and Environmental Fellowship, Stanford University
2005	(Spring Quarter) John D. and Mary L. Carpenter Fellowship, Stanford University

Student Advising

(* denotes expected date)

2024*	Ben Nikaido, Ph.D. in Mechanical Engineering, Naval Postgraduate School Thesis: TBD (reader and minor department representative)

2022* Timothy James, M.S. in Applied Mathematics, Naval Postgraduate School
Thesis: (preliminary title) *An Exploration of Preconditioning Strategies for Hybridized Finite Different Methods*
(advisor with Anthony Austin)

2021 Patrick Mugg, Ph.D.. in Applied Mathematics, Naval Postgraduate School
Thesis: *Extrapolated Multi-Rate Method For Hyperbolic Partial Differential Equations*
(co-advisor with Prof. Frank Giraldo)

2018 Joseph Darcy, Ph.D. in Mechanical Engineering, Naval Postgraduate School
Thesis: *Failure Model For Fibrous Composites Using Multiscale Modeling*
(reader and minor department representative)

2014 Benjamin J. Davis, M.S. in Applied Mathematics, Naval Postgraduate School
Thesis: *A study into discontinuous Galerkin methods for the second order wave equation*
(advisor with Prof.Lucas Wilcox)

2014 Matthew T. Fletcher, M.S. in Applied Mathematics, Naval Postgraduate School
Thesis: *Discovery and optimization of low-storage Runge-Kutta methods*
(co-advised with Prof.Lucas Wilcox)

Teaching Experience

(Unless indicated course was taught at the Naval Postgraduate School in Monterey, CA)

2021	fall	MA1118: Multivariable Calculus for Operations Research
2021	winter	MA3139: Fourier Analysis and Partial Differential Equations
2021	winter	MA4261: High-Performance Scientific Computing
2020	winter	MA3139: Fourier Analysis and Partial Differential Equations
2020	winter	MA4261: High-Performance Scientific Computing
2019	summer	MA3232: Numerical Analysis
2019	spring	MA4261: High-Performance Scientific Computing
2018	spring	MA4393: Topics in Applied Mathematics — teaching instruction
2018	spring	MA1114: Single Variable Calculus II with Matrix Algebra
2018	spring	MA1113: Single Variable Calculus I
2018	winter	MA2121: Differential Equations
2017	summer	MA1114: Single Variable Calculus II with Matrix Algebra
2017	summer	MA1113: Single Variable Calculus I
2017	spring	MA4261: High-Performance Scientific Computing
2016	spring	MA4261: High-Performance Scientific Computing
2016	winter	MA3046: Matrix Analysis
2016	winter	MA3232: Numerical Analysis

2016	fall	MA1116: Vector Calculus
2016	fall	MA1115: Multi-Variable Calculus
2015	spring	MA1116: Vector Calculus
2015	winter	MA4393: Topics in Applied Mathematics — teaching instruction
2015	winter	MA1114: Single Variable Calculus II with Matrix Algebra
2015	winter	MA1113: Single Variable Calculus I
2015	fall	MA1116: Vector Calculus
2015	fall	MA1115: Multi-Variable Calculus
2014	summer	MA3232: Numerical Analysis
2014	spring	MA4332 :: reading course: Partial Differential Equations
2014	spring	MA1113: Single Variable Calculus I
2014	winter	MA3232: Numerical Analysis
2014	winter	MA3232: Numerical Analysis
2013	spring	MA1115: Multi-Variable Calculus
2013	winter	MA2121: Differential Equations
2013	winter	MA2121: Differential Equations
2010	winter	CME 108: Introduction to Scientific Computing, Stanford University
2008	fall	CME 200: Linear Algebra with Application to Engineering Computations, Stanford University (guest lecturer)
2005	fall	CME 200: Linear Algebra with Application to Engineering Computations, Stanford University (course assistant)
2005	winter	CME 102: Ordinary Differential Equations for Engineers, Stanford University (course assistant)
2004	winter	CME 100: Vector Calculus for Engineers, Stanford University (course assistant)