

Jed Brown

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Education

Doctor of Science, ETH Zürich, 2011.
Thesis: Computational Methods for Ice Flow Simulation.
M.S. Mathematics, University of Alaska Fairbanks, 2006.
B.S. Mathematics, *magna cum laude*, University of Alaska Fairbanks, 2004.
B.S. Physics, *magna cum laude*, University of Alaska Fairbanks, 2004.

Employment

Assistant Computational Mathematician, Mathematics and Computer Science Division, Argonne National Laboratory, 2013–present
Argonne Scholar, Mathematics and Computer Science Division, Argonne National Laboratory, 2012–2013
Postdoctoral Appointee, Mathematics and Computer Science Division, Argonne National Laboratory, 2011–2012
Research Assistant, ETH Zürich, 2007–2011
Research Technician, University of Alaska Fairbanks, 2006–2007
Research Assistant, University of Alaska Fairbanks, 2003–2006

Research

Robust hardware-adapted, algorithmically optimal, multiphysics-capable composable algorithms and numerical software.

Journal Papers Published

- [1] Jed Brown, Barry F. Smith, and Aron Ahmadi. Achieving textbook multigrid efficiency for hydrostatic ice flow. *SIAM Journal on Scientific Computing*, 35(2):359–375, 2013. Also preprint ANL/MCS-P743-1298.
- [2] David E. Keyes, Lois Curfman McInnes, Carol Woodward, William Gropp, Eric Myra, Michael Pernice, John Bell, Jed Brown, Alain Clo, Jeffrey Connors, Emil Constantinescu, Don Estep, Kate Evans, Charbel Farhat, Ammar Hakim, Glenn Hammond, Glen Hansen, Judith Hill, Tobin Isaac, Xiangmin Jiao, Kirk Jordan, Dinesh Kaushik, Efthimios Kaxiras, Alice Koniges, Kihwan Lee, Aaron Lott, Qiming Lu, John Magerlein, Reed Maxwell, Michael McCourt, Miriam Mehl, Roger Pawlowski, Amanda Peters Randles, Daniel Reynolds, Beatrice Rivière, Ulrich Rüde, Tim Scheibe, John Shadid, Brendan Sheehan, Mark Shephard, Andrew Siegel, Barry Smith, Xianzhu Tang, Cian Wilson, and Barbara Wohlmuth. Multiphysics simulations: Challenges and opportunities. *International Journal of High Performance Computing Applications*, 27(1):4–83, Feb 2013. Special issue.

- [3] Tareq M. Malas, Aron J. Ahmadi, Jed Brown, John A. Gunnels, and David E. Keyes. Optimizing the performance of streaming numerical kernels on the IBM BlueGene/P PowerPC 450 processor. *International Journal of High Performance Computing Applications*, published online, 2012.
- [4] Rodney Biezuner, Jed Brown, Grey Ercole, and Eder Martins. Computing the first eigenpair of the p -Laplacian via inverse iteration of sublinear supersolutions. *Journal of Scientific Computing*, 52:180–201, 2012.
- [5] Jed Brown. Efficient nonlinear solvers for nodal high-order finite elements in 3D. *Journal of Scientific Computing*, 45:48–63, 2010. 10.1007/s10915-010-9396-8.
- [6] Jason M. Amundson, Mark Fahnestock, Martin Truffer, Jed Brown, Martin P. Lüthi, and Roman J. Motyka. Ice mélange dynamics and implications for terminus stability, Jakobshavn Isbræ, Greenland. *J. Geophys. Res.*, 115:F01005, 2010.
- [7] E. Bueler and J. Brown. Shallow shelf approximation as a “sliding law” in a thermomechanically coupled ice sheet model. *Journal of Geophysical Research-Earth Surface*, 114(F3):F03008, 2009.
- [8] E. Bueler, J. Brown, and C. Lingle. Exact solutions to the thermomechanically coupled shallow ice approximation: effective tools for verification. *J. Glaciol.*, 53:499–516, 2007.
- [9] E. Bueler, C.S. Lingle, and J. Brown. Fast computation of a viscoelastic deformable Earth model for ice-sheet simulations. *Ann. Glaciol.*, 46:97–105, 2007.
- [10] E. Bueler, C. S. Lingle, J. A. Kallen-Brown, D. N. Covey, and L. N. Bowman. Exact solutions and numerical verification for isothermal ice sheets. *J. Glaciol.*, 51(173):291–306, 2005.

Refereed Proceedings Papers

- [1] Jed Brown and Peter Brune. Low-rank quasi-Newton updates for robust Jacobian lagging in Newton-type methods. In *International Conference on Mathematics and Computational Methods Applied to Nuclear Science and Engineering*, pages 2554–2565, 2013.
- [2] J. Brown, M. G. Knepley, D. A. May, L. C. McInnes, and B. F. Smith. Composable linear solvers for multiphysics. In *Proceedings of the 11th International Symposium on Parallel and Distributed Computing (ISPDC 2012)*, pages 55–62. IEEE Computer Society, 2012.
- [3] K. Burckhardt, D. Szczerba, J. Brown, K. Muralidhar, and G. Székely. Fast implicit simulation of oscillatory flow in human abdominal bifurcation using a schur complement preconditioner. In *Euro-Par 2009*, 2009.

Technical Reports

- [1] Jed Brown. Vectorization, communication aggregation, and reuse in stochastic and temporal dimensions. In *Exascale Mathematics Workshop, Aug 21–22, Washington, DC*. DOE Office of Advanced Scientific Computing Research, 2013.
- [2] Mark F. Adams, Jed Brown, and Matt Knepley. Low-communication techniques for extreme-scale multi-level solvers. In *Exascale Mathematics Workshop, Aug 21–22, Washington, DC*. DOE Office of Advanced Scientific Computing Research, 2013.
- [3] Jennifer Arrigo, Jed Brown, Louise Kellogg, Lorraine Hwang, Scott Peckham, and David Tarboton. EarthCube modeling workshop results. Technical report, Computational Infrastructure for Geodynamics, 2013.

- [4] Jed Brown. User-defined non-blocking collectives must make progress. *IEEE Technical Committee on Scalable Computing*, 2012.
- [5] Barry Smith, Lois Curfman McInnes, Emil Constantinescu, Mark Adams, Satish Balay, Jed Brown, Matthew Knepley, and Hong Zhang. PETSc’s software strategy for the design space of composable extreme-scale solvers. Preprint ANL/MCS-P2059-0312, Argonne National Laboratory, 2012. DOE Exascale Research Conference, April 16-18, 2012, Portland, OR.
- [6] Mark Adams, Jed Brown, and Barry F. Smith. Exascale programming models must vigorously enable libraries. In *DOE Exascale Research Conference*, 2012.
- [7] Mihai Anitescu, Jed Brown, Paul Fischer, Sven Leyffer, Lois Curfman McInnes, Todd Munson, and Barry F. Smith. Exascale co-design opportunities: Multilevel approaches for hierarchical models, architectures, algorithms, and software. In *DOE Exascale Research Conference*, 2012.
- [8] L. Ridgway Scott, Jed Brown, George W. Bergantz, Dan Cooley, Clint Dawson, Maarten de Hoop, Donald Estep, Natasha Flyer, Efi Foufoula-Georgiou, Michael Ghil, Matthew Knepley, Randall J. LeVeque, Lek-Heng Lim, Serge Prudhomme, Adrian Sandu, Frederik J. Simons, Philip B. Stark, Michael Stein, Seth Stein, Toshiro Tanimoto, Daniel Tartakovsky, Jonathan Weare, Robert Weiss, Grady B. Wright, and Dave Yuen. Fostering interactions between the geosciences and mathematics, statistics, and computer science. Technical Report 2012-02, University of Chicago, 2012.
- [9] Satish Balay, Jed Brown, Kris Buschelman, Victor Eijkhout, William D. Gropp, Dinesh Kaushik, Matthew G. Knepley, Lois Curfman McInnes, Barry F. Smith, and Hong Zhang. PETSc users manual. Technical Report ANL-95/11 - Revision 3.4, Argonne National Laboratory, 2013.

Papers Submitted

- [1] Matthew G. Knepley, Jed Brown, Karl Rupp, and Barry F. Smith. Achieving high performance with unified residual evaluation. *arXiv preprint arXiv:1309.1204*, 2013.
- [2] Matthew G. Knepley, Jed Brown, Lois Curfman McInnes, and Barry F. Smith. Accurately citing software and algorithms used in publications. *figshare preprint <http://dx.doi.org/10.6084/m9.figshare.785731>*, 2013.
- [3] Barry F. Smith Jed Brown, Matthew G. Knepley. Run-time extensibility: anything less is unsustainable. *figshare preprint <http://dx.doi.org/10.6084/m9.figshare.791571>*, 2013.
- [4] David A. May, Jed Brown, and Laetitia Le Pourhiet. A scalable matrix-free Stokes discretization for geodynamic applications. submitted, 2013.

Selected Presentations

- J. Brown, P. Brune, E. Constantinescu, D. Ghosh, L.C. McInnes, *PETSc and BOUT++*, 2013 BOUT++ workshop, LLNL, 2013-09-04.
- J. Brown and S. Dalton, *GPU-accelerated smoothed aggregation algebraic multigrid: Multi-node scalability and versatility*, GPU-SMP13, Changchun, China, 2013-07-30.
- J. Brown, *Vectorization, communication aggregation, and reuse in stochastic and temporal dimensions*, JointLab workshop, Lyon, France, 2013-06-13.
- J. Brown and P. Brune, *Low-rank Quasi-Newton Updates for Robust Jacobian Lagging in Newton Methods*, International Conference for Numerical and Mathematics and Computational Methods Applied to Nuclear Science and Engineering (MC2013), Sun Valley, ID, 2013-05-08.

- J. Brown, *Discretization, Solvers, and Statistics in Computational Geodynamics*, EarthCube Modeling Workshop, Boulder, CO, 2013-04-23.
- J. Brown, S. Abhyankar, B. Smith, *Sharing Thread Pools and Caches for Inter-library Composition and Multicore Performance*, SIAM CSE, Boston, MA, 2013-02-25 to 03-01.
- J. Brown, M. Adams, P. Brune, M. Knepley, and B. Smith, *Communication elimination and fault tolerance in multilevel solvers*, Computer Science seminar, UIUC, 2013-02-06.
- J. Brown, M. Adams, M. Knepley, and B. Smith, *Multilevel solvers with adaptive coarse space construction for lithosphere dynamics*, 1st International Conference on Frontiers in Computational Physics: Modeling the Earth System, Boulder, CO, 2012-12-16 to 20.
- J. Brown, M. Adams, M. Knepley, B. Smith, *Adaptive coarse space construction and nonlinear smoothers for heterogeneous Stokes problems*, AGU Fall Meeting, San Francisco, December 3-7, 2012.
- J. Brown, M. Adams, P. Brune, M. Knepley, D. May, B. Smith, *Composable multilevel solvers in PETSc*, Oak Ridge National Laboratory, November 14, 2012.
- J. Brown and M. Knepley, *Modern algorithms through libraries*, EarthCube End-User Domain Workshop for EarthScope, Tempe, AZ, October 29-30, 2012.
- J. Brown, *Pervasive multiscale modeling, analysis, and solvers*, Bridging the Gap Between the Geosciences and Mathematics, Statistics, and Computer Science, Princeton, October 1-2, 2012.
- J. Brown, *Multilevel Stokes flow solvers: Adapting to heterogeneity and rheology*, Mantle Convection and Lithospheric Dynamics Workshop, UC Davis, July 30, 2012.
- J. Brown, M. Adams, P. Brune, M. Knepley, L.C. McInnes, and B. Smith, *Composable multilevel methods for multiphysics simulation*, SIAM Annual Meeting, Minneapolis, 2012-07-13.
- J. Brown, I. Grindeanu, B. Smith, and T. Tautges, *A parallel unstructured implicit 3D polythermal model for outlet glaciers*, International Glaciology Society International Symposium, Fairbanks, AK, 2012-06-28.
- J. Brown, P. Brune, E. Constantinescu, M. Knepley, and B. Smith, *Towards high throughput composable multilevel solvers for implicit multiphysics simulation*, National Renewable Energy Laboratory, Golden, CO, 2012-04-27.
- J. Brown, *User-defined nonblocking collectives must make progress*, DOE Exascale Research Conference, Portland, 2012-04-16.
- J. Brown, M. Knepley, D. May, and B.F. Smith, *Scalable and composable implicit solvers for polythermal ice flow with steep topography*, International Conference on Scientific Computing and Applications, Las Vegas, 2012-04-03.
- J. Brown, M. Adams, P. Brune, M. Knepley, D. May, L. C. McInnes, and B.F. Smith, *Commuting block preconditioning with multigrid*, Copper Mountain Conference on Iterative Methods, 2012-03-27.
- J. Brown, M. Knepley, D. May, and B.F. Smith, *Towards high throughput composable multilevel solvers for implicit multiphysics simulation*, Center for Computational Engineering Distinguished Speaker Series, MIT, 2012-03-21.
- J. Brown, M. Knepley, D. May, and B. Smith, *Towards algorithmic and software composability for implicit multiphysics with high throughput*, ICES/PECOS seminar, UT Austin, 2012-02-23
- J. Brown, M. Knepley, D. May, and B. Smith, *Commuting block preconditioned splitting with multigrid within the same code base*, SIAM conference on Parallel Processing, 2012-02-17.
- J. Brown, A. Ahmadi, M. Knepley, and B. Smith, *Utilizing emerging multicore and GPU hardware for multiphysics simulation through implicit high-order finite element methods with tensor product structure*, SIAM conference on Parallel Processing, 2012-02-15.

- J. Brown, M. Adams, P. Brune, M. Knepley, D. May, and B. Smith, *Toward less synchronous composable multilevel methods for implicit multiphysics simulation*, invited talk at Workshop on High Performance Computing, and Hybrid Programming Concepts for Hyperbolic PDE Codes [HPC]³, KAUST, Saudi Arabia, 2012-02-06.
- J. Brown, M. Adams, P. Brune, M. Knepley, and B.F. Smith, *Toward less synchronous composable multilevel methods for implicit multiphysics simulation*, invited talk at the Workshop on Synchronization-reducing and Communication-reducing Algorithms and Programming Models for Large-scale Simulations, ICERM, Brown University, 2012-01-10.
- D. May, L. Le Pourhiet, and J. Brown, *Tightly coupled geodynamic systems: Software, implicit solvers, and applications*, invited talk at the American Geophysical Union Fall Meeting, 2011-12-05.
- J. Brown, A. Ahmadi, M. Knepley, and B.F. Smith, *Utilizing emerging hardware for multiphysics simulation through implicit high-order finite element methods with tensor product structure*, invited talk at the American Geophysical Union Fall Meeting, 2011-12-05.
- J. Brown, E. Constantinescu, and B. Smith, *Tightly coupled solvers, loosely coupled software: Multiphysics solvers and time integration in PETSc*, Los Alamos National Laboratory, Center for Nonlinear Studies, 2011-11-02.
- J. Brown, I. Grindeanu, D. Karpeev, B.F. Smith, and T.J. Tautges, *Interactive transient and steady-state analysis of regional ice flow*, World Climate Research Programme, Denver, CO, 2011-10-26.
- J. Brown, D. May, and B.F. Smith, *Strongly coupled solvers with loosely coupled software*, 7th International Congress on Industrial and Applied Mathematics - ICIAM 2011, Vancouver, Canada, 2011-07-21.
- J. Brown, I. Grindeanu, D. Karpeev, B.F. Smith, and T.J. Tautges, *Scalable implicit methods for free surface flows in glaciology*, 7th International Congress on Industrial and Applied Mathematics - ICIAM, Vancouver, Canada, 2011-07-20.
- A. Ahmadi, J. Brown, N. Collier, T. Malas, and J. Gunnels, *A software framework in Python for generating optimal isogeometric kernels on the PowerPC 450*, SciPy, Austin, 2011-07-13.
- J. Brown, *Strongly coupled solvers with weakly coupled software: Modular linear algebra for multi-physics*, invited talk at the Workshop on High Performance Computing and Hybrid Programming Concepts for Hyperbolic PDE Codes, KAUST, Saudi Arabia, 2011-03-27.
- J. Brown, *Implicit solution of free surface flows in glaciology*, SIAM Conference on Computational Science and Engineering, Reno, NV, 2011-03-01.
- J. Brown, *Computational methods for several models of ice stream flow*, International Conference on the Diversity of Research on Geophysical Environmental Sciences, ETH Zürich, 2011-02-18.
- J. Brown, *Solving free surface flows for steady state without time stepping*, American Geophysical Union Fall Meeting, 2010-12-14.
- J. Brown, *Implicit discretizations for grounding line dynamics*, CCSM Annual Meeting, Breckenridge, CO, 2010-06-30.
- J. Brown, *PETSc: new developments, memory performance, and algorithmic experimentation*, invited talk at NOTUR, Bergen, Norway, 2010-05-21.
- J. Brown, *Implicit integration of 3D ice sheet flow using hybrid factorization/relaxation block preconditioning*, invited talk at the Copper Mountain Conference on Iterative Methods, CO, 2010-04-08.
- J. Brown, *Scalable solvers for the 3D non-Newtonian Stokes problem in ice flow modeling*, CCSM Annual Meeting, Breckenridge, CO, 2010-06-17.
- J. Brown and B.F. Smith, *Textbook multigrid efficiency for hydrostatic ice flow*, CCSM Land Ice Working Group, Boulder, CO, 2010-02-17.

J. Brown, *Accurate Time Integration of 3D Grounding Line Dynamics*, American Geophysical Union Fall Meeting, 2009-12-15.

J. Brown, *Scalable solvers for optimal control of a power-law fluid*, American Geophysical Union, Fall Meeting 2008-12-15.

Software

Developer of the Portable Extensible Toolkit for Scientific computing (PETSc) since 2008, <http://mcs.anl.gov/petsc>.

Principal author of the Parallel Ice Sheet Model (PISM) 2004–2007, <http://pism-docs.org>.

Author of the Dohp finite element library, <https://github.com/jedbrowndohp>.

I have released and maintained software written in C, C++, Fortran, Python, Haskell, Perl, Ruby, and L^AT_EX, and have a working knowledge of several other languages including Lisps and x86 and PowerPC assembly.

Activities

Member of the Science Steering Committee for CIG (Computational Infrastructure for Geodynamics), Sep 2011 to Sep 2014.

Session convener at the American Geophysical Union Fall Meeting, 2009, 2010, 2011, 2012, 2013.

Technical program committee:

11th International Meeting on High-Performance Computing for Computational Science (VECPAR 2014), Eugene, OR, 2014-06-30 to 2013-07-03.

International Conference for High Performance Computing, Networking, Storage and Analysis (SC13), Denver, CO, 2013-11-17 to 22.

International Workshop of GPU and MIC Solutions to Multiscale Problems in Science and Engineering (GPU-SMP2013), Changchun, China, 2013-07-29 to 08-02.

International Conference for Numerical and Mathematics and Computational Methods Applied to Nuclear Science and Engineering (MC2013), Sun Valley, ID, 2013-05-06 to 10.

Workshop on High Performance Computing and Hybrid Programming Concepts for Hyperbolic PDE Codes ([HPC]³), KAUST, Saudi Arabia, 2013-02-04 to 08.

Contributed to the MPI-3 standard.

Reviewer for *Advances in Water Resources*, *Computational Science and Discovery*, *EuroMPI*, *Geoscientific Model Development*, *International Journal of High Performance Computing Applications*, *IEEE International Parallel and Distributed Processing Symposium*, *International Conference on Supercomputing*, *IMUDI*, *Journal of Computational Physics*, *Journal of Fluid Mechanics*, *Journal of Geophysical Research*, *Journal of Scientific Computing*, *SIAM Journal on Scientific Computing*, *The Cryosphere*, *Transactions and Mathematical Software*, *ACM Transactions on Mathematical Software*, *SIAM books*, *Wiley books*

Teaching and Advising

Argonne summer students advised/co-advised:

2013

Steven Dalton, UIUC, GPU-accelerated distributed-memory parallel algebraic multigrid

Jesse Lopez, CSGF at OHSU, performance optimization, multilevel solvers, and discretization for estuary simulation

Matthew Otten, IIT, “Scientific Application Web server” for monitoring and steering simulations

Patrick Sanan, Caltech, adaptive HMM and FLAVORS multiscale and variational time integrators in PETSc

2012

Lulu Liu, KAUST, nonlinear solution methods for oil extraction problems

Abraham Taicher, UT Austin, compatible discretizations for Darcy-Stokes melt-migration

Xuan Zhou, IIT, scalable dense linear support in PETSc using Elemental

Founding member of scicomp.stackexchange.com, profile at <http://scicomp.stackexchange.com/users/119/jed-brown>

Thousands of technical explanations of numerical methods and software design in support of hundreds of scientific and engineering applications (many on PETSc mailing lists and externally).

Tutorials and short courses

PETSc, tutorial at PRACE summer school, Ostrava, Czech Republic, 2013-06-17 to 21.

High performance implicit solvers for geodynamics, CIG Webinar, 2013-01-10.

PETSc, tutorial at National Renewable Energy Laboratory, Golden, CO, 2012-04-27.

Advanced PETSc, tutorial at TACC, Austin, TX, 2012-02-20.

PETSc tutorial at the 2011 ACTS workshop, NERSC, Berkeley, CA, 2011-08-17.

PETSc, 3-day tutorial at the Arctic Region Supercomputing Center, Fairbanks, AK, 2010-08-03 to 05.

PETSc, 2-day tutorial at the Swiss National Supercomputing Center, Manno, Switzerland, 2010-05-10 to 11.

Scalable solvers for nonlinear equations: mini-course on Newton-Krylov methods, 3-week mini-course at the University of Alaska Fairbanks, 2009-01-22 to 02-05, 59A2.org/newton-krylov.

Software carpentry boot camp, University of Chicago, 2013-01-12 to 13.

Memberships

Society of Industrial and Applied Mathematics

American Geophysical Union

American Nuclear Society

International Glaciological Society

Honors & Awards

2009 Piolet d’Or international mountaineering award for first ascent of Xuelian West (6422 m, China) via ‘The Great White Jade Heist’.

2005 NCAA All American in cross-country skiing

2004 Outstanding Mathematics Student of the Year, University of Alaska Fairbanks

2004 Outstanding Physics Student of the Year, University of Alaska Fairbanks

2000–2004 Alaska Scholar