ED BUELER

PROFESSOR OF MATHEMATICS (APPLIED)

May 2, 2022

Department of Mathematics and Statistics
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Previous Academic Positions

Associate (2005–2017) and Assistant (1998–2005) Professor, DMS, UAF.
Postdoctoral Fellow, *Year in Stochastic Analysis*, Mathematical Sciences Research Institute, Berkeley, August 1997–May 1998.

Education

Ph. D. Mathematics, Cornell University, Ithaca NY, 1997. (advisor: Leonard Gross; thesis: *The heat kernel weighted Hodge Laplacian on noncompact manifolds*)
M. S. Mathematics, Cornell University, Ithaca NY, 1994.
B. S. Mathematics with Honors, Minor in Physics, Minor in Electrical Engineering, California State University, Chico CA, 1991.

Honors

Nominated for Robert Piacenza Teaching in Excellence award from UAF Honors College, 2022.
Geophysical Institute 2015 Best Faculty Paper Award.
Faculty Advising Award for Outstanding Undergraduate Advising, 2003-2004.
Honorary Faculty Certificate of Appreciation for support of a student-athlete, 2004.
Bonus for Extraordinary Performance, CSEM, 2003.

Book and book chapter

B1. E. Bueler, *PETSc for Partial Differential Equations: Numerical Solutions in C and Python*, SIAM Press 2021. Supporting codes hosted at github.com/bueler/p4pdes.

BC1. E. Bueler, "Chapter 8. Numerical modeling of ice sheets, streams, and shelves," in *Glaciers and Ice Sheets in the Climate System: The Karthaus Summer School Lecture Notes*, A. Fowler and F. Ng editors, Springer 2021.

Publications (peer-reviewed)

E. Bueler, *On multilevel constraint decomposition methods for nonlinear variational inequalities*, in preparation.

E. Bueler and L. Mitchell. *Multilevel computation of glacier geometry from Stokes dynamics*, in preparation.

E. Bueler. *Geometric multigrid for glacier modeling: New concepts and algorithms*, in preparation.

P28. E. Bueler. *Conservation laws for free-boundary fluid layers*, 2021. SIAM J. Appl. Math., 81 (5), 2007–2032.

P27. D. J. Brinkerhoff, C. R. Meyer, E. Bueler, and M. Truffer, 2016. *Inversion of a glacier hydrology model*, Ann. Glaciol. 57 (72), 84–95.
P26. E. Bueler, 2016. *Stable finite volume element schemes for the shallow-ice approximation*, J. Glaciol. 62 (232), 230–242.
P25. E. Bueler and W. van Pelt, 2015. *Mass-conserving subglacial hydrology in the Parallel Ice Sheet Model*, Geoscientific Model Development 8 (6), 1613–1635.
P24. E. Bueler, 2014. *An exact solution for a steady, flow-line marine ice sheet*, J. Glaciol. 60 (224), 1117–1125.
P23. E. Bueler, 2014. *Correspondence: Extending the lumped subglacial-englacial hydrology model of Bartholomaus and others (2011)*, J. Glaciol. 60 (222), 80–810.
P22. S. Nowicki and 30 others including E. Bueler, 2013. *Insights into spatial sensitivities of ice mass response to environmental change from the SeaRISE ice sheet modeling project II: Greenland*, J. Geophys. Res. (Earth Surface) 118 (2), 1025–1044.
P21. S. Nowicki and 30 others including E. Bueler, 2013. *Insights into spatial sensitivities of ice mass response to environmental change from the SeaRISE ice sheet modeling project I. Antarctica*, J. Geophys. Res. (Earth Surface), 118 (2), 1002–1024.
P20. G. Jouvet, E. Bueler, C. Gräser, and R. Kornhuber, 2013. *A nonsmooth Newton multigrid method for a hybrid, shallow model of marine ice sheets*, AMS Contemporary Mathematics (SCA 2012) 586, 197–205.
P19. G. Jouvet and E. Bueler, 2012. *Steady, shallow ice sheets as obstacle problems: well-posedness and finite element approximation*, SIAM J. Appl. Math. 72 (4), 1292–1314.
P18. A. Aschwanden, E. Bueler, C. Khroulev, and H. Blatter, 2012. *An enthalpy formulation for glaciers and ice sheets*, J. Glaciol. 58 (209), 441–457.
P17. F. Pattyn, C. Schoof, and 16 others including E. Bueler, 2012. *Results of the Marine Ice Sheet Model Intercomparison Project, MISMIP*, The Cryosphere 6, 573–588.
P16. M. A. Martin, R. Winkelmann, M. Haseloff, T. Albrecht, E. Bueler, C. Khroulev, and A. Levermann, 2011. *The Potsdam Parallel Ice Sheet Model (PISM-PIK)–Part 2: Dynamic equilibrium simulation of the Antarctic ice sheet*, The Cryosphere 5, 727–740.
P15. R. Winkelmann, M. A. Martin, M. Haseloff, T. Albrecht, E. Bueler, C. Khroulev, and A. Levermann, 2011. *The Potsdam Parallel Ice Sheet Model (PISM-PIK)–Part 1: Model description*, The Cryosphere 5, 715–726.
P14. G. Jouvet, J. Rappaz, E. Bueler, and H. Blatter, 2011. *Existence and stability of steady state solutions of the shallow ice sheet equation by an energy minimization approach*, J. Glaciol. 57 (202), 345–354.
P13. R. Calov, R. Greve, A. Abe-Ouchi, E. Bueler, P. Huybrechts, J. V. Johnson, F. Pattyn, D. Pollard, C. Ritz, F. Saito, and L. Tarasov, 2010. *Results from the Ice-Sheet Model Intercomparison Project—Heinrich Event INtercOmparison (ISMIP–HEINO)*, J. Glaciol. 56 (197), 371–383.
P12. E. Bueler and J. Brown, 2009. *Shallow shelf approximation as a "sliding law" in a thermomechanically coupled ice sheet model*, J. Geophys. Res. (Earth Surface) 114, F03008, doi:10.1029/2008JF001179.
P11. E. A. Butcher, M. Sari, E. Bueler, and T. Carlson, 2009. *Magnus' expansion for time-periodic systems: parameter-dependent approximations*, Communications in Nonlinear Sciences and Numerical Simulation 14, 4226–4245.
P10. E. A. Butcher, O. A. Bobrenkov, E. Bueler, and P. Nindujarla, 2009. *Analysis of milling stability by the Chebyshev collocation method: Algorithm and optimal stable immersion levels*, Journal of Computational and Nonlinear Dynamics (ASME) 4 (3), 031003.

P9. V. Deshmukh, E. A. Butcher, and E. Bueler, 2008. *Dimensional reduction of nonlinear delay differential equations with periodic coefficients using Chebyshev spectral collocation*, Nonlinear Dynamics 52, 137–149.
P8. E. Bueler, 2007. *Error bounds for approximate eigenvalues of periodic-coefficient linear delay differential equations*, SIAM J. Num. Analysis 45 (6), 2510–2536.
P7. E. Bueler, J. Brown, and C. Lingle, 2007. *Exact solutions to the thermomechanically coupled shallow ice approximation: effective tools for verification*, J. Glaciol. 53 (182), 499–516.
P6. E. Bueler, C. S. Lingle, and J. A. Brown, 2007. *Fast computation of a viscoelastic deformable earth model for ice flow simulations*, Ann. Glaciol. 46, 97–105.
P5. E. Bueler, C. S. Lingle, J. A. Kallen-Brown, D. N. Covey, and Latrice N. Bowman, 2005. *Exact solutions and the verification of numerical models for isothermal ice sheets*, J. Glaciol. 51 (173), 291–306.
P4. E. A. Butcher, H. Ma, E. Bueler, V. Averina, and Z. Szabo, 2004. *Stability of time-periodic delay-differential equations via Chebyshev polynomials*, International Journal on Numerical Methods in Engineering 59 (7), 895–922.
P3. E. A. Butcher, H. Ma, and E. Bueler, 2003. *Chebyshev expansion of linear dynamic systems with time delay and periodic coefficients under control excitations*, Journal of Dynamic Systems, Measurement and Control (ASME) 125, 236–243.
P2. E. Bueler and I. Prokhorenkov, 2002. *Hodge theory and cohomology with compact supports*, Soochow Journal of Mathematics 28 (1), 33–55.
P1. E. Bueler, 1999. *The heat kernel weighted Hodge Laplacian on noncompact manifolds*, Transactions of the American Mathematical Society 351, 683–713.

Editor-reviewed Publications

C6. W. Lipscomb, R. Bindschadler, E. Bueler, D. Holland, J. Johnson, and S. Price, 2009. *Building a Next-Generation Community Ice Sheet Model*, Eos Transactions, AGU, 90 (3), 23.
C5. E. Bueler, *Lessons from the short history of ice sheet model intercomparison*, The Cryosphere Discussions 2, 1–14, 2008.
C4. E. A. Butcher, V. Deshmukh, and E. Bueler, *Center manifold reduction of periodic delay differential systems*, Proceedings of the ASME IDETC/CIE, 2007.
C3. E. A. Butcher, P. Nindujarla and E. Bueler, *Stability of up- and down-milling using a Chebyshev collocation method*, Proceedings of ASME IDETC/CIE, 2005.
C2. V. Averina and four others, *Effect of delay on engine air-to-fuel ratio control*, Proceedings of the IEEE Conference on Control Applications, Toronto, 2005.
C1. E. A. Butcher and four others, *Stability analysis of parametrically excited systems with time-delay*, Proceedings of ASME DETC, 2003.

Technical Reports

T12. E. Bueler, *The full approximation storage multigrid scheme: A 1D finite element example*, `arxiv:2101.05408`, 2021.
T11. E. Bueler and J. Brown, *The shallow shelf approximation as a "sliding law" in a thermomechanically coupled ice sheet model*, `arXiv:0810.3449`, 2008.
T10. E. Bueler, *An exact solution to the temperature equation in a column of ice and bedrock*, `arXiv:0710.1314`, 2007.
T9. E. Bueler and J. Brown, *On exact solutions for cold, shallow, and thermocoupled ice sheets*, `arXiv:physics/0610106`, 2006.

T8. E. Bueler, C. S. Lingle, and J. Brown, *Computation of combined spherical-elastic and viscous-half-space earth model for ice sheet simulation*, `arXiv:physics/0606074` (2006).
T7. E. Bueler, *Chebyshev collocation for linear, periodic ordinary and delay differential equations:* a posteriori *estimates*, `arXiv:math.NA/0409464` (2004).
T6. E. Bueler, C. S. Lingle, J. Brown, D. Covey, and L. N. Bowman, *Exact time-dependent similarity solutions for isothermal shallow ice sheets*, UAF DMS Tech. Rep. 04–01 (2004).
T5. E. Bueler, *Construction of steady state solutions for isothermal shallow ice sheets*, UAF DMS Tech. Rep. 03–02 (2003).
T4. E. Bueler and E. A. Butcher, *Stability of periodic linear delay–differential equations and the Chebyshev approximation of fundamental solutions*, UAF DMS Tech. 02–03 (2002).
T3. E. Bueler, *Numerical approximation of a two dimensional thermomechanical model for ice flow*, UAF DMS Tech. Rep. 02–02 (2002).
T2. E. Bueler, *Dirac operators as "annihilation operators" on Riemannian manifolds*, (2001).
T1. E. Bueler, *Number operators for Riemannian manifolds*, `arXiv:math-ph/0104022` (2000).

Computer Software Projects

Programs in support of *PETSc for Partial Differential Equations*.
`github.com/bueler/p4pdes`
A collection of programs in support of book **B1**. Each code uses PETSc to solve a PDE or related problem. The C codes call PETSc directly while the Python codes apply the Firedrake finite element library, which applies PETSc as a solver library.

Programs for teaching glacier and ice sheet modeling.
`github.com/bueler/mccarthy` and `github.com/bueler/stokes-ice-tutorial`
A suite of introductory models in Matlab and Python, with extensive documentation, from my lectures at the International Summer School in Glaciology, McCarthy, Alaska and the Summer School on Ice Sheets and Glaciers in the Climate System, Karthaus, Italy; see also book chapter **BC1**. My tutorial on solving the glaciological Stokes equations uses the Firedrake Python library for finite elements.

Parallel Ice Sheet Model (PISM):
`github.com/pism` and `www.pism-docs.org`
PISM is an open-source, numerical fluid simulation code for ice sheets and glaciers. Based on modern, parallel HPC libraries PETSc and MPI, it consists of about 250,000 lines of C++ and Python. It runs on laptops or on thousands of processor cores on supercomputers. There is an extensive user-support website and *User's Manual*. Most of the source code and all of the user support and documentation is through our group at UAF, but some parts were co-developed with the Potsdam Institute for Climate Impact Research, Germany. The primary authors are: C. Khroulev (lead programmer), A. Aschwanden (current Principal Investigator), E. Bueler (programmer and first Principal Investigator), J. Brown (original author), D. Maxwell (inversion codes), and T. Albrecht (ice shelf physics). PISM has been funded by seven NASA and NSF grants in the period 2002–present. Since 2007 there have been at least 138 peer-reviewed articles in scientific journals which apply PISM or describe its design. Of these I am author or co-author of 10 papers: **P6**, **P7**, **P12**, **P13**, **P15**, **P16**, **P18**, **P21**, **P22**, **P25**. For the others see the publication tab at `pism-docs.org`.

DDEC.
`bueler.github.io/ddes/DDEcharts.htm`

A suite of *Matlab* programs, used in publications **P8**, **P9**, **P10**, for stability charts of linear periodic delay differential equations.

Funded Research Grants

E. Bueler (PI), M. Fahnestock (Co-I), A. Aschwanden (Co-I), *Understanding Measured Variability in the Greenland Ice Sheet Using the Parallel Ice Sheet Model (PISM)*, NASA Modeling Analysis and Prediction Program grant #NNX13AM16G, June 2013–June 2018. Award of $700k.

E. Bueler (PI), R. Hock (Co-I), D. Maxwell (Co-I), and M. Truffer (Co-I), *A high resolution Parallel Ice Sheet Model including fast, sliding flow: advanced development and application*, NASA Modeling Analysis and Prediction Program grant #NNX09AJ38G, June 2009–June 2013. Award of $997k.

C. Lingle (PI), D. Covey (Co-I), and E. Bueler (Co-I), *Ice Sheet Modeling: a component of NSF grant PRISM: Polar Radar for Ice Sheet Measurements* NASA Cryospheric Sciences Program grant #NAG5-11371, October 2001–September 2006. Award of $436k.

E. A. Butcher (PI) and E. Bueler (Co-PI), *Symbolic Stability and Bifurcation Analysis of Time-Periodic Differential-Delay Equations: Applications to High-Speed Machining Models*, NSF Civil and Mechanical Systems Directorate for Engineering #0114500, September 2001–August 2004. Award of $205k, plus $5k supplemental for one REU student.

Supervisor/Mentor of

- Constantine Khroulev, GI Research Professional, 2009–2018.
- Dr. Andreas Aschwanden, ARSC and GI Postdoctoral Fellow, 2009–2013.

Advising of Graduate Research

- Wesley Voley, M.S. Mathematics, Thesis: *Navier-Stokes equations: An overview of existence and regularity theorems*, UAF, August 2021.
- Max Heldman, M.S. Mathematics, Project: *Toward an optimal solver for the obstacle problem*, UAF, May 2018.
- Lyman Gillispie, M.S. Mathematics, Thesis: *A temperature-only formulation for ice sheets*, UAF, May 2014.
- William Mitchell, M.S. Mathematics, Thesis: *Exact and numerical solutions for Stokes flow in glaciers*, UAF, August 2012.
- Daniella DellaGiustina (co-advisee), M.S. Computational Physics, Thesis: *Regional modeling of Greenland's outlet glaciers with PISM*, UAF, December 2011.
- Jacob Stroh, M.S. Mathematics, Thesis: *Non-normality in scalar delay differential equations*, UAF, December 2006.
- Jed A. Kallen-Brown, M.S. Mathematics, Project: *Multi-modal ice sheet dynamics: theory and implementation*, UAF, August 2006.
- Timothy Carlson, M.S. Mathematics, Thesis: *Magnus' expansion as an approximation tool for ODEs*, UAF, May 2005.
- Latrice N. Bowman, M.S. Mathematics, Project: *Stability and accuracy of numerical finite difference methods applied to two dimensional isothermal ice flow*, UAF, November 2002.
- Viktoria A. Averina, M.S. Mathematics, Thesis: *Symbolic stability of delay differential equations*, UAF, August 2002.

- Mikhail Korotiaev, M.S. Mathematics, Thesis: *Critical points of the heat kernel on a compact semisimple Lie group*, UAF, August 2002.
- Liane Hansen, M.S. Mathematics, Project: *Numerical solution of a weighted Hodge Laplacian*, UAF DMS, May 1999.

Advising of Undergraduate Research

- Sarah Williamson, Alaska Space Grant Program Undergraduate Fellowship, Spring 2017.
- Jeremiah Harrington, Honors Thesis in Mathematics, May 2013.
- Benjamin Sperisen, ARSC undergraduate Intern, Summer 2008.
- Nathan Shemonski, ARSC undergraduate Intern, Summer 2007.
- Benjamin White, NSF REU, Summer 2004.

Courses Taught at UAF (S=Spring, F=Fall semester)

Undergraduate.

Math 251 Calculus I (F99, F01, S06, S08, F08, S13, F13, F18, S19, S20; Cornell S92, F93, S94)
Math 252 Calculus II (S99, S01, F03, S18, S22; Cornell F92)
Math 253 Calculus III (F98, F02, F15, S18)
Math 265 Introduction to Mathematical Proofs (S02, cotaught with J. Faudree)
Math 302 Differential Equations (S00, F00, S09, S19 online)
Math 310 Numerical Analysis (F98, F99, F00, F02, F04, F09, F10, F11, F12, F17, F19, F21)
Math 314 Linear Algebra (S07, S22)
Math 401 Introduction to Real Analysis (F13)
Math 404 Topology (F16)
Math 412 Differential Geometry (S99, S03)
Math 421 Applied Analysis (F01, F04, F07, F11)
Math 422 Introduction to Complex Analysis (S08, S16)
Math 490 Senior Seminar (S02, cotaught with J. Faudree)

Graduate.

Math 611/612 Mathematical Physics I (F05) & II (S06)
Math 614 Numerical Linear Algebra (new course creation; F03, S09, S11, S13, F15, F21)
Math 615 Numerical Analysis of Diff. Eqns. (S00, S02, S05, S07, S10, S12, S14, S17)
Math 617 Functional Analysis (S20)
Math 641 Real Analysis (F00, F01, F19)
Math 661 Optimization (F16, F18)

Seminars: random walks (S01), differential forms (F01 with J. Wiens),
iterative methods in linear algebra (F03), PETSc for PDEs (S16),
finite elements (F04 with D. Maxwell; F18 with X. Ye), and
machine learning (S22)

Signifcant Professional Activities

- Lecturer on *Numerical modelling of ice sheets and glaciers*, 2010, 2012, 2014, 2016, 2018, International Summer School in Glaciology, McCarthy, Alaska.
- Lecturer on *Numerical modelling of ice sheets and ice shelves*, 2009, 2010, 2012, 2014, Summer School on Ice Sheets and Glaciers in the Climate System, Karthaus, Italy

- Invited speaker, European PISM (Parallel Ice Sheet Model) Workshop, May 2012, Max Planck Institute for Meteorology.
- Contributor to the *Sea-level Response to Ice Sheet Evolution (SeaRISE)* assessment, a NASA-funded international effort to estimate ice sheet contributions to sea level.
- Member of Arctic Region Supercomputing Center technical advisory panel (2010).
- Workshop on *Building a Next-Generation Community Ice Sheet Model* (co-organizer), Los Alamos, New Mexico, August 2008.
- Minisymposium on ice flow, SIAM Conference on Mathematical and Computational Issues in the Geosciences, Santa Fe, New Mexico, March 2007.
- Reviews of articles for more than a dozen journals in applied mathematics, numerical analysis, geosciences, and glaciology. About three per year.
- DOE review panel (2011,2014,2017), NASA review panel (2012,2016), NSF proposals (2001,2006,2009,2021), Netherlands NSF proposal (2007), U.K. NERC proposal (2010), Austrian FWF proposal (2019). SIAM Activity Group on Geosciences prizes panel (2018).
- 14 reviews for *Mathematical Reviews* from 1998 to 2005
- Reviews of numerical analysis texts for Addison-Wesley (2000, 2001).
- Member of Society for Industrial and Applied Mathematics (SIAM) and the International Glaciological Society (IGS)