Erica Rutter

Current Position: Postdoctoral Scholar, North Carolina State University
: https://erutter.wordpress.ncsu.edu, ✉: erutter@ncsu.edu, ☎: 734-255-8893

Education

Aug 2012-Aug 2016 | Ph.D. in Applied Mathematics, Arizona State University
Commitee: Yang Kuang (co-chair), Eric Kostelich (co-chair), David Frakes, Carl Gardner, and Zdzislaw Jackiewicz
Thesis: A Mathematical Journey of Cancer Growth.

Sept 2005-May 2009 | B.Sc in Applied Mathematics & Japanese,
The University of Michigan

Research Employment

Aug 2016-Current | Postdoctoral Researcher, North Carolina State University
PIs: Kevin B. Flores and H. T. Banks
Developed machine learning algorithms to increase data collection efficiency. Integrated data collection, modeling, and uncertainty quantification to answer biological questions about cancer growth and migration and ecotoxicological modeling of *Daphnia magna*.

May 2009-July 2012 | Research Technician, University of Michigan
PI: R. Paul Drake
Contributed to code development (in FORTRAN) for modeling astrophysical phenomena at the Center for Radiative Shock Hydrodynamics (CRASH) at the University of Michigan. Collected experimental data at the OMEGA laser at Rochester Institute of Technology.

Student Research Experiences

Jan 2014-May 2014 | Research Assistant, Arizona State University
PIs: Yang Kuang and Eric Kostelich
Converted Magnetic Resonance (MR) images of murine brains into computational domains using medical imaging software Mimics. Simulated models of glioma progression and compared with collected data.

May 2008-Aug 2009 | SUBMERGE Research Participant, University of Michigan
PI: Patrick Nelson
Explored Bayesian network approaches to diagnosing rotator cuff tears non-invasively based on individualized patient metrics such as patient strength, age, gender, and range of motion during year-long research opportunity.

May 2007-Aug 2007 | REU Participant, North Carolina State University
PI: Mette Olufsen
Modeled sensitivity analysis of parameters in a blood flow model in a summer REU.

Publications

Peer-Reviewed Papers in Mathematics

[1] **Erica M. Rutter**, H. T. Banks, and Kevin B. Flores. Estimating Intratumoral Heterogeneity from Spatiotemporal Data. *Journal of Mathematical Biology*. *In Press*. doi:10.1007/s00285-018-1238-6

[2] **Erica M. Rutter**, John Lagergren, and Kevin B. Flores. Automated Object Tracing for Biomedical Image Segmentation Using a Deep Convolutional Neural Network. In: *International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)*, 686–694. Springer, Cham, 2018. doi:10.1007/978-3-030-00937-3_78

[3] **Erica M. Rutter**, Christopher L. Langdale, James A. Hokanson, Franz Hamilton, Hien Tran, Warren M. Grill, and Kevin B. Flores. Detection of bladder contractions from the activity of the external urethral sphincter in rats using sparse regression. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, 26(8):1636–1644, 2018. doi:10.1109/TNSRE.2018.2854675

[4] H. T. Banks, Kevin B. Flores, I. G. Rosen, **Erica M. Rutter**, Melike Sirlanci, and W. Clayton Thompson. The Prohorove metric framework and aggregate data inverse problems for random PDEs. *Communications in Applied Analysis*, 23(3):415–446, 2018. doi:10.12732/caa.v22i3.6

[5] Tracy L. Stepien, **Erica M. Rutter** and Yang Kuang. Traveling Waves of a Go-or-grow Model of Glioma Growth. *SIAM Journal of Applied Mathematics*, 78(3):1778–1801, 2018. doi:10.1137/17M1146257

[6] Tin Phan, Bruce Pell, **Erica M. Rutter**, Gerardo Chowell, and Yang Kuang. Simple multi-scale modeling of the transmission dynamics of the 1905 plague epidemic in Bombay. *Mathematical Biosciences*. 301:83–92, 2018. doi:10.1016/j.mbs.2018.04.003

[7] **Erica M. Rutter**, H. T. Banks, Gerald A. LeBlanc, and Kevin B. Flores. Continuous structured population models for *Daphnia magna*. *Bulletin of Mathematical Biology*, 79(11):2627–2648, 2017. doi:10.1007/s11538-017-0344-8

[8] Adam Mahdi, **Erica M. Rutter**, and Stephen J. Payne. Effects of non-physiological blood pressure artefacts on measures of cerebral autoregulation. *Medical Engineering and Physics*, 47:218–221, 2017. doi:10.1016/j.medengphy.2017.06.007

[9] **Erica M. Rutter**, Tracy L. Stepien, Barrett J. Anderies, Jonathan D. Placensia, Eric C. Woolf, Adrienne C. Scheck, et al. Mathematical Analysis of Glioma Growth in a Murine Model. *Scientific Reports*, 7(2508), 2017. doi:10.1038/s41598-017-02462-0

[10] **Erica M. Rutter** and Yang Kuang. Global dynamics of a model of joint hormone treatment with dendritic cell vaccine for prostate cancer. *Discrete and Continuous Dynamical Systems: DCDS-B*, 22(3):1001–1021, 2017. doi:10.3934/dcdsb.2017050

[11] Tracy L. Stepien, **Erica M. Rutter**, and Yang Kuang. A data-motivated density-dependent diffusion model of in vitro glioblastoma growth. *Mathematical Biosciences and Engineering: MBE*, 12(6):1157-1172, 2015. doi:10.3934/mbe.2015.12.1157

[12] Nikolay L. Martirosyan*, **Erica M. Rutter***, Wyatt L. Ramey, Eric J. Kostelich, Yang Kuang, and Mark C. Preul. Mathematically modeling the biological properties of gliomas: A review. *Mathematical Biosciences and Engineering: MBE*, 12(4):879–905, 2015. doi:10.3934/mbe.2015.12.879 (* denotes equal author contributions.)

Peer-Reviewed Papers in Physics

[13] Avishek Chakraborty, Derek Bingham, Soma S. Dhavala, Carolyn C. Kuranz, R. P. Drake, Michael J. Grosskopf, **Erica M. Rutter**, et al. Emulation of Numerical Models with Over-Specified Basis Functions. *Technometrics*, 59(2):153–164, 2017. doi:10.1080/00401706.2016.1164078

[14] Robert B. Gramacy, Derek Bingham, James P. Holloway, Michael J. Grosskopf, Carolyn C. Kuranz, **Erica Rutter**, Matt Trantham, and R. P. Drake. Calibrating a large computer experiment simulating radiative shock hydrodynamics. *The Annals of Applied Statistics*, 9(3):1141-1168, 2015. doi:10.1214/15-AOAS850

[15] Joslin Goh, Derek Bingham, James P. Holloway, Michael J. Grosskopf, Carolyn C. Kuranz, and **Erica Rutter**. Prediction and computer model calibration using outputs from multifidelity simulators. *Technometrics*, 55(4):501–512, 2013. doi:10.1080/00401706.2013.838910

[16] Avishek Chakraborty, Bani K. Mallick, Ryan G. McClarren, Carolyn C. Kuranz, Derek Bingham, Michael J. Grosskopf, **Erica M. Rutter**, Hayes F. Stripling, and R. P. Drake. Spline-based emulators for radiative shock experiments with measurement error. *Journal of the American Statistical Association*, 108(502):411–428, 2013. doi:10.1080/01621459.2013.770688

[17] Carolyn C. Kuranz, R. P. Drake, Christine M. Krauland, Donna C. Marion, Michael J. Grosskopf, **Erica Rutter**, Ben Torralva, James P. Holloway, Derek Bingham, Joslin Goh, et al. Initial conditions of radiative shock experiments). *Physics of Plasmas (1994-present)*, 20(5):056321, 2013. doi:10.1063/1.4805021

[18] **Erica M. Rutter**, Michael J. Grosskopf, Guy Malamud, Carolyn C. Kuranz, Eric C. Harding, Paul A. Keiter, and R. P. Drake. Comparison between Kelvin–Helmholtz instability experiments on omega and simulation results using the CRASH code. *High Energy Density Physics*, 9(1):148–151, 2013. doi:10.1016/j.hedp.2012.12.002

[19] Michael J. Grosskopf, R. P. Drake, Carolyn C. Kuranz, **Erica M. Rutter**, James S. Ross, Nathan L. Kugland, et al. Simulation of laser-driven, ablated plasma flows in collisionless shock experiments on omega and the nif. *High Energy Density Physics*, 9(1):192–197, 2013. doi:10.1016/j.hedp.2012.11.004

[20] Hayes F. Stripling, Ryan G. McClarren, Carolyn C. Kuranz, Michael J. Grosskopf, **Erica Rutter**, and Ben R. Torralva. A calibration and data assimilation method using the bayesian mars emulator. *Annals of Nuclear Energy*, 52:103–112, 2013. doi:10.1016/j.anucene.2012.08.025

[21] Bruce Fryxell, **Erica Rutter**, and Eric S. Myra. Simulations of laser experiments of radiative and non-radiative shocks. *High Energy Density Physics*, 8(2):141–149, 2012. doi:10.1016/j.hedp.2011.12.002

[22] Ryan G. McClarren, Duchwan Ryu, R. P. Drake, Michael Grosskopf, Derek Bingham, Chuan-Chih Chou, [and 7 others, including **Erica M. Rutter**]. A physics informed emulator for laser-driven radiating shock simulations. *Reliability Engineering & System Safety*, 96(9):1194–1207, 2011. doi:10.1016/j.ress.2010.08.012

[23] R P. Drake, Forrest W. Doss, Ryan G. McClarren, Marvin L. Adams, Nancy Amato, Derek Bingham, Chuan-Chih Chou, [and 29 others, including **Erica M. Rutter**]. Radiative effects in radiative shocks in shock tubes. *High Energy Density Physics*, 7(3):130–140, 2011. doi:10.1016/j.hedp.2011.03.005

Peer-Reviewed Conference Proceedings

[24] Hayes F. Stripling, Ryan G. McClarren, Carolyn C. Kuranz, Michael J. Grosskopf, **Erica Rutter**, and Ben R. Torralva. Calibration of uncertain inputs to computer models using experimentally measured quantities

and the bmars emulator. In *Proceedings of international conference on mathematics and computational methods applied to nuclear science and engineering. Rio de Janeiro, Brazil*, 2011.

Pedagogical Materials

Jed Harmon. *Calculus*. Openstax College, 2016. Calculus Volume 1. Calculus Volume 2. Calculus Volume 3. (Listed as contributing author)

Jay P Abramson and Valereee Falduto. *Precalculus*. Openstax College, 2014. Precalculus. (Listed as a reviewer and consultant in the preface, here)

Scholarships, Grants, and Awards

Sept 2018 — MICCAI Society NIH Travel Award
Award Amount: $500.00
Merit-based travel award for the International Conference on Medical Image Computing and Computer Assisted Intervention, description: here

Fall 2016-Spring 2017 — ASU Dissertation Fellowship
Award Amount: $17,000
Awarded tuition and stipend for the last year of graduate school in a competitive university-wide fellowship awarded by Arizona State University. *Awarded to < 25 students univeristy-wide per year.*

June 2016 — GPSA Travel Grant
Award Amount: $450
Competitive travel grant, awarded to 40% of applicants, description: here.

Apr 2016 — GPSA Outstanding Research Award
Award Amount: $500.00
Merit-based research award judged by graduate peers and faculty from various departments. Award presented by Graduate and Professional Student Association, description: here.

Dec 2015 — GPSA Teaching Excellence Award
Nominated for award by current students and/or faculty observers. Judged on teaching philosophy and in-class observations by several graduate peers from a variety of disciplines. Presented by Graduate and Professional Student Association, description: here. *Awarded to < 25% of nominees.*

July 2015 — Society for Mathematical Biology Landahl Travel Award
Award Amount: $100.00
Grant to present and attend 2015 Society for Mathematical Biology meeting, described: here.

June 2015 — Outstanding Poster Award
Award Amount: €150.00
Mathematical Methods in Systems Biology conference poster award, awarded to 3 posters.

Fall 2014	GAANN Graduate Student Fellowship *Award Amout: $9,765.00* Tuition and stipend awarded for fall semester of 2014. Funding from US Department of Education: Graduate Assistantships in Areas of National Need.
Summer 2013	Summer Block Grant Recipient *Award Amount: $6,644.00* Awarded departmental funding (School of Mathematical and Statistical Sciences at Arizona State University) for written proposal to perform summer research.

Presentations and Invited Talks

Oral

1. (Invited) "Estimating Intratumoral Heterogeneity from Spatiotemporal Data" to be presented at the Banff International Research Station - Casa Matemática Oaxaca (BIRS-CMO): Mathematical Challenges in the Analysis of Continuum Models for Cancer Growth, Evolution and Therapy Workshop; 2018 Nov 26–30; Oaxaca, Mexico.
2. (Invited) "Modeling and Estimating Biological Heterogeneity in Spatiotemporal Data" presented at the Statistical and Applied Mathematical Sciences Institute (SAMSI) E&O: Undergraduate Workshop; 2018 Oct 22–23; Raleigh, NC.
3. (Invited) "Optimal Experimental Design for *Daphnia magna* Age-Structured Models" presented at the Society for Mathematical Biology Annual Meeting; 2017 July 17–20; Salt Lake City, Utah.
4. "Influence of Non-Physiological Blood Pressure Artifacts on Cerebral Autoregulation" presented at the AMS Special Session on Mathematics in Physiology and Medicine II, Joint Mathematical Meetings; 2016 Jan 4-7; Atlanta, Georgia.
5. (Invited) "A Mathematical Model of GL261-Luc2 Glioma Growth in Mice" presented at SIAM Conference on the Life Sciences; 2016 July 11-14; Boston, MA.
6. (Invited) "Global Dynamics of a Joint Hormone Therapy and Dendritic Cell Vaccine for Late-Stage Prostate Cancer", presented at the 11th AIMS Conference on Dynamical Systems, Differential Equations, and Applications; 2016 July 1-5; Orlando, FL.
7. "Global Dynamics of a Joint Hormone Therapy and Dendritic Cell Vaccine for Late-Stage Prostate Cancer", presented at BAMM! (Biology and Medicine through Mathematics); 2016 May 20-22; Richmond, VA.
8. "Exploring Partial Differential Equation Models of Glioma Growth", presented at the Partial Differential Equation Seminar at Arizona State University, March 25, 2016.
9. "Global Dynamics of a Joint Hormone Therapy and Dendritic Cell Vaccine for Late-Stage Prostate Cancer", presented at the Mathematical Biology Seminar at Arizona State University, January 22, 2016.
10. "A Mathematical Model of GL261-Luc2 Glioma Growth in Mice", presented at Joint Mathematical Meetings; 2016 Jan 6-9; Seattle, Washington.

Poster

1. "Automated Object Tracing for Biomedical Image Segmentation Using a Deep Convolutional Neural Network", presented at the International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI); 2018 Sept 16-20; Granada, Spain.
2. "Modeling Tumor Heterogeneity", presented at the Precisision Medicine (PMED) Opening Workshop; 2018 August 14; Raleigh, NC.
3. "Mathematically Modeling Populations of *Daphnia magna*", presented at the Postdoctoral Research Symposium; 2017 May 24; Raleigh, NC.
4. "Global Dynamics of a Joint Hormone Therapy and Dendritic Cell Vaccine for Late-Stage Prostate Cancer", presented at the Association of Women in Mathematics Workshop at Joint Mathematical Meetings; 2016 Jan 6-9; Seattle, Washington.
5. "Data-Validated Model of Glioblastoma Growth in Murine Brains", presented at Society of Mathematical Biology Annual Meeting; 2015 June 30-July 3; Atlanta, Georgia
6. "Analysis of Dendritic Cell Vaccine Therapy with Intermittent Androgen Deprivation Therapy for Late-Stage Prostate Cancer", presented at Mathematical Methods in Systems Biology; 2015 June 15-19; Dublin, Ireland. **Outstanding Poster Award**.
7. "Data-Motivated Models of *in vitro* Glioblastoma Growth", presented a Micro and Macro Systems in Life Sciences; 2015 June 8-13; Bedlewo, Poland.
8. "A Data-Validated Density-Dependent Diffusion model of Glioblastoma Growth" at MBI (Mathematical Biosciences Institute) Cancer and the Immune System Workshop; 2014 November 17-21; Columbus, Ohio.
9. "Kelvin-Helmholtz Instability Modeling using the CRASH Code", presented at 9th International Conference on High Energy Density Laboratory Astrophysics; 2012 April 30-May 4; Tallahassee, Florida.
10. "Modeling the Kelvin-Helmholtz Instability in High-Energy-Density Experiments using CRASH Code", presented at 53rd American Physical Society Annual Division of Plasma Physics Meeting; 2011 November 14-18; Salt Lake City, Utah.
11. "Early-Time Radiation-Hydrodynamic Modeling of Radiative shock Experiments", presented at the 52nd American Physical Society Annual Division of Plasma Physics Meeting; 2010 November 8-12; Chicago, Illinois.
12. "Expected Variation in Shock Behavior due to Experimental Variability" at 8th International Conference on High Energy Density Laboratory Astrophysics; 2010 March 15-18; Pasadena, California.
13. "1D Hyades Study of Varying Input Parameters of a Gaussian Distribution" presented at the 51st American Physical Society Annual Division of Plasma Physics Meeting; 2009 November 2-6; Atlanta, Georgia.

Workshops, Short Courses, and Attended Conferences

1. Program on Statistical, Mathematical, and Computational Methods for Precision Medicine (PMED) Opening Workshop; 2018 August 13–17; Raleigh, NC.
2. Tutorial Workshop on Parameter Estimation for Biological Models; 2018 July 25–28; Raleigh, NC.

3. International Conference on Machine Learning (ICML); 2018 July 10–15; Stockholm, Sweden.
4. Cancer Systems Biology Short Course at the Center for Cancer Systems Biology UC Irvine; 2018 May 7–26; Irvine, CA.
5. Stoichiometric Ecotoxicology Workshop at NimBios; 2018 Jan 17–29; Knoxville, TN.
6. Neural Information Processing Systems (NIPS); 2017 Dec 4–9; Long Beach, CA.
7. International Conference on Machine Learning (ICML); 2017 Aug 6–11; Sydney, Australia.
8. Neural Information Processing Systems (NIPS); 2016 Dec 5–10; Barcelona, Spain.
9. Tutorial Workshop on Parameter Estimation for Biological Models; 2018 July 28–31; Raleigh, NC.
10. Mathematics in Physiology and Medicine, Mathematics Research Communities (MRC); 2016 June 19–25; Snowbird, UT.

Teaching Employment

Fall 2017 — Course Instructor at North Carolina State University
Differential Equations for the Life Sciences
Developed curriculum for differential equations course for non-math majors focused on applications to biological problems. Designed course to investigate inverse problems applied to real-world data with a final project in which students proposed models and fit them to data.

Spring 2016, Fall 2015 — Course Instructor at Arizona State University
Calculus for Engineers II
Created lectures for 150 minutes per week. Administered and graded written and online homework and exams for coordinated course. Class consisted of 40 undergraduate students.

Summer 2015 — Course Instructor at Arizona State University
Calculus for Engineers I
Developed curriculum for Calculus I in an accelerated, uncoordinated, summer course. Prepared and graded lectures, homework, and exams. Course consisted of 32 undergraduate students.

Spring 2013, Fall 2014 — Lab Instructor at Arizona State University
Differential Equations and Linear Algebra
Introduced MATLAB and basic coding principles to students relevant to their coursework (either differential equations or linear algebra). Course consisted of one-hour meetings 6 times per semester. Class consisted of 4 sections of 45 students each.

Fall 2012 — Teaching Assistant at Arizona State University
Calculus and Analytic Geometry I
Planned and led recitations for Calculus I for two sections of 30 students. Devised classwork to engage and deepen student understanding through group work, board work, quizzes, and games.

Teaching Development

Aug 2015	**Teaching Assistant Trainer at Arizona State University** Selected to train incoming graduate student TA's in a week-long session on approaches to running recitations, preparing lectures, and grading. Observed and gave feedback for their lectures and helped match TA's to their corresponding assignments.
Fall 2013 - Spring 2015	**Textbook Writer for OpenStax** Created End-of-Section textbook problems for open-source textbooks for undergraduate mathematics – see pedagogical materials. Emphasized application and technological problems.

Mentoring Experience

Fall 2016 - Current	**Mentoring at Flores Lab at North Carolina State University** Mentored two undergraduates in laboratory experiments and computational image processing, leading to publications with undergraduates as co-authors.
Summer 2016	**Graduate Assistant at Mentoring through Critical Transition Points (MCTP) Undergraduate Research Program, Arizona State University** Organized and presented a boot-camp style introduction to differential equations, modeling, and MATLAB programming for undergraduate researchers (approximately 20 students). Answered student research questions and suggested possible research avenues to explore.
May 2009 - July 2012	**Research Technician at University of Michigan** Interviewed undergraduate researchers for a large physics laboratory. Mentored and supervised undergraduate researchers by writing introductory manuals, answering day-to-day questions, and helping students prepare poster, talks, and papers discussing their research.

Professional Development

July 2017	**Society of Mathematical Biology Mentoring Workshop** Mentored a graduate student and answered her questions about applying to postdoctoral positions. Also received mentoring from faculty members on how to approach tenure-track applications and interviews.
Fall 2015 - Spring 2016	**Preparing Future Faculty** Attended various panel discussions addressing excellence in teaching, presentation techniques, and job materials. Learned about job opportunities in various types of academic institutions.
Jan. 2016	**Association of Women in Mathematics Workshop** Presented at a special poster session and met with mentors who guided us in our career goals.
June 2015	**Society of Mathematical Biology Mentoring Workshop** Participated in workshops on creating job materials, interview techniques. Met with assigned mentor to discuss different career opportunities.

Service

National: Served as reviewer for the following journals:
- *Scientific Reports*
- *Discrete and Dynamical Systems-B*
- *Mathematical Biosciences and Engineering*
- *Letters in Biomathematics*
- *International Journal for Numerical Methods in Biomedical Engineering*

University-level: Member of the Postdoc Research Symposium Organization committee (2017–2018). Organized an all-day symposium showcasing postdoctoral research at Duke, University of North Carolina and North Carolina State University.

Outreach: Volunteered at "BugFest", hosted at the Raleigh Natural Science Museum in 2016, 2017, and 2018 at the "Math Doesn't Bug Me" Booth. Introduced kids and parents to the fun things that can be done with math.

Research Skills

Wet Lab: Lab Equipment Proficiency: Spectrophotometry, D.O./p.H. readings, pipetting, making hard water, and other basic lab skills.
Electronics: Building computer workstations with GPUs, 3D printing design and usage, robot design and building experience

Computational: Programming Languages: *MATLAB, Fortran, Python, Tensorflow, Keras*
Operating Systems: *Windows, Mac OS, Linux/Unix*
Other Skills: Supercomputing, bash scripting