Romit Maulik

Argonne Leadership Computing Facility
Building 240, Argonne National Laboratory
9700 Cass Avenue, Lemont, IL 60439

Phone: (405) 982-0161
Email: rmaulik@anl.gov
Homepage: romit-maulik.github.io

Research interests

Scientific machine learning, high-performance computing, reduced-order modeling, numerical methods, geophysical sciences, stochastic processes.

Education

PhD. Mechanical & Aerospace Engineering, Oklahoma State University, 2019.

M.S. Mechanical & Aerospace Engineering, Oklahoma State University, 2015.

B.E. Mechanical Engineering, Birla Institute of Technology, India, 2012.

Positions held

Margaret Butler Postdoctoral Fellow, Argonne National Laboratory, Jun, 2019 - Present.

Research Assistant Professor, Department of Applied Mathematics, Illinois Institute of Technology, Chicago, Oct, 2020 - Present.

Predoctoral Appointee - MCS, Argonne National Laboratory, Jan 2019 - May 2019.

RA - Computational Fluid Dynamics Laboratory, Oklahoma State University, Jan 2016 - Jan 2019.

RA - Computational Biomechanics Laboratory, Oklahoma State University, Aug 2013 - July 2015.

TA - Mechanical & Aerospace Engineering, Oklahoma State University, Jan 2013 - Dec 2018.

Design Engineer - Tata Technologies Limited, India, Aug 2012 - Aug 2013.

Honors & awards

Margaret Butler Fellow, Argonne Leadership Computing Facility, Argonne National Laboratory, 2019-2021.

Best Oral presentation, MAE Graduate Research Symposium, Oklahoma State University, 2018.

Outstanding Graduate Student, College of Engineering Architecture and Technology, Oklahoma State University, 2018.

7^{th} place in Worldsteel-Steel Challenge 8 - North American University Category, 2014.

Committee membership

DOE INCITE program (2020) - Reviewed 2 proposals every year

ADSP program (2020) - Reviewed 2 proposals every year

Member of program committee - International Conference on Parallel Processing, Chicago, 2021.

Mentoring

Argonne mentor for the Afro-Academic, Cultural, Technological and Scientific Olympics (ACT-SO) High School Research Program, 2020-2021.

Supervising

Suraj Pawar (Oklahoma State): Scalable reinforcement learning for computational fluid dynamics, ALCF Summer Internship Project, 2020.

Dominic Skinner (MIT): Deep learning reduced-order models for computational physics applications, National Science Foundation, Mathematical Sciences Graduate Internship, Summer 2020.

Publications

In preparation

1. **R. Maulik**, R. Egele, B. Lusch, P. Balaprakash: Scalable autoencoder search for advection-dominated PDE reduced-order models.
2. **R. Maulik**, D. Fytanidis, B. Lusch, S. Patel, V. Vishwanath: PythonFoam - Distributed in-situ data analysis with Python bindings to OpenFOAM.
3. S. Renganathan, **R. Maulik**, J. Ahuja: Probabilistic aerodynamic data fusion using deep autoencoders.
4. K. Raghavan, **R. Maulik**, P. Balaprakash: Randomized methods for direct error-driven deep learning.
5. **R. Maulik**, N. Ramachandra: A Bayesian inverse approach for geophysical flow reconstruction under uncertainty.
6. J. Choi, W. Wehde, **R. Maulik**: Comparing Relative Decisiveness for Public Support of Climate Change Mitigation Policies Using Machine Learning.
7. Q. Tang, J. Burby, **R. Maulik**: Exact reproduction of parameterized Hamiltonian dynamics using HenonNets.
8. V. Iungo, **R. Maulik**, S. Renganathan, V. Rao: Cluster-based forecasting in reduced-order space for wind-turbine wakes using LiDAR data.
9. **R. Maulik**, S. Renganathan, V. Iungo, V. Rao: Wind-turbine wake predictions using deep convolutional autoencoders and latent space regression.

Peer-reviewed journal articles

1. **R. Maulik**, B. Lusch, P. Balaprakash: Reduced-order modeling of advection-dominated systems with recurrent neural networks and convolutional autoencoders , *Physics of Fluids*, 33, 037106, 2021.
2. S. Pawar, **R. Maulik**: Distributed deep reinforcement learning for simulation control, *Machine Learning: Science and Technology, To appear*, `https://iopscience.iop.org/article/10.1088/2632-2153/abdaf8`.
3. S. Renganathan, **R. Maulik**, J. Ahuja: Enhanced data efficiency using deep neural networks and Gaussian processes for aerodynamic design optimization, *Aerospace Science and Technology*, 111, 106522, 2021.
4. J. Burby, Q. Tang, **R. Maulik**: Fast neural Poincaré maps for toroidal magnetic fields, *Plasma Physics and Controlled Fusion*, 63, 024001, 2021.
5. **R. Maulik**, T. Botsas, N. Ramachandra, M. Lachlan, I. Pan: Latent-space time evolution of non-intrusive reduced-order models using Gaussian process emulation, *Physica D: Nonlinear Phenomena*, 132797, 2021.
6. **R. Maulik**, H. Sharma, S. Patel, B. Lusch, E. Jennings : A turbulent eddy-viscosity surrogate modeling framework for Reynolds-Averaged Navier-Stokes simulations, *Computers and Fluids*, 104777, 2020.
7. **R. Maulik**, K. Fukami, N. Ramachandra, K. Fukagata, K. Taira : Probabilistic neural networks for fluid flow model-order reduction and data recovery, *Physical Review Fluids*, 5, 104401, 2020.
8. **R. Maulik**, P. Balaprakash, B. Lusch: Non-autoregressive time-series methods for stable parameteric reduced-order models, *Physics of Fluids*, 32, 087115, 2020.
9. **R. Maulik**, N. Garland, X. Tang, P. Balaprakash: Neural network representability of fully ionized plasma fluid model closures, *Physics of Plasmas*, 27, 072106, 2020.
10. J. Choi, S. Robinson, **R. Maulik**, W. Wehde: What Matters the Most for Individual Disaster Preparedness? Understanding Emergency Preparedness Using Machine Learning, *Natural Hazards*, 103, 1183-1200, 2020.
11. S. Renganathan **R. Maulik**, V. Rao : Machine learning for nonintrusive model order reduction of the parametric inviscid transonic flow past an airfoil, *Physics of Fluids*, 32, 047110, 2020.
12. **R. Maulik**, O. San: Numerical assessments of a parametric implicit large eddy simulation model, *Journal of Computational and Applied Mathematics*, 112866, 2020.
13. **R. Maulik**, O. San, J. Jacob: Spatiotemporally dynamic implicit large eddy simulation using machine learning classifiers, *Physica D: Nonlinear Phenomena*, 406, 132409, 2020.
14. **R. Maulik**, A. Mohan, B. Lusch, S. Madireddy, P. Balaprakash, D. Livescu: Time-series learning of latent-space dynamics for reduced-order model closure, *Physica D: Nonlinear Phenomena*, 405, 132368, 2020.
15. Y. Hossain, **R. Maulik**, H. Park, M. Ahmed, C. Bach, O. San: Improvement of Unitary Equipment and Heat Exchanger Testing Methods, *ASHRAE Transactions*, 125.2, 2019.
16. **R. Maulik**, O. San, J. Jacob, C. Crick: Online turbulence model classification for large eddy simulation using deep learning, *Journal of Fluid Mechanics*, 870, 784-812, 2019.
17. O. San, **R. Maulik**, M. Ahmed: An artificial neural network framework for reduced order modeling of transient flows, *Communications in Nonlinear Science and Numerical Simulation*, 77, 271-287, 2019.

18. **R. Maulik**, O. San, A. Rasheed, P. Vedula: Subgrid modeling for two-dimensional turbulence using artificial neural networks, *Journal of Fluid Mechanics*, 858, 122-144, 2019.

19. **R. Maulik**, O. San, A. Rasheed, P. Vedula: Data-driven deconvolution for large eddy simulation of Kraichnan turbulence, *Physics of Fluids*, 30, 125109, 2018.

20. O. San, **R. Maulik**: Stratified Kelvin-Helmholtz turbulence of compressible shear flows, *Nonlinear Processes in Geophysics*, 25, 457–476, 2018.

21. O. San, **R. Maulik**: Extreme learning machine for reduced order modeling of turbulent geophysical flows, *Physical Review E*, 97, 042322, 2018.

22. O. San, **R. Maulik**: Machine learning closures for model order reduction of thermal fluids, *Applied Mathematical Modelling*, 60, 681-710, 2018.

23. **R. Maulik**, O. San, R. Behera : An adaptive multilevel wavelet framework for scale-selective WENO reconstruction schemes, *International Journal of Numerical Methods in Fluids*, 87 (5), 239-269, 2018.

24. O. San, **R. Maulik**: Neural network closure models for nonlinear model order reduction, *Advances in Computational Mathematics*, 44, 1717-1750, 2018.

25. **R. Maulik**, O. San: A dynamic closure modeling framework for large eddy simulation using approximate deconvolution: Burgers equation, *Cogent Physics*, 5, 1464368, 2018.

26. **R. Maulik**, O. San: A neural network approach for the blind deconvolution of turbulent flows, *Journal of Fluid Mechanics*, 831, 151-181, 2017.

27. **R. Maulik**, O. San: A novel dynamic framework for subgrid-scale parametrization of mesoscale eddies in quasigeostrophic turbulent flows, *Computers and Mathematics with Applications*, 74, 420-445, 2017.

28. **R. Maulik**, O. San: Explicit and implicit LES closures for Burgers turbulence, *Journal of Computational and Applied Mathematics*, 327, 12-40, 2017.

29. **R. Maulik**, O. San: Resolution and energy dissipation characteristics of implicit LES and explicit filtering models for compressible turbulence, *Fluids*, 2(2)-14, 2017.

30. **R. Maulik**, O. San: A dynamic subgrid-scale modeling framework for Boussinesq turbulence, *International Journal of Heat and Mass Transfer*, 108, 1656-1675, 2017.

31. **R. Maulik**, O. San: A dynamic framework for scale-aware parameterizations of eddy viscosity coefficient in two-dimensional turbulence, *International Journal of Computational Fluid Dynamics*, 31(2), 69-92, 2017.

32. **R. Maulik**, O. San: A stable and scale-aware dynamic modeling framework for subgrid-scale parameterizations of two-dimensional turbulence, *Computers & Fluids* 158, 11-38, 2016.

33. **R. Maulik**, O. San: Dynamic modeling of the horizontal eddy viscosity coefficient for quasigeostrophic ocean circulation problems, *Journal of Ocean Engineering and Science* 1, 300-324, 2016.

34. H. H. Marbini, **R. Maulik**: A biphasic transversely isotropic poroviscoelastic model for the unconfined compression of hydrated soft tissue, *Journal of Biomechanical Engineering* 138, 031003, 2016.

Under review

1. K. Fukami, **R. Maulik**, N. Ramachandra, K. Taira, K. Fukagata: Global field reconstruction from sparse sensors with Voronoi tessellation-assisted deep learning, *arXiv:2101.00554*.
2. **R. Maulik**, J. Choi, W. Wehde, P. Balaprakash: Determining feature importance for actionable climate change mitigation policies, *arXiv preprint : 2003.10234*.
3. B. Hamzi, **R. Maulik**, H. Owhadi: Data-driven geophysical forecasting: Simple, low-cost, and accurate baselines with kernel methods.
4. V. Sastry, **R. Maulik**, V. Rao, S. Renganathan, B. Lusch, R. Kotamarthi: Data-driven deep learning emulators for geophysical forecasting.

Peer-reviewed conference publications

1. **R. Maulik**, R. Egele, B. Lusch, P. Balaprakash: Recurrent neural network architecture search for geophysical emulation, *Proceedings of the International Conference for High Performance Computing, Networking, Storage and Analysis (SC), 2020, 10.5555/3433701.3433711*. Acceptance rate: 20%.
2. V. Rao, **R. Maulik**, E. Constantinescu, M. Anitescu: A machine learning method for computing rare event probabilities, *International Conference on Computational Science, 2020*, `https://link.springer.com/chapter/10.1007%2F978-3-030-50433-5_14`. Acceptance rate: 30.7%.
3. **R. Maulik**, O. San, C. Bach: A computational investigation of the effect of ground clearance in vertical ducting systems, 2018, Purdue University, Herrick Labs Conferences 2018. `https://docs.lib.purdue.edu/ihpbc/308/`.

Conference publications

1. **R. Maulik**, H. Sharma, S. Patel, B. Lusch, E. Jennings: Deploying deep learning in OpenFOAM with TensorFlow: A tutorial, AIAA SciTech Forum 2021, `https://doi.org/10.2514/6.2021-1485`.
2. P. Milan, R. Torelli, B. Lusch, **R. Maulik**, G. Magnotti: Data-Driven Modeling of Large-Eddy Simulations for Fuel Injector Design, AIAA SciTech Forum 2021, `https://doi.org/10.2514/6.2021-1016`.
3. **R. Maulik**, V. Rao, S. Renganathan, S. Letizia, G. Iungo: Cluster analysis of wind turbine wakes measured through a scanning Doppler wind LiDAR, AIAA SciTech Forum 2021, `https://doi.org/10.2514/6.2021-1181`.

Peer-reviewed workshop proceedings

1. D. Skinner, **R. Maulik**: Meta-modeling strategy for data-driven forecasting, *Tackling Climate Change with Machine Learning Workshop, NeurIPS*, 2020. `https://www.climatechange.ai/papers/neurips2020/13.html`.
2. N. Garland, **R. Maulik**, Q. Tang, X. Tang, P. Balaprakash: Progress towards high fidelity collisional-radiative model surrogates for rapid in-situ evaluation, *Machine Learning for Physical Sciences Workshop, NeurIPS*, 2020. `https://ml4physicalsciences.github.io/2020/files/NeurIPS_ML4PS_2020_79.pdf`.
3. K. Fukami, **R. Maulik**, N. Ramachandra, K. Fukagata, K. Taira: Probabilistic neural network-based reduced-order surrogate for fluid flows, *Machine Learning for Physical Sciences Workshop, NeurIPS*, 2020. `https://ml4physicalsciences.github.io/2020/files/NeurIPS_ML4PS_2020_7.pdf`

4. **R. Maulik**, R. S. Assary, P. Balaprakash: Site-specific graph neural network for predicting protonation energy of oxygenate molecules, *Machine Learning for Physical Sciences Workshop, NeurIPS*, 2019. `https://ml4physicalsciences.github.io/2019/files/NeurIPS_ML4PS_2019_134.pdf`

5. **R. Maulik**, V.Rao, S. Madireddy, B. Lusch, P. Balaprakash: Using recurrent neural networks for non-linear component computation in advection-dominated reduced-order models, *Machine Learning for Physical Sciences Workshop, NeurIPS*, 2019. `https://ml4physicalsciences.github.io/2019/files/NeurIPS_ML4PS_2019_99.pdf`.

Talks presented

1. **R. Maulik**, R. Egele, B. Lusch, P. Balaprakash : Scalable recurrent neural architecture search for geophysical emulation, **Invited talk** at SIAM-CSE Minisymposium on Physics-Guided Machine Learning and Data-Driven Methods in Computational Geoscience.
2. **R. Maulik**: Incorporating Inductive Biases as Hard Constraints for Scientific Machine Learning, MCS-LANS seminar, Argonne National Laboratory, February 2021.
3. **R. Maulik**: Scalable scientific machine learning for computational fluid dynamics, **Invited talk**, Department of Mechanical Engineering, The City College of New York, October, 2020.
4. **R. Maulik**: Data-driven model order reduction for geophysical emulation. **Invited talk** at the Second Symposium on Machine Learning and Dynamical Systems, Fields Institute, Toronto, September, 2020.
5. **R. Maulik**: Scalable scientific machine learning for computational fluid dynamics, **Invited talk**, Department of Mechanical Engineering, Rice University, September, 2020.
6. **R. Maulik**: Machine Learning Enablers for System Optimization and Design, MCS-LANS seminar, Argonne National Laboratory, August 2020.
7. **R. Maulik** : Surrogate-based machine-learning for system optimization and design, **Invited talk** at Los Alamos National Laboratory for Tokamak Disruption Simulation (TDS) working group, August, 2020.
8. **R. Maulik** : Non-intrusive reduced-order model search for geophysical emulation, **Guest lecture**, MAE259a: Data science for fluid dynamics (offered by Kunihiko Taira), University of California Los Angeles, June 2020.
9. **R. Maulik**, O. San, J. D. Jacob : Spatiotemporally dynamic implicit large eddy simulation using machine learning classifiers, **Invited talk** at Session on Domain-Aware, Interpretable and Robust Scientific Machine Learning Methods Applied to Computational Mechanics, AIAA Aviation Forum, June, 2020, Reno.
10. **R. Maulik** : Machine learning for computational fluid dynamics, **Invited talk** at PyData Meetup Chicago, May 2020.
11. **R. Maulik**, R. Egele, B. Lusch, P. Balaprakash : Recurrent neural architecture search for geophysical emulation using DeepHyper, **Invited talk** at AI-HPC seminar, Argonne National Laboratory, April, 2020.
12. **R. Maulik**, B. Lusch, P. Balaprakash: Machine Learned Reduced-Order Models for Advective Partial Differential Equations, MCS-LANS seminar, Argonne National Laboratory, February, 2020.

13. **R. Maulik**, B. Lusch, P. Balaprakash : Machine Learned Reduced-Order Models for Advective Partial Differential Equations, 2020 Spring Multiscale Seminar, Illinois Institute of Technology, Chicago, February, 2020.

14. **R. Maulik**, H. Sharma, S. Patel, B. Lusch, E. Jennings, P. Balaprakash: General purpose data science for general purpose CFD: Integrating Tensorflow into OpenFOAM at scale, **Invited poster** at the workshop for Machine Learning for Transport Phenomena, February, 2020, Dallas.

15. **R. Maulik**, A. Mohan, S. Madireddy, B. Lusch, P. Balaprakash, D. Livescu: Machine learning of sequential data for non-intrusive reduced-order models, Bulletin of the American Physical Society 72, November, 2019.

16. **R. Maulik**, B. Lusch, P. Balaprakash: Tackling the limitations of conventional ROMs for advection-dominated nonlinear dynamical systems using machine learning, **Invited talk** at the Advanced Statistics meets Machine Learning-III workshop, Argonne National Laboratory, November, 2019.

17. **R. Maulik**, B. Lusch, O. San, P. Balaprakash: Data-driven sub-grid models for the large-eddy simulation of turbulence, **Invited talk** at John Zink Hamworthy Combustion, Tulsa, August, 2019.

18. **R. Maulik**, H. Sharma, S. Patel, E. Jennings, B. Lusch, P. Balaprakash, V. Vishwanath: Novel turbulence closures using physics-informed machine learning, **Invited talk** at the Argonne Physical Sciences and Engineering Division AI Townhall, July, 2019.

19. **R. Maulik**, O. San, A. Rasheed, P. Vedula: Data-driven deconvolution for the sub-grid modeling of large eddy simulations of two-dimensional turbulence, SIAM-CSE, March, 2019.

20. **R. Maulik**, O. San, A. Rasheed, P. Vedula: Data-driven deconvolution for the large eddy simulation of Kraichnan turbulence, Bulletin of the American Physical Society 71, November, 2018.

21. **R. Maulik**, O. San, C. Bach: A computational investigation of the effect of ground clearance in vertical ducting systems, 2018, Purdue University, Herrick Labs Conferences, July, 2018.

22. **R. Maulik**, O. San: A neural network approach for the blind deconvolution of turbulent flows, Bulletin of the American Physical Society 70, November, 2017.

23. **R. Maulik**, Ratikanta Behera, O. San: A generalized wavelet based grid-adaptive and scale-selective implementation of WENO schemes for conservation laws, Texas Applied Mathematics and Engineering Symposium, The University of Texas, Austin, September 2017.

24. **R. Maulik**, O. San: An explicit filtering framework based on Perona-Malik anisotropic diffusion for shock capturing and subgrid scale modeling of Burgers' turbulence, Bulletin of the American Physical Society 69, November, 2016.

25. **R. Maulik**, O. San: A dynamic hybrid subgrid-scale modeling framework for large eddy simulations, Bulletin of the American Physical Society 69, November, 2016.

Other participation in workshops

Invited participant, Vistas in the Applied Mathematical Sciences, Institute for Mathematical Statistical Innovation (IMSI), The University of Chicago, IL, 2020.

Invited participant, NSF workshop on Machine Learning for Transport Phenomena, Southern Methodist University, TX, 2020.

Invited participant, Mathematics of Reduced Order Models, ICERM, Brown University, RI, 2020.

Invited participant, Algorithms for Dimension and Complexity Reduction, ICERM, Brown University, RI, 2020.

Invited participant, IPAM Workshop III: Validation and Guarantees in Learning Physical Models: from Patterns to Governing Equations to Laws of Nature, UC Los Angeles, October 2019.

Invited participant, Department of Energy - AI for Science Townhall, Argonne National Laboratory, June 2019.

Invited participant, Advances in PDEs: Theory, Computation and Application to CFD, ICERM, Brown University, RI, 2018.

Invited participant, SDSC Summer program in HPC and Data Science, UC San Diego, 2017.

Professional service

Tutorials organized

Tutorial lead - Autoencoders for PDE surrogate models, ATPESC 2020.

Tutorial lead - Statistical methods for machine learning, ALCF AI4Science tutorial 2019, Argonne National Laboratory.

Tutorial lead - DeepHyper for scalable hyperparameter and neural architecture search on ALCF machines, ALCF Simulation Data and Learning workshop 2019, Argonne National Laboratory.

TensorFlow workshop, Mechanical & Aerospace Engineering, Oklahoma State University, 2018.

An introduction to high performance computing for middle school kids, National Lab Day, Oklahoma State University 2017, 2018.

Minisymposia

Organizer - Acceleration and Enhancement of High-fidelity PDE Solvers through Machine Learning, 16th U.S. National Congress on Computational Mechanics, IL, 2021.

Co-organizer - Argonne National Laboratory - AI, Statistics and Machine Learning Journal Club.

Session chair - Domain-Aware, Interpretable and Robust Scientific Machine Learning Methods Applied to Computational Mechanics, AIAA Aviation Forum, Reno, NV, 2020.

MS Organizer & Session chair - Domain-Aware, Interpretable and Robust Machine Learning for Computational Science, SIAM-CSE, 2021.

MS Organizer & Session chair - Machine Learning methods in Computational Fluid Dynamics, SIAM-CSE, Spokane, WA, 2019.

Session chair - MAE Graduate Research Symposium, Oklahoma State University, 2018.

Reviews

Journal reviewer for - AIAA Journal, Applied Mathematical Modeling, Computer Methods in Applied Mathematics and Engineering, Computer Physics Communications, Computers and Fluids, International Journal of Computational Fluid Dynamics, Journal of Fluid Mechanics, Physics of Fluids, Physica D: Nonlinear Phenomena, IEEE Transactions on Plasma Science, International Journal of Numerical Methods in Fluids, Nature Communications, Nature Scientific Reports, Nature Machine Intelligence, Theoretical and Computational Fluid Dynamics, Atmospheric Science Letters, New Journal of Physics.

Conference reviewer for - Mathematics of Scientific Machine learning (2020-2021).

Software developed

1. R. Maulik, H. Sharma, S. Patel, B. Lusch, E. Jennings, TensorFlowFoam: A framework that enables the deployment of deep learning (in Python) and partial differential equation solutions concurrently in OpenFOAM - a C++-based open-source finite-volume based computational physics package. `https://github.com/argonne-lcf/TensorFlowFoam`.
2. R. Maulik, S. Pawar, PAR-RL: A framework that leverages the Ray library to deploy scalable deep reinforcement learning for arbitrary scientific environments on leadership class machines. Tested on ALCF supercomputer Theta for controlling simulations of dynamical systems. `https://github.com/Romit-Maulik/PAR-RL`.
3. R. Maulik, PyParSVD: A Parallelized, streaming, and randomized implementation of the SVD for Python using mpi4py. `https://github.com/Romit-Maulik/PyParSVD`. DOI: 10.5281/zenodo.4562889.

Funding & support

Funded

AI emulator assisted data assimilation, Future computing, LDRD-Prime, Argonne National Laboratory, U.S. Department of Energy. Role: Co-PI; Year: 2021–2023.

RAPIDS2: A SciDAC Institute for Computer Science, Data, and Artificial Intelligence, U.S. Department of Energy. Role: Senior Personnel; Year: 2020–2025.

RAPIDS: A SciDAC Institute for Computer Science and Data, and Artificial Intelligence, U.S. Department of Energy, 2019-2020.

Margaret-Butler Fellowship project: Scalable machine learning for turbulence closure and reduced-order modeling. Role: PI ; Year 2019–2021.

SIAM Travel Grant: 2019 SIAM Conference on Computational Science and Engineering, Spokane, WA, 2019.

SIAM TX-LA Section Travel Grant, Texas Applied Mathematics and Engineering Symposium, 2017.

Graduate Student Travel Grant, American Physical Society - Division of Fluid Dynamics, 2017.

Graduate Student Travel Grant, Graduate Program Student Government Authority, Oklahoma State University, 2017.

FGSA Travel Grant for Excellence in Graduate Research, American Physical Society, 2017.

Graduate College Robberson Summer Research Fellowship, Oklahoma State University, 2017.

John Brammer Fellowship, Oklahoma State University, 2016.

Graduate College Top Tier Fellowship, Oklahoma State University, 2016.

Unfunded

Closure Model Development with deep Reinforcement Learning and High-fidelity, High-void-fraction Experiment Data, U.S. Department of Energy Nuclear Energy University Program, Nuclear Energy Advanced Modeling and Simulation-4. Role: Co-PI, 2020.

DeepRefinement: Machine-Learned Adaptive Mesh Refinement for Predictive Scientific Computing, U.S. Department of Energy ASCR LAB 20-2319, Role: PI, 2020.

Machine learning linear solvers for accelerating numerical methods, LDRD-Seed. Role: PI, 2019.