Curriculum Vitae — Jonathan Francis MacArt

Department of Aerospace and Mechanical Engineering
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Appointments

University of Notre Dame	Notre Dame, Indiana
Assistant Professor, Department of Aerospace and Mechanical Engineering	2020–present

University of Illinois at Urbana–Champaign	Urbana, Illinois
Postdoctoral Research Associate	2018–2019
The Center for Exascale Simulation of Plasma-coupled Combustion	

Education

Princeton University	Princeton, New Jersey
Ph.D., Mechanical and Aerospace Engineering	2013–2018
M.A., Mechanical and Aerospace Engineering	2013–2015

University of Notre Dame	Notre Dame, Indiana
B.S., Aerospace Engineering	2009–2013
Magna cum laude with honors thesis	

Awards & Honors

National Science Foundation CAREER Award, 2023
Summer Research Fellowship, Center for Turbulence Research, Stanford University, 2018
Graduate School Teaching Award, Princeton University, 2017
Crocco Award for Teaching Excellence, Princeton University, 2016
Sydney Kelsey Excellence Prize in Structural Mechanics, University of Notre Dame, 2013
National Science Foundation Research Experiences for Undergraduates Fellowship, 2012
NISCA All-America Swimmer, 2008, 2009

Journal Articles (Refereed) – Published

1. A. Nair, J. Sirignano, M. Panesi, J. F. MacArt, "Deep Learning Closure of the Navier–Stokes Equations for Transitional Flows," *AIAA Journal* (2023), in press

2. J. Sirignano, J. F. MacArt, "Deep learning closure models for large-eddy simulation of flows around bluff bodies," *Journal of Fluid Mechanics* 966 (2023), A26

3. J. Sirignano, J. F. MacArt, K. Spiliopoulos, "PDE-constrained Models with Neural Network Terms: Optimization and Global Convergence," *Journal of Computational Physics* 481 (2023), 112016

4. J. F. MacArt, J. Sirignano, J. B. Freund, "Embedded training of neural-network subgrid-scale turbulence models," *Physical Review Fluids* 6 (2021), 050502

5. J. F. MacArt, M. E. Mueller, "Damköhler number scaling of active cascade effects in turbulent premixed combustion," *Physics of Fluids* 33 (2021), 035103

6. J. M. Wang, J. F. MacArt, J. B. Freund, "Flow dynamics of laser-induced breakdown at a fuel–oxidizer interface and its effect on ignition," *Combustion and Flame* 229 (2021), 111375

7. J. F. MacArt, J. M. Wang, P. P. Popov, J. B. Freund, "Detailed simulation of ignition, flame acceleration, and instability transition in spherically-expanding flame kernels," *Proceedings of the Combustion Institute* 38 (2021), p. 2341–2349

8. J. Sirignano, J. F. MacArt, J. B. Freund, "DPM: A deep learning PDE augmentation method with application to large–eddy simulation," *Journal of Computational Physics* 432 (2020), 109811

9. J. Lee, J. F. MacArt, M. E. Mueller, "Heat release effects on the Reynolds stress budgets in turbulent premixed flames," *Combustion and Flame* 216 (2020), p. 1–8

10. J. F. MacArt, T. Grenga, M. E. Mueller, "Evolution of flame-conditioned velocity statistics in turbulent premixed jet flames at low and high Karlovitz numbers," *Proceedings of the Combustion Institute* 37 (2019), p. 2503–2510

11. T. Grenga, J. F. MacArt, M. E. Mueller, "Dynamic Mode Decomposition of a Direct Numerical Simulation of a Turbulent Premixed Planar Jet Flame: Convergence of the Modes," *Combustion Theory and Modelling* 22 (2018), p. 795–811

12. J. F. MacArt, T. Grenga, M. E. Mueller, "Effects of combustion heat release on velocity and scalar statistics in turbulent premixed jet flames at low and high Karlovitz numbers," *Combustion and Flame* 191 (2018), p. 468–485

13. J. F. MacArt, M. E. Mueller, "Semi-implicit iterative methods for low Mach number turbulent reacting flows: Operator splitting versus approximate factorization," *Journal of Computational Physics* 326 (2016), p. 569–595

Conference Papers (Not Refereed)

1. P. Kakka, J. F. MacArt, "Enhancing Turbulent Combustion Predictions with Ensemble Kalman Filter RANS-Model Corrections," AIAA SciTech 2024, Orlando, FL, January 8–12, 2024

2. J. Jacobowitz, J. F. MacArt, "Adjoint-Based Control of Supersonic Cavity Flows," AIAA SciTech 2024, Orlando, FL, January 8–12, 2024

3. A. Nair, D. Waidmann, J. Sirignano, N. Singh, M. Panesi, J. F. MacArt, "Adjoint-Trained Deep-Learning Closures of the Navier–Stokes Equations for 2D Nonequilibrium Flows," AIAA SciTech 2024, Orlando, FL, January 8–12, 2024

4. X. Liu, T. Hickling, J. Sirignano, J. F. MacArt, "Turbulent Flow Control for Drag Reduction Using Adjoint-based Deep Learning," AIAA SciTech 2024, Orlando, FL, January 8–12, 2024

5. E. Monti, N. Singh, J. Sirignano, J. F. MacArt, M. Panesi, G. Gori, "Physics-constrained deep learning-based model for non-equilibrium flows," AIAA SciTech 2024, Orlando, FL, January 8–12, 2024

6. T. Hickling, J. Sirignano, J. F. MacArt, "Large Eddy Simulation of Airfoil Flows Using Adjoint-Trained Deep Learning Closure Models ," AIAA SciTech 2024, Orlando, FL, January 8–12, 2024

7. N. Daultry Ball, M. Panesi, J. F. MacArt, J. Sirignano, "Adjoint Optimization of the BGK Equation with an Embedded Neural Network for Reduced-Order Modeling of Hypersonic Flows," AIAA SciTech 2024, Orlando, FL, January 8–12, 2024

8. P. Kakka, J. F. MacArt, "Data assimilation for reacting flows: Deep learning PDE models to augment turbulent combustion simulations," 13th U.S. National Meeting on Combustion, College Station, TX, March 19–22, 2023

9. A. Nair, J. Sirignano, M. Panesi, J. F. MacArt, "Entropy-stable Deep Learning for Navier–Stokes Predictions of Transitional-regime Flows," AIAA SciTech 2023, National Harbor, MD, January 23–27, 2023

10. J. F. MacArt, J. Sirignano, M. Panesi, "Deep Learning Closure of the Navier–Stokes Equations for Transitional Flows," AIAA SciTech 2022, San Diego, CA, January 3–7, 2022

11. P. P. Popov, M. Nishihara, A. Munafò, J. F. MacArt, G. S. Elliott, J. B. Freund, "Laser-induced breakdown ignition of low-pressure hydrogen-air premixtures," AIAA SciTech 2020, Orlando, FL, January 6–10, 2020

12. A. C. Nunno, B. A. Perry, J. F. MacArt, M. E. Mueller, "Data-driven dimension reduction in turbulent combustion: Utility and limitations," AIAA SciTech 2019, San Diego, CA, January 7–11, 2019

13. J. F. MacArt, T. Grenga, M. E. Mueller, "Budgets of flame-conditioned second-order turbulence statistics in low and high Karlovitz number turbulent premixed jet flames," 2018 Spring Technical Meeting of the Eastern States Section of the Combustion Institute, State College, PA, March 5–7, 2018

14. T. Grenga, J. F. MacArt, M. E. Mueller, "Multi-modal counterflow flames under autoignitive conditions", 2018 Spring Technical Meeting of the Eastern States Section of the Combustion Institute, State College, PA, March 5–7, 2018

15. J. F. MacArt, T. Grenga, M. E. Mueller, "Karlovitz number effects on velocity and scalar statistics in turbulent premixed combustion", 10th U.S. National Meeting on Combustion, College Park, MD, April 23–26, 2017

16. T. Grenga, J. F. MacArt, M. E. Mueller, "Multi-Modal Counterflow Flame Structure under Autoignitive Conditions", 10th U.S. National Combustion Meeting, College Park, MD, April 23–26, 2017

17. J. F. MacArt, T. Grenga, M. E. Mueller, "Effects of small-scale heat release on turbulence scaling in premixed and nonpremixed flames", 2016 Spring Technical Meeting of the Eastern States Section of the Combustion Institute, Princeton, NJ, March 13–16, 2016

Research Briefs (Not Refereed)

1. J. Sirignano, J. F. MacArt, "Deep Learning Closure Models for Large-Eddy Simulation of Flows around Bluff Bodies," arXiv:2208.03498 (2022)

2. J. Sirignano, J. F. MacArt, K Spiliopoulos, "PDE-constrained Models with Neural Network Terms: Optimization and Global Convergence," arXiv:2105.08633 (2021)

3. J. B. Freund, J. F. MacArt, J. Sirignano, "DPM: A deep learning PDE augmentation method (with application to large–eddy simulation)," arXiv:1911.09145 (2019)

4. J. F. MacArt, M. E. Mueller, "Scaling and modeling of heat-release effects on subfilter turbulence in premixed combustion," *Center for Turbulence Research Proceedings of the Summer Program* (2018), p. 299–308

Invited Seminars

1. J. F. MacArt, "Embedded Deep Learning for Prediction and Control of Complex Turbulent Flows," Mathematical Institute, University of Oxford, UK, June 5, 2023

2. J. F. MacArt, "Adjoint-Based Data Assimilation for Turbulent and Reacting Flows," Air Force Research Laboratory, Rocket Propulsion Division, Edwards Air Force Base, CA, February 15, 2023

3. J. F. MacArt, "Simulation and Modeling of Turbulent Reacting Flows: Opportunities and Challenges for Data Assimilation," Department of Aerospace Engineering, University of Illinois at Urbana–Champaign, Urbana, IL, February 9, 2023

4. J. F. MacArt, "Data Assimilation for Reacting Flows: PDE Constraints and Efficient Optimization," Department of Mechanical and Aerospace Engineering, The Ohio State University, Columbus, OH, October 7, 2022

5. J. F. MacArt, "Embedded Deep Learning for Predictive Science," Ansys, Inc., Lebanon, NH, May 20, 2022

6. J. F. MacArt, "Embedded Deep Learning for Predictive Science and Control," Center for Hypersonics & Entry Systems Studies, University of Illinois at Urbana–Champaign, Urbana, IL, November 9, 2021

7. J. Sirignano, J. F. MacArt, "PDE Models with Neural Networks: Optimization, Global Convergence, and Applications in Fluid Mechanics," Symposium on Model-Consistent Data-Driven Turbulence Modeling, University of Michigan, Ann Arbor, MI, June 22–24, 2021

8. J. F. MacArt, J. Sirignano, J. B. Freund, "Learning sub-grid-scale turbulence models: coupling back-propagation with the adjoint flow equations," European Mechanics Society, Colloquium 614: Machine learning methods for prediction and control of turbulent flows, Paris, France, June 16–18, 2021

9. J. F. MacArt, "Turbulent reacting flow physics discovery using high-fidelity numerical tools," School for Engineering of Matter, Transport and Energy, Arizona State University, Tempe, AZ, January 13, 2021

10. J. F. MacArt, "Why trust AI?," Trinity College, Hartford, CT, October 25, 2020

11. J. Sirignano, J. F. MacArt, J. B. Freund, "Deep learning closure models for large–eddy simulation," NSF Workshop on Exuberance of Machine Learning in Transport Phenomena, Dallas, TX, February 10–11, 2020

12. J. F. MacArt, "High fidelity, (potentially) low cost: Reconciling physics-based and machine-learning-based turbulence modeling in turbulent combustion," School for Engineering of Matter, Transport and Energy, Arizona State University, Tempe, AZ, January 31, 2020

13. M. E. Mueller, J. F. MacArt, "Large Eddy Simulation Subfilter Modeling of Combustion-Affected Turbulence in Turbulent Premixed Combustion," 71st Annual Meeting of the APS Division of Fluid Dynamics, Atlanta, GA, November 18–20, 2018

14. J. F. MacArt, "Turbulent Combustion: Multiscale, Multiphysical Interactions and the Challenge of High-Fidelity Simulation," Department of Mechanical Science and Engineering, University of Illinois at Urbana–Champaign, Urbana, IL, September 7, 2018

15. J. F. MacArt, "Simulation and Modeling of Heat Release Effects on Turbulence in Turbulent Combustion," Design Physics Division, Lawrence Livermore National Laboratory, Livermore, CA, March 2, 2018

16. J. F. MacArt, "Simulation and Modeling of Heat Release Effects on Turbulence in Turbulent Combustion," Department of Aerospace and Mechanical Engineering, University of Notre Dame, Notre Dame, IN, February 17, 2018

17. J. F. MacArt, "Simulation and Modeling of Heat Release Effects on Turbulence in Turbulent Premixed Combustion," The Center for Exascale Simulation of Plasma-coupled Combustion, University of Illinois at Urbana–Champaign, Urbana, IL, January 23, 2018

Conference Presentations (Contributed)

1. T. Hickling, J. Sirignano, J. F. MacArt, "Large Eddy Simulation of Low Reynolds Number Airfoil Flows Using Adjoint-Trained Deep Learning Closure Models," 14th International ERCOFTAC Symposium on Engineering Turbulence Modelling and Measurements, Barcelona, Spain, September 6–8, 2023

2. L. Nista, F. Fröde, J. F. MacArt, T. Grenga, A. Attili, H. Pitsch "A-posteriori investigations of a Super-Resolution Data-Driven Model for Large Eddy Simulations," International Centre for Numerical Methods in Engineering (CIMNE) Math2Product 2023, Taormina, Italy, May 30–June 1, 2023

3. S. Suh, J. F. MacArt, L. Olson, J. B. Freund, "Neural network sub-grid-scale models for planar turbulent premixed flames," IACM Computational Fluids Conference, Cannes, France, April 25–28, 2023

4. X. Liu, J. F. MacArt, "Robust, data-efficient active flow control using embedded deep learning," 75th Annual Meeting of the APS Division of Fluid Dynamics, Indianapolis, IN, November 20–22, 2022

5. S. Suh, J. F. MacArt, L. Olson, J. B. Freund, "Adjoint-based neural network optimization for sub-grid-scale combustion modeling," 75th Annual Meeting of the APS Division of Fluid Dynamics, Indianapolis, IN, November 20–22, 2022

6. X. Liu, J. F. MacArt, "Embedded Deep Learning for Flow Control," 2022 SIAM Annual Meeting, Pittsburgh, PA, July 11–15, 2022

7. S. Suh, J. F. MacArt, L. Olson, J. B. Freund, "Physics-constrained machine learning for LES of turbulent premixed flames," 18th International Conference on Numerical Combustion, La Jolla, CA, May 8–11, 2022

8. J. F. MacArt, "Deep Learning-Based PDE Augmentation for Large-Eddy Simulation," 2021 SIAM Annual Meeting, Spokane, WA (virtual), July 19–23, 2021

9. J. F. MacArt, J. M. Wang, P. P. Popov, J. B. Freund, "Detailed simulation of ignition, flame acceleration, and instability transition following a laser-induced breakdown," 38th International Symposium on Combustion, Adelaide, Australia (virtual), January 24–29, 2021

10. J. F. MacArt, "Parametric study of sub-grid-scale flame–turbulence interactions in jet flames using a simplified kinetic model," 73rd Annual Meeting of the APS Division of Fluid Dynamics, Chicago, IL (virtual), November 22–24, 2020

11. J. M. Wang, J. F. MacArt, J. B. Freund, "Ignition of a fuel–oxidizer interface by laser-induced breakdown," 73rd Annual Meeting of the APS Division of Fluid Dynamics, Chicago, IL (virtual), November 22–24, 2020

12. J. Sirignano, J. F. MacArt, J. B. Freund, "Embedded training of neural-network sub-grid-scale turbulence models," 73rd Annual Meeting of the APS Division of Fluid Dynamics, Chicago, IL (virtual), November 22–24, 2020

13. J. F. MacArt, J. M. Wang, J. B. Freund, Three-dimensional effects in vorticity production, cellular instabilities, and transition to turbulence in focused-laser-induced ignition kernels, 72nd Annual Meeting of the APS Division of Fluid Dynamics, Seattle, WA, November 23–26, 2019

14. J. M. Wang, D. A. Buchta, J. F. MacArt, J. B. Freund, Hydrodynamic ejection from a laser-induced breakdown and its implications for ignition, 72nd Annual Meeting of the APS Division of Fluid Dynamics, Seattle, WA, November 23–26, 2019

15. C. P. Byers, J. F. MacArt, M. E. Mueller, M. Hultmark, Triple-correlations in decaying isotropic turbulence, 72nd Annual Meeting of the APS Division of Fluid Dynamics, Seattle, WA, November 23–26, 2019

16. C. P. Byers, J. F. MacArt, M. E. Mueller, M. Hultmark, Similarity Constraints in Decaying Isotropic Turbulence, 11th International Symposium on Turbulence and Shear Flow Phenomena, Southampton, UK, July 30–August 2, 2019

17. J. F. MacArt, J. A. Sirignano, D. A. Buchta, J. B. Freund, Data-driven subfilter turbulence models and analysis in turbulent combustion, 17th International Conference on Numerical Combustion, Aachen, Germany, May 6–8, 2019

18. M. E. Mueller, B. A. Perry, A. C. Nunno, J. F. MacArt, L. Berger, Integrating data-based tools into physics-based model development for turbulent combustion, 17th International Conference on Numerical Combustion, Aachen, Germany, May 6–8, 2019

19. A. C. Nunno, B. A. Perry, J. F. MacArt, M. E. Mueller, A comparison of physics-based and data-based methods of dimension reduction in turbulent combustion, 71st Annual Meeting of the APS Division of Fluid Dynamics, Atlanta, GA, November 18–20, 2018

20. C. P. Byers, J. F. MacArt, M. E. Mueller, M. Hultmark, Similarity in decaying isotropic turbulence: Functional forms, constraints in single- and two-time evolution, and DNS results, 71st Annual Meeting of the APS Division of Fluid Dynamics, Atlanta, GA, November 18–20, 2018

21. J. F. MacArt, T. Grenga, M. E. Mueller, Evolution of flame-conditioned velocity statistics in turbulent premixed jet flames at varying Karlovitz number, 37th International Symposium on Combustion, Dublin, Ireland, July 29–August 3, 2018

22. J. F. MacArt, M. E. Mueller, Flame-conditioned turbulence modeling for reacting flows, 70th Annual Meeting of the APS Division of Fluid Dynamics, Denver, CO, November 19–21, 2017

23. T. Grenga, J. F. MacArt, M. E. Mueller, Dynamic mode decomposition of a turbulent premixed planar jet flame, 10th Mediterranean Combustion Symposium, Naples, Italy, September 17–21, 2017

24. J. F. MacArt, T. Grenga, M. E. Mueller, Heat Release Effects on Turbulence Statistics in Premixed and Nonpremixed Flames, 16th International Conference on Numerical Combustion, Orlando, FL, April 3–5, 2017

25. T. Grenga, J. F. MacArt, M. E. Mueller, Dynamic Mode Decomposition of Turbulent Non-reacting and Reacting Nonpremixed Jets, 16th International Conference on Numerical Combustion, Orlando, FL, April 3–5, 2017

26. J. F. MacArt, T. Grenga, M. E. Mueller, Conditional budgets of second-order statistics in nonpremixed and premixed turbulent combustion, 69th Annual Meeting of the APS Division of Fluid Dynamics, Portland, OR, November 20–22, 2016

27. T. Grenga, J. F. MacArt, M. E. Mueller, Three dimensional dynamic mode decomposition of premixed turbulent jet flames, 69th Annual Meeting of the APS Division of Fluid Dynamics, Portland, OR, November 20–22, 2016

28. J. F. MacArt, M. E. Mueller, Computationally-efficient schemes for large-scale simulations of turbulent reacting flows, 1st Annual Research Computing Day, Princeton Institute for Computational Science and Engineering, Princeton, NJ, October 14, 2016

29. J. F. MacArt, M. E. Mueller, Semi-implicit iterative methods for low Mach number turbulent reacting flows, 68th Annual Meeting of the APS Division of Fluid Dynamics, Boston, MA, November 22–24, 2015

30. J. F. MacArt, M. E. Mueller, Analysis of operator splitting errors for DNS of low Mach number turbulent reacting flows, 67th Annual Meeting of the APS Division of Fluid Dynamics, San Francisco, CA, November 23–25, 2014

31. J. F. MacArt, Modeling of energetic composites under small-strain chemo-thermo-mechanical loading, 2012 Undergraduate Research Summer Symposium, Notre Dame, IN, August 3, 2012

Undergraduate Teaching

Instructor, University of Notre Dame
- AME 30332: Compressible Aerodynamics (Spring 2023)
- AME 30332: Compressible Aerodynamics (Spring 2021)

Assistant in Instruction, Princeton University
- MAE 335, Fluid Dynamics (Fall 2016)
- MAE 427/ENE 427, Energy Conversion and the Environment (Spring 2016)
- MAE 335, Fluid Dynamics (Fall 2015)

Graduate Teaching

Instructor, University of Notre Dame
- AME 60614: Numerical Methods (Fall 2023)
- AME 60730: Turbulent Reacting Flows (Fall 2022)
- AME 60614: Numerical Methods (Fall 2021)
- AME 60614: Numerical Methods (Spring 2020)

Assistant in Instruction, Princeton University
- APC 523/MAE 507: Numerical Algorithms for Scientific Computing (Spring 2018)
- APC 523/MAE 507: Numerical Algorithms for Scientific Computing (Spring 2015)

Graduate Advisees

University of Notre Dame
- Jared Jacobowitz, AME Ph.D. student, Aug. 2022–present; anticipated completion: 2027
- Priyesh Kakka, AME Ph.D. student, Dec. 2021–present; anticipated completion: 2025
- Xuemin Liu, AME Ph.D. student, Sept. 2021–present; anticipated completion: 2024
- Ashish Nair, AME Ph.D. student, July 2021–present; anticipated completion: 2025
- Matthew McHugh, AME M.S., Aug. 2020–Dec. 2021; currently Research Engineer, Applied Materials Inc., Kalispell, MT

Undergraduate Advisees

- Conrad Delgado (Undergraduate Research; Notre Dame AE '24), 2023–present
- Alex Aragon (Undergraduate Research; Notre Dame ME '24), 2023
- Katherine Fink (Undergraduate Research; Notre Dame AE '22), 2021–2022; currently: Boeing, St. Louis, MO
- Aidan Oblepias (Building Bridges; Notre Dame '25), 2021
- Ian Guajardo (Building Bridges; Notre Dame '24), 2020
- Omkar B. Shende (Princeton BSE '18, with M. E. Mueller), 2017–2018; currently Stanford Ph.D. student

Professional Service

Journal Reviewer: *Combustion and Flame*; *Combustion Science and Technology*; *Computers and Fluids*; *Journal of Computational Physics*; *Journal of Fluid Mechanics*; *Physical Review E*; *Physical Review Fluids*; *Proceedings of the Combustion Institute*

Minisymposium Co-organizer
- "Deep Learning for Predictive Science and Design" (with Justin Sirignano, University of Oxford), 2021 SIAM Annual Meeting, July 19–23, 2021, Spokane, WA

Conference Local Organizing Committees
- Student Luncheons, 75th Annual Meeting of the APS Division of Fluid Dynamics, Indianapolis, IN, November 22–24, 2022
- Young Investigators Workshop, 73rd Annual Meeting of the APS Division of Fluid Dynamics, Chicago, IL, November 22–24, 2020

Outreach
- Lead Coordinator, MATHCOUNTS middle-school mathematics competition, 2022–2023

Professional Memberships

American Institute of Aeronautics and Astronautics (AIAA), 2021–present
Society for Industrial and Applied Mathematics (SIAM), 2017–present
The Combustion Institute (CI), 2016–present
American Physical Society (APS) Division of Fluid Dynamics, 2014–present
Sigma Gamma Tau, 2012–present
Tau Beta Pi, 2012–present

Updated: September 8, 2023