Colin A. Z. Towery

Postdoctoral Research Associate
Department of Mechanical Engineering
University of Colorado, Boulder

850 W Moorhead Cir, Apt 3H
Boulder, CO 80305
+1 (720) 768-3887
colin.towery@colorado.edu

Education

May 2018 **Ph.D. in Mechanical Engineering**, *University of Colorado Boulder*, Boulder, CO.
Dissertation: Multi-Physics and Multi-Scale Interactions in High-Intensity Turbulent Premixed Reacting Flows.
Advisor: Dr. Peter E. Hamlington.

May 2018 **M.S. in Mechanical Engineering**, *University of Colorado Boulder*, Boulder, CO.

May 2010 **B.S. in Mechanical Engineering**, *Washington University in St. Louis*, St. Louis, MO.

Professional Experience

2018 – Present **Postdoctoral Research Associate**, *Turbulence and Energy Systems Laboratory*, Mechanical Engineering, University of Colorado, Boulder, CO.
Advisor: Dr. Peter E. Hamlington.

Fall 2019 **Adjunct Lecturer**, Mechanical Engineering, University of Colorado, Boulder, CO.
Taught 70-student section of MCEN 3021, the junior-level undergraduate fluid dynamics course in the core curriculum

2013 – 2017 **Graduate Research Assistant**, *Turbulence and Energy Systems Laboratory*, Mechanical Engineering, University of Colorado, Boulder, CO.
Advisor: Dr. Peter E. Hamlington.

Summer 2016 & Summer 2015 **Department of Defense High Performance Computing Intern**, *Laboratory for Computational Physics and Fluid Dynamics*, Naval Research Laboratory, Washington, DC.
Mentor: Dr. Alexei Y. Poludnenko

Computational Science Skills

Languages/APIs Expert: Fortran 77/90/03, Python (numpy, scipy, mpi4py, numba), MPI

Advanced: MATLAB, bash/csh, OpenMP, LaTeX, Microsoft Office

Basic: C/C++, CUDA, Chombo/Boxlib, git, hg, HTML, CSS, Markdown

Knowledge Areas Expert: CFD, turbulence theory, compressible gas dynamics, combustion, nonlinear multi-scale dynamics, Fourier analysis, petascale HPC programming and workflow management

Advanced: dimensional analysis and similarity, turbulence modeling for LES and URANS

Basic: Bayesian inference, uncertainty quantification, data assimilation, collaborative software development, parallel code profiling, scientific visualization

Honors

2017 Thomas & Brenda Geers Graduate Fellowship, Department of Mechanical Engineering, University of Colorado Boulder

March 2017 Kenneth Johnsen Graduate Student of the Month, Department of Mechanical Engineering, University of Colorado Boulder

2016 Distinguished Paper on Turbulent Flames, 36th International Symposium on Combustion, The Combustion Institute

2015 Best Talk in Thermofluid Sciences, 12th Graduate Engineering Annual Research and Recruitment Symposium, Department of Mechanical Engineering, University of Colorado Boulder

Activities

2019 Organizing Committee, 5th Rocky Mountain Fluid Mechanics Symposium. Boulder, CO, July 29, 2019.

2018 Organizing Committee & Panel Discussion Moderator, 4th Rocky Mountain Fluid Mechanics Symposium. Boulder, CO, August 13-14, 2018.

2017 Timing & A.V. Chair, Local Organizing Committee, 70th Meeting of the Division of Fluid Dynamics, American Physical Society. Denver, CO, November 19–21, 2017.

2017 Organizing Committee, 3rd Rocky Mountain Fluid Mechanics Symposium. Boulder, CO, August 11, 2017.

2014 – 2017 Secretary, Mechanical Engineering Graduate Student Research and Recruitment Committee, Department of Mechanical Engineering, University of Colorado Boulder

2014 – 2016 Fundraising Chair, Graduate Engineering Annual Research and Recruitment Symposium, Department of Mechanical Engineering, University of Colorado Boulder

Publications

Peer-Reviewed Journal Publications - Published

[1] **C. A. Z. Towery**, A. Y. Poludnenko, and P. E. Hamlington. Detonation initiation by compressible turbulence thermodynamic fluctuations. *Comb. Flame*, 213:172–183, 2020.

[2] S. H. R. Whitman, P. E. Hamlington, **C. A. Z. Towery**, and A. Y. Poludnenko. Scaling and collapse of conditional velocity structure functions in turbulent premixed flames. *Proc. Comb. Inst.*, 37:2527–2535, 2019.

[3] J. Kim, M. Bassenne, **C. A. Z. Towery**, P. E. Hamlington, A. Y. Poludnenko, and J. Urzay. Spatially-localized multi-scale energy transfer in turbulent premixed combustion. *J. Fluid Mech.*, 848:78–116, 2018.

[4] P. E. Hamlington, R. Darragh, C. A. Briner, **C. A. Z. Towery**, B. D. Taylor, and A. Y. Poludnenko. Lagrangian analysis of high-speed turbulent premixed reacting flows: Thermochemical trajectories in hydrogen-air flames. *Comb. Flame*, 186:193–207, 2017.

[5] J. O'Brien, **C. A. Z. Towery**, P. E. Hamlington, M. Ihme, A. Y. Poludnenko, and J. Urzay. The cross-scale physical-space transfer of kinetic energy in turbulent premixed flames. *Proc. Comb. Inst.*, 36(2), 2017.
Distinguished Paper on Turbulent Flames, *36th International Symposium on Combustion*.

[6] **C. A. Z. Towery**, A. Y. Poludnenko, J. Urzay, J. O'Brien, M. Ihme, and P. E. Hamlington. Spectral kinetic energy transfer in turbulent premixed reacting flows. *Phys. Rev. E*, 93(5), 2016.

Peer-Reviewed Journal Publications - Submitted

[7] R. Darragh, **C. A. Z. Towery**, A. Y. Poludnenko, and P. E. Hamlington. Particle pair dispersion in a turbulent premixed flame. *Proc. Comb. Inst.*, 2021. *Accepted for presentation at the 38th International Symposium on Combustion. Under review for publication in the Proceedings.*

[8] O. A. Doronina, **C. A. Z. Towery**, and P. E. Hamlington. Parameter estimation for subgrid-scale models using Markov chain Monte Carlo approximate Bayesian computation. *Comput. Fluids*, 2020. *Under review*.

[9] A. Kshitij, E. W. Stallcup, **C. A. Z. Towery**, P. E. Hamlington, and W. J. A. Dahm. Balancing accuracy and efficiency in the autonomic closure methodology for large eddy simulations. *Flow Turbul. Combust.*, 2020. *Under review*.

Conference Proceedings - Published

[10] O. Doronina, **C. A. Z. Towery**, J. Christopher, I. Grooms, and P. E. Hamlington. Turbulence model development using Markov chain Monte Carlo approximate Bayesian computation. *AIAA Paper*, 2019-1883, January 2019.

[11] B. Schmidt, **C. A. Z. Towery**, P. E. Hamlington, and J. Sutton. Evaluation of wavelet-based optical flow velocimetry from OH scalar fields in reacting turbulent flows. *AIAA Paper*, 2019-0270, January 2019.

[12] **C. A. Z. Towery**, P. E. Hamlington, X. Zhao, X. Chao, T. Lu, and A. Y. Poludnenko. Lagrangian chemical explosive mode analysis of highly turbulent premixed flames. *AIAA Paper*, 2019-1643, January 2019.

[13] **C. A. Z. Towery**, B. Schmidt, J. Sutton, and P. E. Hamlington. Benchmark direct numerical simulations with Lagrangian tracers for evaluating combustion diagnostics algorithms. *AIAA Paper*, 2019-0836, January 2019.

[14] O. Doronina, J. Christopher, **C. A. Z. Towery**, P. E. Hamlington, and W. J. A. Dahm. Autonomic closure for turbulent flows using approximate Bayesian computation. *AIAA Paper*, 2018-0594, January 2018.

[15] R. Darragh, **C. A. Z. Towery**, A. Y. Poludnenko, and P. E. Hamlington. Development of a Lagrangian fluid parcel tracking algorithm for reacting flows. *AIAA Paper*, 2017-3466, June 2017.

[16] **C. A. Z. Towery**, A. Y. Poludnenko, and P. E. Hamlington. Compressible turbulence effects on premixed autoignition. *AIAA Paper*, 2017-4268, June 2017.

[17] **C. A. Z. Towery**, A. Y. Poludnenko, J. Urzay, M. Ihme, and P. E. Hamlington. Spectral energy dynamics in premixed flames. *Proc. Stanford CTRSP*, 2014.

[18] **C. A. Z. Towery**, K. M. Smith, P. Shrestha, P. E. Hamlington, and M. Van Schoor. Examination of turbulent flow effects in rotating detonation engines. *AIAA Paper*, 2014-3031, 2014.

Conference Proceedings - Other

[19] **C. A. Z. Towery**, J. Urzay, A. Y. Poludnenko, and P. E. Hamlington. The cross-scale flux of kinetic energy by baropycnal work in premixed reacting flows. In *2019 Fall Technical Meeting, Western States Section of The Combustion Institute*, October 2019.

[20] P. E. Hamlington, R. Darragh, **C. A. Z. Towery**, and A. Y. Poludnenko. Retrospective Lagrangian analysis of turbulence-chemistry interactions in highly-turbulent premixed flames. In *11th U.S. National Combustion Meeting*, March 2019.

[21] **C. A. Z. Towery**, X. Gao, S. M. Guzik, S. Walters, and P. E. Hamlington. Required transition zone size in hybrid LES-DNS for the study of premixed turbulence-chemistry interactions. In *11th U.S. National Combustion Meeting*, March 2019.

[22] R. Darragh, **C. A. Z. Towery**, A. Y. Poludnenko, and P. E. Hamlington. Lagrangian analysis of enstrophy in turbulent premixed flames. In *2017 Fall Technical Meeting, Western States Section of The Combustion Institute*, October 2017.

[23] **C. A. Z. Towery**, R. Darragh, A. Y. Poludnenko, and P. E. Hamlington. Lagrangian analysis of premixed autoignition in compressible turbulence. In *2017 Fall Technical Meeting, Western States Section of The Combustion Institute*, October 2017.

[24] S. H. R. Whitman, **C. A. Z. Towery**, A. Y. Poludnenko, and P. E. Hamlington. Dependence of intermittency on turbulence intensity, fuel type, and simulation fidelity in premixed reacting flows. In *2017 Fall Technical Meeting, Western States Section of The Combustion Institute*, October 2017.

[25] **C. A. Z. Towery**, A. Y. Poludnenko, and P. E. Hamlington. Direct numerical simulation of premixed autoignition in non-linear subsonic and sonic compressible turbulence. In *10th U.S. National Combustion Meeting*, April 2017.

Public Research Codes

[C.1] spectralLES: a pure-Python pseudo-spectral large eddy simulation solver for model development and testing. https://github.com/phamlington/teslapy/tree/master/spectralLES, April 2018. In pre-release development.

Conference and Seminar Presentations

[P.1] The Cross-Scale Flux of Kinetic Energy by Baropycnal Work in Premixed Reacting Flows. 2019 Fall Technical Meeting of the Western States Section of the Combustion Institute. Albuquerque, NM, October 14-15, 2019.

[P.2] Required Transition Zone Size in Hybrid LES-DNS for the Study of Premixed Turbulence-Chemistry Interactions. 11th US National Combustion Meeting, US Sections of the Combustion Institute. Pasadena, CA, March 24-27, 2019.

[P.3] Benchmark Direct Numerical Simulations with Lagrangian Tracers for Evaluating Combustion Diagnostics Algorithms. AIAA SciTech 2019 Forum, American Institute of Aeronautics and Astronautics. San Diego, CA, January 7-11, 2019.

[P.4] Spontaneous Detonation Initiation by Temperature Gradients in Compressible Isotropic Turbulence. 71st Meeting of the Division of Fluid Dynamics, American Physical Society. Atlanta, GA, November 18-20, 2018.

[P.5] Spontaneous Detonation Initiation in Compressible Isotropic Turbulence. 4th Rocky Mountain Fluid Mechanics Symposium. Boulder, CO, August 13-14, 2018.

[P.6] Dissertation Defense. Boulder Fluid and Thermal Sciences Seminar, Dept. Mechanical Engineering, Univ. Colorado Boulder. Boulder, CO, January 4, 2018.

[P.7] Direct numerical simulations of premixed autoignition in compressible turbulence. 70th Meeting of the Division of Fluid Dynamics, American Physical Society. Denver, CO, November 19-21, 2017.

[P.8] Lagrangian Analysis of Premixed Autoignition in Compressible Turbulence. 2017 Fall Technical Meeting of the Western States Section of the Combustion Institute. Cheyenne, WY, October 2017.

[P.9] Lagrangian Analysis of Premixed Autoignition in Compressible Turbulence. 3rd Rocky Mountain Fluid Mechanics Symposium. Boulder, CO, August 11, 2017.

[P.10] Compressible Turbulence Effects on Premixed Autoignition. 46th Fluid Dynamics Conference, American Institute of Aeronautics and Astronautics. Denver, CO, June 5-9, 2017.

[P.11] Direct numerical simulation of premixed autoignition in non-linear subsonic and sonic compressible turbulence. 10th U.S. National Combustion Meeting, US Sections of the Combustion Institute. College Park, MD, April 23-26, 2017.

[P.12] Detailed Analyses of Compressible Turbulence Thermodynamics in Direct Numerical Simulations. 69th Meeting of the Division of Fluid Dynamics, American Physical Society. Portland, OR, November 21, 2016.

[P.13] Small-scale Resolution Requirements for DNS of Supersonic Turbulence. 11th European Fluid Mechanics Conference, European Mechanics Society. Sevilla, ES, September 16, 2016.

[P.14] Multi-Scale, Multi-Physics Interactions in High-Speed Turbulent Combustion. 13th Graduate Engineering Annual Research and Recruitment Symposium, Dept. Mechanical Engineering, Univ. Colorado Boulder. Boulder, CO, March 3, 2016.

[P.15] Dynamics of Strongly Compressible Turbulence. 68th Meeting of the Division of Fluid Dynamics, American Physical Society. Boston, MA, November 22, 2015.

[P.16] Turbulence in Thermofluid Systems. 1st RMACC HPC Symposium, Rocky Mountain Advanced Computing Consortium. Boulder, CO, August 12, 2015.

[P.17] The Dynamics of Strongly Compressible Turbulence. 1st Rocky Mountain Fluid Mechanics Symposium. Boulder, CO, August 4, 2015.

[P.18] The Dynamics of Strongly Compressible Turbulence. LCP&FD Seminar Series, Naval Research Laboratory. Washington, DC, July 23, 2015.

[P.19] Detonation Combustion for Aerospace and Power Plant Applications. 12th Graduate Engineering Annual Research and Recruitment Symposium, Dept. Mechanical Engineering, Univ. Colorado Boulder. Boulder, CO, March 5, 2015.

[P.20] Spectral Kinetic Energy Transfer Through a Premixed Flame Brush. 67th Meeting of the Division of Fluid Dynamics, American Physical Society. San Francisco, CA, November 23, 2014.

[P.21] Examination of Turbulent Flow Effects in Rotating Detonation Engines. Boulder Fluid Dynamics Seminar, Dept. Mechanical Engineering, Univ. Colorado Boulder. Boulder, CO, June 17, 2014.

[P.22] Examination of Turbulent Flow Effects in Rotating Detonation Engines. 44th Fluid Dynamics Conference, American Institute of Aeronautics and Astronautics. Atlanta, GA, June 19, 2014.

[P.23] Modeling the Effects of Turbulence in Rotating Detonation Engines. 2014 March Meeting, American Physical Society. Denver, CO, March 6, 2014.