

EDUCATION

Doctor of Philosophy, Aerospace Science and Engineering September 2018 – June 2024
University of Toronto *Toronto, Canada*
Thesis: [Provably stable discontinuous spectral-element methods with the summation-by-parts property: Unified matrix analysis and efficient tensor-product formulations on curved simplices](#)
Advisor: David Zingg
Bachelor of Engineering, Mechanical Engineering September 2014 – June 2018
Carleton University *Ottawa, Canada*
Capstone project: Performance analysis and numerical optimization of a supercritical carbon dioxide Brayton cycle

CURRENT POSITION

Postdoctoral Researcher, Department of Mathematics and Computer Science January 2024 – Present
University of Cologne *Cologne, Germany*
Project: Robust split-form and entropy-stable discontinuous spectral-element methods for the ICON-DG atmospheric dynamical core; collaboration with the Deutscher Wetterdienst (DWD) and German Aerospace Center (DLR) as part of the [WarmWorld](#) project for kilometre-scale climate predictions at exascale, which is funded by the German Federal Ministry of Education and Research (BMBF)
Advisor: Gregor Gassner

RESEARCH INTERESTS

Numerical analysis and scientific computing focused on nonlinear hyperbolic and advection-dominated systems of partial differential equations with applications in geophysical fluid dynamics; specific topics include robust structure-preserving high-order methods using summation-by-parts operators, dynamical core development for weather and climate models using discontinuous Galerkin and spectral-element methods, dynamical systems and control-theoretic approaches to adaptive simulations, data-driven methods for subgrid-scale parametrization, efficient implementation on modern high-performance computing systems, and open-source scientific software development

PUBLICATIONS IN PEER-REVIEWED JOURNALS

T. Montoya and D. W. Zingg, [Efficient entropy-stable discontinuous spectral-element methods using tensor-product summation-by-parts operators on triangles and tetrahedra](#). *Journal of Computational Physics* 516, article no. 113360, 2024.
T. Montoya and D. W. Zingg, [Efficient tensor-product spectral-element operators with the summation-by-parts property on curved triangles and tetrahedra](#). *SIAM Journal on Scientific Computing* 46(4), pp. A2270–A2297, 2024.
T. Montoya and D. W. Zingg, [A unifying algebraic framework for discontinuous Galerkin and flux reconstruction methods based on the summation-by-parts property](#). *Journal of Scientific Computing* 92(3), article no. 87, 2022.

PUBLICATIONS IN CONFERENCE PROCEEDINGS

T. Montoya* and D. W. Zingg, [Stable and conservative high-order methods on triangular elements using tensor-product summation-by-parts operators](#). *11th International Conference on Computational Fluid Dynamics*, Maui, United States, July 2022. **Awarded best student paper.**

CONFERENCE PRESENTATIONS (EXCLUDING ABOVE PROCEEDINGS)

T. Montoya* and D. W. Zingg, Efficient entropy-stable discontinuous spectral-element methods in collapsed coordinates for hyperbolic systems on curved triangular and tetrahedral meshes. *Canadian Applied and Industrial Mathematics Society Annual Meeting*, Kingston, Canada, June 2024.
T. Montoya* and D. W. Zingg, Efficient entropy-stable tensor-product spectral-element methods on simplices. *9th European Congress on Computational Methods in Applied Sciences and Engineering*, Lisbon, Portugal, June 2024.
T. Montoya* and D. W. Zingg, Efficient tensor-product spectral-element methods with the summation-by-parts property on triangles and tetrahedra. *SIAM Conference on Computational Science and Engineering*, Amsterdam, Netherlands, February 2023.
T. Montoya* and D. W. Zingg, Unified analysis of discontinuous Galerkin and flux reconstruction methods based on the summation-by-parts property. *International Conference on Spectral and High-Order Methods* (online), July 2021.

*Presenting author.

T. Montoya* and D. W. Zingg, Unified analysis of high-order methods based on the summation-by-parts property: Application to discontinuous Galerkin and flux reconstruction discretizations. *SIAM Conference on Computational Science and Engineering* (online), March 2021.

INVITED TALKS

T. Montoya, A. M. Rueda-Ramírez, G. J. Gassner, J. Markert,* M. Baldauf, and D. Reinert, ICON-DG: Gearing up the ICON model with smarter discretizations. *WarmWorld General Assembly*, Bremerhaven, Germany, October 2024.

T. Montoya* and D. W. Zingg, Provably stable tensor-product discontinuous spectral-element methods on triangular and tetrahedral unstructured grids. Ansys, Inc. (online), July 2024.

T. Montoya* and D. W. Zingg, Entropy-stable tensor-product discontinuous spectral-element methods on curved triangles and tetrahedra. Rice University (online), March 2024.

T. Montoya* and D. W. Zingg, Efficient and robust spectral-element methods on triangles using tensor-product summation-by-parts operators. *NASA Advanced Modeling and Simulation Seminar Series* (online), October 2022.

T. Montoya* and S. Nadarajah, Robust deformation of unstructured grids. Bombardier Aerospace, Montréal, Canada, August 2016.

OTHER APPOINTMENTS

Visiting Researcher, Department of Mechanical Engineering
National University of Singapore August 2022
Singapore

Project: Koopman operator approaches to data-driven stability analysis of numerical methods

Advisor: Gianmarco Mengaldo

Undergraduate Researcher, Institute for Aerospace Studies May 2017 – August 2017
University of Toronto Toronto, Canada

Projects: Optimization of finite-difference operators with the summation-by-parts property on non-uniform nodal distributions; comparison of continuation methods for steady aerodynamic flows

Advisor: David Zingg

Undergraduate Researcher, Department of Mechanical Engineering May 2016 – August 2016
McGill University Montréal, Canada

Project: Robust deformation of unstructured grids using radial basis functions and linear elasticity

Advisor: Siva Nadarajah

Undergraduate Researcher, Department of Mechanical and Aerospace Engineering May 2015 – August 2015
Carleton University Ottawa, Canada

Projects: Optimal estimation of uncertain parameters in computer models of welding processes; novel interpolation techniques for stress and strain tensor fields using quaternions

Advisor: John Goldak

AWARDS AND SCHOLARSHIPS

Best Student Paper, International Conference on Computational Fluid Dynamics	2022
Ontario Graduate Scholarship	2019 – 2020, 2022 – 2023
Kenneth Molson Fellowship	2021 – 2022, 2022 – 2023
Queen Elizabeth II Graduate Scholarship in Science and Technology	2020 – 2021, 2021 – 2022
Douglas Patton Hogg Memorial Award	2021
NSERC Canada Graduate Scholarship - Master's	2018 – 2019
University Medal (highest academic standing of any Bachelor of Engineering graduate)	2018
Canadian Society for Mechanical Engineering Gold Medal	2018
Rajesh Ahluwalia Memorial Scholarship	2017 – 2018
NSERC Undergraduate Student Research Award	2015, 2017
McGill University Summer Undergraduate Research in Engineering Award	2016
Allan Buchanan Undergraduate Scholarship	2015 – 2016
Deans' Honour List	2014 – 2018
Faculty Scholarship	2014 – 2018

SUPERVISION OF GRADUATE AND UNDERGRADUATE RESEARCH

Paula Weiß, Master of Science thesis student August 2024 – Present
University of Cologne (Co-supervised with Gregor Gassner and Benedict Geihe) Cologne, Germany

Project: High-order vertical discretizations for nonhydrostatic atmospheric models

Fabian Höck, Master of Science thesis student
University of Cologne (Co-supervised with Gregor Gassner and Benedict Geihe)
Project: Discontinuous Galerkin methods for moist atmospheric flows with rain

April 2024 – Present
Cologne, Germany

Ruilin (Jerry) Bai, Bachelor of Applied Science student intern
University of Toronto (Co-supervised with David Zingg)
Project: Optimization of summation-by-parts operators for minimal solution error

September 2020 – December 2020
Toronto, Canada

Yewon Lee, Bachelor of Applied Science student intern
University of Toronto (Co-supervised with David Zingg and Masayuki Yano)
Project: Comparative evaluation of energy- and entropy-stable discontinuous Galerkin and summation-by-parts methods

May 2019 – August 2019
Toronto, Canada

OPEN-SOURCE SOFTWARE CONTRIBUTIONS AS PRINCIPAL DEVELOPER

TrixiAtmo.jl <https://github.com/trixi-framework/TrixiAtmo.jl>
Julia package extending the [Trixi.jl numerical framework](#) for conservation laws to enable the solution of atmospheric flow problems using a high-order discontinuous spectral-element dynamical core

StableSpectralElements.jl <https://github.com/tristanmontoya/StableSpectralElements.jl>
Julia framework for energy-stable and entropy-stable discontinuous spectral-element methods on general element types based on multidimensional and tensor-product formulations; emphasis on dispatched strategies for matrix-based and matrix-free operator evaluation

GHOST: Generalized High-Order Solver Toolbox <https://github.com/tristanmontoya/GHOST>
Python implementation of discontinuous Galerkin and flux reconstruction schemes in one or two spatial dimensions with various design choices

OTHER OPEN-SOURCE SOFTWARE CONTRIBUTIONS

Trixi.jl <https://github.com/trixi-framework/Trixi.jl>
Modified mesh data type to enable the solution of partial differential equations on surfaces

NodesAndModes.jl <https://github.com/jlchan/NodesAndModes.jl>
Added high-order symmetric quadrature rules on triangular and tetrahedral elements

TEACHING

Scientific Computing: Introduction to the Simulation of Atmospheric Flows April 2024 – July 2024
University of Cologne Cologne, Germany
Assisted in the development and delivery of a new graduate-level course on modern numerical methods for atmospheric dynamics; contributed to curriculum design and preparation of lecture notes, and was responsible for the creation and supervision of the final project, in which students implement a discontinuous Galerkin solver for the spherical shallow water equations and assess its effectiveness for a series of standard atmospheric test problems

SERVICE

Lab Representative, Computational Aerodynamics December 2021 – June 2024
Centre for Computational Science and Engineering Toronto, Canada
Member of the student organizing committee for an interdepartmental group of researchers at the University of Toronto across various disciplines of computational science and engineering

Editor, Physics and Mathematics Section June 2022 – March 2024
Canadian Science Fair Journal <https://csfjournal.com/>
Volunteer editor and mentor for an open-access online publication showcasing science projects by children and youth at primary and secondary schools across Canada

TECHNICAL SKILLS

Programming languages	Julia, Python (NumPy/SciPy), C, C++, MATLAB, Fortran, \LaTeX
Development tools	Unix shell, Git, GNU Make, Anaconda, Jupyter Notebook, VS Code, Vim, Emacs, Slurm

OTHER ACTIVITIES

Music (performing guitarist/bassist), cycling, alpine skiing (former ski instructor), non-fiction reading

CITIZENSHIP

Canada, France