Tristan Montoya

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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*

CURRENT POSITION

Postdoctoral Researcher — January 2024 – Present
University of Cologne — *Cologne, Germany*

Project: Efficient and robust discontinuous spectral-element methods for the ICON-DG atmospheric dynamical core; partnership with the Deutscher Wetterdienst (DWD) and German Aerospace Center (DLR) funded by the German Federal Ministry of Education and Research (BMBF) as part of the WarmWorld project on exascale Earth system models for kilometre-scale climate predictions
Advisor: Gregor Gassner

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, 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), 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), 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. *11^{th} International Conference on Computational Fluid Dynamics*, 2022. **Awarded best student paper**.

SELECTED TALKS (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. Contributed talk, *Canadian Applied and Industrial Mathematics Society Annual Meeting*, 2024.

T. Montoya and D. W. Zingg, Efficient entropy-stable tensor-product spectral-element methods on simplices. Contributed talk, *9^{th} European Congress on Computational Methods in Applied Sciences and Engineering*, 2024.

T. Montoya and D. W. Zingg, Efficient tensor-product spectral-element methods with the summation-by-parts property on triangles and tetrahedra. Contributed talk, *SIAM Conference on Computational Science and Engineering*, 2023.

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

T. Montoya and D. W. Zingg, Unified analysis of discontinuous Galerkin and flux reconstruction methods based on the summation-by-parts property. Contributed talk, *International Conference on Spectral and High-Order Methods*, 2021.

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. Contributed talk, *SIAM Conference on Computational Science and Engineering*, 2021.

OTHER APPOINTMENTS

Visiting Researcher August 2022
National University of Singapore *Singapore*

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

Undergraduate Student Researcher 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 Student Researcher May 2016 – August 2016
McGill University *Montreal, Canada*

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

Undergraduate Student Researcher 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 April 2024 – Present
University of Cologne (Co-supervised with Gregor Gassner and Benedict Geihe) *Cologne, Germany*

Project: Discontinous Galerkin methods for moist atmospheric flows with rain

Ruilin (Jerry) Bai, Bachelor of Applied Science student intern September 2020 – December 2020
University of Toronto (Co-supervised with David Zingg) *Toronto, Canada*

Project: Optimization of summation-by-parts operators for minimal solution error

Yewon Lee, Bachelor of Applied Science student intern May 2019 – August 2019
University of Toronto (Co-supervised with David Zingg and Masayuki Yano) *Toronto, Canada*

Project: Comparative evaluation of energy- and entropy-stable discontinuous Galerkin and summation-by-parts methods

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 numerical methods for atmospheric flows, focusing on theoretical and computational aspects of modern high-order discretizations applied to atmospheric simulations; created final project in which students implement a discontinuous Galerkin solver for the shallow water equations on the cubed sphere in Julia 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

Volunteer editor and mentor for an open-access journal showcasing science projects by students 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