TRISTAN MONTOYA

tmontoya@uni-koeln.de tjbmontoya.com

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 W. 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 (supported by the German Federal Ministry of Education and Research as part of the WarmWorld funding initiative for kilometre-scale prediction of weather events in a warming climate)
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: Data-driven stability analysis and control of numerical schemes using the Koopman operator
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 W. 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 A. 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 summer student — May 2021 – August 2021
University of Toronto (Co-supervised with David W. Zingg) — *Toronto, Canada*

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

Yewon Lee, Bachelor of Applied Science summer student — May 2019 – August 2019
University of Toronto (Co-supervised with David W. 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

Reviewer for Academic Journals — August 2022 – Present

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

REFERENCES

Available upon request