

RECENT DEVELOPMENTS IN HIGH-ORDER CFD SOLVERS: ACCURACY, EFFICIENCY, AND STABILITY

KRZYSZTOF J. FIDKOWSKI*, SIVA NADARAJAH[†], CUONG
NGUYEN[§], AND PER-OLOF PERSSON[¶]

*University of Michigan
3012 FXB, 1320 Beal Avenue, Ann Arbor, MI 48109, USA
kfid@umich.edu, <http://www-personal.umich.edu/~kfid/>
Corresponding Organizer

[†]McGill University
817 Sherbrooke Street West, Room MD151, Montreal, QC H3A 0C3, Canada
siva.nadarajah@mcgill.ca, <https://www.mcgill.ca/mecheng/sivakumaran-nadarajah>

[§]Massachusetts Institute of Technology
77 Massachusetts Avenue, Office 37-371, Cambridge, MA 02139, USA
cuongng@mit.edu, <https://www.mit.edu/~cuongng/>

[¶]U.C. Berkeley
1081 Evans Hall, Berkeley, CA, USA
persson@berkeley.edu, <https://persson.berkeley.edu/>

ABSTRACT

High-order computational fluid dynamics (CFD) solvers are increasingly important for high-fidelity simulations in science and engineering. However, their widespread adoption for large-scale applications remains limited by computational cost, scalability, and robustness challenges. This minisymposium will highlight recent developments in high-order CFD solvers that improve accuracy, efficiency, and stability while reducing overall time-to-solution. Particular emphasis will be placed on advances that leverage both discretization and solver technologies to reduce computational cost without compromising predictive capability. A central theme of the minisymposium is the development of spatial and temporal discretization strategies that enable scalable solvers on modern high-performance computing architectures. These approaches play a critical role in improving solver robustness, reducing iteration counts, enhancing parallel efficiency, and enabling efficient simulations at unprecedented scales. Topics include high-order discretizations for compressible and incompressible flows, adaptive methods, space-time formulations, and techniques that improve the conditioning and performance of large-scale solver frameworks.

Contributions addressing provably stable discretizations, shock-capturing methodologies, and advanced time-integration schemes are also encouraged. The minisymposium will further explore the interaction between discretization design and linear and nonlinear solver performance, including advances in preconditioning and solver acceleration strategies. Applications demonstrating practical benefits for industrially relevant CFD problems are particularly welcome. Overall, the objective is to showcase developments that are making high-order CFD solvers more accurate, scalable, stable, and computationally affordable for the next-generation of predictive simulations.

SPEAKERS

1. Tan Bui-Thanh, U. Texas, A scalable exponential DG approach for compressible resistive MHD
2. Krzysztof Fidkowski, U. Michigan, High-Order Basis Function Adaptation for Singular-Perturbation Problems
3. Tamas Horvath, Oakland U., Adaptive 2D+t Space-Time Mesh Generation
4. Chongam Kim, Seoul National U., Shock-capturing PID controller for heat flux prediction in hypersonic flows
5. Siva Nadarajah, McGill U., Comparative Study of Entropy-Stable Discontinuous Galerkin Discretization Strategies for Conservation Laws
6. Cuong Nguyen, MIT, Implicit High-Order Discontinuous Galerkin Solvers for GPU-Accelerated Direct Numerical Simulation of Compressible Flows
7. Jan Nordström, Linköping U., Provably energy and/or entropy stable interface conditions for nonlinear flow problems
8. Jing-Mei Qiu, U. Delaware, A Mass, Momentum, and Energy Conserving Semi-Lagrangian Adaptive-Rank (SLAR) Method for the Vlasov-Poisson System
9. Ranocha Hendrik, U. Mainz, Robust and Efficient Entropy-Stable Discontinuous Galerkin Methods with Rosenbrock Time Integration for Modern Dynamical Cores
10. Sander Rhebergen, Preconditioning HDG for incompressible Navier-Stokes at high Reynolds number
11. Steven Walton, LANL, High-Order Virtual Element Methods for Lagrangian Hydrodynamics on Arbitrary Unstructured Grids
12. Zelalem Worku, Element-local entropy-stable residual correction discretization for hyperbolic PDEs