Shinhoo Kang

Address: Argonne National Laboratory, 9700 S. Cass Avenue, Lemont, IL 60439
Email: shinhoo.kang@anl.gov
Homepage: https://shinhookang.github.io
Scholar profile
ORCID: 0000-0003-4649-9727

Education

2014–2019 **Ph.D. in Engineering Mechanics**
Department of Aerospace and Engineering Mechanics
The University of Texas at Austin, TX
Thesis: *High-order (hybridized) discontinuous Galerkin method for geophysical flows*
Advisor: Tan Bui-Thanh

2007–2009 **M.Eng. in Spatial Design and Engineering**
Handong Global University, South Korea
Thesis: *The yellow sand effect on radiowave propagation*
Advisor: Cheo K. Lee

1999–2007 **B.Eng. in Computer Science and Electrical Engineering**
Handong Global University, South Korea

Memberships

2015–present **Member**, *Society for Industrial and Applied Mathematics (SIAM)*

Employment

2019–present **Postdoctoral Appointee**, *Argonne National Laboratory*, Lemont, IL
Mentor, Dr. Emil M. Constantinescu

2014–2019 **Research Assistant**, *The University of Texas at Austin*, Austin, TX
Advisor, Prof. Tan Bui-Thanh

2012–2014 **Research Scientist**, *Korea Institute of Atmospheric Prediction Systems*, South Korea
Numerical Modeling Group

2010–2011 **Research Scientist**, *National Institute of Meteorological Science*, South Korea
Observation Research Department

Publications

Submitted

Kang, Shinhoo, Alp Dener, Aidan Hamilton, Emil Constantinescu, Hong Zhang, and Robert Jacob, "Multirate Partitioned Runge–Kutta Methods for Coupled Navier–Stokes Equations." *https://arxiv.org/pdf/2202.11890.pdf, submitted to Computers & Fluids*

Refereed journal articles

Kang, Shinhoo and Emil Constantinescu, "Learning Subgrid-scale Models with Neural Ordinary Differential Equations." *Computers & Fluids*, 105919, 2023

Kang, Shinhoo and Emil Constantinescu, "Entropy-Preserving and Entropy-Stable Relaxation IMEX and Multirate Time-Stepping Methods." *Journal of Scientific Computing*, 93(23), 2022

Kang, Shinhoo and Tan Bui-Thanh, "A Scalable Exponential-DG Approach for Nonlinear Conservation Laws: with Application to Burger and Euler Equations." *Computer Methods in Applied Mechanics and Engineering*, 385(1), Nov. 2021

Kang, Shinhoo, Emil Constantinescu, Hong Zhang, and Rob Jacob, "Mass-Conserving Implicit-Explicit Methods for Coupled Compressible Navier-Stokes Equations." *Computer Methods in Applied Mechanics and Engineering*, 384(1), Oct. 2021

Kang, Shinhoo, Francis X. Giraldo, Tan Bui-Thanh, "IMEX HDG-DG: A Coupled Implicit Hybridized Discontinuous Galerkin (HDG) and Explicit Discontinuous Galerkin (DG) Approach for Shallow Water Systems." *Journal of Computational Physics*, 401, Jan. 2020

Kang, Shinhoo, Tan Bui-Thanh, Todd Arbogast, "A Hybridized Discontinuous Galerkin Method for a Linear Degenerate Elliptic Equation Arising from Two-Phase Mixtures." *Computer Methods in Applied Mechanics and Engineering*, 350, pp. 315-336, 2019

Kang, Shin-Hoo, Tae-Young Goo, and Mi-Lim Ou, "Improvement of AERI T/q Retrievals and Their Validation at Anmyeon-Do, South Korea." *Journal of Atmospheric and Oceanic Technology*, 30(7), pp. 1433-1446, 2013

Refereed conference proceedings

Lee, Joon-Yong, Yung-Hoon Jo, **Shin-Hoo Kang**, A-Young Kang, Dong-Heon Ha, and Sung-Jun Yoon, "Determination of the Existence of LOS Blockage and Its Application to UWB Localization." In *Military Communications Conference, 2006*, IEEE, 2006

Jo, Yung-Hoon, Joon-Yong Lee, Dong-Heon Ha, and **Shin-Hoo Kang**, "Accuracy Enhancement for UWB Indoor Positioning Using Ray Tracing." In *The Journal of Korean Institute of Communications and Information Sciences*, 31(10C), 921-926, 2006

Unrefereed conference proceedings

Kang, Shin-Hoo, Tae-Jin Oh, and Hyun Nam, "Comparison of HEVI Time-Stepping Methods for Non-hydrostatic Equations in Continuous Galerkin Discretization." In *First Half Conference of the Korean Meteorological Society*, 49-50, 2014

Tae-Hyeong Yi, Suk-Jin Choi, Tae-Jin Oh, **Shin-Hoo Kang**, and Ja-Rin Park, "Comparison of Numerical Fluxes for Shallow Water Equations in the Discontinuous Galerkin Discretization." In *First Half Conference of the Korean Meteorological Society*, 286-287, 2013

Oh, Tae-Jin, Tae-Hyeong Yi, Suk-Jin Choi, **Shin-Hoo Kang**, Ja-Rin Park, Young-Joon Kim, "Progress and Plans for the Dynamical Core Module Development at KIAPS." In *First Half Conference of the Korean Meteorological Society*, 12-13, 2013

Kang, Shin-Hoo, Ki-Hwan Kim, Suk-Jin Choi, Jung-Han Kim, Sun-Hee Yun, and Tae-Jin Oh, "Parallelization of KIAPS-SWE Based on Continuous and Discontinuous Galerkin Methods." In *Second Half Conference of the Korean Meteorological Society*, 504-505, 2013

Kang, Shin-Hoo, Tae-Jin Oh, and Suk-Jin Choi, "Examining One-way and Two-way Grid Nesting in Continuous/Discontinuous Galerkin Discretization." In *Second Half Conference of the Korean Meteorological Society*, 476-477, 2012

Presentations

Invited Talks

Kang, Shinhoo and Tan Bui-Thanh, "A Scalable Exponential-DG Approach for Nonlinear Conservation Laws: With Application to Burger and Euler Equations," 2021 International Conference on Spectral and High Order Methods (virtual), July 13, 2021

Kang, Shinhoo and Tan Bui-Thanh, "Toward Wind Turbine Simulation with High-Order Hybridized Discontinuous Galerkin Method: IMEX HDG-DG and Sliding Mesh," SIAM Conference on Computational Science and Engineering, Spokane, Washington, Feb. 27, 2019

Contributed Talks

Kang, Shinhoo, "Additive Operator Splitting Methods for Multiscale and Multi-physics Problems," Laboratory for Applied Mathematics, Numerical Software, and Statistics (LANS) Seminar at Argonne National Laboratory, Lemont, IL, June 8, 2022

Kang, Shinhoo, Alp Dener, Aidan Hamilton, Hong Zhang, Emil Constantinescu, and Rob Jacob, "Multirate Partitioned Runge–Kutta Methods for a Coupled Compressible Navier–Stokes Equations," 2022 SIAM Conference on Mathematics of Planet Earth (virtual), July 13, 2022

Kang, Shinhoo, Emil Constantinescu, Alp Dener, Hong Zhang and Rob Jacob, "Implicit-Explicit and Multirate Methods for a Coupled Navier–Stokes Equations," 2021 American Geophysical Union (AGU) Fall Meeting (virtual), December 14, 2021

Kang, Shinhoo, Emil Constantinescu, Hong Zhang and Rob Jacob, "Mass-Conserving Implicit-Explicit Methods for Coupled Compressible Navier–Stokes Equations," 16th U.S. National Congress on Computational Mechanics (virtual), July 28, 2021

Kang, Shinhoo, and Emil Constantinescu, "A Relaxed Multirate Integrator for Hyperbolic Equations," 2021 International Conference on Spectral and High Order Methods (virtual), July 12, 2021

Kang, Shinhoo, Emil Constantinescu, Hong Zhang, and Rob Jacob, "Mass-Conserving Implicit-Explicit Methods for Coupled Compressible Navier–Stokes Equations," 9th edition of the International Conference on Computational Methods for Coupled Problems in Science and Engineering (virtual), June 15, 2021

Kang, Shinhoo, Emil Constantinescu, Hong Zhang, and Rob Jacob, "Implicit-Explicit (IMEX) Methods for Coupled Compressible Navier–Stokes Equations," 2021 SIAM Conference on Computational Science and Engineering (virtual), Fort Worth, TX, March 3, 2021

Kang, Shinhoo and Tan Bui-Thanh, "A Scalable Exponential-DG Approach for Nonlinear Conservation Laws: With Application to Burger and Euler Equations," workshop on Modeling and Simulation of Transport Phenomena (virtual), Moselle, Germany, October 14, 2020

Kang, Shinhoo, Francis X. Giraldo, and Tan Bui-Thanh, "IMEX HDG-DG: A Coupled Implicit Hybridized Discontinuous Galerkin and Explicit Discontinuous Galerkin Approach for Shallow Water Systems," North American High-Order Methods Conference, San Diego, CA, USA, June 3, 2019

Kang, Shinhoo, Tan Bui-Thanh, and David A. Kopriva, "Discrete Stable, Conservative, and Constant-Preserving HDG Methods for Hyperbolic Equations on Nonconforming Curved Meshes," Finite Element in Fluid Conference, Chicago, IL, April 3, 2019

Kang, Shinhoo, Tan Bui-Thanh and Todd Arbogast, "Construction and Analysis of HDG Methods for Two-Phase Flow," SIAM Conference on Mathematical and Computational Issues in the Geosciences, Houston, TX, March 11, 2019

Kang, Shinhoo, Sriramkrishnan Muralikrishnan and Tan Bui-Thanh, "IMEX HDG-DG: A Coupled Implicit Hybridized Discontinuous Galerkin and Explicit Discontinuous Galerkin Approach for Euler Systems," Texas Applied Mathematics and Engineering Symposium, Austin, TX, Sept. 21, 2017

Kang, Shinhoo, Sriramkrishnan Muralikrishnan, Stephen Shannon, and Tan Bui-Thanh, "Some Advances in the Upwind Hybridized Discontinuous Galerkin Method for Dynamical Cores," workshop on Partial Differential Equations on the Sphere, Paris, France, April 4, 2017

Kang, Shinhoo, Francis X. Giraldo, and Tan Bui-Thanh, "IMEX-HDG-DG Schemes for Shallow Water Equation," The Finite Element Rodeo, TAMU, College Station, TX, March 4-5, 2016

Kang, Shinhoo, Francis X. Giraldo, and Tan Bui-Thanh, "IMEX-HDG-DG Schemes for Shallow Water Equation," PDEs on the Sphere, Seoul, South Korea, October 27-28, 2015

Kang, Shinhoo, Tan Bui-Thanh, and Francis X. Giraldo, "IMEX-HDG-DG Schemes for Nonlinear Partial Differential Equations," The Finite Element Rodeo, SMU, Dallas, TX, February 27-28, 2015

Poster Presentations

Kang, Shinhoo, and Tan Bui-Thanh, "A Hybridized Discontinuous Galerkin Method for Geophysical Flows," Advances in PDEs: Theory, Computation and Application to CFD, Providence, RI, Aug. 21, 2018

Kang, Shinhoo, Sriramkrishnan Muralikrishnan, Stephen Shannon, and Tan Bui-Thanh, "An Upwind Hybridized Discontinuous Galerkin Framework," Advances in Mathematics of Finite Elements, Austin, TX, March 22, 2016

Kang, Shin-Hoo, Tae-Jin Oh, and Hyun Nam, "Comparison of HEVI Time-Stepping Methods for Non-Hydrostatic Equations in Continuous Galerkin Discretization," First Half Conference of the Korean Meteorological Society, Buyeo, Korea, April 21, 2014

Kang, Shin-Hoo, Ki-Hwan Kim, Suk-Jin Choi, Jung-Han Kim, Sun-Hee Yun, and Tae-Jin Oh, "Parallelization of KIAPS-SWE based on Continuous and Discontinuous Galerkin Methods," Second Half Conference of Korean Meteorological Society, Gwangju, Korea, Nov. 2013

Kang, Shin-Hoo and Tae-jin Oh, "Comparison Study of Spurious Wave Reflection Response with Staggered Finite-Volume and Unstaggered Element-Based Galerkin Schemes under Mesh-Refinement," SIAM Conference on the Mathematical and Computational Issues in the Geosciences, Padova, Italy, June, 2013

Kang, Shin-Hoo, Tae-Jin Oh, Suk-Jin Choi and Tae-Hyeong Yi, "Examining One-Way and Two-Way Grid Nesting in Continuous/ Discontinuous Galerkin Discretization," Fall Meeting of AGU, San Francisco, CA, Dec. 2012

Kang, Shin-Hoo, Tae-Jin Oh, and Suk-Jin Choi, "Examining One-Way and Two-Way Grid Nesting in Continuous/Discontinuous Galerkin Discretization," Second Half Conference of the Korean Meteorological Society, Nov. 2012

Kang, Shin-Hoo, Tae-Young Goo, and Mi-Lim Ou, "Improvement of AERI T/q Retrievals," Autumn Meeting of Korean Meteorological Society Conference, Pusan, Korea, Oct. 2011

Symposium Organizer

2019.2 **Co-organizer**, *Minisymposium High-order Finite Element Methods for Complex and Multiphysics Applications, at the SIAM Conference on Computational Science and Engineering, Washington, 2019*

HPC Allocation

Data-Driven Coupling Methods for Atmospheric-Ocean Interactions, Director's Discretionary Allocation, 2021-2023, 1000 node-hours on POLARIS, 3000 node-hours on ThetaGPU, and 8000 node-hours on Theta

Research Proposals

Not funded

"Model Integration and Numerical Coupling in E3SM (MINCE)," DOE SciDAC SAP-BER, April 2022. Lead PI: Robert Jacob, ANL. **Role: co-I.**

Kang, Shinhoo and Romit Maulik, "Neural Approximation of Dynamics for Stiff Problems," LDRD Seed, 2022. **Role: co-PI.**

Kang, Shinhoo, "Physics-Informed Neural Network for Non-hydrostatic Equations," LDRD Seed, 2022. **Role: PI.**

Kang, Shinhoo, "Data-Driven Coupling Strategy for Atmospheric and Ocean Interactions," LDRD Seed, 2022. **Role: PI.**

Kang, Shinhoo, "Entropy Stable Multirate Time Integrator for Solving Stiff Problems," LDRD Seed, 2021. **Role: PI.**

Kang, Shinhoo, Hong Zhang, and Emil M. Constantinescu, "Scalable High-Order Numerical Methods for Solving Stiff Problems on GPUs," LDRD Seed, 2020. **Role: PI.**

Research Interests

- Machine Learning
- Numerical Methods: (Hybridized) Discontinuous Galerkin method, Arbitrary Lagrangian-Eulerian (ALE), Adaptive Mesh-Refinement (AMR), IMplicit-EXplicit (IMEX) method, Multirate/ Exponential Time Integrators
- Computational Mechanics: computational fluid dynamics (CFD), geophysical flows (atmospheric flows, mantle convection), two-phase flows
- High-Performance Computing (HPC)
- Remote Sensing

Computer skills

Languages C++, C, Fortran, Python, Julia, MATLAB

Tools PETSc, JAX, PyTorch, ParaView

Workshop Participation

2022.10 **Workshop**, *ALCF Simulation, Data, and Learning Workshop*, Lemont, IL

2022.2 **Workshop**, *ALCF AI for Science Training Series*, Lemont, IL

2022.1 **Workshop**, *ALCF Getting Started on ThetaGPU*, Lemont, IL

2021.5 **Workshop**, *ALCF Computational Performance Workshop*, Lemont, IL

2018.8 **Workshop**, *Advances in PDEs: Theory, Computation and Application to CFD*, Providence,RI

2017.8 **Workshop**, *Argonne Training Program on Extreme-Scale Computing*, Lemont, IL

References

Dr. Emil M. Constantinescu, Mathematics and Computer Science Division, Argonne National Laboratory, Lemont, IL 60439, USA, emconsta@anl.gov

Distinguished Professor Francis X. Giraldo, Dep. of Applied Mathematics, Naval Postgraduate School, Monterey, CA 93940, USA, fxgirald@nps.edu

Associate Professor Tan Bui-Thanh, Dep. of Aerospace Engineering and Engineering Mechanics, The Oden Institute for Computational Engineering and Sciences, The University of Texas at Austin, Austin, TX 78705, USA, tanbui@oden.utexas.edu

Professor Todd Arbogast, Dep. of Mathematics, The Oden Institute for Computational Engineering and Sciences, The University of Texas at Austin, Austin, TX 78705, USA, arbogast@oden.utexas.edu