Sungju Moon

Curriculum Vītae

Contact Information

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Research Interests

Applications of nonlinear dynamics and chaos theory
Numerical weather modeling, atmospheric predictability, and data assimilation
Infectious disease modeling, particularly network and agent-based modeling
Undergraduate mathematics education and dynamics of learning

Education

Seoul National University, Seoul, South Korea
Ph.D. in Earth and Environmental Sciences (conc.: nonlinear dynamics and chaos), Aug 2021
Dissertation: *High-Dimensional Lorenz Systems, Atmospheric Predictability, and Data Assimilation*
Advisor: Jong-Jin Baik

Syracuse University, Syracuse, NY, USA
M.S. in Mathematics, May 2016

Wake Forest University, Winston-Salem, NC, USA
B.S. in Mathematics (Honors) and B.A. in Classical Studies, May 2013
Honors thesis: *Computational Modeling of Precautionary Behavior During an Epidemic*

Academic Appointments

Assistant Professor of Mathematics — Jan 2023–Present
Department of Data, Media, and Design, Nevada State University — Henderson, NV, USA

Postdoctoral Fellow — Apr 2022–Dec 2022
Department of Mathematics & Statistics, McMaster University — Hamilton, ON, Canada
Mathematics for Public Health (MfPH) Network, The Fields Institute

Postdoctoral Fellow — Sep 2021–Mar 2022
Research Institute for Basic Sciences, Seoul National University — Seoul, South Korea

Technical Research Personnel (South Korean Military Service) — Sep 2018–Aug 2021
Seoul National University — Seoul, South Korea

Courses Taught

At Nevada State University
Calculus I (MATH 181), Fall '23, Spring '24, Fall '24, Spring '25
Differential Equations (MATH 427), Fall '23, Fall '24 (Ind. Study)
Fundamentals of College Mathematics (MATH 120), Spring '23
Fundamentals of College Mathematics Expanded (MATH 120E), Spring '24, Fall '24, Spring '25
History of Mathematics (MATH 314), Spring '24
Linear Algebra I (MATH 330), Spring '23, Spring '24 (Ind. Study), Spring '25
Linear Algebra II (MATH 430), Fall '23
Elementary Complex Analysis (MATH 459), Fall '24
Undergraduate Research (MATH 498), Summer '24, Spring '25

At McMaster University
Linear Algebra I (MATH 1B03), Fall '22 (Online)

At Syracuse University
Algebraic Operations and Functions (MAT 112), Summer '15
Calculus I (MAT 295), Fall '14
Calculus for Life Sciences II (MAT 286), Spring '16

Other Teaching Experiences

As Grader and Teaching Assistant, Seoul National University
Atmospheric Physics II (Undergraduate, Online), Fall '21
Cloud Physics (Graduate), Fall 2017, Fall 2018, Fall '20 (Online)
Mesoscale Meteorology (Graduate), Spring '18
Topics in Atmospheric Science (Graduate), Spring '20 (Online)

As Recitation Instructor, Syracuse University
Business Calculus (MAT 284), Spring '15
Calculus I (MAT 295), Fall 2015, Spring '15
Calculus II (MAT 296), Spring '14
Elementary Probability and Statistics I (MAT 121), Fall '13

As Math Clinic Tutor, Syracuse University (Fall '13–Spring '16)

Student Research Supervision &Mentorship

At Nevada State University
Jason Rice (Independent Study, Spring '25)
Mary Giles (INBRE iSurf-Flex (NIH) summer program '24)
- Agent-Based Modeling of Viral Mutation
- Oral presentation at a professional conference

Nigel Sherfield (TRIO-McNair (DOE) program '24)
- Dynamical Modeling of Learning

Rose Reasons (INBRE iSurf-Flex (NIH) summer program '24)
- Network-Based Disease Modeling

Ryllie Pate (INBRE iSurf-Flex (NIH) summer program '24)
- Parameter Space Analysis of Disease Models

At Seoul National University
Seong-Ho Hong (undergraduate thesis '19)
- Numerical Exploration of Coexistence in the Lorenz–Stenflo Equations
- Peer-reviewed publication

Taehyeok Kim (undergraduate thesis '21)
- The Relation Between Computational Accuracy and Predictability of the 6D Lorenz System Using Various Orders of the Runge–Kutta Method

Research Projects

Kneading-Based Exploration of Lorenz-like Systems Nov 2021–Ongoing
In collaboration with Roberto Barrio and Sergio Serrano (U. Zaragoza, Spain)
Uncovering previously unobserved features within the chaotic regions of the parameter space of high-dimensional Lorenz systems with connections to atmospheric predictability

Mathematics for Public Health Project 4 Apr 2022–Dec 2023
Robust Agent-Based and Network Infectious Disease Models
PI: Thomas Hurd (1956–2022) and Michael C. Wolfson (uOttawa)
In collaboration with Steve Gribble (StatCan)
The Fields Institute Mathematics for Public Health (MfPH)
Emerging Infectious Disease Modelling Initiative, an NSERC grant
Developed compartmental and agent-based models for the infectious disease dynamics considering issues such as co-circulation, social network, and data availability

Atmospheric Predictability: From the Perspective of Chaos Theory Sep 2021–Apr 2022
Partial grant funding through National Research Foundation of Korea (NRF) ∼$120,000
Investigation of the relationship between atmosphere's chaotic nature and its predictability with particular focus on the effects of changing a model's spatial resolution or numerical precision

Research Projects

Chaos and Synchronization in High-Order Lorenz Models Nov 2018–Oct 2021
Small Grant for Exploratory Research (SGER), National Research Foundation of Korea (NRF)
PI: Jong-Jin Baik (Seoul National U.)
Rigorous derivation and analysis of high-dimensional extensions of the Lorenz system with additional physically-relevant features, focusing on bifurcation and chaos synchronization

Mathematical Modeling in Epidemiology Sep 2011–May 2013
co-PIs: Frederick Chen and Miaohua Jiang (Wake Forest U.)
URECA Summer Research Fellowship, Wake Forest University
Undergraduate honors thesis project building a computational epidemiological model considering learning-based risk behavior of population

Other Projects

Markov vs. Nekrasov Dec 2023–Ongoing
Project lead: Chad Curtis (NSU)
Developing a reacting-to-the past game, *Markov vs. Nekrasov: Markov Chains, the Central Limit Theorem, and the Battle Over Free Will* centered around the development of statistics and debates about free will.

Communicating Mathematical Beauty Apr 2024–Ongoing
In collaboration with Chris Harris (Communication)
Developing a new course material for introducing deeper mathematics ideas to non-STEM majors focusing on creative expression

Book Project: Natural and Human-Made Disasters Modeling Jan 2024–Ongoing
Co-author: J. Mango Seo (LANL)
Project-based mathematics modeling text focusing on simulation, dynamical systems, and chaos

Publications

Book Chapters

2. S. Moon, M. Wolfson, 2025. Exploring the Chaotic Dynamics of Cocirculating Disease Strains: Toward Agent-Based Modeling. In: Skiadas, C.H., Y. Dimotikalis. *16th Chaotic Modeling and Simulation International Conference.*, Springer: 435–448

1. J. David, G. Brankston, I. Sekkak, S. Moon, X. Li, S. Jahedi, Z. Mohammadi, A. Li, M. Grunnil, P. Song, W. Assefa, N. Bragazzi, J. Wu, 2023. Mathematical models: perspectives of mathematical modelers and public health professionals. In: J. David, J. Wu, 2023. *Mathematics of Public Health: Mathematical Modelling from the Next Generation*, Springer: 1–35.

Journal Articles (*student/mentee involvement)

16. H. Lee, G. Ganbat, H.-G. Jin, J.M. Seo, S. Moon, H. Bok, J.-J. Baik, 2023. Effects of Lake Baikal on summertime precipitation climatology over the lake surface. *Geophysical Research Letters* 50, e2023GL103426.

15. S. Moon, J.-J. Baik, H.-J. Song, J.-Y. Han, 2022. Increasing model vertical resolution may not necessarily lead to improved atmospheric predictability. *Chaos* 32, 073120.

14. S. Moon, J.-J. Baik, 2021. Using the $(3N)$-dimensional generalized Lorenz systems as a testbed for data assimilation: The ensemble Kalman filter. *Monthly Weather Review* 149, 3691–3705.

13. K.-H. Kwak, B.-S. Han, K. Park, S. Moon, H.-G. Jin, S.-B. Park, J.-J. Baik, 2021. Inter- and intra-city comparisons of $PM_{2.5}$ concentration changes under COVID-19 social distancing in seven major cities of South Korea. *Air Quality, Amosphere & Health* 14, 1155–1168.

12. J. Park, S. Moon, J.M. Seo, J.-J. Baik, 2021. Systematic comparison between the generalized Lorenz equations and DNS in the two-dimensional Rayleigh–Bénard convection. *Chaos* 31, 073119.

11. M. Jwa, H.-G. Jin, J. Lee, S. Moon, J.-J. Baik, 2021. Characteristics of raindrop size distribution in Seoul, South Korea according to rain and weather types. *Asia-Pacific Journal of Atmospheric Sciences* 57, 605–617.

10. S. Moon, J.-J. Baik, S.-H. Hong,* 2021. Coexisting attractors in a physically extended Lorenz system. *International Journal of Bifurcation and Chaos* 31, 2130016 (Featured).

9. S. Moon, J.-J. Baik, J.M. Seo, 2021. Chaos synchronization in generalized Lorenz systems and an application to image encryption. *Communications in Nonlinear Science and Numerical Simulation* 96, 105708.

8. S. Moon, J.-J. Baik, J.M. Seo, B.-S. Han, 2021. Effects of density-affecting scalar on the onset of chaos in a simplified model of thermal convection: A nonlinear dynamical perspective. *The European Physical Journal Plus* 136, 92.

7. B.-S. Han, K. Park, K.-H. Kwak, S.-B. Park, H.-G. Jin, S. Moon, J.-W. Kim, J.-J. Baik, 2020. Air quality change in Seoul, South Korea under COVID-19 social distancing: Focusing on $PM_{2.5}$. *International Journal of Environmental Research and Public Health* 17, 6208.

6. S. Moon, J.M. Seo, J.-J. Baik, 2020. High-dimensional generalizations of the Lorenz system and implications for predictability. *Physica Scripta* 95, 115201.

5. J.M. Seo, H. Lee, S. Moon, J.-J. Baik, 2020. How mountain geometry affects aerosol-cloud-precipitation interactions: Part I. Shallow convective clouds. *Journal of the Meteorological Society of Japan* 98, 43–60.

4. S. Moon, J.M. Seo, B.-S. Han, J. Park, J.-J. Baik, 2019. A physically extended Lorenz system. *Chaos* 29, 063129 (Featured).

3. Y.-L. Jeon, S. Moon, H. Lee, J.-J. Baik, J. Lkhamjav, 2018. Non-monotonic dependencies of cloud microphysics and precipitation on aerosol loading in deep convective clouds: A case study using the WRF model with bin microphysics. *Atmosphere* 9, 434.

2. J.M. Seo, J.-J. Baik, S. Moon, 2018. Orographic-convective flows, wave reflection, and gravity-wave momentum fluxes in a two-layer hydrostatic atmosphere. *Tellus* 70A, 1–16.

1. S. Moon, B.-S. Han, J. Park, J.M. Seo, J.-J. Baik, 2017. Periodicity and chaos of high-order Lorenz systems. *International Journal of Bifurcation and Chaos* 27, 1750176.

Talks & Seminars

Invited Seminars

A comparison of generalized Lorenz models to the Boussinesq model and investigations into chaotic properties, TRR 181 Seminar, University of Hamburg, Germany, May 25, 2023, Online

Chaos synchronization in high-dimensional Lorenz systems, School of Computing and Data Science, Wentworth Institute of Technology, Boston, MA, Jan 13, 2021, Online

Chaos synchronization and data assimilation, Department of Atmospheric Science, Yonsei University, Seoul, South Korea, Sep 28, 2021, Online

Chaos and atmospheric predictability, Department of Atmospheric Science, Kongju National University, Kongju, South Korea, Sep 14, 2021

Conference Talks (⋆presented by a student)

Agent-Based Modeling of Viral Mutations (with Mary Giles⋆ as speaker), 2024 Fall Symposium, "Health and Human Services", Nevada Chapter of the American Statistical Union (ASA), Las Vegas, NV

Math History Spillover, New Twists on Your Favorite Math Circle Activity, MathFest 2024, Indianapolis, IN, Aug 2024, *Withdrawn due to medical emergency*

Toward support for epidemic preparedness via digital twin data (with M. C. Wolfson as speaker), The Canadian Network for Modelling Infectious Diseases: Progress and Next Steps (23w5151), Banff International Research Station (BIRS) for Mathematical Innovation and Discovery, Banff, AB, Canada, Nov 2023

Exploring the chaotic dynamics of two interacting viral strains: agent-based modelling approach, 16^{th} CHAOS 2023 International Conference, Heraklion, Crete, Greece, Jun 2023, Online

Explorations in interacting infectious disease modelling, Poster (with Michael C. Wolfson and Steve Gribble), Mathematics for Public Health Festival (MfPHest), The Fields Institute, Toronto, ON, Canada, Oct 2022

Chaos synchronization in generalized Lorenz Systems and connections to data assimilation, 15^{th} CHAOS 2022 International Conference, Athens, Greece, Jun 2022, Online

The $(3N)$*- and* $(3N+2)$*-dimensional generalizations of the Lorenz system, chaos synchronization, and their applications as a testbed Model for data assimilation algorithms*, AMS Contributed Paper Session on Dynamical Systems and Applications, Joint Mathematics Meetings, Seattle, WA, USA, Apr 2022, Online

High-dimensional Lorenz systems, atmospheric predictability, and data assimilation: An overview, Autumn Meeting of the Korean Meteorological Society, Special Session for Emerging Scientists, Gwangju, South Korea, Oct 2021, Online

The generalized Lorenz systems: A new testbed model for data assimilation, Autumn Meeting of the Korean Meteorological Society, Gwangju, South Korea, Oct 2021, Online

Attractor coexistence in extended Lorenz systems revealed through bifurcation analysis, 14^{th} CHAOS 2021 International Conference, Athens, Greence, Jun 2021, Online

High-dimensional generalizations of the Lorenz system and implications for predictability, Autumn Meeting of the Korean Meteorological Society, Gyeongju, South Korea, Oct 2020, Online

The $(3N)$*- and* $(3N+2)$*-dimensional generalized Lorenz systems*, 13^{th}International Conference on Chaotic Modeling, Simulation and Applications, CHAOS 2020, Jun 2020, Florence, Italy, *Withdrawn due to global pandemic*

A physically extended Lorenz system, Autumn Meeting of the Korean Meteorological Society, Gyeongju, South Korea, Oct 2019

A physically extended Lorenz system, 1^{st} International Conference on Climate Change and Environment in Central and North-East Asia (ICCCECNEA), National University of Mongolia, Ulaanbaatar, Mongolia, Sep 2019

Non-monotonic dependence of cloud microphysics and precipitation on aerosol loading in deep convective clouds: A case study using the WRF-bin model (with Y.-L. Jeon), Poster, 15^{th} Conference on Cloud Physics/Atmospheric Radiation, American Meteorological Society, Vancouver, BC, Canada, July 2018

Chaos and periodicity of high-order Lorenz systems, Autumn Meeting of the Korean Meteorological Society, Busan, South Korea, Oct 2017

Internal Talks

Threading sustainability into your curriculum (with J. Edmonds - lead, K. Corsaro, E. Hoover, R. Perez, G. Rum, A. Varga, C. Way), 5th Annual Faculty Symposium on Teaching and Learning, Nevada State University, Henderson, NV, Jan 12, 2024

Journey from cloud modeling to the Lorenz equations—the microphysical and dynamical effects of aerosols, AIMS Lab Seminar, Department of Mathematics & Statistics, McMaster University, Hamilton, ON, Canada, Sep 26, 2022

Honors & Awards

The KMS Award for Outstanding Dissertation Sep 2021
Korean Meteorological Society (KMS)

Best Ph.D. Dissertation Award Aug 2021
College of Natural Sciences, Seoul National University

Pi Mu Epsilon, Wake Forest University Inducted 2013

Service to University

Committee Work
Foundation Scholarship Application Review, Apr–Jun 2024

Other Internal Service Activities
Nevada State Mathematics Colloquium (link), Fall 2023–Ongoing
NSU Open House, Nov 2023, Oct 2024
First Point-Of-Contact Program for Mathematics Majors, Oct 2024–Ongoing

Service to Profession

Conference Activities
MAA MathFest 2025 Workshop Session, Reacting to the Past: Historical Roleplaying Games in Math Education (lead: Chad Curtis), Co-organizer, Jan 2025–Present
MAA MathFest 2025 Contributed Paper Session, SoTL: Focus on Game-based Learning, Lead Organizer, Dec 2024–Present
UNLV STEM Ed Meet 2025, Organizing Committee, Feb 2024–Present
MAA MathFest 2024 Project NExT Session on Grant Writing, Session Organizer, Feb–Aug 2024
West Coast Number Theory (WCNT) Conference 2023, On-Site Volunteer, Dec 2023
Mathematics for Public Health Festival (MfPHest), Organizing Committee, Jun–Oct 2022
15th International Conference on Chaotic Modeling, Simulation and Applications (CHAOS 2021) Special and Contributed Session: Chaos Theory–Quantum–Lorenz, Session Chair, June 2022

Manuscript Reviews
Atmosphere
IEEE Transactions on Network Science and Engineering
International Journal of Bifurcation and Chaos
International Journal of Modern Physics C
Nonlinear Dynamics
Walailak Journal of Science and Technology

Societies & Memberships

Mathematical Association of America (MAA), Project NExT Green '23
Society for Industrial and Applied Mathematics (SIAM)

Professional Development, Workshops & Training

NSU Center for Teaching & Learning Excellence (CTLE) Activities:

- Faculty Learning Community (FLC)—Active Learning, Spring 2023
- Workshop—Threading Sustainability into Your Curriculum, Summer 2023
- Faculty Learning Community (FLC)—Intro to SoTL, Fall 2023
- Workshop—Active Learning Retreat, Summer 2024

MAA Project NExT (New Experiences in Teaching), 2023–2024

Agent-Based & Hybrid Modeling Bootcamp & Incubator for Health & Health Care, Mathematics for Public Health (MfPH), the Fields Institute, Saskatoon, SK, Canada (& Online), Aug 2022

Understanding Machine Learning and Deep Learning, Korean Data and Information Science Society & Department of Statistics, Kyungpook National University, Daegu, South Korea, Jan 2020

Introduction to Parallel Programming Workshop, National Center for Meteorological Supercomputer, Cheongju, South Korea, Oct 2018

Introduction to Parallel Programming Workshop, National Center for Meteorological Supercomputer, Cheongju, South Korea, Oct 2018

WRF Tutorial, National Center for Atmospheric Research (NCAR), Boulder, CO, USA, Jan 2018

Park City Mathematics Institute (PCMI), Undergraduate Program, Institute for Advanced Study (IAS), Park City, UT, USA, July 2013

Other Experiences

Seoul National University PhD Dissertation Template Design (link), 2021

Republic of Korea Army Basic Training, Nonsan, South Korea, Jul–Aug 2019

Friday Weather Forecasting Club, Seoul National University, 2016–2019

Club Secretary, Wake Forest University Anthropology, 2010–2013

Technical Skills

Proficient in LaTeX, MATLAB, and Python

Familiar with Linux working environments, WRF, NCL, Fortran, and R

Some experience implementing the ensemble Kalman filter

Currently learning AnyLogic and OpenM++ agent-based modeling (ABM) tools

Languages

Bilingual (English & Korean), Working knowledge of Latin