

EDUCATION

- **University of Wisconsin-Madison** Madison, WI
Ph.D. - Mathematics (Advisor: Nan Chen) Jul 2023 – present
- **Nanjing University** Nanjing, China
M.S. - Atmospheric Science (Advisor: Lili Lei) Sep 2020 – Jun 2023
B.S. - Atmospheric Science Sep 2016 – Jun 2020

RESEARCH INTERESTS

My research lies at the interface of applied and computational mathematics, statistics, and machine learning. Specifically, I am interested in data assimilation and scientific machine learning for complex dynamical systems:

1. **Surrogate modeling of complex systems.** Conventional physics-based models are interpretable and principled, but they rely on extensive domain knowledge, expensive numerical simulations, and may fail to capture the long-term statistics or rare events. I leverage recent advances in data-driven modeling to develop surrogate models that are *accurate*, *efficient*, and *robust*.
2. **Data assimilation theory and algorithms.** Operational DA algorithms in high dimensions often rely on strong simplifying assumptions (e.g., Gaussianity, linearity, independence) to remain computationally feasible, which can introduce large approximation errors. I develop *analytically accurate yet computationally tractable* DA algorithms that relax these assumptions.

PUBLICATIONS

- **Zhongrui Wang**, Rebecca Willett, Yinling Zhang, and Nan Chen. “A Physics-Informed Multi-Model Framework for Data Assimilation and Prediction”, *In preparation*
- **Zhongrui Wang**, Chuanqi Chen, Jinlong, Wu, and Nan Chen. “Lagrangian Data Assimilation via Conditional Gaussian Koopman Network”, *In preparation*
- Chuanqi Chen, **Zhongrui Wang**, Nan Chen, and Jinlong Wu. “Modeling partially observed nonlinear dynamical systems and efficient data assimilation via discrete-time conditional Gaussian Koopman network”, *Computer Methods in Applied Mechanics and Engineering*, 2025
- **Zhongrui Wang**, Nan Chen, and Di Qi. “A Nonlinear Data Assimilation Algorithm with Closed-Form Approximations for Multi-Layer Flow Fields”, *Monthly Weather Review*, 2025.
- **Zhongrui Wang**, Haohao Sun, Lili Lei, Zhe-Min Tan, and Yi Zhang. “The importance of data assimilation components for initial conditions and subsequent error growth”, *Science China Earth Sciences*, 2024
- **Zhongrui Wang**, Lili Lei, Jeffrey L Anderson, Zhe-Min Tan, and Yi Zhang. “Convolutional Neural Network-Based Adaptive Localization for an Ensemble Kalman Filter”, *Journal of Advances in Modeling Earth Systems*, 2023
- Lili Lei, **Zhongrui Wang**, and Zhe-Min Tan. “Integrated Hybrid Data Assimilation for an Ensemble Kalman Filter”, *Monthly Weather Review* 149, 12, 4091-4105, 2021.
- Shibao Wang, Yun Ma, **Zhongrui Wang**, Lei Wang, Xuguang Chi, Aijun Ding, Mingzhi Yao, Yunpeng Li, Qilin Li, Mengxian Wu, Ling Zhang, Yongle Xiao, and Yanxu Zhang. “Mobile monitoring of urban air quality at high spatial resolution by low-cost sensors: impacts of COVID-19 pandemic lockdown”, *Atmospheric Chemistry and Physics* 21, 7199–7215, 2021.
- Yanxu Zhang, Xingpei Ye, Shibao Wang, Xiaojing He, Lingyao Dong, Ning Zhang, Haikun Wang, **Zhongrui Wang**, Yun Ma, Lei Wang, Xuguang Chi, Aijun Ding, Mingzhi Yao, Yunpeng Li, Qilin Li, Ling Zhang, and Yongle Xiao. “Large-eddy simulation of traffic-related air pollution at a very high resolution in a mega-city: evaluation against mobile sensors and insights for influencing factors”, *Atmospheric Chemistry and Physics* 21, 2917–2929, 2021.

CONFERENCES AND SEMINARS

- Scientific Machine Learning: Theory, Algorithms, and Applications, Purdue University, Sep 2025
- IMSI Digital Twins: Mathematical and Statistical Foundations and Complex Applications, Chicago, Oct 2025
- Data Meets Dynamics: Workshop on Data Assimilation for Complex Systems and Applications, Madison, Aug, 2025
- Third Joint SIAM/CAIMS Annual Meetings (AN25), Montréal, Jul-Aug 2025
- SIAM Conference on Applications of Dynamical Systems on nonlinear and stochastic dynamics in weather and climate science, Denver, May 2025
- The Institute for Foundations of Data Science (IFDS) ideas forum, Madison, May 2025
- ISDA online: Nonlinear Data Assimilation, Online, May 2025
- The American Geophysical Union (AGU) Annual Meeting, Washington, D.C., Sep 2024
- 102nd American Meteorological Society (AMS) Annual Meeting, 26th Conference on Integrated Observing and Assimilation Systems for the Atmosphere, Oceans, and Land Surface (IOAS-AOLS), Jan 2022

SERVICE

- Reviewer: npj Artificial Intelligence, 2025

TEACHING

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| • Teaching Assistant
<i>Math 211: Survey of Calculus I</i> | University of Wisconsin-Madison
<i>Fall 2025</i> |
| • Undergraduates Mentoring
<i>Madison Experimental Mathematics Lab (MXM)</i>
<i>Project: Integrating Machine Learning with Data Assimilation for Complex Dynamical System Predictions</i> | University of Wisconsin-Madison
<i>Spring 2025</i> |
| • Teaching Assistant
<i>Math 114: Precalculus</i> | University of Wisconsin-Madison
<i>Fall 2023</i> |
| • Teaching Assistant
<i>Dynamic Meteorology</i> | Nanjing University
<i>Fall 2021</i> |

AWARDS

- SIAM Student Travel Awards - 2025
- UW-Madison Student Graduate Research Grants - 2025

PROGRAMMING

Python(numpy, scipy, Tensorflow, Pytorch)/MATLAB/R/linux/C/fortran