

Theodore MacMillan

Ph.D. Candidate — AI Weather & Climate Modeling
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Education

Stanford University, Stanford, CA Fall 2021 – Present

Ph.D. Candidate, Environmental Engineering

Minor: Computer Science

GPA: 4.11 / 4.30

- Machine Learning: Mining Massive Datasets, Graph Machine Learning
- Applied Mathematics: Stochastic Processes, SDEs, Fourier Analysis
- Algorithms & Uncertainty: Randomized Algorithms, Uncertainty Quantification

University of Notre Dame, Notre Dame, IN Fall 2017 – May 2021

B.S. in Mechanical Engineering

GPA: 3.99 / 4.00

Research Experience

Stanford University — Environmental Complexity Lab Fall 2021 – Present

Graduate Researcher

- Develop interpretability methods for large-scale AI weather models, including internal representation analysis of DeepMind GraphCast
- Integrate sparse autoencoders and feature attribution techniques into physics-informed neural networks
- Study stochastic processes and randomized algorithms for structured analysis of spatiotemporal dynamical systems
- Analyze learned atmospheric representations using spectral, time-series, and graph-based methods

University of Notre Dame — Richter Lab Fall 2018 – May 2021

Undergraduate Researcher

- Led computational simulations of turbulence, cloud microphysics, and cloud formation in marine boundary layers

Industry & Consulting Experience

Cascade Trading Winter 2024 – Present

Machine Learning Consultant

- Develop physics-informed ML models for wind and solar power forecasting using numerical weather prediction inputs
- Engineer cloud-based data pipelines for ingesting weather forecasts, backtesting trading strategies, and online deployment

Selected Publications

- MacMillan, T., Ouellette, N.T. (2025). *Towards mechanistic understanding in a data-driven weather model: internal activations reveal interpretable physical features*. arxiv.
- MacMillan, T., Hilditch, J., Ouellette, N.T. (2025). *Expected correlation in time-series analysis*. Physical Review E (Editors' Suggestion).

- MacMillan, T., Ouellette, N.T. (2024). *Spectral energy transfer on complex networks*. Scientific Reports.
- MacMillan, T., Ouellette, N.T. (2022). *Lagrangian scale decomposition via the graph Fourier transform*. Physical Review Fluids.
- MacMillan, T., Shaw, R., Cantrell, W., Richter, D.H. (2022). *Direct numerical simulation of turbulence and microphysics in the Pi Chamber*. Physical Review Fluids.
- MacMillan, T., Ouellette, N.T., Richter, D.H. (2020). *Detection of evolving Lagrangian coherent structures*. Physical Review Fluids.

Technical Skills

Programming & ML: Python (PyTorch, NumPy, Pandas, PySpark), SQL

Scientific Computing: Stochastic modeling, time-series analysis, spectral methods, graph ML

Visualization: Matplotlib, Plotly

Cloud & Tools: Google Cloud Platform

Other: MATLAB

Honors and Awards

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| • Stanford Graduate Fellowship | 2021 – Present |
| • National Science Foundation Graduate Research Fellowship | 2021 – Present |
| • Barry Goldwater Scholarship | 2020 |