Mike Coughlan

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Current Position

University of New Hampshire
Ph.D. Candidate, Advisor: Dr. Amy Keesee — 2018–Current
Research Assistant, MAGICIAN Project

Experience

University of New Hampshire — Durham, NH
Research Assistant: MAGICIAN Project — 2019-Current

- Performed data analysis on large datasets and prepared them for input into machine learning models.
- Designed machine leaning models for predicting space weather phenomena.
- Presented research results in group settings and at scientific conferences.
- Aided in the preparation of peer reviewed papers submitted for publication.
- Mentored junior students as they were learning how to program machine learning models to examine space weather phenomena.

University of Warwick/Alan Turing Institute — Coventry, UK
Data Science For Social Good Fellow — 2022

- Partnered with the West Midlands Combined Authority and Pure Leapfrog to address the challenge of targeting areas for retrofit by leveraging machine learning and data science techniques.
- Implemented advanced machine learning models to accurately predict missing EPC ratings, enabling targeted retrofitting efforts for energy efficiency improvements.
- Designed and applied a novel methodology to assess the additional strain on the electricity network resulting from the transition to electric heat pumps from fossil fuel burning heat sources.
- Conducted a detailed analysis comparing the estimated load capability of the current electricity network with the projected demand, identifying areas requiring network upgrades for large scale instillation of electric heat pumps.
- Collaborated effectively within a team environment, working closely with fellow data scientists, policymakers, and stakeholders to achieve project objectives and deliver impactful solutions.

University of New Hampshire — Durham, NH
Research Assistant: X-Calibur Project — 2019

- Ran x-ray polarization simulations using GEANT4 simulation software and performed data analysis using ROOT Data Analysis Framework.

Temple University College of Science and Technology — Philadelphia, PA
Student Ambassador/Ombudsperson — 2016-2017

- Handled student grievances against the Physics Department.
- Represented the Physics Department at open house events.
- Coordinated student visits with Ambassadors.

Temple University — Philadelphia, PA
Research Assistant: Darkside Project — Summer 2015

- Ran particle tracing simulations using COMSOL Multiphysics software.

Apple Ardmore, PA
Technical Specialist 2015-2018

- Troubleshooting of customers technical problems.
- Sale of products and device operation training.
- Handling of customer service issues.

Education

University of New Hampshire Durham, NH
Ph.D. Candidate in Physics and Astronomy, Advisor: Dr. Amy Keesee 2018–Current
M.S. Physics and Astronomy

Temple University Philadelphia, PA
B.S. Physics 2014–2017

West Chester University of Pennsylvania West Chester, PA
B.A. Political Science 2009–2013
B.A. Communications

Publications

1. Smith, A., Rae, J., Forsyth, C., Coxon, J., Walach, M.-T., Lao, C. J., Bloomfield, D. S., Reddy, S. A., **Coughlan, M. K.**, Keesee, A., Bentley, S. (2024). Space Weather Forecasts of Ground Level Space Weather in the UK: Evaluating Performance and Limitations. Space Weather, 22(11), Article e2024SW003973. https://doi.org/10.1029/2024sw003973

2. **Coughlan, M.**, Keesee, A., Pinto, V., Mukundan, R., Marchezi, J. P., Johnson, J., et al. (2023). Probabilistic forecasting of ground magnetic perturbation spikes at mid-latitude stations. Space Weather, 21, e2023SW003446. https://doi. org/10.1029/2023SW003446

3. Pinto V, Keesee AM, **Coughlan M**, Mukundan R, Johnson J, Ngwira CM and Connor HK (2022) Revisiting the Ground Magnetic Field Perturbations Challenge: A Machine Learning Perspective. *Front. Astron. Space Sci.*

4. Keesee AM, Pinto V, **Coughlan M**, Lennox C, Mahmud MS and Connor HK (2020) Comparison of Deep Learning Techniques to Model Connections Between Solar Wind and Ground Magnetic Perturbations. *Front. Astron. Space Sci. 7:550874.* doi: 10.3389/fspas.2020.550874

Conference Presentations

1. **Coughlan M**, Keesee AM, Pinto V, Mukundan R, Marchezi JP, Johnson J, Adewuyi M, Tibbetts J, Connor HK, Hampton D (2024, September). Probabilistic Predictions of Geomagnetic Field Perturbations and Using Explainability Methods to Uncover Drivers of the Localization Effect *1st Scientific Understanding through Data Science Conference, Pasadena CA* (Oral Presentation)

2. **Coughlan M**, Keesee AM, Pinto V, Mukundan R, Marchezi JP, Johnson J, Adewuyi M, Tibbetts J, Connor HK, Hampton D (2024, September). Probabilistic Predictions of Geomagnetic Field Perturbations and Using Explainability Methods to Uncover Drivers of the Localization Effect *1st Scientific Understanding through Data Science Conference, Pasadena CA* (Poster)

3. **Coughlan M**, Keesee AM, Pinto V, Mukundan R, Marchezi JP, Johnson J, Adewuyi M, Tibbetts J, Connor HK, Hampton D (2024, June). Including TWINS Ion Temperature Maps in ML Models Predicting the Degree of Localization in dBH/dt and Analyzing Inputs Using SHAP Method *Geospace Environment Modeling Summer Workshop, Ft. Collins CO* (Oral Presentation)

4. **Coughlan M**, Keesee AM, Pinto V, Mukundan R, Marchezi JP, Johnson J, Adewuyi M, Tibbetts J, Connor HK, Hampton D (2024, June). Analyzing the Influence of Ion Temperature Maps on Probabilistic Predictions of Localized Geomagnetic Perturbations *Geospace Environment Modeling Summer Workshop, Ft. Collins CO* (Poster)

5. **Coughlan M**, Keesee AM, Pinto V, Mukundan R, Marchezi JP, Johnson J, Connor HK, Hampton D (2023, December). Analyzing the Influence of Magnetotail Phenomena on the Localization of Ground Magnetic Field Perturbations Using Machine Learning Interpretability Techniques *American Geophysical Union Fall Meeting, San Francisco CA* (Oral Presentation)

6. **Coughlan M**, Keesee AM, Pinto V, Mukundan R, Marchezi JP, Johnson J, Connor HK, Hampton D (2023, June). Interpretable Probabilistic Forecasting of Ground Magnetic Perturbation Spikes at Mid-Latitude Stations. *Geospace Environment Modeling Summer Workshop, San Diego CA* (Oral Presentation)

7. **Coughlan M**, Keesee AM, Pinto V, Mukundan R, Marchezi JP, Johnson J, Connor HK, Hampton D (2023, June). Interpretable Probabilistic Forecasting of Ground Magnetic Perturbation Spikes at Mid-Latitude Stations. *Geospace Environment Modeling Summer Workshop, San Diego CA* (Poster)

8. **Coughlan M**, Keesee AM, Pinto V, Mukundan R, Marchezi JP, Johnson J, Connor HK, Hampton D (2023, April). Interpretable Probabilistic Forecasting of Ground Magnetic Perturbation Spikes at Mid-Latitude Stations. *Graduate Research Conference, Durham NH* (Oral Presentation)

9. **Coughlan M**, Keesee AM, Pinto V, Mukundan R, Marchezi JP, Johnson J, Connor HK, Hampton D (2023, April). Interpretable Probabilistic Forecasting of Ground Magnetic Perturbation Spikes at Mid-Latitude Stations. *Graduate Research Conference, Durham NH* (Poster)

10. **Coughlan M**, Keesee AM, Pinto V, Mukundan R, Marchezi JP, Johnson J, Connor HK, Hampton D (2022, December). Forecasting of Extreme Ground Magnetic Field Fluctuations at Mid-Latitudes using Machine Learning *American Geophysical Union Fall Meeting, Chicago IL* (Poster)

11. Li-Lian A, Asthana M, **Coughlan M**, Tarcar SK, Bhagwanani S, Mehta M (2022, September). Targeting Residential Areas For Retrofit. *Learning and Doing Data for Good, Seattle WA* (Poster)

12. Li-Lian A, Asthana M, **Coughlan M**, Tarcar SK, Bhagwanani S, Mehta M (2022, August). Targeting Residential Areas For Retrofit. *Data Science for Social Good Datafest, London UK* (Poster)

13. **Coughlan M**, Keesee AM, Pinto V, Mukundan R, Johnson J, Connor H (2022, March). Using a Convolutional Neural Network with Uncertainty to Forecast GIC Risk of Occurrence at Mid-Latitudes. *Machine Learning in Heliophysics Conference, Boulder CO* (Poster)

14. **Coughlan M**, Keesee AM, Pinto V, Mukundan R, Johnson J, Connor H (2021, December). Using Convolutional Neural Networks and Long- Short Term Machine Learning Models to Provide Insights into GIC Drivers and Risk of Occurrence. *American Geophysical Union Fall Meeting, New Orleans, LA.* (Poster)

15. **Coughlan M**, Keesee AM, Pinto V, Mukundan R, Connor H, Johnson J (2021, July). Using OMNI and SuperMag Data to Determine the Risk of dB/dt Threshold Exceedance with Long-Short Term Memory and Convolutional Neural Networks *Geospace Environment Modeling Summer Workshop, Virtual Conference* (Oral Presentation)

16. **Coughlan M**, Keesee AM, Pinto V, Mukundan R, Connor H, Johnson J (2021, July). Using OMNI and SuperMag Data to Determine the Risk of dB/dt Threshold Exceedance with Deep Learning *Geospace Environment Modeling Summer Workshop, Virtual Conference* (Poster)

17. **Coughlan M**, Keesee AM, Pinto V, Connor H, Johnson J (2021, February). Using an LSTM and Classification Methods to Determine Risk of dB/dt Threshold Crossings as Proxy for Geomagnetically Induced Currents *Second AI and Data Science Workshop for Earth and Space Sciences, Virtual Conference* (Poster)

18. **Coughlan M**, Keesee AM, Pinto V, Connor H, Johnson J (2021, January). Using Machine Learning and Geomagnetic Storm Data to Determine the Risk of GIC Occurrence *American Meteorological Society 101st Annual Meeting, Virtual Conference* (Poster)

19. **Coughlan M**, Keesee AM, Pinto V, Connor H, Johnson J (2020, December). Using Machine Learning and Geomagnetic Storm Data to Determine the Risk of GIC Occurrence *American Geophysical Union Fall Meeting, Virtual Conference* (Lightning Presentation)

20. **Coughlan M**, Keesee AM, Pinto V, Johnson J, Connor H (2020, July). Training a Neural Network using Geomagnetic Storm Data to Predict Ground Magnetic Field Fluctuations *American Geophysical Union Fall Meeting, Virtual Conference* (Lightning Presentation)

Invited Talks

Coughlan M, Keesee AM, Pinto V, Mukundan R, Marchezi JP, Johnson J, Adewuyi M, Tibbetts J, Connor HK, Hampton D (2024, October). Probabilistic Predictions of Geomagnetic Field Perturbations and Using Explainability Methods to Uncover Drivers of the Localization Effect *Geomagnetically Induced Currents Workshop, College Park, MD*

Coughlan M, Keesee AM, Pinto V, Mukundan R, Marchezi JP, Johnson J, Connor HK, Hampton D (2023, July). Ground Magnetic Perturbation Predictions Using Machine Learning and Interpretability Methods. *Magnetosphere Online Seminars, Online Seminar*

Awards

- Student Presentation Award - Best Solar Wind-Magnetosphere Interaction Poster
  Geospace Environment Modeling Summer Workshop 2023

Seminar Series

Machine Learning In Space Physics
Created and directed a seminar series that invites leading experts in data science and machine learning to enrich the understanding of graduate students and postdocs specializing in space physics. The series was designed to address the gap between their extensive understanding of the space physics domain and the growing demand for proficiency in data science and machine learning techniques within their field. By fostering these interactions, the seminar series aims to facilitate a comprehensive learning experience and nurture meaningful, cross-disciplinary connections between experts and emerging talents in the sciences.

Teaching

- **Teaching Assistant** at University of New Hampshire Physics Department 2018-2019 Academic Year
  General Physics II (PHYS 408)

Skills

- **Programming Languages:** Python, C++, Mathematica, Matlab, C
- **Machine Learning/Deep Learning:** Long-Short Term Memory(LSTM), Convolutional Neural Networks, Artificial Neural Networks, Logistic Regression, Decision Trees, Auto-Encoders
- **Interpersonal/Teamwork:** Public Speaking, Time Management, Diplomacy, Customer Service, Delegation, Project Management
- **Microsoft Office:** Word, Excel, Powerpoint
- **Miscellaneous:** Pandas, Numpy, Pytorch, Latex, Git, SciKit-Learn, Tensorflow, ROOT, COMSOL Multiphysics, MacOS, Linux, Slurm Linux batching system, GEANT4 simulation software

Languages

- **English:** Fluent
- **Spanish:** Beginner

Projects

Machine Learning Algorithms for Geomagnetically Induced Currents in Alaska and New Hampshire (MAGICIAN) (2019-Current)
Dynamic interaction between solar wind and the Earth's magnetosphere can create strong geomagnetic field disturbances on the ground and trigger Geomagnetically Induced Currents (GICs). GICs can cause dramatic space weather impact such as damage to high-voltage power transformers and increased corrosion of pipelines. Machine Learning Algorithms for Geomagnetically Induced Currents in Alaska and New Hampshire (MAGICIAN) is a joint team between the University of Alaska Fairbanks and the University of New Hampshire that applies Machine Learning techniques to the ever-growing space science data for improving our understanding and prediction of hazardous GICs.

Targeting Residential Areas For Retrofit (2022)
The collaborative project I participated in as a Data Science for Social Good Fellow in 2022, led jointly by the University of Warwick and the Alan Turing Institute, focused on leveraging machine learning and data science techniques to address the urgent need for targeted retrofitting to combat climate change and promote energy efficiency. Our project was driven by the West Midlands Combined Authority and Pure Leapfrog's commitment to reducing carbon emissions and achieving sustainability goals. With a focus on filling in missing Energy Performance Certificate (EPC) ratings for homes in the region, we harnessed the power of publicly available government data and private sources to implement advanced machine learning models. These models enabled predictions of missing EPC ratings, empowering cost effective retrofitting initiatives that significantly reduced energy consumption and carbon emissions. We also assessed the impact of transitioning from fossil fuel burning heat sources to electric heat pumps on the electricity network, guiding the identification of necessary infrastructure upgrades to support a sustainable transition. Through collaborative teamwork involving data scientists, policymakers, and stakeholders, our project contributed to the UK's ongoing efforts to combat climate change and create a more sustainable future.

Workshops/Schools Attended

Geomagnetically Induced Currents Workshop 2024
College Park MD, October 2024
Artificial Intelligence for Fundamental Interactions Summer School 2024
Cambridge MA, September 2024
Geospace Environment Modeling (GEM) 2024
Ft. Collins CO, June 2024
Geospace Environment Modeling (GEM) 2023
San Diego CA, June 2023
Geospace Environment Modeling (GEM) 2021 Virtual Workshop
Virtual Workshop, July 2021
Geospace Environment Modeling (GEM) 2020 Virtual Workshop
Virtual Workshop, July 2020
The First Artificial Intelligence Data Analysis (AIDA) School for Heliophysicists
Bologna, Italy, January 2020

Extracurricular Activities

- Physics Club - Vice President 2015–2017
  Scheduled guest presenters and coordinated group activities
- Philadelphia Phoenix Professional Ultimate Frisbee Team - Player 2013