SEBASTIAN H. M. HICKMAN

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EDUCATION

University of Cambridge

PhD, AI for Environmental Risks Centre for Doctoral Training (AI4ER CDT) 2021 - 25
Yusuf Hamied Department of Chemistry
Understanding ozone and climate with deep causal machine learning
PhD fully funded by the Engineering and Physical Sciences Research Council.
Supervisors: Prof. Alex Archibald, Prof. Peer Nowack, Dr Paul Griffiths

MRes, AI4ER CDT 2020 - 21
Departments of Computer Science and Earth Sciences
Courses: Probabilistic Machine Learning, Machine Learning in the Physical World, Advanced Machine Learning

MSci, Natural Sciences (Physical Chemistry) 2019 - 20
Courses: Computer Simulation Methods in Physics, Atmospheric Chemistry and Global Change
Earth System and Climate Change, Energy Landscapes and Soft Matter, Polymers, Diffraction

BA, Natural Sciences 2016 - 19
Courses: Maths, Physics, Chemistry, Earth Sciences, Scientific Computing

RELEVANT RESEARCH EXPERIENCE

Causal representation learning for climate model emulation Mar. to Aug. 2024
Internship with Prof. David Rolnick, Mila - Quebec AI Institute, Montreal, Canada

- Implemented probabilistic generative models for emulating climate models across forcings
- Algorithmic improvement of novel dynamic variational autoencoder architectures in PyTorch
- Developing methods for improved roll-out of probabilistic generative models

AtmoRep testing and MLAir development Sep. to Nov. 2023
Helmholtz Visiting Researcher with Prof. Martin Schultz, Forschungszentrum Jülich, Germany

- Testing the AtmoRep model and codebase, and contribution to documentation
- Large-scale computing on some of Europe's most powerful HPC facilities

PhD research 2021 to 2024
University of Cambridge, UK

- Substantial experience researching building and deploying machine learning for forecasting ozone and climate
- Implemented efficient multi-GPU training of transformers and variational autoencoders in PyTorch
- Practical experience with physically-based numerical atmospheric chemistry modelling
- Developed initial code and contributed to an open-source Python package, detectree2
- Mentored multiple masters students in machine learning research projects

TECHNICAL SKILLS

Languages	Python, Julia, R, French (learning!)
Libraries	PyTorch, xarray, netcdf, dask, PyTorch Lightning, scikit-learn, NumPy, pandas, zarr, DoWhy

PUBLICATIONS

5 peer-reviewed papers published, 4 first/joint-first author publications. Particularly relevant papers are 'Causal representation learning for climate model emulation', 'Short-term forecasting of ozone air pollution in Europe with transformers' and 'Accurate delineation of individual tree crowns in tropical forests from aerial RGB imagery using Mask R-CNN.'.

Hickman, S.H.M.*, J. Boussard, C. Lange, I. Trajkovic, Griffiths, P. T., Nowack, P. J., Gurwicz, Y., Rolnick, D., 2024. Causal representation learning for climate model emulation.
In prep.

Hickman, S.H.M.*, Griffiths, P. T., Nowack, P. J. and Archibald, A.T., 2024. Observation-driven estimate of the ozone-climate penalty with double machine learning.
Uncertainty in Artificial Intelligence 2024: Causal Inference for Time Series Data Workshop.

Hickman, S.H.M.*, Griffiths, P. T., Nowack, P. J. and Archibald, A.T., 2023. Short-term forecasting of ozone air pollution in Europe with transformers.
Environmental Data Science.
Also in NeurIPS 2022: Workshop on Tackling Climate Change with Machine Learning.

Hickman, S.H.M.*, Ball, J.G.C.*, Jackson, T.D.*, Koay, X.J., Hirst, J., Jay, W., Aubry-Kientz, M., Vincent, G. and Coomes, D.A., 2023. Accurate delineation of individual tree crowns in tropical forests from aerial RGB imagery using Mask R-CNN.
Remote Sensing in Ecology and Conservation.
[Paper] [Code] [Package] [Binder]

Sun, H.Z., Yu, P., Lan, C., Wan, M.W., **Hickman, S.H.M.**, Murulitharan, J., Shen, H., Yuan, L., Guo, Y. and Archibald, A.T., 2022. Cohort-based long-term ozone exposure-associated mortality risks with adjusted metrics: A systematic review and meta-analysis.
The Innovation.

Pettit, M.H.*, **Hickman, S.H.M.***, Khanduja, V., 2023. Development of machine learning algorithms to predict attainment of minimal clinically important difference after hip arthroscopy with UK National Registry Data.
Arthroscopy.

Watson, M.L., **Hickman, S.H.M.**, Dreesbeimdiek, K.M., Stubbs, D.J., Kohler, K., 2023. Directed acyclic graphs in perioperative observational research – a systematic review and critique against best practice recommendations.
PLOS One.

See my Google Scholar for a full list of publications and conference papers.

CONFERENCE PRESENTATIONS AND INVITED TALKS

LEAP STC, Columbia University (Invited)	September 2024
Learning causal representations of climate model data	*New York*
Large-Scale Deep Learning for the Earth System Workshop	August 2024
Learning causal representations of climate model data	*Bonn*
Uncertainty in Artificial Intelligence, CI4TS Workshop	July 2024
Observation-driven estimate of the ozone-climate penalty with double machine learning.	*Barcelona*
Department of Informatics, Karlsruhe Institute of Technology (Invited)	December 2023
Machine learning and causal inference in air pollution studies	*Karlsruhe*
IEK7, Jülich Supercomputing Centre (Invited)	October 2023
Causal learning in atmospheric science	*Jülich*
EGU: Machine Learning for Climate Science (Highlight Talk)	April 2023
Using reduced representations of atmospheric fields to quantify the causal drivers of air pollution	*Vienna*

Machine Learning for Air Quality Workshop
Forecasting ozone air pollution with transformers

March 2023
Cologne

UCL AI Centre: AI for Sustainability Workshop (Invited)
Forecasting ozone air pollution with transformers

January 2023
London

AAAI Symposium: The Role of AI in Responding to Climate Challenges
Predicting daily surface ozone air pollution with transformers

November 2022
Washington D.C.

Transformers for Environmental Science
Transformers show high skill in forecasting atmospheric ozone pollution in Europe

September 2022
Magdeburg

Conference on Environmental Data Science
Predicting ozone air pollution in Europe with temporal deep learning

July 2022
Lancaster

EGU: Machine Learning for Earth System Modelling
Can simple machine learning methods predict concentrations of OH better than state of the art chemical mechanisms?

May 2022
Vienna

NCEO: Researcher's Forum (Invited)
Introducing Detectree: accurate individual tree crown delineation with RGB imagery

March 2022
Leicester

British Hip Society: Annual Scientific Meeting
Can machine learning algorithms predict which patients will achieve MCID after arthroscopic management of femoroacetabular impingement?

March 2022
Bournemouth

Invenia Labs: Research Lab (Invited)
Forecasting ozone air pollution: approaches and challenges

January 2022
Cambridge

The Alan Turing Institute: Environmental Sensors Project (Invited)
Accurate individual tree crown delineation with Mask R-CNN

October 2021
London

AWARDS AND GRANTS

Internship - Causal Climate Emulation Team
Mila - Quebec AI Institute, Canada
Funded internship to work with Professor David Rolnick at Mila in Montreal.

2024
£10,000

Helmholtz Visiting Researcher Grant
Forschungszentrum Jülich, Germany
Grant from the Helmholtz Information and Data Science Academy to visit Professor Martin Schultz to work on AtmoRep, a large-scale ML model of atmospheric dynamics, and MLAir.

2023
£10,000

Enrichment Scheme
The Alan Turing Institute, London
Awarded a place on the Turing's Enrichment Scheme, with a 9 month placement at the Alan Turing Institute in London. Collaborated with researchers at the Institute focusing on applying causal methods to questions in atmospheric chemistry.

2022-23
£7,000

Accelerate Programme for Scientific Discovery
Department of Computer Science, University of Cambridge
Funding initiated a project focussed on building a UK-based community of researchers working on causal methods. The funding allowed us to run a workshop on causal machine learning in the environmental sciences, CMES.

2022
£7,500

AI4ER Centre for Doctoral Training
University of Cambridge
Place on the AI4ER Centre for Doctoral Training at the University of Cambridge, fully funded by the UK Engineering and Physical Sciences Research Council.

2020-25
£120,000

Postgraduate Research Fund
Corpus Christi College

2022, 2024

Awarded research grant to attend and present at the British Hip Society Annual Scientific Meeting, and to visit NIES.

Undergraduate Travel Grant 2017
Corpus Christi College
Travel grant to study in Paris.

Frisby Fund & Hawks' Trust Grants 2017-20
Corpus Christi College & The Hawks' Trust
Awarded for academic and sporting achievement as an undergraduate.

PROFESSIONAL SERVICE

Conference Organisation

Probabilistic Approaches in Weather and Climate Workshop May 2023
Program Chair and Member of Scientific Organising Committee
AIMS, Kigali, Rwanda

- Co-organised the 1st workshop on Probabilistic Approaches in Weather and Climate at AIMS in Rwanda. Invited by Professor Marc Deisenroth to be a member of the Scientific Organising Committee, and Program Chair.

Causal Methods in Environmental Science Workshop December 2022
Chair of the Scientific Organising Committee
Department of Computer Science, University of Cambridge

- Independently won funding for and organised a workshop on Causal Methods in Environmental Science at the Department of Computer Sciences at the University of Cambridge. Consistent engagement with the funder to meet their priorities. Invited keynote speakers and moderated group discussions.

Organisation

Co-Chair, Machine Learning for Tropospheric Ozone (ML4O3) Working Group 2023 - 2024
Tropospheric Ozone Assessment Report, Phase II (TOAR-II)

Organised causal reading groups in the Department of Computer Science and at The Alan Turing Institute. 2023
Organised ML for Atmospheric Science reading group in the Centre for Atmospheric Science, Cambridge. 2022

Reviewing

JGR: Atmospheres, NeurIPS: Tackling Climate Change with Machine Learning Workshop, ICLR: Tackling Climate Change with Machine Learning Workshop, Artificial Intelligence for the Earth System, Atmospheric Chemistry and Physics, Environmental Data Science

ADDITIONAL EXPERIENCE

Research Supervision

MSci Research Projects
University of Cambridge

Evaluation of UKESM1 tropospheric ozone using in-situ observations in remote marine environments 2023 - 24
Machine learning analysis of the impact of blocking events on air quality 2022 - 23
How Do Synoptic Scale Circulation Phenomena Affect Air Quality? 2021 - 22
Awarded **Unilever Prize** for best physical chemistry project.

Bachelors Thesis
Karlsruhe Institute of Technology
Causal Discovery with Single-Parent Decoding on Synthetic Ground-Truth Datasets 2024

Undergraduate Research Project
University of Cambridge
Optimisation and Evaluation of Detectree and Mask R-CNN 2021

Teaching

Atmospheric chemistry and global change 2022, 2023
MSci Natural Sciences
Taught Masters level course covering atmospheric chemistry and dynamics to students in small supervision groups.

Chemistry in the atmosphere 2022
BA Natural Sciences
Taught 3rd year undergraduate course to students in small supervision groups.

Workshop teaching

Data science and big data analytics 2023
HPSC Summer School, University of Bonn
Prepared code materials and delivered workshop on data science and big data to 30 research students alongside Dr Martin Schultz.
[Code]

Causal inference and discovery 2022, 2023, 2024
AI4ER CDT, University of Cambridge
Delivered a workshop on causal inference and discovery to MRes students on the AI4ER CDT.
[Code]

Machine learning for climate science 2022
Cambridge Centre for Climate Science
Alongside two other graduate students, organised and delivered a workshop introducing machine learning to researchers in the atmospheric sciences with interactive sessions and a hackathon implementing ML on real world atmospheric data.
[Code]

Activities

President 2021 - 22
Cambridge University Artificial Intelligence Society

- Led and directed CUAI, a University society of 1200 members. Pitched for and secured sponsorship for the society for the first time, raising £25k total from organisations including DeepMind, Microsoft Research and Amazon Research.
- Coordinated society activities including invited talks, workshops and projects. Co-organised the 1st Cambridge AI in Drug Discovery Conference, with 9 speakers and 1000 online participants.

Captain 2018 - 19
Cambridge University Golf Club

- Led and directed CUGC, one of the nine Full Blue clubs at Cambridge. Organised the activities of the club including funding, fixtures and training, managing £30k of funds and securing an increase of £1.5k in total funding.

REFEREES

Referees are available on request.