PAULA HARDER

scholar github.com/paulaharder paulaharder.github.io paula.harder@mila.quebec

EDUCATION

University of Kaiserslautern, Kaiserslautern, Germany — *Oct 2020 - ongoing*
Ph.D. Computer Science: Physics-constrained deep learning for climate modeling
Thesis submitted. Expected defense November 2024

University of Oxford, Oxford, UK — *Oct 2021 - Dec 2021*
Student visitor at the Climate Processes group

University of Tübingen, Tübingen, Germany — *Oct 2017 - Sep 2019*
M.S. Mathematics, specialization in numerical analysis, Grade: 1.0^1

University of Tübingen, Tübingen, Germany — *Oct 2014 - Sep 2017*
B.S. Mathematics, Grade: 1.2^1

[1]German grading system: 1.0 (best) to 5.0 (worst)

RESEARCH/WORK EXPERIENCE

Mila Quebec AI Institute, Montreal, Canada — *Febr 2024 - ongoing*
Researcher generalizable DL for climate and weather

Fraunhofer Institute for Industrial Mathematics, Kaiserslautern, Germany — *Jul 2020 - Dec 2023*
Research in adversarial DL and DL for climate science

Allen Institute AI2, Seattle, USA — *Jun 2023 - Sep 2023*
Internship with climate modeling team, reservoir computing for ocean modelling

Mila Quebec AI Institute, Montreal, Canada — *Jan 2022 - May 2022*
Research intern, working on physics-constrained DL for climate downscaling

University of Oxford, Oxford, UK — *May 2022 - Oct 2022*
Visiting researcher, researching physics-constrained emulation of aerosol microphysics

Frontier Development Lab ESA, remote — *Jun 2022 - Aug 2022*
Team Lead, leading a team on DL for thunderstorm prediction during wildfires

Frontier Development Lab NASA, remote — *Jun 2021 - Aug 2021*
Machine Learning Scientist, DL for lunar super-resolution

TWT Science and Innovation, Stuttgart, Germany — *Nov 2019 - May 2020*
Junior Development Engineer, developed software in Python, Matlab, applied ML for automotive sector

DigSILENT, Gomaringen, Germany — *Jul 2018 - Oct 2018*
Research intern, simulation of electrical networks

German Climate Computation Center, Hamburg, Germany — *Feb 2018 - Apr 2018*
Student Research Assistant, performance prediction with Python

AWARDS

E-fellows scholarship — *from Nov 2022*
German online scholarship for high-potential students

Poster Award, Climate Informatics Conference — *May 2022*

Fraunhofer Doctoral Scholarship — *from Jul 2020*
Funding for independent research in AI for climate science

Germany Scholarship (Deutschlandstipendium) — *2018*
Award for high-achieving students

Germany Scholarship (Deutschlandstipendium) *2015*
Award for high-achieving students

JOURNAL/CONFERENCE PUBLICATIONS

1. Hard-Constrained Deep Learning for Climate Downscaling *2023*
Journal of Machine Learning Research (JMLR).
Paula Harder, Venkatesh Ramesh, Alex Hernandez-Garcia, Qidong Yang, Prasanna Sattigeri, Daniela Szwarcman, Campbell Watson, David Rolnick

2. Enhancing Regional Downscaling Through Advances in Machine Learning *2023*
Artificial Intelligence for the Earth Systems Journal.
Neelesh Rampal, Sanaa Hobeichi, Peter B. Gibson, Jorge Baño-Medina, Tom Beucler, Jose González-Abad, Gab Abramowitz, William Chapman, **Paula Harder**, José Manuel Gutiérrez

3. Physics-Informed Learning of Aerosol Microphysics *2022*
Environmental Data Science Journal (EDS).
Paula Harder, Duncan Watson-Parris, Philip Stier, Dominik Strassel, Nico Gauger, Janis Keuper

4. ClimateBench: A benchmark dataset for data-driven climate projections *2022*
Journal of Advances in Modeling Earth Systems (JAMES).
Duncan Watson-Parris, Yuhan Rao, Dirk Olivié, Øyvind Seland, Peer J Nowack, Gustau Camps-Valls, Philip Stier, Shahine Bouabid, Maura Dewey, Emilie Fons, Jessenia Margarita Marina Gonzalez, **Paula Harder** et al.

5. Super-Resolution of Lunar-Satellite Images for Enhanced Robotic Traverse Planning *2022*
IEEE Robotics and Automation Journal.
Jose Delgado-Centeno, **Paula Harder**, Ben Moseley, Valentin Bickel, Siddha Ganju, Miguel Olivarez, Freddie Kalaitzis

6. SpectralDefense: Detecting Adversarial Attacks on CNNs in the Fourier Domain *2021*
International Joint Conference on Neural Networks (IJCNN).
Paula Harder, Margret Keuper, Franz-Josef Pfreundt, Janis Keuper

7. Error estimates for the Cahn–Hilliard equation with dynamic boundary conditions *2020*
IMA Journal of Numerical Analysis.
Paula Harder*, Balázs Kovács*

WORKSHOP PAPERS (PEER-REVIEWED)

8. Evaluating the transferablity potential of deep learning models for climate downscaling *2024*
International Conference on ML (ICML) Workshop Tackling Climate Change with ML.
Ayush Prasad, **Paula Harder**, Qidong Yang, Prasanna Sattigeri, Daniela Szwarcman, Campbell Watson, David Rolnick

9. A CNN for the Spatial Downscaling of Global Aerosol Optical Depth *2024*
International Conference on Learning Representations (ICLR) Workshop Tackling Climate Change with ML.
Josh Millar, **Paula Harder**, Lilli Freischem, Philip Stier

10. Multi-variable hard physical constraints for climate model downscaling *2023*
Association for the Advancement of Artificial Intelligence (AAAI) Fall Symposium.
Jose Gonzalez-Abad, Alex Hernandez-Garcia, **Paula Harder**, David Rolnick, José Manuel Gutiérrez

11. Fourier Neural Operators for Arbitrary Resolution Climate Data Downscaling *2023*
ICLR Workshop Tackling Climate Change with Machine Learning.
Qidong Yang, **Paula Harder**, Venkatesh Ramesh, Alex Hernandez-Garcia, Prasanna Sattigeri, Daniela Szwarcman, Campbell Watson, David Rolnick

12. Climate Variable Downscaling with Conditional Normalizing Flows *2023*
Neural Information Processing Systems (NeurIPS) Workshop Tackling Climate Change with AI.
Christina Winkler, **Paula Harder**, David Rolnick

13. Identifying causes of Pyrocumulonimbus (PyroCb) *2022*
NeurIPS Workshop Causal ML for Impact.
Emiliano Díaz Salas-Porras, Kenza Tazi, Ashwin Braude, Daniel Okoh, Kara Lamb, Duncan Watson-Parris, **Paula Harder**, Nis Meinert

14. Pyrocast: a Machine Learning Pipeline to Forecast Pyrocumulonimbus (PyroCb) clouds *2022*
NeurIPS workshop Tackling Climate Change with ML.
Kenza Tazi, Emiliano Díaz Salas-Porras, Ashwin Braude, Daniel Okoh, Kara Lamb, Duncan Watson-Parris, **Paula Harder**, Nis Meinert

15. Generating physically-consistent high-resolution climate data with hard-constrained neural networks *2022*
AAAI 2022 Fall Symposium: The Role of AI in Responding to Climate Challenges &
NeurIPS Workshop Tackling Climate Change with ML.
Paula Harder, Qidong Yang, Venkatesh Ramesh, Prasanna Sattigeri, Alex Hernandez-Garcia, Campbell Watson, Daniela Szwarcman, David Rolnick

16. Single Image Super-Resolution with Uncertainty Estimation for Lunar Satellite Images *2021*
NeurIPS Workshop Deep Generative Models Applications and ML for Physical Sciences.
Jose Delgado-Centeno*, **Paula Harder***, Ben Moseley, Valentin Bickel, Siddha Ganju, Miguel Olivarez, Freddie Kalaitzis

17. Emulating Aerosol Microphysics with Machine Learning *2021*
ICML Workshop Tackling Climate Change with AI.
Paula Harder, Duncan Watson-Parris, Dominik Strassel, Nico Gauger, Philip Stier, Janis Keuper

18. Detecting AutoAttack Perturbation in the Frequency Domain *2021*
ICML Workshop Adversarial Machine Learning.
Peter Lorenz, **Paula Harder**, Dominik Strassel, Margret Keuper, Janis Keuper

19. NightVision: Generating Nighttime Satellite Imagery from Infra-Red Observations *2020*
NeurIPS Workshop Tackling Climate Change with AI.
Paula Harder, William Jones, Redouane Lguensat, Shahine Bouabid, James Fulton, Dánell Quesada-Chacón, Aris Marcolongo, Sofija Stefanović, Yuhan Rao, Peter Manshausen, Duncan Watson-Parris

OTHER WORKS

A Benchmark Dataset for Meteorological Downscaling *2024*
Proposal at ICLR Workshop Tackling Climate Change with ML.
Michael Langguth, **Paula Harder**, Irene Schicker, Ankit Patnala, Sebastian Lehner, Konrad Mayer, Markus Dabernig

Reservoir Computing for Sea Surface Temperature Prediction in Earth System Digital Twins *2023*
Abstract at American Geophysical Union (AGU) Fall meeting.
Paula Harder, Anna Kwa, Andre Perkins, Christopher Bretherton

Fourier Neural Operators for Arbitrary Resolution Climate Data Downscaling *2023*
Under review at JMLR.
Qidong Yang, **Paula Harder**, Venkatesh Ramesh, Alex Hernandez-Garcia, Prasanna Sattigeri, Daniela Szwarcman, Campbell Watson, David Rolnick

Climate Model Downscaling in Central Asia: A Dynamical and a Neural Network Approach *2023*
Under review at Geophysical Model Development (GMD) Journal.
Bijan Fallah, Christoph Menz, Emmanuele Russo, **Paula Harder**, Peter Hoffmann, Iulii Didovet, Fred F. Hattermann

MENTORING AND TEACHING

Co-Supervision, Mila Quebec AI Institute *2022-ongoing*
Co-supervision of five interns/master students working on downscaling related research projects
Co-Supervision, University of Oxford *2023*
Supervising two students (master/PhD) during summer research projects.
NeurIPS Climate Change AI Mentor *2023*
Supervision of three researchers to help submit to the CCAI NeurIPS workshop.
Frontier Development Lab Team Lead *2022*
Co-leading a team of four PhD and postdoctoral researcher during a 9-week research sprint.
Teaching assistant, Numerical analysis, University of Tuebingen *2018*
15-week class
Teaching 18 students
Responsibilities:

- Teaching weekly 2h exercise class.
- Providing lecture recaps.
- Preparating sample solutions.
- Coordinating meeting with other teachers.
- Correcting exercise submissions.
- Correcting final examiation.

TALKS

Invited talk, AI2 Environmental Seminar	*Jul 2024*
Invited talk, ICLR Workshop AI for Differential Equations	*May 2024*
Poster presentation, ICLR main conference	*May 2024*
Invited talk, International Aerosol Modeling Algorithms Conference	*Dec 2024*
Invited talk, ECMWF Maelstroem Dissamination Workshop	*Nov 2023*
Invited talk, LEAP Seminar, NYU	*Oct 2023*
Invited talk, ECMWF Seminar	*Oct 2023*
Invited talk, TUHH Hamburg, Numerical Analysis Seminar	*Oct 2023*
Contributed talk, EGU Meeting	*April 2023*
Contributed talk, Climate Informatics Conference	*April 2023*
Invited talk, Media Education 360 degree	*Febr 2023*
Invited talk, UCL Workshop AI for sustainability	*Jan 2023*
Poster presentation, AGU Fall Meeting	*Dec 2022*
Contributed talk, WiML workshop NeurIPS	*Dec 2022*
Poster presentation, CCAI workshop NeurIPS	*Dec 2022*
Contributed talk, AAAI 2022 Fall Symposium, The Role of AI in Responding to Climate Challenges	*Nov 2022*
Scientific Computing Seminar, University of Kaiserslautern	*May 2022*
Poster presentation, Climate Informatics Conference	*May 2022*
Invited talk, ECMWF Machine Learning Workshop	*Mar 2022*
Contributed talk, International Aerosol Modeling Algorithms Conference	*Dec 2021*
FDL USA 2021, Digital Showcase	*Aug 2021*
Seti live: A mission to the South Pole of the Moon	*Jul 2021*
Poster presentation, ICML 2021	*Jul 2021*
Scientific Computing Seminar, University of Kaiserslautern	*May 2021*
Deep Learning Seminar talk, Fraunhofer ITWM	*Apr 2021*
Poster presentation, NeurIPS 2020	*Dec 2020*
Deep Learning Seminar talk, Fraunhofer ITWM	*Dec 2020*

PROFESSIONAL SERVICE

Reviewing, Climate Dymanics	*2024*
Reviewing, Journal of Advances in Modeling Earth Systems (JAMES)	*2024*
Scientific Commitee, ML4ESM ICML Workshop	*2024*
Scientific Commitee, ESA Super-Resolution Workshop	*2024*
Reviewing, ICML	*2024*
Reviewing, ICLR	*2024*
Reviewing, ML for Physical Sciences, NeurIPS	*2023*
Mentor, NeurIPS CCAI Workshop	*2023*
Reviewing, NeurIPS	*2023*
Reviewing, SynS and ML, ICML Workshop	*2023*
Focus Lead, Earth System Predictability Forum (ESP)	*2023*
Reviewing, Artificial Intelligence for the Earth Systems (AI4ES)	*2023*
Reviewing, ML for Physical Sciences, NeurIPS	*2022*
Reviewing, Atmospheric Chemistry and Physics (ACP)	*2022*
Session Chair, Climate Informatics Conference	*2022*
Reviewing, Journal of Advances in Modeling Earth Systems (JAMES)	*2022*
Reviewing, Climate Informatics Conference	*2022*
Volunteer, WiML Un-Wokshop ICML	*2021*

HACKATHONS

Climate Informatics Hackathon, Drought Forecasting *2022*
Co-organizer, supported participants for one week of coding ML methods in Python

3rd NOAA AI Workshop Hackathon, Climate Model Emulation *2021*
Three days of developing a CNN emulator for long-term climate prediction, Winning team 🏆

FZML Hackathon 2021, Physics-Informed Neural Networks *2021*
Two weeks of developing PINNs with flexible initial conditions in Tensorflow

Met Office Hackathon Challenge, Support the most vulnerable communities *2021*
Three days of developing methods and ideas for helping for an early-warning system for heatwaves

Climate Crisis AI Hackathon, AI Artist Challenge *2021*
Two days of development using Python/PyTorch to create AI Art, Winning team 🏆

AI for Climate Hackathon, Forest Fire Challenge *2021*
Three days of developing an ML algorithm in Python with Sklearn to predict forest fires, Winning team 🏆

AI Chess Competition *2019*
Two weeks of programming an AI in Java which competes against other AIs in chess, Winning team 🏆

PUBLICITY

Interview with Computer Vision News, *Hard-Constrained Climate Downscaling*	*Jul 2024*
Article Fraunhofer Annual Reports, *Small particles with big impact: aerosols in climate models*	*Oct 2022*
Interview with AI Hub, *Super-resolution for climate data with physics-based constraints*	*Aug 2022*
Interview with Fraunhofer Innovisions, *25 Years of Fraunhofer ITWM*	*Oct 2021*

SUMMER SCHOOLS

Oxford Machine Learning Summer School, remote *Aug 2021 - Sept 2021*
Two weeks of advanced topics in ML in various areas of Sustainable Development Goals

Trustworthy Artificial Intelligence for Environmental Science Summer School, remote *July 2021*
One week of talks and workshops on explainable AI for environmental applications

VOLUNTEERING

Greenpeace Germany	*2015-2019*
Greenpeace Tübingen	*2014-2019*
German Alpine Club, Youth coach	*2014*

SKILLS

Languages:	German (native), English (fluent), Russian (basic)
Programming:	Python (proficient), Matlab (proficient), PyTorch (proficient)
	Tensorflow (basic), Java (basic), C/C++ (basic), Fortran (basic)