Tom Beucler

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Research Interests

Atmospheric Physics, Climate Informatics, Deep Learning, Environmental Fluid Dynamics, Tropical Meteorology.

Education

MIT Program in Atmospheres, Oceans, and Climate **2014 – 2019**
Ph.D. in Atmospheric Science: Interaction between Water Vapor, Radiation and Convection *Cambridge, USA*
Thesis committee: K. Emanuel (co-advisor), T. Cronin (co-advisor), P. O'Gorman, Z. Kuang, C. Bretherton.

École Polytechnique **2013 – 2014**
Master of Science in Mechanics *Palaiseau, France*
Major in fluid dynamics and environmental science.

École Polytechnique & Lycée Sainte-Geneviève **2009 – 2013**
Bachelor of Engineering *Versailles & Palaiseau, France*
Coursework in mechanics, physics, mathematics, chemistry and biology.

Academic Employment

University of Lausanne, Switzerland **2021 – Present**
Assistant Professor in Environmental Data Science *Lausanne, Switzerland*

University of California, Irvine **2019 – 2021**
Assistant Project Scientist in Atmospheric Science: Machine Learning for Climate Science *Irvine, USA*
Principal investigators: M. Pritchard and P. Gentine.

University of California, Irvine and Columbia University **2019**
Postdoctoral Scholar in Atmospheric Science: Deep Learning for Convection and Clouds *Irvine & NYC, USA*
Co-advisors: P. Gentine and M. Pritchard.

Awards

- (2021-Present) **Principal Investigator, Canton de Vaud funding for IDYST professors**: *∂^3AWN Lab at IDYST*. Awarded resources: $120,000/year (2 PhD students)
- (2021–Present) **Visiting scholar,** Earth System Science Department, UCI
- (2022) **AGU 2021 Editor's citation for excellence in refereeing**, Geophysical Research Letters
- (2021) **Invited Participant**, KITP Program on Machine Learning and the Physics of Climate at UCSB
- (2021) **AGU 2020 Editor's citation for excellence in refereeing**, Journal of Advances in Modeling Earth Systems
- (2020-2021) **Principal Investigator, Columbia University subaward**: *Physics-Guided Deep Learning for Climate Predictions*. Estimated value of awarded resources: $51,986
- (2020-2021) **Co-Investigator, XSEDE computational resources allocation**: *Simulating global climate with turbulence-permitting cloud superparameterization to train machine learning emulators and advance understanding of aerosol-cloud feedbacks*. Lead PI: Mike Pritchard. Estimated value of awarded resources: $2,025,427
- (2019–2021) **Visiting scholar,** Scripps Institution of Oceanography, UCSD
- (2019) **Rossby award for best doctoral thesis,** Program in Atmospheres, Oceans and Climate, MIT
- (2019) **Invited scholar,** Max Planck Institute for Meteorology
- (2019) **Summer fellow,** 2nd ICTP Summer School on Climate Dynamics and Convective Organization
- (2018) **Finalist of the "Climate Changed" @ MIT competition**, *Higher Grounds* at MIT
- (2018) **AGU 2017 Editor's citation for excellence in refereeing**, Geophysical Research Letters
- (2018) **Best poster prize (Water & Society)**, *Preparing MIT for 2050 Floodwaters* at the MIT Water Night
- (2018) **Graduate research fellow**, Program on Math. and Stat. Methods for Climate & the Earth System at SIAM Institute
- (2017) **Summer fellow**, Les Houches Summer School on Fundamental Aspects of Turbulent Flows in Climate Dynamics
- (2015) **Geophysical fluid dynamics fellow**, Woods Hole Oceanographic Institution
- (2014-2015) **Rasmussen fellow**, MIT Department of Earth, Atmospheric and Planetary Sciences
- (2014) **Outstanding master's thesis**, École Polytechnique

Peer-Reviewed Journal Publications and Book Chapters

- (2022) *Submitted, Preprint available,* Behrens, G., **T. Beucler** et al.: Non-Linear Dimensionality Reduction with a Variational Autoencoder Decoder to Understand Convective Processes in Climate Models.
- (2022) *Submitted, Preprint available,* Grundner, A., **T. Beucler** et al.: Deep Learning Based Cloud Cover Parameterization for ICON, *arXiv:2112.11317*.
- (2022) *Submitted, Preprint available*, **Beucler, T.** et al.: Climate-Invariant Machine Learning, *arXiv:2112.08440*.
- (2022) *In press, Preprint available,* **Beucler, T.** et al.: Machine Learning for Clouds and Climate (Invited Chapter for the AGU Geophysical Monograph Series: *Clouds and Climate*).
- (2021) Gentine, P., V. Eyring & **T. Beucler**: Deep Learning for the Parametrisation of Subgrid Processes in Climate Models, *Deep learning for the Earth Sciences: With Applications and R, Second Edition*, **307-314**.
- (2021) Griffin, M., M. Pritchard, **T. Beucler** et al.: Assessing the Potential of Deep Learning for Emulating Cloud Superparameterization in Climate Models with Real-Geography Boundary Conditions. *Journal of Advances in Modeling Earth Systems*, **13**, e2020MS002385.
- (2021) **Beucler, T.** et al.: Enforcing Analytic Constraints in Neural-Networks Emulating Physical Systems, *Physical Review Letters*, **126.9**: 098302. **Editors' Suggestion**.
- (2020) Brenowitz, N., **T. Beucler**, M. Pritchard & C. Bretherton: Interpreting and Stabilizing Machine-Learning Parametrizations of Convection, *Journal of the Atmospheric Sciences*, **77.12**, 4357-4375.
- (2020) **Beucler, T.**, D. Leutwyler & J. Windmiller: Quantifying Convective Aggregation Using the Tropical Moist Margin's Length, *Journal of Advances in Modeling Earth Systems*, **12.10**, e2020MS002092.
- (2020) Abbott, T., T. Cronin & **T. Beucler**: Convective Dynamics and the Response of Precipitation Extremes to Warming in Radiative–Convective Equilibrium, *Journal of the Atmospheric Sciences*, **77**, 1637-1660.
- (2019) **Beucler, T.**, T. Abbott, T. Cronin & M. Pritchard: Comparing Convective Self-Aggregation in Idealized Models to Observed Moist Static Energy Variability Near the Equator, *Geophysical Research Letters*, **46**, 17-18.
- (2019) **Beucler, T.**: Interaction between Water Vapor, Radiation and Convection in the Tropics, *Ph.D. Thesis in Atmospheric Science.*
- (2018) **Beucler, T.** & T. Cronin: A Budget for the Size of Convective Self-Aggregation, *Quarterly Journal of the Royal Meteorological Society*, **145**, 947– 966.
- (2018) **Beucler, T.**, T. Cronin & K. Emanuel: A Linear Response Framework for Radiative-Convective Instability, *Journal of Advances in Modeling Earth Systems*, **10**, 1924-1951.
- (2016) **Beucler, T.** & T. Cronin: Moisture-Radiative Cooling Instability, *Journal of Advances in Modeling Earth Systems*, **8**, 1620–1640.
- (2016) **Beucler, T.**: A Correlated Stochastic Model for the Large-Scale Advection, Condensation and Diffusion of Water Vapour. *Quarterly Journal of the Royal Meteorological Society*, **142**, 1721–1731.
- (2014) **Beucler, T.** & K. Emanuel: Self-Aggregation Phenomenon in Cyclogenesis, *Masters Thesis in Fluid Mechanics.*

Peer-Reviewed Conference and Workshop Publications

- (2022) *Submitted,* Wu, Z., **T. Beucler** et al.: Modeling Stratospheric Polar Vortex Variation and Identifying Vortex Extremes Using Explainable Neural Networks.
- (2021) Mangipudi, H., G. Mooers, M. Pritchard, **T. Beucler** & S. Mandt: Analyzing High-Resolution Clouds and Convection using Multi-Channel VAEs. *2021 Conference on Neural Information Processing Systems (Workshop).*
- (2020) **Beucler, T.** et al.: Towards Physically-Consistent, Data-Driven Models of Convection. *IEEE International Geoscience and Remote Sensing Symposium 2020.*
- (2020) Mooers, G., J. Tuyls, S. Mandt, M. Pritchard & **T. Beucler**: Generative Modeling of Atmospheric Convection. *Proceedings of the 10th International Conference on Climate Informatics*, 98-105.
- (2019) **Beucler, T.** et al.: Achieving Conservation of Energy in Neural Network Emulators for Climate Modeling. *2019 International Conference on Machine Learning (Workshop).*

Conference Presentations and Invited Seminars

AGCI Workshop on Machine Learning and Climate Science — **Jun 2022**
Invited Workshop Paper in the Category: Cross-cutting Challenges for ML Method Development — *Aspen, USA*

102nd AMS Annual Meeting; Postdam Institute for Climate Impact Research — **Jan 2022–Present**
Invited Presentation: Climate-Invariant, Causally-Informed Neural Networks — *Remote & Vienna, Austria*
- Also given at the ECMWF Machine Learning Workshop 2022
- Upcoming: 11th Climate Informatics Conference, EGU22

NCAR Climate & Global Dynamics; ESA-ECMWF Workshop 2021 — **May 2021–Present**
Invited Seminar: Atmospheric Physics-Guided Machine Learning — *Remote & Europe*
Also given at:
- Uni Bern Colloquium in Climatology, Climate Impacts & Remote Sensing
- ENS Lyon IXXI; AI Super-Resolution Simulations Workshop (CMU)
- LANL Machine Learning in Solid Earth Geoscience Lecture Series
- MIT Sack Lunch; Princeton PPPL Machine Learning Seminar Series
- MeteoSwiss; UCLA Atmospheric & Oceanic Sciences Departmental Seminar Series
- Caltech CliMA; EPFL Applied Machine Learning days 2022

AI2ES NCAR Summer School on Trustworthy AI — **July 2021**
Invited Tutorial: Integrating Physics into Machine Learning — *Remote*

SIAM MPE20 & 101st AMS Annual Meeting — **Aug 2020–Jan 2021**
Invited Presentations: Physical Rescalings Help Neural Networks Generalize Across Climates — *Remote*
Also given as a poster at the AGU Fall Meeting 2020

IEEE International Geoscience and Remote Sensing Symposium 2020 — **Apr 2020–Dec 2020**
Invited Webinar/Paper: Towards Physically-Consistent, Data-Driven Models of Convection — *Remote*
Also given at:
- NOAA Satellite Applications and Research Seminar Series
- 1st Annual Workshop on Knowlege-Guided Machine Learning (UMN)
- UCSD SIO Machine Learners Group Meeting & UCI Earth System Science Departmental Seminar Series

AGU Fall Meeting 2019 & 100th AMS Annual Meeting — **Dec 2019–Jan 2020**
Invited Presentation: Building a Hierarchy of Hybrid, Neural Network Models of Convection — *SF & Boston, USA*

AGU Fall Meeting 2019 & 100th AMS Annual Meeting — **Dec 2019–Jan 2020**
Poster & Presentation: Comparing Self-Aggregation in Models to Observed MSE Variability — *SF & Boston, USA*

UCLA Atmospheric & Oceanic Sciences, UCI Earth System Science Departmental Seminar Series — **Aug 2018–Jul 2019**
Invited Seminars: Interaction between Water Vapor, Radiation and Convection in the Tropics — *USA, France & Germany*
Also given at:
- MIT Sack Lunch Seminar; Yale Earth & Planetary Science
- ENS Paris Geosciences; LMU Munich Meteorology; MPI-Meteorology

International Conference on Machine Learning 2019. Climate Change: How Can AI Help? — **Jun 2019**
Workshop Paper: Achieving Conservation of Energy in Neural Network Emulators for Climate Modeling — *Long Beach, USA*

9th Northeast Tropical Workshop — **Jun 2019**
Presentation: Towards Interpretable Neural-Network Parametrizations of Convection — *Dedham, USA*

33rd Conference on Hurricanes and Tropical Meteorology — **Apr 2018**
Presentation: A Spectral Budget for the Size of Convective Self-Aggregation — *Ponte Vedra, USA*

Seminar in Geosciences, Université Pierre et Marie Curie — **Dec 2017**
Invited Seminar: A Spectral Budget for the Size of Convective Self-Aggregation — *Paris, France*

17th Conference on Mesoscale Processes — **Jul 2017**
Presentation: A Moist Static Energy Perspective on Atmospheric Rivers — *San Diego, USA*

21st Conference on Atmospheric and Oceanic Fluid Dynamics — **Jun 2017**
Presentation: The Vertical Structure of Radiative-Convective Instability — *Portland, USA*

Seminar in Geosciences, École Normale Supérieure — **Jan 2017**
Invited Seminar: Radiative-Convective Instability — *Paris, France*

2016 International Atmospheric Rivers Conference - CW3E, Scripps institution of oceanography — **Aug 2016**
Presentation: A Moist Static Energy Perspective on Atmospheric Rivers — *La Jolla, USA*

32nd Conference on Hurricanes and Tropical Meteorology — **Apr 2016**
Presentation: Instabilities of Radiative Convective Equilibrium with an Interactive Surface — *San Juan, USA*

Formal Mentoring Experience

Direct Research Supervision — **Aug 2021 – Present**, *Lausanne, Switzerland*

- (Aug 2021 – Present) Milton Gomez (PhD student at UNIL)
- (Aug 2021 – Present) Saranya Ganesh Sudheesh (Postdoctoral scholar at UNIL)
- (Sep 2021 – Present) Frederick Iat-Hin Tam (PhD student at UNIL)
- (Mar 2022 – Present) Deborah Bassotto (Post Masters intern at UNIL)

Technical Advising (Weekly to Biweekly Mentoring of Early-Career Scientists) — **Jul 2019 – Present**, *Europe & USA*

- (Feb 2022 – Present) Francesco Zanetta (PhD student at ETH/MeteoSwiss, Visiting student at UNIL)
- (Sep 2021 – Present) Costa Christopoulos (PhD student at Caltech, Thesis committee member)
- (Jul 2019 – Present) Arthur Grundner, Gunnar Behrens (PhD students at DLR)
- (Apr 2019 – Present) Griffin Mooers (PhD student at UC Irvine, Thesis committee member)
- (Dec 2019 – Jul 2021) Andrea Jenney (Postdoctoral fellow at UC Irvine)

Thesis Committee Member — **Sep 2021 – Present**, *Lausanne, Switzerland*

Janbert Aarnink (UNIL)

Teaching Experience

European Centre for Medium-Range Weather Forecasts — **Mar 2022 – Present**, *Remote*

Consultant, Reviewer, and Content Provider of "Machine Learning for Weather and Climate"

6-Week Massive Open Online Course targeted at anyone interested in both ML and weather/climate.

FGSE, University of Lausanne — **Jan 2022 – Present**, *Lausanne, Switzerland*

Main Instructor of "Machine Learning for Earth and Environmental Sciences"

Design and delivery of yearly 10-week course open to all Masters and PhD students in Earth/env. sciences & geography.

MIT Teaching and Learning Laboratory — **Feb 2017 – May 2017**, *Cambridge, USA*

Kaufman teaching certificate program

Program for MIT graduate students aimed at improving teaching skills.

PAOC, MIT — **Feb 2016 – May 2016**, *Cambridge, USA*

Teaching Assistant in 12.801, The General Circulation of the Ocean

Prof. Raffaele Ferrari.

PAOC, MIT — **Sep 2015 – Dec 2015**, *Cambridge, USA*

Teaching Assistant in 12.815, Atmospheric Radiation and Convection

Prof. Sara Seager and Prof. Kerry Emanuel.

Lycée Sainte-Geneviève — **Sep 2012 – Mar 2014**, *Versailles, France*

Teaching Assistant in physics

Undergraduate level: waves, electromagnetism, optics, newtonian, solid and fluid mechanics.

Service

Reviewer for Journals and Workshops (32 submissions, 50 rounds) — **Nov 2016 – Present**, *USA & Europe*

AGU Books, GMD, GRL, JAMES, JAS, JCLI, JGR, JHM, MWR, NeurIPS, PNAS, QJRMS

Reviewer for Proposals (6 subimssions) — **Sep 2020 – Present**, *USA & Europe*

American National Science Foundation, Belgian Science Policy Office, Climate Change AI

Swiss Geocomputing Centre — **Mar 2022 – Present**, *Lausanne, Switzerland*

Scientific Committee Member

20th Edition of the Swiss Geoscience Meeting — **Feb 2022 – Present**, *Lausanne, Switzerland*

Co-chair of the session: Spatial Data Science

UNIL Climate Physics Journal Club — **Dec 2021 – Present**, *Lausanne, Switzerland*

Co-founder and faculty support for student-driven seminar series

AMS 21st Conference on AI for Environmental Science — **Apr 2021 – Jan 2022**, *Houston, USA*

Co-chair of the session: Applications of AI for Improved Estimation and Prediction of Weather and Climate

CLIVAR Webinar: Emerging Data Science Tools for Climate Variability & Predictability — **May 2020 – July 2021**, *USA*

Invited Working Group Member: Co-organizer and moderator of the webinar

NeurIPS 2020 Workshop: AI for Earth Sciences — **Jun 2020 – Dec 2020**, *Vancouver, Canada*

Co-organizer: Meta-reviewer and organizer of the atmospheric science session

Editor-in-Chief Search Committee for JAMES (AGU) — **Apr 2020 – Sep 2020**, *USA*

Committee Member

MIT Office of Sustainability — **Feb 2018 – Dec 2018**, *Cambridge, USA*

Graduate research assistant in the Climate Resiliency Committee

Student and Post-doc Atmospheric Dynamics Lunch **Sep 2016 – May 2018**
Head of the organizing committee and founding member *Cambridge, USA*

EAPS Graduate Student Advisory Council **Sep 2016 – May 2018**
Secretary *Cambridge, USA*

Program in Atmospheres, Oceans and Climate Colloquium Series **Sep 2016 – Dec 2017**
Head of the organizing committee and founding member *Cambridge, USA*

Program in Atmospheres, Oceans, and Climate 2015 and 2016 Retreats **Jan 2015 – Oct 2016**
Co-organized 2015/2016 PAOC retreats for the professors, post-docs and students of the program *Hancock and Brewster, USA*

EAPS Social Hour **Dec 2015 – Apr 2016**
Organized the daily informal social gathering of the EAPS staff *Cambridge, USA*

Graduate Climate Conference 2015 **Jan 2015 – Nov 2015**
Member of the organizational committee of the 2015 Graduate Climate Conference *Woods Hole, USA*

Professional Experience

Cronite Castings Limited **Jul 2013 – Aug 2013**
Maintenance engineer *Crewkerne, UK*
Engineering and operator internship in the Crewkerne foundry.

French Air Force **Sep 2011 – Apr 2012**
Lieutenant *Cazaux, France*
Leadership training as part of the engineering school's curriculum.

Computer Skills

OS: Linux, Unix, Windows **Programming:** Python (incl. TensorFlow, Keras, xarray), Matlab, Fortran 77/90, VBA, Java

Language Skills

Native: French, **Fluent:** English, **Intermediate:** Spanish, German, **Beginner:** Japanese (N5), Esperanto

Interests

Weather Forecasting, Weightlifting, Swimming, Jogging, Trombone, Video Games, Recently rescued two feral kittens (photo).