Eviatar Bach

Lecturer (Assistant Professor) in Mathematics of Environmental Data Science, University of Reading, Reading, UK
✉ e.bach@reading.ac.uk
eviatarbach.com

Professional Appointments

2024– **Lecturer (Assistant Professor) in Mathematics of Environmental Data Science**
Department of Meteorology & Department of Mathematics and Statistics, University of Reading
Reading, UK

Member of the Data Assimilation Research Centre (DARC), member of the steering committee of the Centre for Mathematics of Planet Earth (CMPE), and member of the National Centre for Earth Observation (NCEO). Outreach Officer for the Centre for Doctoral Training in Mathematics for Our Future Climate.

2022–2024 **Postdoctoral Research Fellow**
Department of Environmental Science and Engineering & Department of Computing and Mathematical Sciences, Caltech
Pasadena, California, USA

Stanback Postdoctoral Fellow in Global Environmental Science under the supervision of Tapio Schneider and Andrew Stuart. Part of the Science and Engineering Team at the Climate Modeling Alliance (CliMA).

2021–2022 **Postdoctoral Research Fellow**
Laboratoire de Météorologie Dynamique, École Normale Supérieure
Paris, France

Make Our Planet Great Again Postdoctoral Fellow under the supervision of Michael Ghil.

Education

2017–2021 **PhD in Atmospheric and Oceanic Science**
University of Maryland, College Park
College Park, Maryland, USA
Supervisors: Eugenia Kalnay (primary) and Safa Mote (secondary).

2012–2017 **BSc in Physics and Computer Science (Honours), Minor in Mathematics**
University of British Columbia
Vancouver, British Columbia, Canada

Grants

2025–2029 **Natural Environment Research Council (NERC)** (£2.35m)
Co–lead, "AUSPICE – Advancing Understanding of the Signal-to-noise Paradox and its Impacts on Climate Ensembles"
Addressing environmental challenges: NERC highlight topics 2024 call
With Antje Weisheimer (PI) and co-leads Jochen Bröcker, Christopher O'Reilly, Scott Osprey, Jon Robson, Ted Shepherd, Rowan Sutton, and Tim Woollings.

2025 **NERC** (£50k)
Co–lead, "Data Assimilation Training Course"
Delivering training courses for environmental scientists call
Funding to deliver Data Assimilation Training Course with Alison Fowler (PI) and co-leads Amos Lawless, Jochen Bröcker, Ross Bannister, and Sarah Dance.

Publications

In review

23. **Bach, Eviatar**, Ricardo Baptista, Edoardo Calvello, and Andrew Stuart (2025). "Learning Enhanced Ensemble Filters". arXiv: 2504.17836 [stat] (under review in *Journal of Computational Physics*).

22. Deck, Katherine et al. "ClimaLand: A Land Surface Model Designed to Enable Data-Driven Parameterizations" (under review in *Journal of Advances in Modeling Earth Systems*).

21. **Bach, Eviatar**, Ricardo Baptista, Enoch Luk, and Andrew Stuart (2025). "Learning Optimal Filters Using Variational Inference". arXiv: 2406.18066 [cs] (under review in *SIAM/ASA Journal on Uncertainty Quantification*).

    Spotlight talk at Machine Learning for Earth System Modeling (ML4ESM) Workshop at ICML 2024.

20. Li, Ziyan, Yan Li, Yinzuo Qin, Laibao Liu, **Eviatar Bach**, Alona Armstrong, Guoqing Li, Mingquan Li, Zheng Wang, Yongqing Bai, and Zhengchao Chen. "A Comprehensive Impact Assessment of 675 Wind Farms on Land Surface Temperature and Vegetation in China Based on Remote Sensing" (under review in *Geography and Sustainability*).

Preprints and workshop papers

19. **Bach, Eviatar**, Ricardo Baptista, Daniel Sanz-Alonso, and Andrew Stuart (2024). *Inverse Problems and Data Assimilation: A Machine Learning Approach*. arXiv: 2410.10523 [cs, math, stat]

Published (see Google Scholar)

18. **Bach, Eviatar**, Dan Crisan, and Michael Ghil (2025). "Forecast Error Growth: A Dynamic–Stochastic Model". In: *Chaos: An Interdisciplinary Journal of Nonlinear Science* 35.7, p. 073118. DOI: 10.1063/5.0248102

17. Vernon, Sydney, **Eviatar Bach**, and Oliver R. A. Dunbar (2025). "Nesterov Acceleration for Ensemble Kalman Inversion and Variants". In: *Journal of Computational Physics* 535, p. 114063. DOI: 10.1016/j.jcp.2025.114063

16. Vishny, David, Matthias Morzfeld, Kyle Gwirtz, **Eviatar Bach**, Oliver R. A. Dunbar, and Daniel Hodyss (2024). "High-Dimensional Covariance Estimation From a Small Number of Samples". In: *Journal of Advances in Modeling Earth Systems* 16.9, e2024MS004417. DOI: 10.1029/2024MS004417

15. Manta, Gaston, **Eviatar Bach**, Stefanie Talento, Marcelo Barreiro, Sabrina Speich, and Michael Ghil (2024). "The South Atlantic Dipole via Multichannel Singular Spectrum Analysis". In: *Scientific Reports* 14.1, p. 15534. DOI: 10.1038/s41598-024-62089-w

14. **Bach, Eviatar**, V. Krishnamurthy, Safa Mote, Jagadish Shukla, A. Surjalal Sharma, Eugenia Kalnay, and Michael Ghil (2024). "Improved Subseasonal Prediction of South Asian Monsoon Rainfall Using Data-Driven Forecasts of Oscillatory Modes". In: *Proceedings of the National Academy of Sciences* 121.15, e2312573121. DOI: 10.1073/pnas.2312573121

    Written about by UN Office for Disaster Risk Reduction.

13. **Bach, Eviatar**, Tim Colonius, Isabel Scherl, and Andrew Stuart (2024). "Filtering Dynamical Systems Using Observations of Statistics". In: *Chaos: An Interdisciplinary Journal of Nonlinear Science* 34.3, p. 033119. DOI: 10.1063/5.0171827

    Chaos Editor's Pick

12. Xu, Zhengjie, Yan Li, Yingzuo Qin, and **Eviatar Bach** (2024). "A Global Assessment of the Effects of Solar Farms on Albedo, Vegetation, and Land Surface Temperature Using Remote Sensing". In: *Solar Energy* 268, p. 112198. DOI: 10.1016/j.solener.2023.112198

11. **Bach, Eviatar** and Michael Ghil (2023). "A Multi-Model Ensemble Kalman Filter for Data Assimilation and Forecasting". In: *Journal of Advances in Modeling Earth Systems* 15.1, e2022MS003123. DOI: 10.1029/2022MS003123

    In top 10% most-viewed papers published by the journal in 2023.

10. Chattopadhyay, Ashesh, Ebrahim Nabizadeh, **Eviatar Bach**, and Pedram Hassanzadeh (2023). "Deep Learning-Enhanced Ensemble-Based Data Assimilation for High-Dimensional Nonlinear Dynamical Systems". In: *Journal of Computational Physics* 477, p. 111918. DOI: 10.1016/j.jcp.2023.111918

    Featured in *SIAM News Blog*.

9. Dunbar, Oliver R. A., Ignacio Lopez-Gomez, Alfredo Garbuno-Iñigo, Daniel Zhengyu Huang, **Eviatar Bach**, and Jin-long Wu (2022). "EnsembleKalmanProcesses.Jl: Derivative-free Ensemble-Based Model Calibration". In: *Journal of Open Source Software* 7.80, p. 4869. DOI: 10.21105/joss.04869

8. Chattopadhyay, Ashesh, Mustafa Mustafa, Pedram Hassanzadeh, **Eviatar Bach**, and Karthik Kashinath (2022). "Towards Physics-Inspired Data-Driven Weather Forecasting: Integrating Data Assimilation with a Deep Spatial-Transformer-Based U-NET in a Case Study with ERA5". In: *Geoscientific Model Development* 15.5, pp. 2221–2237. DOI: 10.5194/gmd-15-2221-2022

7. Qin, Yingzuo, Yan Li, Ru Xu, Chengcheng Hou, Alona Armstrong, **Eviatar Bach**, Yang Wang, and Bojie Fu (2022). "Impacts of 319 Wind Farms on Surface Temperature and Vegetation in the United States". In: *Environmental Research Letters* 17.2, p. 024026. DOI: 10.1088/1748-9326/ac49ba

6. **Bach, Eviatar**, Safa Mote, V. Krishnamurthy, A. Surjalal Sharma, Michael Ghil, and Eugenia Kalnay (2021). "Ensemble Oscillation Correction (EnOC): Leveraging Oscillatory Modes to Improve Forecasts of Chaotic Systems". In: *Journal of Climate* 34.14, pp. 5673–5686. DOI: 10.1175/JCLI-D-20-0624.1

5. **Bach, Eviatar** (2021). "parasweep: A Template-Based Utility for Generating, Dispatching, and Post-Processing of Parameter Sweeps". In: *SoftwareX* 13, p. 100631. DOI: 10.1016/j.softx.2020.100631

4. **Bach, Eviatar**, Safa Motesharrei, Eugenia Kalnay, and Alfredo Ruiz-Barradas (2019). "Local Atmosphere–Ocean Predictability: Dynamical Origins, Lead Times, and Seasonality". In: *Journal of Climate* 32.21, pp. 7507–7519. DOI: 10.1175/JCLI-D-18-0817.1

   3rd most read article in the *Journal of Climate* in the period 5 June 2019 – 5 June 2020.

3. Penny, Stephen G., **Eviatar Bach**, Kriti Bhargava, Chu-Chun Chang, Cheng Da, Luyu Sun, and Takuma Yoshida (2019). "Strongly Coupled Data Assimilation in Multiscale Media: Experiments Using a Quasi-Geostrophic Coupled Model". In: *Journal of Advances in Modeling Earth Systems* 11.6, pp. 1803–1829. DOI: 10.1029/2019MS001652

2. Li, Yan, Eugenia Kalnay, Safa Motesharrei, Jorge Rivas, Fred Kucharski, Daniel Kirk-Davidoff, **Eviatar Bach**, and Ning Zeng (2018). "Climate Model Shows Large-Scale Wind and Solar Farms in the Sahara Increase Rain and Vegetation". In: *Science* 361.6406, pp. 1019–1022. DOI: 10.1126/science.aar5629

   - 14th top Earth science article on Altmetric in 2018, 79th of all articles in 2018, most-blogged about article of September 2018.
   - 10th most featured climate paper in the media in 2018, according to Carbon Brief.
   - Written about by the BBC, *Los Angeles Times*, *Popular Science*, and other international media.

1. **Bach, Eviatar**, Valentina Radić, and Christian Schoof (2018). "How Sensitive Are Mountain Glaciers to Climate Change? Insights from a Block Model". In: *Journal of Glaciology* 64.244, pp. 247–258. DOI: 10.1017/jog.2018.15

   - Shortlisted for 2020 IACS-IGS Graham Cogley Award, for papers published by early career scientists in the *Journal of Glaciology* or *Annals of Glaciology*.
   - Selected glaciology article for the period 2015–2019, Canadian National Committee for the International Union of Geodesy and Geophysics.

Non-refereed

- **Bach, Eviatar** and Oliver Dunbar (2023). "How Do We Estimate Climate Parameters? An Introduction to Ensemble Kalman Inversion". In: *Climate Modeling Alliance Blog*. URL: https://clima.caltech.edu/2023/06/12/how-do-we-estimate-climate-parameters-an-introduction-to-ensemble-kalman-inversion/

- Chattopadhyay, Ashesh, Ebrahim Nabizadeh, **Eviatar Bach**, and Pedram Hassanzadeh (2021). "Deep Learning-Augmented Data Assimilation for Next-Generation Predictive Models". In: *SIAM News Blog*. URL: https://sinews.siam.org/Details-Page/deep-learning-augmented-data-assimilation-for-next-generation-predictive-models

- Pentakota, Sreenivas, Sagar V. Gade, Suryachandra A. Rao, Cheng Da, Kriti Bhargava, Chu-Chun Chang, **Eviatar Bach**, Eugenia Kalnay, and Travis Sluka (2020). "Advances in Coupled Data Assimilation, Ensemble Forecasting, and Assimilation of Altimeter Observations". In: *CLIVAR Exchanges* 79, pp. 27–30. DOI: 10.36071/clivar.79.2020

Honors and Awards

2022–2024 **Foster and Coco Stanback Postdoctoral Fellowship in Global Environmental Science**
Division of Geological and Planetary Sciences, Caltech, Pasadena, California, USA

2021–2022 **Make Our Planet Great Again Postdoctoral Fellow**
Campus France, République Française

2020 **Eugene Rasmusson Fellowship**
Department of Atmospheric and Oceanic Science, University of Maryland, College Park, USA

2020–2021 **Ann G. Wylie Dissertation Fellowship**
University of Maryland, College Park, USA

2017–2021 **Flagship Fellowship**
University of Maryland, College Park, USA

Presentations

Invited talks

2025 **Probabilistic AI for Environmental Science** (October 21–22)
Isaac Newton Institute for Mathematical Sciences
Cambridge, England

2025 **Applied Inverse Problems 2025** (July 28 – August 1)
Minisymposia on "Data Assimilation for Inverse Problems" and "Probabilistic Learning Methods for Inverse Problems"
Rio de Janeiro, Brazil

2025 **Workshop on Uncertainty Quantification for Dynamical Modelling** (July 9)
University of Edinburgh
Edinburgh, Scotland

2025 **Accelerating statistical inference and experimental design with machine learning** (June 27)
Isaac Newton Institute for Mathematical Sciences
Cambridge, England

2024 **Computational and Methodological Statistics (CMStatistics) 2024** (December 15)
Session on Mathematics of deep-learning for solving differential equations
London, England (online talk)

2024 **Dynamics Days Europe 2024** (July 29 – August 2)
Minisymposium on Stability, long term behaviour, and data assimilation in infinite dimensional stochastic systems for weather, climate, and ocean
Bremen, Germany

2024 **AMS-UMI International Joint Meeting** (July 23–26)
Special session on Analysis, control and inverse problems in climate sciences
Unione Matematica Italiana and American Mathematical Society
Palermo, Italy

2024 **Chaos, Computation, Analysis and Optimization (CaCAO) Days** (April 15)
Scripps Institution of Oceanography
La Jolla, California, USA

2024 **Department of Applied Mathematics** (April 8)
University of California, Santa Cruz, California, USA

2024 **SIAM UQ24** (March 1)
Probabilistic Approaches to Uncertainty Quantification in Dynamical Systems session
Society for Industrial and Applied Mathematics
Trieste, Italy

2023 **ICIAM 2023** (August 24)
Combining Machine Learning and Stochastic Methods for Modeling and Forecasting Complex Systems session
International Council for Industrial and Applied Mathematics
Tokyo, Japan

2023 **SIAM Conference on Mathematical & Computational Issues in the Geosciences 2023** (June 19)
Computational Aspects of Ensemble Design and Interpretation in Climate Science and Modelling session
Society for Industrial and Applied Mathematics
Bergen, Norway

2023 **Energy and Machine Learning Seminar** (April 25)
Pacific Northwest National Laboratory, Richland, Washington, USA (online)

2023 **Atmosphere Ocean Science Colloquium** (March 29)
Courant Institute for Mathematical Sciences, New York University, New York City, USA

2023 **Department of Scientific Computing Seminar** (March 1)
Florida State University, Tallahassee, USA

2022 **Applied Math Seminar** (October 14)
Florida International University, Miami, USA (online)

2022 **Applied Math Seminar** (October 6)
Hunter College, City University of New York, New York City, USA (online)

2022 **Forecast Verification and Data Assimilation in intermediate and large scale models of geophysical fluid dynamics** (September 23)
Isaac Newton Institute for Mathematical Sciences
Reading, England

2022 **Department of Atmospheric, Oceanic & Earth Sciences Seminar** (May 11)
George Mason University, Fairfax, Virginia, USA (online)

2022 **AI for Climate Seminar** (January 26)
Sorbonne University, Paris, France

2020 **Climate Modeling Alliance Seminar** (October 21)
Caltech, Pasadena, California, USA (online)

2020 **PrExDA: Predicting Extremes by Data-Driven Analytics** (October 1)
National Science Foundation Convergence Accelerator (online)

2020 **Department of Atmospheric, Oceanic & Earth Sciences Seminar** (April 29)
George Mason University, Fairfax, Virginia, USA (online)

Contributed talks

2025 **International Workshop on Monsoons** (March 17)
World Meteorological Organization
Pune, India (online talk)

2024 **International Symposium on Data Assimilation 2024** (October 21–25)
Kobe, Japan

2024 **Oxford Workshop on Model Uncertainty** (September 25)
Oxford University, Oxford, UK

2024 **Machine Learning for Earth System Modeling workshop** (July 26)
International Conference on Machine Learning (ICML)
Vienna, Austria (online talk, joint with Enoch Luk)

2024 **RMetS Annual Weather and Climate Conference** (July 9)
Royal Meteorological Society
Reading, England

2024 **Toward Minimizing Early Model Biases and Errors in S2S Predictions** (June 7)
National Oceanographic and Atmospheric Administration
Boulder, Colorado, USA (online talk)

2024 **Conference on Hurricanes and Tropical Meteorology** (May 10)
American Meteorological Society
Long Beach, California, USA

2024 **ESA–ECMWF Workshop on Machine Learning for Earth System Observation and Prediction** (May 10)
European Space Agency and the European Centre for Medium-Range Weather Forecasts
Frascati, Italy (online talk)

2024 **International Symposium on Data Assimilation – Predictability** (May 3)
Online

2024 **International Symposium on Data Assimilation – Advancements in Ensemble Data Assimilation** (March 8)
Online

2023 **2023 AGU Fall Meeting** (December 9–13)
American Geophysical Union
San Francisco, California, USA

2023 **EGU General Assembly 2023** (April 28)
European Geosciences Union
Vienna, Austria (online talk)

2022 **2022 Model Hierarchies Workshop** (August 30)
Stanford University, Stanford, California, USA

2022 **SIAM Conference on Mathematics of Planet Earth 2022** (July 14)
Society for Industrial and Applied Mathematics
Pittsburgh, Pennsylvania, USA (online talk)

2022 **International Symposium on Data Assimilation 2022** (June 7)
Colorado State University, Fort Collins, Colorado, USA

2022 **EGU General Assembly 2022** (May 25)
European Geosciences Union
Vienna, Austria (online talk)

2020 **2nd NOAA Workshop on Leveraging AI in Environmental Sciences** (September 10)
Online

2020 **PSU-UMD Data Assimilation Workshop** (August 21)
Pennsylvania State University and University of Maryland (online)

2019 **CISESS Science Meeting** (November 12–14)
Cooperative Institute for Satellites Earth System Studies (CISESS), College Park, Maryland, USA

2019 **2019 AGU Fall Meeting** (December 9–13)
American Geophysical Union
San Francisco, California, USA

Teaching

2025 **Tutorial on Data Assimilation** (September 15–16)
University of Warsaw, Warsaw, Poland

2025 **NERC/NCEO/DARC Training course on data assimilation and its interface with machine learning** (June 9–13)
University of Reading, Reading, UK
Taught lectures and practical on machine learning in data assimilation.

2025 **MTMCW: Causality and Decision-Making** (Semester 2)
Department of Meteorology
University of Reading, Reading, UK
Taught lectures and practicals on causal discovery.

2025 **ST2PST: Probability and Statistical Theory** (Semester 2)
Department of Mathematics and Statistics
University of Reading, Reading, UK
Co-taught (50%) with Jeroen Wouters.

2024 **ACM270: Inverse Problems and Data Assimilation, a Machine Learning Approach** (Spring semester)
Department of Computing and Mathematical Sciences
California Institute of Technology, Pasadena, California, USA
Creating curriculum and co-teaching graduate-level, special topics course with Andrew Stuart.

2019, 2018 **Snakes on a Satellite workshops at AGU Fall Meetings**
American Geophysical Union
Co-taught interactive workshops on the scientific Python ecosystem and its use for Earth science data processing and analysis. Attended by over 70 participants in 2019.

2019, 2018 **Snakes on a Satellite workshops at NOAA**
NOAA Center for Weather and Climate Prediction, College Park, Maryland, USA
Co-taught interactive workshops on the scientific Python ecosystem. Attended by over 100 NOAA scientists.

Editorial

2023–2025 **Special Issue Editor, *Earth System Dynamics***
Co-editor of special issue "Theoretical and computational aspects of ensemble design, implementation, and interpretation in climate science", with David Stainforth, Christian Franzke, Irina Tezaur, and Francisco de Melo Virissimo.
Joint issue between *Earth System Dynamics*, *Nonlinear Processes in Geophysics*, and *Geoscientific Model Development*.

Sessions Co-Chaired

2024 **SIAM UQ24** (February 27)
Advances at the intersection of probabilistic machine learning, inverse problems and data assimilation mini-symposium
Society for Industrial and Applied Mathematics
Trieste, Italy

2023 **SIAM Conference on Mathematical & Computational Issues in the Geosciences 2023** (June 21–22)
Theoretical Aspects of Ensemble Design and Interpretation in Climate Science and Modelling session
Society for Industrial and Applied Mathematics
Bergen, Norway

2022 **2022 Model Hierarchies Workshop** (August 30)
Model Hierarchies for the Ocean 2 session
Stanford, California, USA

2022 **SIAM Conference on Mathematics of Planet Earth 2022** (July 14)
Data Science session
Pittsburgh, Pennsylvania, USA

Advising

2024–2025 **Enoch Luk** (Caltech, undergrad; now Machine Learning Engineer at Instagram)
Advising a research project on using variational inference to learn optimal filters for data assimilation.

2024 **Kota Okuda** (Tohoku University, undergrad)
Co-advised (with Oliver Dunbar) a Summer Undergraduate Research Fellowship (SURF) on accelerated Markov chain Monte Carlo methods for emulators.

2022, 2024 **Anagha Satish** (Caltech, undergrad)
Co-advised (with Oliver Dunbar) a SURF on the impact of time-step size on ensemble Kalman inversion, and advised a research project on combining numerical and machine learning models for data assimilation.

2023 **Sydney Vernon** (Caltech, undergrad)
Co-advised (with Oliver Dunbar) a SURF on accelerating the convergence of ensemble Kalman inversion using momentum methods.

2019–2020 **Greta Easthom** (University of Maryland, College Park undergrad; now PhD student at North Caroline State University)
Co-advised (with Safa Mote) an undergraduate thesis on mathematical modelling of population dynamics.

Thesis Committees

2025 **Internal examiner for Reyk Börner's viva** (June 5)
Department of Mathematics and Statistics
University of Reading, Reading, UK

Visiting Positions

2025 **Residential Programme participant, Isaac Newton Institute Programme on "Representing, calibrating & leveraging prediction uncertainty from statistics to machine learning"** (June 19–July 8)
Cambridge, England

2022 **Residential Programme participant, Isaac Newton Institute Satellite Programme on Geophysical Fluid Dynamics** (September 10–25)
Reading, England

2018 **Visiting Researcher, Indian Institute of Tropical Meteorology** (November 18 – December 8)
Pune, Maharashtra, India

Service

- Journal reviews (over 55):

  General interest: *Science*; *Proceedings of the National Academy of Sciences*; *PLOS ONE*; *Journal of Open Source Software*

  Earth science: *Geophysical Research Letters*; *Journal of Advances in Modeling Earth Systems*; *Journal of Climate*; *Monthly Weather Review*; *Geoscientific Model Development*; *npj*

Climate and Atmospheric Science; *Communications Earth & Environment*; *Climate Dynamics*; *Quarterly Journal of the Royal Meteorological Society*; *Nonlinear Processes in Geophysics*; *International Journal of Climatology*; *The Cryosphere*; *Earth's Future*; *Journal of Applied Meteorology and Climatology*; *Earth and Space Science*; *Geografiska Annaler: Series A, Physical Geography*; *Journal of Glaciology*

Physics: *Chaos: An Interdisciplinary Journal of Nonlinear Science*; *Physics of Fluids*

Machine learning/data science: *Nature Machine Intelligence*; *Journal of Geophysical Research: Machine Learning and Computation*; *Information Fusion*

- Reviewed a book manuscript on data analysis for Earth science for Wiley.
- Grant reviewer for National Research, Development and Innovation Office, Hungary (2022).