

Ching-Yao Lai

Department of Geophysics, Stanford University
397 Panama Mall Mitchell Building, Stanford, CA 94305, USA
[Website](#) Phone: (609) 937-6329 Email: cyaolai@stanford.edu

Research Interests

Ice Dynamics, Fluid Dynamics, Geophysics, Machine Learning

Education

Ph.D. in Mechanical and Aerospace Engineering, Princeton University (2013-2018)

Advisor: Professor Howard A. Stone

Thesis title: *Fluid-structure interactions for energy and the environment*

B.S. in Physics, National Taiwan University (2009-2013)

Research Appointments

Stanford University (June 2023-present)

Assistant Professor, Department of Geophysics

Princeton University (Jan 2021-May 2023)

Assistant Professor, Department of Geosciences (GEO)

Assistant Professor, Program in Atmospheric and Oceanic Sciences (AOS)

Affiliated Faculty, Program in Statistics and Machine Learning (SML)

Columbia University (2018-2020)

Lamont Postdoctoral Fellow, Lamont-Doherty Earth Observatory

Mentors: Professor Jonathan Kingslake, Professor Roger Buck, and Dr. Timothy Creyts

Princeton University

PhD Student, Complex Fluids Group, Advisor: Professor Howard A. Stone (2013-2018)

Visiting PhD Student, Advisor: Professor Luc Deike (2017-2018)

National Taiwan University (2012-2013)

Undergraduate Researcher, Theoretical Nonlinear Physics Group, Department of Physics

Advisor: Professor Yih-Yuh Chen

Institute of Physics, Academia Sinica (2011-2013)

Undergraduate Researcher, Advisor: Dr. Jih-Chiang Tsai

Honors

Research Scholar Award, Google Research (June 2023-May 2024)

Lamont Doherty Postdoctoral Fellowship (Sep 2018-Aug 2019)

[Maeder Graduate Fellowship in Energy and the Environment](#) (June 2017 - June 2018)

Mary and Randall Hack '69 Graduate Award (July 2016 - July 2017)

Publications

Group members' names are in bold.

Under Review

Y. Wang, C. Y. Lai, "Multi-stage neural networks: Function approximator of machine precision," [arXiv.2307.08934](https://arxiv.org/abs/2307.08934)

Y. Wang, C. Y. Lai, C. Cowen-Breen, "Discovering the rheology of Antarctic Ice Shelves via physics-informed deep learning," [doi:10.21203/rs.3.rs-2135795/v1](https://doi.org/10.21203/rs.3.rs-2135795/v1)

Y. Meng, R. Culberg, C. Y. Lai, "Vulnerability of firn to hydrofracture: Poromechanics modeling," [doi:10.31223/X5D085](https://doi.org/10.31223/X5D085)

R. Eusebi, G. A. Vecchi, C. Y. Lai, M. Tong, "Physics-informed neural networks for hurricane reconstruction and data assimilation," [doi:10.21203/rs.3.rs-2706220/v1](https://doi.org/10.21203/rs.3.rs-2706220/v1)

Peer Reviewed Articles

Y. Iwasaki*, C. Y. Lai, "1D ice shelf hardness inversion: Clustering behavior and collocation resampling in physics-informed neural networks," *J. Comput. Phys.*, 492, 112435 (2023). [doi: 10.1016/j.jcp.2023.112435](https://doi.org/10.1016/j.jcp.2023.112435)

Y. Wang, C. Y. Lai, J. Gomez-Serrano, T. Buckmaster, "Asymptotic self-similar blow-up profile for 3-D axisymmetric Euler equations using neural networks," *Phys. Rev. Lett.*, **130**, 244002 (2023). [doi: 10.1103/PhysRevLett.130.244002](https://doi.org/10.1103/PhysRevLett.130.244002)

J. Lockwood, N. Lin, M. Oppenheimer, **C. Y. Lai**, "Using neural networks to predict hurricane storm surge and to assess the sensitivity of surge to storm characteristics," *J. Geophys. Res.*, **127**, e2022JD037617 (2022). doi.org/10.1029/2022JD037617

N. Coffey, D. R. MacAyeal, L. Copland, D. Mueller, O. V. Sergienko, A. F. Banwell, C. Y. Lai, "Enigmatic surface rolls of the Ellesmere Ice Shelf," *J. Glaciol.*, 1–12 (2022). [doi:10.1017/jog.2022.3](https://doi.org/10.1017/jog.2022.3)

D. L. Chase, **C. Y. Lai**, and H. A. Stone, "Relaxation of a fluid-filled blister on a porous substrate," *Phys. Res. Fluids*, **6**, 084101 (2021). [doi: 10.1103/PhysRevFluids.6.084101](https://doi.org/10.1103/PhysRevFluids.6.084101)

C. Y. Lai, L. A. Stevens, D. L. Chase, T. T. Creyts, M. D. Behn, S. B. Das, H. A. Stone, "Hydraulic transmissivity inferred from ice-sheet relaxation following Greenland supraglacial lake drainages," *Nat Commun*, **12**, 3955 (2021). doi.org/10.1038/s41467-021-24186-6

W. R. Buck and **C. Y. Lai**, "Flexural Control of Basal Crevasse Opening Under Ice Shelves," *Geophys. Res. Lett.*, **48**, e2021GL093110 (2021). [doi: 10.1029/2021GL093110](https://doi.org/10.1029/2021GL093110)

S. Shim, S. Khodaparast, **C. Y. Lai, J. Yan, J. T. Ault, B. Rallabandi, O. Shardt, H. A. Stone**, "CO₂-Driven diffusiophoresis for maintaining a bacteria-free surface," *Soft matter*, **17**, 2568–2576 (2021). [doi: 10.1039/D0SM02023K](https://doi.org/10.1039/D0SM02023K)

C. Y. Lai, J. Kingslake, M. Wearing, P.-H. Cameron Chen, P. Gentine, H. Li, J. Spergel, J. M. van Wessem, "Vulnerability of Antarctica's ice shelves to meltwater-driven fracture," *Nature*, **584**, 574–578 (2020). [doi: 10.1038/s41586-020-2627-8](https://doi.org/10.1038/s41586-020-2627-8)

C. Y. Lai, J. Eggers, and L. Deike, "Bubble bursting: universal cavity and jet profiles," *Phys. Rev. Lett.*, **121**, 144501 (2018). [doi: 10.1103/PhysRevLett.121.144501](https://doi.org/10.1103/PhysRevLett.121.144501)

C. Y. Lai, B. Rallabandi, A. Perazzo, Z. Zheng, S. Smiddy, and H. A. Stone "Foam-driven fracture," *Proc. Natl. Acad. Sci.*, 201808068 (2018). [doi: 10.1073/pnas.1808068115](https://doi.org/10.1073/pnas.1808068115)

H. S. Rabbani, D. Or, Y. Liu, **C. Y. Lai, N. Lu, S. S. Datta, H. A. Stone, and N. Shokri**, "Suppressing viscous fingering in structured porous media," *Proc. Natl. Acad. Sci.*, 201800729 (2018). [doi: 10.1073/pnas.1800729115](https://doi.org/10.1073/pnas.1800729115)

- C. Y. Lai, Z. Zheng, E. Dressaire, G. Ramon, H. E. Huppert, H. A. Stone, “Elastic relaxation of fluid-driven cracks and the resulting backflow,” *Phys. Rev. Lett.*, **117**, 268001 (2016). doi: [10.1103/PhysRevLett.117.268001](https://doi.org/10.1103/PhysRevLett.117.268001)
- C. Y. Lai, Z. Zheng, E. Dressaire, H. A. Stone, “Fluid-driven crack in an elastic matrix in the toughness-dominated limit,” Invited paper to *Philos. Trans. R. Soc. A*, **374**, 20150425 (2016). doi: [10.1098/rsta.2015.0425](https://doi.org/10.1098/rsta.2015.0425)
- C. Y. Lai, Z. Zheng, E. Dressaire, J. Wexler, H. A. Stone, “Experimental study on penny-shaped fluid-driven cracks in an elastic matrix,” *Proc. R. Soc. A*, **471**, 20150255 (2015). doi: [10.1098/rspa.2015.0255](https://doi.org/10.1098/rspa.2015.0255)
- J. C. Tsai, C. Y. Tao, Y. C. Sun, C. Y. Lai, K. H. Huang, W. T. Juan, and J. R. Huang, “Vortex-induced morphology on a two-fluid interface and the transitions,” *Phys. Rev. E*, **92**, 031002(R) (2015). doi: [10.1103/PhysRevE.92.031002](https://doi.org/10.1103/PhysRevE.92.031002)

Energy Policy

G. Davies*, R. Edwards*, C. Y. Lai*, B. Perry*, and K. Spokas*, “Institutional Emissions and Energy Planning: Understanding the interactions between carbon accounting, institutional goal setting, and energy procurement,” published by the Princeton Environmental Institute at Princeton University (2019). *Equally Contributed (report available [online](#))

Presentations

Invited Talks

Math

AOS Colloquium, NYU Courant Institute of Mathematical Sciences, NY (April 2023)

Machine Learning + X Seminars, Brown University, RI (virtual) (April 2023)

Flatiron Computational Methods and Data Science Journal Club, Flatiron Institute, NY (March 2023)

Scientific Machine Learning Webinar, Department of Applied Mathematics, National Yang Ming Chiao Tung University, Taiwan (virtual) (March 2023).

Brandeis-Harvard-MIT-Northeastern Joint Mathematics Colloquium, Department of Mathematics, Massachusetts Institute of Technology, MA (February 2023).

Simons Collaboration on Wave Turbulence Workshop, Courant Institute of Mathematical Sciences, New York University, NY (December 2022).

Mathematical Institute, University of Oxford, UK (virtual) (February 2021).

Earth Sciences

Department of Earth and Environmental Science, University of Pennsylvania, PA (September 2023)

Department of Earth and Planetary Science, University of California Berkeley, CA (September 2023)

Department of Atmospheric Sciences, National Taiwan University, Taiwan (July 2023)

AGU Fall Meeting (December 2022).

Department of the Geophysical Sciences, University of Chicago, IL (December 2022).

Earth Resources Laboratory, Massachusetts Institute of Technology, MA (virtual) (April 2022).

Stanford Earth, Stanford University, CA (April 2022).

Department of Earth and Planetary Sciences, Harvard University, MA (virtual) (April 2022).

AGU Fall Meeting (December 2021).

Department of Earth and Environmental Sciences, Vanderbilt University, TN (virtual) (December 2021).

Department of Geophysics, Stanford University, CA (virtual) (October 2021).

Department of Earth and Planetary Sciences, Harvard University, MA (virtual) (March 2021).

Department of Earth Sciences, University of Oxford, UK (virtual) (February 2021).

Climate Seminar Series, Princeton University, NJ (March 2020).

The School of Earth and Atmospheric Sciences, Georgia Institute of Technology, GA (February 2020).

Division of Marine Geology and Geophysics, Lamont-Doherty Earth Observatory, Columbia University, NY (November 2017).

Physics and Engineering

Institute of Physics Colloquium, Academia Sinica, Taiwan (August 2023)

Fluids Seminar, School of Engineering, Brown University, RI (February 2023).

Physics Department Colloquium, Department of Physics, Emory University, GA (October 2022).

National Center for Theoretical Sciences, Physics Division, Taiwan (August 2022).

American Physical Society March Meeting (March 2022).

Department of Mechanical and Civil Engineering Department, Caltech, CA (virtual) (February 2021).

Department of Physics, National Tsing Hua University, Taiwan (November 2020).

Department of Civil and Environmental Engineering, Massachusetts Institute of Technology, MA (March 2020).

Department of Physics and Astronomy, University of Pennsylvania, PA (February 2020).

The Rowland Institute at Harvard, Harvard University, MA (September 2019).

School of Mechanical Engineering, Purdue University, West Lafayette, IN (May 2016).

Informal Seminars Talks

"Ice-shelf hydrofracture and flexural control of basal crevasse opening," Maths on Ice Forum (international virtual talks) (April 2021).

"Vulnerability of Antarctica's ice shelves to meltwater-driven fracture," Glaciological Seminar Series, ETH Zürich, Switzerland (virtual) (April 2021).

"How does ice flow and crack in a warming climate?" Climate Seminar Series, Princeton University, NJ (February 2020).

"Fluid-structure interactions: from fluid-induced cracks to ice-shelf disintegration," Institute of Physics, Academia Sinica, Taiwan (November 2020).

"Hydrofractures: How meltwater impacts ice sheets and ice shelves in a warming climate," Geodynamics Summer Series, Boston College, MA (virtual) (August 2020).

“Physics of hydrofracturing and its impact on ice-shelf vulnerability,” Division of Marine Geology and Geophysics, Lamont-Doherty Earth Observatory, Columbia University, NY (March 2019).

“The simplicity in complexity: The simple scaling laws for hydraulic fractures,” Department of Mechanical and Aerospace Engineering, Princeton University, Princeton, NJ (May 2015).

Conference Talks

C. Y. Lai, L. A. Stevens, D. L. Chase, T. T. Creyts, M. D. Behn, S. B. Das, H. A. Stone, *“Seasonally evolving hydraulic transmissivity beneath Greenland supraglacial lakes”* American Geophysical Union Fall Meeting (virtual) (December 2020)

C. Y. Lai, J. Kingslake, M. Wearing, P.-H. Cameron Chen, P. Gentine, H. Li, J. Spergel, J. M. van Wessem, *“Vulnerability of Antarctica’s ice shelves to meltwater-driven fracture”* American Geophysical Union Fall Meeting, San Francisco, CA (December 2019)

C. Y. Lai, D. L. Chase, L. A. Stevens, T. T. Creyts, H. A. Stone, *“Relaxation of ice-sheet uplift on a porous bed”* 72th Annual Meeting of the American Physical Society’s Division of Fluid Dynamics, Seattle, CA (November 2019).

C. Y. Lai, J. Kingslake, M. Wearing, P.-H. Cameron Chen, P. Gentine, H. Li, J. Spergel, J. M. van Wessem, *“Vulnerability of Antarctica’s ice shelves to meltwater-driven fracture”* West Antarctica Ice Sheet Workshop, Julian, CA (October 2019)

C. Y. Lai, J. Eggers, L. Deike, *“Bubble bursting: universal cavity and jet profiles”* 71th Annual Meeting of the American Physical Society’s Division of Fluid Dynamics, Atlanta, GA (November 2018).

C. Y. Lai, B. Rallabandi, A. Perazzo, S. Hilgenfeldt, S. Smiddy, H. A. Stone, *“Foam relaxation in fractures and narrow channels”* 70th Annual Meeting of the American Physical Society’s Division of Fluid Dynamics, Denver, CO (November 2017).

C. Y. Lai, Z. Zheng, E. Dressaire, G. Ramon, H. E. Huppert, H. A. Stone, *“Elasticity-driven backflow of fluid-driven cracks”* 69th Annual Meeting of the American Physical Society’s Division of Fluid Dynamics, Portland, OR (November 2016).

C. Y. Lai, *“A laboratory-scale model of hydraulic fracturing and the resulting flowback,”* The 5th International Education Forum on Environment and Energy Science, San Diego, CA (December 2016).

C. Y. Lai, S. Smiddy, H. A. Stone, *“Foam-driven fractures of an elastic matrix”* 68th Annual Meeting of the American Physical Society’s Division of Fluid Dynamics, Boston, MA (November 2015).

C. Y. Lai, Z. Zheng, E. Dressaire, J. Wexler, H. A. Stone, *“Fluid-driven fracture of elastic reservoirs followed by viscous backflow”* 67th Annual Meeting of the American Physical Society’s Division of Fluid Dynamics, San Francisco, CA (November 2014).

C. Y. Lai, Y. T. Sun, C. C. Chang, Y. Y. Chen, P. Arratia, J. C. Tsai, *“Interfacial Instabilities in Torsional Flows”* 65th Annual Meeting of the American Physical Society’s Division of Fluid Dynamics, San Diego, CA (November 2012).

Reviewer

Nature, Proceedings of the National Academy of Sciences (PNAS), Geophysical Research Letters (GRL), Journal of Geophysical Research (JGR), Journal of Glaciology (JOG), The Cryosphere, Frontiers in Earth Science

Teaching

Princeton University

Graduate Courses

Instructor - "Deep Learning in Geophysical Fluid Dynamics". Evaluation score: 5/5 (Fall 2021, 2022)

Undergraduate Courses

Instructor - "The Physics of Glaciers". (Spring 2022)

Teaching Assistant - "Mathematics in Engineering". Evaluation score: 4.6/5 (Fall 2017)

Teaching Assistant - "Mechanics of Fluids". (Spring 2015 and 2016)

Mentoring

Lai Research Group, Stanford University

Postdoctoral Scholars

Yue (Olivia) Meng (2023-present)

Nicole Shibley (Postdoc Fellow at Princeton Center for Theoretical Sciences) (2023-present)

Yongji Wang (2023-present)

PhD Students

Niall Coffey (Geophysics) (2023-present)

Josh Rines (Geophysics) (2023-present)

Undergraduate Students

Jakin Ng (Math), summer research (Summer 2023)

Lai Research Group, Princeton University

Postdoctoral Scholars

Yue (Olivia) Meng (2022-2023)

Riley Culberg (HESS postdoctoral fellow) (2022-2023)

Nicole Shibley (Postdoc Fellow at Princeton Center for Theoretical Sciences) (2021-2023)

Yongji Wang (2021-2023)

PhD Students

Niall Coffey (AOS) (2021-2023)

Josh Rines (AOS) (2021-2023)

Undergraduate Students

Evan Chandran (Physics), junior paper (JP) research (Spring 2023)

Elizabeth Berzin (Physics), Applied and Computational Math independent work (2021 - 2023)

Hugh Shields (Geosciences), junior paper (JP) research (Fall 2022; Spring 2023)

Wiley Kohler (Mathematics), HMEI summer research (Summer 2022)

Jakob Kintzele (Geosciences), summer research (Summer 2022)

Charlie Cowen-Breen (Mathematics), junior (JP) and senior thesis (ST) (Spring 2021 - Spring 2022)

Ryan Eusebi (Computer Science), senior thesis (ST) (Fall 2021 - Spring 2022)

Yunona Iwasaki (Physics), junior paper (JP) research (Fall 2021)

Elijah Pomerantz (Physics), HMEI summer research (Summer 2021)

Lamont-Doherty Earth Observatory, Columbia University

Jay (Ji-Hyung) Ryu (master's student in Statistics)	(Summer 2020)
Serena Yuan (master's student in Statistics)	(Summer 2020)
Russel Arbore (high school intern)	(Summer 2020)

Complex Fluids Group, Princeton University

Danielle Chase (PhD student in MAE)	(Summer 2018)
Samuel Smiddy (undergraduate in CBE), senior thesis (ST) and summer research	(2015 - 2018)
Minh Pham (visiting master's student)	(Summer 2016)

Outreach

American Museum of Natural History Earth Fest, New York, NY

Explain fracturing of Antarctica's ice shelves with experiment "Ice Cracks".	(Spring 2019)
A museum-wide festival of art, science, and culture in honor of Earth Day.	

Lamont Open House, Palisades, NY

Demonstrate iceberg calving experiments.	(October 2018 and 2019)
A large outreach event held each fall on the Lamont campus that attracts around 4000 attendees of all ages.	

Prison Teaching Initiative, Garden State Youth Correctional Facility, Crosswicks, NJ

Volunteer Instructor - "Elementary algebra"	(Spring 2017)
An initiative aiming to reduce incarceration rates in New Jersey by increasing access to post-secondary education in state prisons.	

Princeton Day School, Princeton, NJ

Volunteer Speaker - "Technological solutions for climate change"	(Spring and Fall 2017)
Strengthen climate education in a local high school via discussions on policies and technologies for mitigating climate change, led by Princeton PhD students.	

Harlem Prep Elementary School Visit, Princeton, NJ

Demonstrate fluids experiments.	(May 2015, 2016, 2017 & April 2018)
An annual lab visit, organized by Princeton's Mechanical and Aerospace Engineering Department, to show simple experiments on Princeton's campus to elementary students from Harlem Prep.	