

HENRI F. DRAKE

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EDUCATION

MIT/WHOI Joint Program in Oceanography 2016 – 2021
 Ph.D. in Physical Oceanography
Control of the Abyssal Ocean Overturning Circulation by Mixing-Driven Bottom Boundary Layers

Haverford College 2011 – 2015
 B.S. in Mathematics (Honors); Magna Cum Laude

EMPLOYMENT / RESEARCH EXPERIENCE

Assistant Professor, Department of Earth System Science (ESS), UC Irvine 2023 –

Postdoctoral Fellow, NOAA Climate & Global Change Program 2021 – 2023
 Hosted by Sonya Legg (Princeton University and NOAA GFDL)

Graduate Research Assistant, MIT/WHOI Joint Program in Oceanography 2016 – 2021
 Advised by Raffaele Ferrari (MIT)

Research Specialist in Physical Oceanography, Princeton University 2015 – 2016
 Advised by Jorge Sarmiento (Princeton University) and Stephen Griffies (NOAA GFDL)

AWARDS

NASA Early Career Investigator 2024 – 2026

NOAA Climate and Global Change Postdoctoral Fellowship 2021 – 2023

NSF Graduate Research Fellowship 2017 – 2020

MIT Rosenblith Presidential Fellowship 2016 – 2017

RESEARCH PUBLICATIONS

In preparation

Drake, H. F., Griffies, S., MacGilchrist, G., Tesdal, J-E. Krasting, J. Dussin, R. Diagnosing Water Mass Budgets in Finite-Volume Generalized Vertical Coordinate Ocean Models. *Preprint*. [\[doi\]](#)

Drake, H. F. Reconstructing the Global Ocean Overturning Circulation.

Drake, H. F., Legg, S. Parameterization of submesoscale baroclinic instability in bottom frontal zones along sloping topography.

Drake, H. F., Pratt, L. Hydraulic control of rotating and stratified channel flow with non-zero potential vorticity.

Published

11. Le Boyer, A., Couto, N., Alford, M. H., **Drake, H. F.**, Bluteau, C. E., Hughes, K. G., Naveira Garabato, A. C., Moulin, A. J., Peacock, T., Fine, E. C., Mashayek, A., Cimoli, L., Meredith, M. P., Melet, A., Fer, I., Dengler, M., Stevens, C. L. (2023). Turbulent diapycnal fluxes as a pilot Essential Ocean Variable. *Frontiers in Marine Science (Review)*. [\[doi\]](#)

10. **Drake, H. F.**, Ruan, X., Ferrari, R. (2022). Diapycnal displacement, diffusion, and distortion of tracers in the ocean. *Journal of Physical Oceanography*. [doi]
9. **Drake, H. F.**, Ruan, X., Callies, J., Ogden, K., Thurnherr, A., Ferrari, R. (2022). Dynamics of eddying abyssal mixing layers over rough topography. *Journal of Physical Oceanography*. [doi]
8. **Drake, H. F.**, Henderson, G. (2022). A defense of usable climate mitigation science: how science can contribute to social movements. *Climatic Change*. [doi]
7. Brady, R. X., Maltrud, M. E., Wolfram, P. J., **Drake, H. F.**, Lovenduski, N. C. (2021). The influence of ocean topography on the upwelling of carbon in the Southern Ocean. *Geophysical Research Letters*. [doi]
6. **Drake, H. F.**, Rivest, R. L., Deutch, J., Edelman, A. (2021). A simple model for assessing climate control trade-offs and responding to unanticipated climate outcomes. *Environmental Research Letters*. [doi]
5. **Drake, H. F.**, Ferrari, R., Callies, J. (2020). Abyssal circulation driven by near-boundary mixing: water mass transformations and interior stratification. *Journal of Physical Oceanography*. [doi].
4. Hausfather, Z., **Drake, H. F.**, Abbott, T., Schmidt, G. A. (2020). Evaluating the performance of past climate model projections. *Geophysical Research Letters*, **46**. [doi]
3. **Drake, H. F.**, Morrison, A. K., Griffies, S. M., Sarmiento, J. L., Weijer, W., Gray, A. R. (2018). Lagrangian timescales of Southern Ocean upwelling in a hierarchy of model resolutions. *Geophysical Research Letters*, **45**. [doi] [Read online]
2. van Sebille, E., Griffies, S. M., Abernathey, R., Adams, T. P., Berloff, P., Biastoch, A., Blanke, B., Chassignet, E. P., Yu Cheng, Y., Cotter, C. J., Deleersnijder, E., Döös, K., **Drake, H. F.**, Drijfhout, S., Gary, S. F., Heemink, A. W., Kjellsson, J., Koszalka, I. M., Lange, M., Lique, C., MacGilchrist, G. A., Marsh, R., Adame, C. G. M., McAdam, R., Nencioli, F., Paris, C. B., Piggott, M. D., Polton, J. A., Rühls, S., Shah, S. H. A. M., Thomas, M. D., Wang, J., Wolfram, P. J., Zanna, L., Zika, J. D. (2018). Lagrangian ocean analysis: fundamentals and practices. *Ocean modeling*, **121**, 49-75. [doi] [Download PDF]
1. Tamsitt, V., **Drake, H. F.**, Morrison, A. K., Talley, L. D., Dufour, C. A., Gray, A. R., Griffies, S. M., Mazloff, M. R., Sarmiento, J. L., Wang, J., Weijer, W. (2017). Spiraling up: pathways of global deep water to the surface of the Southern Ocean. *Nature Communications*, **8**, 172. [doi]

OTHER PUBLICATIONS

Drake, H. F. (2021). Control of the Abyssal Ocean Overturning Circulation by Mixing-Driven Bottom Boundary Layers. *MIT/WHOI Doctoral Thesis*. [doi]

Freilich, M., Wilka, C., Shivamoggi, R., Freese, L., Heiderich, J., **Drake, H. F.**, Cantine, M. (2019). Young Climate Scientists Speak Out. *Special Climate Crisis Issue of DigBoston*. [url]

Drake, H. F. (2019). Eight ways to support women in science. *EOS*. [doi]

FUNDING

NASA Early Career Investigator Program. PI: Drake. \$300,000 to UCI.

Project title: *Diabatic Attribution of Marine Heatwave Formation and Destruction*.

MENTORING AND ADVISING

Research Advising

Doctoral students (1): Isba Keshwani (UCI ESS, 2023–)

Advancement committees (3): Armin Kianfar (UCI MAE, 2023), Subharthi Chowdhuri (UCI CEE, 2024), Kayla Alexis Mitchell (UCI ESS, 2024–)

Postdoctoral researchers (1): Chih-Lun Liu (UCI ESS, 2024–)

Postbaccalaureate researchers (1): Mariana Torres (UCI ESS, 2023–2024)

Undergraduate researchers [ESS] (1): Rohan Vaswani (2024–)

Undergraduate researchers [Other] (2): Kaila Uyeda (Haverford College, 2022), Freddie Furia (Princeton University, 2022)

Career and Peer Mentoring

Mentor for students attending **Ocean Sciences Meetings (2)** (2022)

Peer mentor for **MIT/WHOI Joint Program PhD students (4)** (2018-2020)

Mentor for **WHOI Summer Student Fellow (1)** (2020)

LEADERSHIP AND SERVICE

Seminar series, conferences, and workshops

Discussion Leader, **Ocean Mixing Gordon Research Conference** (2022).

Virtual Session Convener, **Ocean Sciences Meeting** (2022).

Co-Organizer, **MIT EAPS Student Seminar** (2020-2021).

Co-Organizer, **MIT PAOC Sack Lunch Seminar (SLS)** (2020-2021).

Co-Chair, **Graduate Climate Conference** (2019).

Executive Committee Member, **Graduate Climate Conference** [[url](#)] (2017, 2020).

Accessibility, Justice, Equity, Diversity, Inclusion (AJEDI)

Committee member, **NOAA GFDL Diversity, Equity, and Inclusion Committee** (2022)

Pod co-leader [[url](#)], **MIT EAPS' Unlearning Racism in Geoscience (URGE) pod** (spring 2021)

Web developer [[url](#)], **Towards Inclusion and Diversity in EAPS (TIDE)** (2020-2021).

Executive Committee Member, **Society for Women in Marine Sciences Annual Symposium** (2018).

UCI Leadership and Administrative roles

Member, **Academic Senate** (2023-2024)

Member, **ESS Graduate Committee** (2023-2024)

Member, **ESS Undergraduate Committee** (2023-2024)

ESS representative, **UCI School of Physical Sciences Executive Research Committee** (2023-2024)

Other Departmental Leadership and Administrative roles

MIT/WHOI Joint Program Representative, **MIT Graduate Student Council** (2020-2021).

Student Representative for Physical Oceanography, **MIT/WHOI Joint Program** (2019-2020).

Community Building

Organizer, **Princeton/GFDL AOS Tutorial Series for summer interns** (2022).

Co-Organizer of the *ClimateGrad* Slack workspace for 500+ early-career researchers in climate to support each other and network throughout the SARS-Cov-2 pandemic (2020-2022).

Department Retreat Committee Chair, **MIT Program for Atmospheres, Oceans, and Climate** (2017).

Meetings, Symposia, and Workshops

Joint US CLIVAR/OCB Workshop (04/23-25/2024): Pathways Connecting Climate Changes to the Deep Ocean: Tracing Physical, Biogeochemical, and Ecological Signals from Surface to Deep Sea. Hosted at the University of Delaware in Lewes, Delaware.

Deep Ocean Solutions Accelerator (08/2023), hosted by the Deep Ocean Observing System (DOOS) at the Scripps Institution of Oceanography.

UCAR Annual Members Meeting (08/2023), hosted in Boulder, Colorado.

Peer review

Grant funding review panels (1): *NASA ROSES-2022* [Physical Oceanography] (1).

Ad-hoc grant reviews (2): *National Science Foundation* [Physical Oceanography] (2).

Journal articles (23): *Nature* (2), *Nature Communications* (1), *Geophysical Research Letters* (1), *Journal of Physical Oceanography* (5), *Journal of Geophysical Research: Oceans* (6), *Earth System Dynamics* (2), *Ocean Sciences* (1), *Geoscientific Model Development* (1), *Climatic Change* (1), *Communications Earth & Environment* (2), *Ukrainian Antarctic Journal* (1).

LEADERSHIP AND SERVICE

UCI ESS Teaching

EARTHSS 130 – Physical Oceanography (Undergraduate). *Winter 2024* – 15 students.

Other Teaching

Rutgers NJ-STEP: Climate, the Environment, and Justice (2023). *Co-Instructor (8 lessons)* [8 students]. A seminar course reviewing key aspects of environmental and climate justice, bringing together perspectives from physical science, social science, and humanities.

MIT 18.S191: Introduction to Computational Thinking (2020, 2021). *Co-Instructor (6 lessons)*. Developed a flipped-classroom curriculum for introducing undergraduate Computer Science and Math majors to climate modeling through *reactive* notebooks in the Julia programming language.

MIT: Practical Computing Tutorials for Earth Scientists [PraCTES] (2020). *Organizer and Instructor*. Student-led January-term workshop for MIT EAPS and MIT/WHOI students. Responsibilities included curriculum design, development of live code tutorials (via [binder](#)), assisting other instructors during live hands-on exercises, and presenting two 2 hour lectures.

MIT 6.S898: Climate Change Seminar (2019). *Teaching Assistant*. A project-based climate change seminar course cross-listed in the Computer Science and Earth, Atmospheric, and Planetary Sciences departments. Responsibilities included curriculum design, helping students with final projects, leading discussions of assigned readings, and presenting 3 hours of lectures on climate models and data analysis.

MIT/WHOI: Summer Math Review (2017, 2018). *Lecturer*. Blackboard refresher on key concepts in Linear Algebra, ODEs, and PDEs for incoming graduate students.

OUTREACH

Online Science Communication ($\gg 1,000,000$ engagements)

– Actor and writer for Yellow Dot Studios’ viral climate communication video “[You Expect Me To Believe That!?! \(Ft. Tim Robinson\)](#)”, with 375k+ views on Youtube and millions on other platforms.

- Publisher of (margo.plutojl.org), an interactive web application that introduces the concept of climate change using my simple climate-economic model, hosted using Pluto.jl’s novel reactive notebooks.
- Lead instructor for a series of eight [hour-long YouTube lectures / live code demos](#) on Climate Modeling, hosted on the official Julia programming language channel and reaching tens of thousands of viewers.
- Science communicator on Twitter with 3500 followers (formerly @henrifdrake, deactivated 10/2021).
- Panelist on the topics of Ocean Circulation and Climate modeling for [reddit.com/r/science/](https://www.reddit.com/r/science/), an online science forum with 20+ million members, over 30,000 of whom have directly engaged with my educational content through comments or “upvotes”.
- Founder of [Climate Gamers](#), an educational program that used online computer games to communicate climate science to the public (see article in [The Verge](#)), reaching tens of thousands of viewers.

K-12 Outreach

- Active participant of [Skype-a-Scientist](#) program with over 15 virtual classroom visits (2016–2020).
- *Ocean Currents* virtual lecture and discussion with several classrooms of 5th–8th grade students via [Exploring By The Seat Of Your Pants \[Youtube Recording\]](#) (2018)
- Rotating-tank fluid demonstrations at MIT Museum Girls Day event (2017, 2018, 2019).
- Rotating tank “Nor’Easter” demonstration for Science Club at Boston International School (2017).

General Audience Lectures

- *Climate modeling: Whence, What, and Why* lecture for MIT EAPS administrative staff (2019)
- *Warming Oceans and Sea Level Rise* lecture at Science in the News DayCon symposium, open to local residents of Cambridge & Somerville, MA (2017, twice).

FIELD WORK

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| October 2021 | <p>Bottom Layer Turbulence and Abyssal Recipes (Leg #2)
 (39 day cruise on <i>RRS Discovery</i>, DY138)
 The project goal is to quantify the deep bottom boundary layer flows along the continental slope of the Rockall Trough (off the west coast of Ireland), using a combination of ship-based casts, anchored mooring arrays, free-falling profilers, and inert tracer & dye injections to infer turbulent fluxes. I contributed estimates of turbulence from ship-board CTD and LADCP data using various fine-structure parameterizations. The diapycnal transport inferred from the released dyes and tracer will be used to test theoretical predictions from my PhD.</p> |
| June 2018 | <p>MIT-WHOI Joint Program Orientation
 (10 days on <i>R/V Corwith Cramer</i>)
 Conducted hydrographic and biological surveys of the shelf break jet south of Cape Cod and a warm core eddy on the northern flank of the Gulf Stream.</p> |

INVITED TALKS

- Joint US CLIVAR/OCB Workshop.** Pathways Connecting Climate Changes to the Deep Ocean: Tracing Physical, Biogeochemical, and Ecological Signals from Surface to Deep Sea. 04/24/2024
- University of Southern California, Earth Sciences Department Seminar** 04/08/2024
 Turning Classic Paradigms of the Abyssal Ocean Overturning Circulation Upside-Down and Inside-Out
- UC Irvine, Mech. and Aero. Engineering Fluids Seminar** 11/30/2023
 Bottom boundary layer control on the abyssal ocean overturning circulation

McGill University, Atmospheric & Oceanic Sciences Seminar On the life and death of Antarctic Bottom Water	11/27/2023
Caltech, Environmental Science and Engineering Seminar On the life and death of Antarctic Bottom Water	11/15/2023
Haverford College, Bi-College Math Colloquium Challenges in predicting future weather and climate: chaos, turbulence, and (un)predictability	11/21/2022
Temple University, Earth and Environmental Science Towards a revised theory of the abyssal circulation in our topographic oceans	09/16/2022
Ocean Mixing Gordon Research Conference (GRC) Discussion Leader: the Role of Ocean Mixing in Climate Dynamics	06/08/2022
Scripps Institution of Oceanography, UC San Diego Bottom boundary layer control on the abyssal overturning circulation	05/05/2022
Oregon State University, Physics of Oceans and Atmospheres Bottom boundary layer control on the abyssal overturning circulation	04/12/2022
University of Rhode Island, Graduate School of Oceanography Bottom boundary layer control on the abyssal overturning circulation	04/08/2022
Princeton University, Atmospheric and Oceanic Sciences' Climate Seminar Climate Mitigation Modelling: Whence, Whither, Why?	03/14/2022
University of California, Irvine, Department of Earth System Science The little eddies that could: control of global climate by deep ocean turbulence.	03/07/2022
Dartmouth College, Ice+Climate Seminar Mixing-Driven Upwelling of Antarctic Bottom Water: Bottom Boundary Layer and Basin-Scale Dynamics	02/04/2022
University of Liege, GeoHydrodynamics and Environment Research Bottom boundary layer control on the abyssal overturning circulation	12/05/2021
Johns Hopkins University, Atmospheres and Oceans Bottom boundary layer control on the abyssal overturning circulation: basin and submeso-scale dynamics	03/31/2021
University of Washington, School of Oceanography Bottom boundary layer control on the abyssal overturning circulation: basin and submeso-scale dynamics	02/24/2021
Princeton University and the Geophysical Fluid Dynamics Laboratory (GFDL) Bottom boundary layer control on the abyssal overturning circulation: global and regional-scale dynamics	02/01/2021

SELECTED PRESENTATIONS

Drake, H. F., Ruan, X., Ferrari, R. (2022). **Control of the abyssal overturning circulation by mixing-driven bottom boundary layers.** *Physical Oceanography Dissertation Symposium (PODS)*, Kona, HI. [TALK]

Drake, H. F., Ruan, X., Ferrari, R. (2022). **Diapycnal displacement, diffusion, and distortion of tracers in the ocean.** *International Symposium for Stratified Flows (ISSF IX)*, Cambridge, UK. [TALK]

- Drake, H. F., Legg, S., Ruan, X., Ferrari, R. (2022). **Towards a parameterization of bottom mixing layer instabilities.** *Ocean Mixing Gordon Research Conference (GRC)*, Mount Holyoke, MA. [POSTER]
- Drake, H. F. (2022). **The potential value of ocean mixing research in improving climate change projections is wasted by political inaction.** *Ocean Mixing Gordon Research Seminar (GRS)*, Mount Holyoke, MA. [TALK]
- Drake, H. F., Ruan, X., Ferrari, R. (2022). **Diapycnal motion, diffusion, and shear dispersion of tracers in the ocean.** *Ocean Sciences Meeting*, Virtual. [TALK]
- Drake, H. F., Deutch, J. M., Edelman, A., Rivest, R. (2020). **A simple policy process for responding to climate control shortfalls and climate surprises** *American Geophysical Union Fall Meeting* [POSTER]
- Drake, H. F., Hausfather, Z., Abbott, T., Schmidt, G. (2019). **How accurate have climate models been so far?** *Graduate Climate Conference*, Woods Hole, MA. [POSTER]
- Drake, H. F., Callies, J., Ferrari, R. (2019). **Circulation and stratification of an abyssal ocean controlled by bottom boundary mixing.** *Atmospheric and Oceanic Fluid Dynamics (AOFD) Conference*, Portland, ME. [POSTER]
- Drake, H. F., Callies, J., Ferrari, R. (2018). **Impact of Mixing Layer Flows on the Abyssal Circulation and Stratification.** *Workshop on Bottom Boundary Layer Turbulence and the Ocean Overturning Circulation*, Massachusetts Institute of Technology, MA. [TALK]
- Drake, H. F., Callies, J., Ferrari, R. (2018). **Boundary Mixing Forcing Abyssal Overturning.** *Gordon Research Conference on Ocean Mixing*, Hannover, NH. [POSTER]
- Drake, H. F., Callies, J., Ferrari, R. (2018). **Testing a New Paradigm for the Abyssal Ocean Circulation.** *Ocean Sciences Meeting*, Portland, OR. [TALK]
- Drake, H. F., Tamsitt, V., Morrison, A. K., Sarmiento, J. L., Griffies, S. M., Weijer, W., Gray, A. R., Talley, L., Wang, J., Mazzlof, M., Dufour, C. (2016). **Three-Dimensional Pathways of Deep Water Upwelling in the Southern Ocean.** *Southern Ocean Carbon and Climate Observations and modeling (SOCCOM) Annual Meeting*, Scripps Institution of Oceanography, CA. [TALK]
- Drake, H. F., Morrison, A. K., Sarmiento, J. L., Griffies, S. M., Weijer, W., Gray, A. R., Dufour, C. (2016). **Lagrangian Upwelling Pathways of Deep Waters in the Southern Ocean.** *Ocean Sciences Meeting*, New Orleans, LA. [POSTER]

REFERENCES

Raffaele Ferrari
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