

# HENRI F. DRAKE

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## EDUCATION

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<b>MIT/WHOI Joint Program in Oceanography</b>	<i>2016 - 2021</i>
Ph.D. in Physical Oceanography	
<i>Control of the Abyssal Ocean Overturning Circulation by Mixing-Driven Bottom Boundary Layers</i>	
<b>Haverford College</b>	<i>2011 - 2015</i>
B.S. in Mathematics (Honors); Magna Cum Laude	

## EMPLOYMENT / RESEARCH EXPERIENCE

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<b>Assistant Professor, Earth System Science, University of California, Irvine</b>	<i>Upcoming (July 2023)</i>
<b>Postdoctoral Fellow, NOAA Climate &amp; Global Change Program</b>	<i>2021 - 2023</i>
Hosted by Sonya Legg (Princeton University and NOAA GFDL)	
<b>Graduate Research Assistant, MIT/WHOI Joint Program in Oceanography</b>	<i>2016 - 2021</i>
Advised by Raffaele Ferrari (MIT)	
<b>Research Specialist in Physical Oceanography, Princeton University</b>	<i>2015 - 2016</i>
Advised by Jorge Sarmiento (Princeton University) and Stephen Griffies (NOAA GFDL)	

## AWARDS

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<b>NOAA Climate and Global Change Postdoctoral Fellowship</b>	<i>2021 - 2023</i>
<b>National Science Foundation Graduate Research Fellowship</b>	<i>2017 - 2020</i>
<b>MIT Rosenblith Presidential Fellowship</b>	<i>2016 - 2017</i>

## RESEARCH PUBLICATIONS

Students denoted with <sup>†</sup> symbol.

### In preparation

**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.

**Drake, H. F.**, <sup>†</sup>Furia, F., Legg, S. Climate impacts of large-scale deployments of ocean thermal energy conversion.

### Accepted / In Press

10. **Drake, H. F.**, Ruan, X., Ferrari, R. Diapycnal displacement, diffusion, and distortion of tracers in the ocean. *Journal of Physical Oceanography*. [\[doi\]](#) [\[Preprint\]](#)
9. **Drake, H. F.**, Ruan, X., Callies, J., Ogden, K., Thurnherr, A., Ferrari, R. Dynamics of eddying abyssal mixing layers over rough topography. *Journal of Physical Oceanography*. [\[doi\]](#) [\[Preprint\]](#)

### Published

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*. [\[doi\]](#) [\[Preprint\]](#)
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. [\[doi\]](#) [\[Download PDF\]](#)

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## 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* [\[doi\]](#) [\[Download PDF\]](#)

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## MENTORING AND ADVISING

### Research Advising

Undergraduate researchers (2): Kaila Uyeda (Haverford College); Freddie Furia (Princeton University).

### Career and Peer Mentoring

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

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

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

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## 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).

## **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).

## **Peer review**

**Journal articles (13):** *Nature* (1), *Nature Communications* (1), *Geophysical Research Letters* (1), *Journal of Physical Oceanography* (2), *Journal of Geophysical Research: Oceans* (4), *Ocean Sciences* (1), *Geoscientific Model Development* (1), *Earth System Dynamics* (1), *Climatic Change* (1).

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

## **TEACHING EXPERIENCE**

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**Co-Instructor (2020)** for *Introduction to Computational Thinking* (six lectures) [\[MIT 18.S191 course website\]](#). Developed a flipped-classroom curriculum for introducing undergraduate Computer Science and Math majors to climate modeling through *reactive* notebooks in the Julia programming language.

**Organizer and Instructor (2020)** for *Practical Computing Tutorials for Earth Scientists (PraCTES)* [\[course website\]](#), a 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.

**Teaching Assistant (2019)** for *Climate Change* [\[MIT 6.S898 course website\]](#), 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.

**Guest lecturer (2019)** (1.5 hour session) for graduate-level physical oceanography course at University of Rhode Island Graduate School of Oceanography. Lecture on the abyssal ocean circulation.

**Guest Lecturer (2020)** (1 hour session) for *Dimensions of Geoengineering* [\[MIT course 12.884\[J\]\]](#). Interactive [ClimateMARGO.jl](#) demo exploring trade-offs between emissions mitigation, carbon dioxide removal, solar geoengineering, and adaptation.

**Lecturer (2017-2019)** (four 1.5 hour sessions) for *MIT/WHOI Summer Math Review* for incoming graduate students. Blackboard refresher on key concepts in Linear Algebra, ODEs, and PDEs.

## OUTREACH

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### Online Science Communication (>100,000 engagements)

- Publisher of ([margo.plutojl.org](http://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 which have personally engaged with my educational content.
- Founder of [Climate Gamers](#), an educational program that used 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 | <b>Bottom Layer Turbulence and Abyssal Recipes (Leg #2)</b><br>(39 day cruise on <i>RRS Discovery</i> , DY138)<br>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. |
| June 2018    | <b>MIT-WHOI Joint Program Orientation</b><br>(10 days on <i>R/V Corwith Cramer</i> )<br>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.                                                                                                                                                                                                                                                                                                                                                                                                                                          |

## INVITED TALKS

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

## SELECTED PRESENTATIONS

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- 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

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Raffaele Ferrari  
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Princeton University  
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