HENRI F. DRAKE

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EDUCATION

MIT/WHOI Joint Program in Oceanography *2016 - 2021*
PhD in Physical Oceanography

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

AWARDS

NOAA Climate and Global Change Postdoctoral Fellowship *2021 - present*

National Science Foundation Graduate Research Fellowship *2017 - 2020*

MIT Rosenblith Presidential Fellowship *2016 - 2017*

EMPLOYMENT / RESEARCH EXPERIENCE

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

- Developing parameterizations of abyssal mixing layer turbulence for use in next-generation general circulation ocean and climate models.
- Assessing the impact of deep ocean mixing and abyssal mixing layer parameterizations on the large-scale abyssal overturning circulation and global climate.

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

- Interpreted enigmatic twenty-year old observations and informed the practical planning of an upcoming observational field campaign by developing a quasi-realistic high-resolution simulation of the Brazil Basin Tracer Release Experiment.
- United several independent decades-long research tracks into a unified conceptual model of the abyssal circulation, using novel theoretical and numerical ocean circulation models.
- Developed a simple and user-friendly climate-economic model for use in climate education / outreach and for research on the role of scientific uncertainty in climate policy analysis.
- Evaluated the skill of climate projections by analyzing output from hundreds of simulations submitted to the Coupled Model Intercomparison Projects (CMIPs).

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

- Simulated millions of Lagrangian particle trajectories in a high-resolution model of the Southern Ocean and analyzed the spatial and temporal pathways of deep ocean upwelling.

Summer Research Assistant in Topology, Haverford College *2014*

Summer Research Assistant in Quantum Computing, University of Southern California *2013*

Summer Research Assistant in Environmental Engineering, Clarkson University *2012*

RESEARCH PUBLICATIONS

In preparation

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

Submitted / Under Review

Drake, H. F., Ruan, X., Ferrari, R. **Diapycnal motion, diffusion, and stretching of tracers in the ocean**. *Journal of Physical Oceanography*. [Preprint]

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*. [Preprint]

Drake, H. F., Henderson, G. **A defense of usable climate mitigation science: how science can contribute to social movements**. *Climate Change*.

2021

7. Brady, R. X., Maltrud, M. E., Wolfram, P. J., Drake, H. F., Lovenduski, N. C. **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. **A simple model for assessing climate control trade-offs and responding to unanticipated climate outcomes**. *Environmental Research Letters*. [doi]

2020

5. Drake, H. F., Ferrari, R., Callies, J. **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. **Evaluating the performance of past climate model projections**. *Geophysical Research Letters*, **46**. [doi]

2018

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., Rühs, 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 Modelling*, **121**, 49-75. [doi] [Download PDF]

2017

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]

OTHER PUBLICATIONS

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]

TEACHING EXPERIENCE

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 modelling 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-one 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. Mixed blackboard-powerpoint lecture on 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 of linear Algebra, ODEs, and PDEs.

LEADERSHIP AND SERVICE

Seminar series, conferences, and workshops

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

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

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

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

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

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

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

Committee member (2021-), **NOAA GFDL Diversity, Equity, and Inclusion Committee**

Pod co-leader [url] (spring 2020), **MIT EAPS' Unlearning Racism in Geoscience (URGE) pod**

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

DEI Scorecard [url] maintainer (2020-2021), **Towards Inclusion and Diversity in EAPS (TIDE)**.

Departmental Leadership and Administrative roles

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

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

Community Building

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).

Research Advising

Undergraduate researchers (3): Kaila Uyeda (Haverford College) and two upcoming in Summer 2022.

Career and Peer Mentoring

Peer mentor for **MIT/WHOI Joint Program PhD students (3)** (2018-2020)

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

Graduate Residential Advisor for **MIT undergraduates in Maseeh Hall** (2020-2021)

Peer review

Nature (1), *Ocean Sciences* (1), *Journal of Geophysical Research: Oceans* (3), *Journal of Physical Oceanography* (1), *Geoscientific Model Development* (1). *Climatic Change* (1), *Geophysical Research Letters* (1).

OUTREACH

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 Modelling: 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 & Sommerville, MA (2017, twice).

Online Science Communication

– Active climate science communicator on Twitter (@henrifdrake), 3500+ followers (deactivated 2021).

– Founder of Climate Gamers, an educational program that used computer games to communicate climate science to the public (see article in The Verge).

FIELD WORK

October 2021 **Bottom Layer Turbulence and Abyssal Recipes (Leg #2)**
(39 day cruise on *RRS Discovery*, 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.

June 2018 **MIT-WHOI Joint Program Orientation**
(10 days on *R/V Corwith Cramer*)
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

University of Liege, GeoHydrodynamics and Environment Research *12/05/2021*
Bottom boundary layer control on the abyssal overturning circulation

Johns Hopkins University, Atmospheres and Oceans *03/31/2021*
Bottom boundary layer control on the abyssal overturning circulation: basin and submeso-scale dynamics

University of Washington, School of Oceanography *02/24/2021*
Bottom boundary layer control on the abyssal overturning circulation: basin and submeso-scale dynamics

Princeton University and the Geophysical Fluid Dynamics Laboratory (GFDL) *02/01/2021*
Bottom boundary layer control on the abyssal overturning circulation: global and regional-scale dynamics

SELECTED PRESENTATIONS

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 Modelling (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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