

Ryan Patrick Abernathey

Associate Professor
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Contact

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Education

- *Sept. 2006–Feb. 2012* – **Ph.D., Climate Physics and Chemistry**, Massachusetts Institute of Technology, Cambridge, Massachusetts, USA
thesis: Mixing by Ocean Eddies, *advisor*: John Marshall
- *Sept. 2000–May 2004* – **B.A., Physics**, Middlebury College, Middlebury, Vermont, USA
thesis: Phase Dynamics and Synchronization of the Van der Pol Oscillator, *advisor*: Jeffrey Dunham

Appointments

- *July 2018–present* – **Associate Professor**, Columbia University / Lamont Doherty Earth Observatory, New York, New York, USA
- *July 2013–present* – **Assistant Professor**, Columbia University / Lamont Doherty Earth Observatory, New York, New York, USA
- *June 2012–July 2013* – **Postdoctoral Scholar**, Scripps Institution of Oceanography, La Jolla, California, USA
- *Feb. 2012–June 2012* – **Postdoctoral Scholar**, Massachusetts Institute of Technology, Cambridge, Massachusetts, USA
- *Sept. 2006–Feb. 2012* – **Graduate Research Assistant / Ph.D. Student**, Massachusetts Institute of Technology, Cambridge, Massachusetts, USA

Awards

- *July 2017* – Royal Society Exchange Grant (with Laure Zanna, U. of Oxford)
- *May. 2017* – Columbia Lenfest Junior Faculty Development Grant
- *Feb. 2016* – Alfred P. Sloan Research Fellow in Ocean Sciences
- *Feb. 2016* – NSF CAREER Award
- *Apr. 2014* – NASA New Investigator Early Career Award
- *June 2011* – Student Award Winner, AMS Conference on Atmospheric and Oceanic Fluid Dynamics
- *Dec. 2010* – Outstanding Student Presentation, AGU Fall Meeting

Publications

Conventions used for co-author attribution: In physical oceanography, there is no hard convention about author order, other than the fact that the first author is the one who made the dominant contribution to the paper. Generally authors are listed in descending order of the magnitude of their contribution, and sometimes supervising PIs are listed last.

In Review

1. Groeskamp, S., P. B. Barker, T. J. McDougall, R. P. Abernathey, and S. M. Griffies, 2018: A new algorithm to accurately calculate neutral tracer gradients and their impacts on vertical heat transport and water mass transformation. PDF (*Submitted to JPO*)
2. Sinha, A., D. Balwada, N. Tarshish, and R. Abernathey, 2018: Modulation of Lateral Transport by Submesoscale Flows and Inertia Gravity Waves. PDF (*In revision at JAMES*)
3. Busecke, J., and R. P. Abernathey, 2018: Ocean Mesoscale Mixing linked to Climate Variability. PDF (*Accepted to Science Advances*)

Published / In Press

1. Abernathey, R., J. Marshall, E. Shuckburgh, and M. Mazloff, 2010: Enhancement of Mesoscale Eddy Stirring at Steering Levels in the Southern Ocean. *J. Phys. Oceanogr.*, **40**, 170–185, doi:10.1175/2009JPO4201.1. PDF → online
2. Abernathey, R., J. Marshall, and D. Ferreira, 2011: The Dependence of Southern Ocean Meridional Overturning on Wind Stress. *J. Phys. Oceanogr.*, **41**, 2261–2278, doi:10.1175/JPO-D-11-023.1. PDF → online
3. Hill, C., D. Ferreira, J.-M. Campin, J. Marshall, R. Abernathey, and N. Barrier, 2012: Controlling Spurious Diapycnal Mixing in Eddy-Resolving Height-Coordinate Ocean Models: Insights from Virtual Deliberate Tracer Release Experiments. *Ocean Modelling*, **45–46**, 14–26, doi:10.1016/j.ocemod.2011.12.001. PDF → online
4. Abernathey, R., and J. C. Marshall, 2013: Global surface eddy diffusivities derived from satellite altimetry. *J. Geophys. Res.*, **118**, 901–916, doi:10.1002/jgrc.20066. PDF → online
5. Abernathey, R., D. Ferreira, and A. Klocker, 2013: Diagnostics of isopycnal mixing in a circumpolar channel. *Ocean Modelling*, **72**, 1–16, doi:10.1016/j.ocemod.2013.07.004. PDF → online
6. Gnanadesikan, A., R. Abernathey, and M.-A. Pradal, 2014: Exploring the isopycnal mixing and helium-heat paradoxes in a suite of Earth System Models. *Ocean Science Discussions*, **11**, 2533–2567, doi:10.5194/osd-11-2533-201. PDF → online
7. Abernathey, R. P., and P. Cessi, 2014: Topographic Enhancement of Eddy Efficiency in Baroclinic Equilibration. *J. Phys. Oceanogr.*, **44**, 2107–2126, doi:10.1175/JPO-D-14-0014.1. PDF → online
8. Klocker, A., and R. Abernathey, 2014: Global Patterns of Mesoscale Eddy Properties and Diffusivities. *J. Phys. Oceanogr.*, **44**, 1030–1047, doi:10.1175/JPO-D-13-0159.1. PDF → online
9. Abernathey, R., and D. Ferreira, 2015: Southern Ocean isopycnal mixing and ventilation changes driven by winds. *Geophysical Research Letters*, **42**, 10,357–310,365, doi:10.1002/2015GL066238. PDF → online
10. Abernathey, R. P., and C. Wortham, 2015: Phase speed cross spectra of eddy heat fluxes in the Pacific. *J. Phys. Oceanogr.*, **45**, 1285–1301, doi:10.1175/JPO-D-14-0160.1. PDF → online
11. Gnanadesikan, A., M.-A. Pradal, and R. Abernathey, 2015: Isopycnal mixing by mesoscale eddies significantly impacts oceanic anthropogenic carbon uptake. *Geophysical Research Letters*, **42**, 4249–4255, doi:10.1002/2015GL064100. PDF → online (*2015GL064100*)
12. Solomon, A., L. M. Polvani, K. L. Smith, and R. Abernathey, 2015: The impact of ozone depleting substances on the circulation, temperature and salinity of the Southern Ocean: An attribution study with CESM1 (WACCM). *Geophysical Research Letters*, **42**, 5547–5555, doi:10.1002/2015GL064744. PDF → online
13. Sinha, A., and R. Abernathey, 2016: Timescales of Southern Ocean Eddy Equilibration. *J. Phys. Oceanogr.*, **46**, 2785–2805, doi:10.1175/JPO-D-16-0041.1. PDF → online

14. Abernathey, R., I. Cerovečki, P. R. Holland, E. Newsom, M. Mazloff, and L. D. Talley, 2016: Southern Ocean Water Mass Transformation Driven by Sea Ice. *Nature Geoscience*, **9**, 596–601, doi:10.1038/ngeo2749. PDF → online
15. Wang, L., M. F. Jansen, and R. P. Abernathey, 2016: Eddy phase speeds in a two-layer model of quasigeostrophic baroclinic turbulence with applications to ocean observations. *Journal of Physical Oceanography*, **46**, 1963–1985, doi:10.1175/JPO-D-15-0192.1. PDF → online
16. Newsom, E., C. Bitz, F. Bryan, R. P. Abernathey, and P. Gent, 2016: Southern Ocean Deep Circulation and Heat Uptake in a High-Resolution Climate Model. *Journal of Climate*, **29**, 2597–2619, doi:10.1175/JCLI-D-15-0513.1. PDF → online
17. Bishop, S. P., P. R. Gent, F. O. Bryan, A. F. Thompson, M. C. Long, and R. P. Abernathey, 2016: Southern Ocean Overturning Compensation in an Eddy-Resolving Climate Simulation. *Journal of Climate*, **46**, 1575–1592, doi:10.1175/JPO-D-15-0177.1. PDF → online
18. Groeskamp, S., R. P. Abernathey, and A. Klocker, 2016: Water Mass Transformation by Cabbeling and Thermobaricity. *Geophysical Research Letters*, doi:10.1002/2016GL070860. PDF → online (2016GL070860)
19. Gnanadesikan, A., A. Russell, M.-A. Pradal, and R. Abernathey, 2017: Impact of Lateral Mixing in the Ocean on El Nino in a Suite of Fully Coupled Climate Models. *Journal of Advances in Modeling Earth Systems*, doi:10.1002/2017MS000917. PDF → online
20. Uchida, T., R. P. Abernathey, and K. S. Smith, 2017: Seasonality in Ocean Mesoscale Turbulence in a High Resolution Climate Model. *Ocean Modelling*, **118**, 41–58, doi:10.1016/j.ocemod.2017.08.006. PDF → online
21. Busecke, J., R. P. Abernathey, and A. L. Gordon, 2017: Lateral Eddy Mixing in the subtropical salinity maxima of the global Ocean. *J. Phys. Oceanogr.*, doi:10.1175/JPO-D-16-0215.1. PDF → online
22. Balwada, D., K. S. Smith, and R. Abernathey, 2018: Submesoscale Vertical Velocities Enhance Tracer Subduction in an Idealized Antarctic Circumpolar Current. *Geophysical Research Letters*, doi:10.1029/2018GL079244. PDF → online
23. Tesdal, J.-E., R. P. Abernathey, J. I. Goes, A. L. Gordon, and T. W. N. Haine, 2018: Salinity Trends within the Upper Layers of the Subpolar North Atlantic. *Journal of Climate*, **31**, 2675–2698, doi:10.1175/JCLI-D-17-0532.1. PDF → online
24. Tarshish, N., R. Abernathey, C. Zhang, C. O. Dufour, I. Frenger, and S. M. Griffies, 2018: Identifying Lagrangian coherent vortices in a mesoscale ocean model. *Ocean Modelling*, **130**, 15–28, doi:10.1016/j.ocemod.2018.07.001. PDF → online
25. Seville, E. van, and others, 2018: Lagrangian ocean analysis: fundamentals and practices. *Ocean Modelling*, **121**, 49–75, doi:10.1016/j.ocemod.2017.11.008. PDF → online
26. Abernathey, R., and G. Haller, 2018: Transport by Lagrangian Vortices in the Eastern Pacific. *Journal of Physical Oceanography*, **48**, 667–685, doi:10.1175/JPO-D-17-0102.1. PDF → online
27. Tamsitt, V., R. P. Abernathey, M. R. Mazloff, J. Wang, and L. D. Talley, 2018: Transformation of Deep Water Masses Along Lagrangian Upwelling Pathways in the Southern Ocean. *Journal of Geophysical Research: Oceans*, **123**, 1994–2017, doi:10.1002/2017JC013409. PDF → online

Sponsored Projects

- *NSF OCE 13-57133* – \$101,621 (2015-01-01 - 2016-12-31), PI
Collaborative Research: The Upper Branch of the Southern Ocean Overturning in the Southern Ocean State Estimate: Water Mass Transformation and the 3-D Residual Circulation
- *NASA NNX14AI46G* – \$259,539 (2015-05-06 - 2017-05-05), PI
Quantifying Surface Diapycnal Mixing by Mesoscale Eddies using Satellite Observations
- *NSF OCE 15-53593* – \$762,946 (2016-02-15 - 2021-01-31), PI
CAREER: Evolution of Ocean Mesoscale Turbulence in a Changing Climate
- *NASA NNX16AJ35G* – \$339,203 (2016-05-01 - 2020-04-03), Institutional PI
Fluxes of heat, carbon and oxygen at SWOT scales

- *NSF OCE 1740648* – \$1.2M (\$736,713 to LDEO) (2017-09-01 - 2020-08-31), lead PI
Collaborative Proposal: EarthCube Integration: Pangeo: An Open Source Big Data Climate Science Platform
- *NSF OAC 1835778* – \$254,103 (2018-11-01 - 2022-10-31), PI
Collaborative Research: Framework: Data: Toward Exascale Community Ocean Circulation Modeling

Teaching

- *Research Computing in Earth Science* – An intensive and hands-on immersion in the application on modern research computing practices to data analysis and visualization, using datasets and methods drawn from across Earth Science. (Fall 2017, Fall 2018)
- *Ocean Dynamics* – Advanced topics in in ocean circulation theory (Spring 2017)
- *Introduction to Physical Oceanography* – Physical properties of seawater, ocean water masses and their distribution, sea-air interaction, ocean general circulation, mixing processes. Co-taught with Arnold Gordon (Fall 2013, Fall 2014, Fall 2015, Fall 2017, Fall 2018)
- *Geophysical Fluid Dynamics* – Fundamental concepts in the dynamics of rotating stratified flows. Geostrophic and hydrostatic balances, potential vorticity, f and beta plane approximations, gravity and Rossby waves, geostrophic adjustment and quasigeostrophy, baroclinic and barotropic instabilities. (Spring 2015, Spring 2016)
- *Python for Scientific Computing* – An informal introduction to python, designed to take a novice from zero to fully functional in about eight hours. Topics include core python language, IPython notebooks, numpy, matplotlib, Basemap, pandas, and xarray. (September 2014, August 2015)

Software

- *xgcm* – A python package for the analysis of finite-volume ocean general circulation model output. Builds on xarray and dask projects to provide parallel, out-of-core scalability.
- *xmitgcm* – A python package for reading MITgcm binary MDS files into xarray data structures.
- *xarray* – A community-driven open source project to which I contribute. Xarray provides data structures and computational methods for working with labeled multidimensional numerical array data.
- *xrft* – Fourier transforms on xarray data structures.
- *pyqg* – A python quasigeostrophic model for turbulence simulations. Well documented and easy to use—ideal for students, but fast enough for real research.

Presentations

Invited

- *May 2018* – *Transport by Coherent Lagrangian Vortices*, MIT PAOC Colloquium, Cambridge, MA
- *Jan. 2018* – *Pangeo: An Open Source Platform for Big Data Geoscience*, Earth System Information Partners Conference, Washington, DC
- *Nov. 2017* – *Transport by Coherent Lagrangian Vortices*, Duke University, Durham, NC
- *Oct. 2017* – *Transport by Coherent Lagrangian Vortices*, University of Washington, Seattle, WA
- *Apr. 2017* – *Southern Ocean Water Mass Transformation Driven by Sea Ice*, Southern Ocean Workshop, NCAR, Boulder, CO

- *Jan. 2017 – Eulerian eddy fluxes by coherent Lagrangian eddies in the ocean*, Transport in Unsteady Flows: from Deterministic Structures to Stochastic Models and Back Again, Banff International Research Station, Banff, CA
- *Oct. 2016 – What are Ocean Eddies?*, Rutgers University, New Brunswick, NJ
- *Oct. 2016 – Southern Ocean Water Mass Transformation Driven by Sea Ice*, SUNY Stony Brook, Stony Brook, NY
- *Jan. 2016 – Southern Ocean Water Mass Transformation Driven by Sea Ice*, Workshop on thermodynamic analysis for atmospheric and oceanic flows, NYU Abu Dhabi, Abu Dhabi, UAE
- *Jan. 2016 – Southern Ocean Water Mass Transformation Driven by Sea Ice*, Southern Ocean Carbon and Climate Observations and Modeling Webinar
- *Sept. 2015 – Identifying Lagrangian Coherent Structures on a Basin Scale using MITgcm and PyTables*, Workshop on the Future of Lagrangian Ocean Modeling, Imperial College, London, UK
- *Feb. 2015 – The Upwelling Branch of the Southern Ocean Overturning Circulation*, Southern Ocean Dynamics and Biogeochemistry Workshop, California Institute of Technology, Pasadena, CA
- *Dec. 2014 – The Phase Speed Signature of Mesoscale Eddy Fluxes in the Pacific*, Harvard University, Cambridge, MA
- *July 2014 – The Phase Speed Signature of Mesoscale Eddy Fluxes in the Pacific*, Woods Hole Oceanographic Institution, Woods Hole, MA
- *July 2014 – The Phase Speed Signature of Mesoscale Eddy Fluxes in the Pacific*, Geophysical Fluid Dynamics Laboratory, Princeton, NJ
- *May 2014 – Topographic Enhancement of Eddy Efficiency in Baroclinic Equilibration*, Johns Hopkins University, Baltimore, MD
- *Apr. 2014 – Topographic Enhancement of Eddy Efficiency in Baroclinic Equilibration*, Courant Institute at New York University, New York, NY
- *March 2014 – Topographic Enhancement of Eddy Efficiency in Baroclinic Equilibration*, University of Rhode Island, Narragansett, RI
- *April 2013 – Mixing By Ocean Eddies*, National Center for Atmospheric Research, Boulder, CO
- *March 2013 – Mixing By Ocean Eddies*, Scripps Institution of Oceanography, La Jolla, CA
- *Feb. 2013 – Equilibration of Circumpolar Currents with and without Topography*, California Institute of Technology, Pasadena, CA
- *Oct. 2012 – Mixing By Ocean Eddies*, Physical Oceanography Dissertation Symposium, Lihue, Kaua'i, HI
- *April 2012 – Mixing By Ocean Eddies*, Lamont Doherty Earth Observatory, Palisades, NY
- *March 2012 – Mixing By Ocean Eddies*, University of Chicago, Chicago, IL

Conference

- *December 2018 – Beyond netCDF: Cloud Native Climate Data with Zarr and XArray*, AGU Fall Meeting
- *December 2018 – Global Changes in Mesoscale Eddy Kinetic Energy under Greenhouse Warming*, AGU Fall Meeting
- *October 2018 – A Linearized Heat Budget for the World Oceans*, ECCO Meeting
- *June 2018 – Pangeo: An Open Source Platform for Big Data Geoscience*, Earthcube All Hands Meeting, Washington, DC

- *Feb. 2018 – Pangeo: An Open Source Platform for Big Data Geoscience*, AGU Ocean Sciences Meeting, Portland, OR
- *Feb. 2018 – Transport by Coherent Lagrangian Vortices*, AGU Ocean Sciences Meeting, Portland, OR
- *June 2017 – Transport by Coherent Lagrangian Vortices*, AMS Atmosphere Ocean Fluid Dynamics Meeting, Portland, OR
- *May 2016 – Lagrangian Coherent Structures and Eulerian Eddy Fluxes in the East Pacific*, AmeriMech Symposium on Fluid Transport and Nonlinear Dynamics, WHOI, Woods Hole, MA
- *May 2016 – Online Diagnostics of Water Mass Transformation in MITgcm*, ECCO Production meeting, MIT, Cambridge, MA
- *Oct. 2015 – Isopycnal Mixing and Ventilation Controlled by Winds*, CLIVAR Workshop on Translating Process Understanding to Improve Climate Models, Princeton, NJ
- *June 2015 – Phase Speed Spectra of Ocean Mesoscale Eddies*, AMS Conference on Atmosphere Ocean Fluid Dynamics, Minneapolis, MN
- *Dec. 2014 – Surface Water Mass Transformation by Mesoscale Eddy Stirring*, AGU Fall Meeting, San Francisco, CA
- *Feb. 2014 – Evaluating Theories for Mesoscale Eddy Diffusivity Using Satellite Observations*, AGU Ocean Sciences Meeting, Honolulu, HI
- *June 2013 – Macroturbulent Equilibration of Circumpolar Currents with and without Topography*, Ocean Turbulence Conference, Center for Nonlinear Science, Santa Fe, NM
- *Feb. 2013 – Equilibration of Circumpolar Currents with and without Topography*, Southern Ocean Workshop, Massachusetts Institute of Technology, Cambridge, MA
- *Dec. 2012 – Equilibration of Circumpolar Currents with and without Topography*, AGU Fall Meeting, San Francisco, CA
- *April 2012 – European Geosciences Union General Assembly*, Vienna, Austria
- *Feb. 2012 – AGU Ocean Sciences Meeting*, Salt Lake City, UT
- *June 2011 – AMS Conference on Atmospheric and Oceanic Fluid Dynamics*, Spokane, WA
- *Oct. 2011 – Graduate Climate Conference*, Woods Hole Oceanographic Institution, Woods Hole, MA
- *Dec. 2010 – AGU Fall Meeting*, San Francisco, CA
- *Feb. 2010 – AGU Ocean Sciences Meeting*, Portland, OR
- *June 2009 – AMS Conference on Atmospheric and Oceanic Fluid Dynamics*, Stowe, VT

Service

Community

- Session Chair, Transport and Coherent Structures: New and Traditional Approaches for Studying Ocean Stirring and Mixing, 2018 Ocean Sciences Meetings, Portland, OR
- Faculty Member, 2014 Geophysical Fluid Dynamics Summer School, Woods Hole Oceanographic Institution, Woods Hole, MA
- Session Chair, The Southern Ocean and Its Role in the Climate System; Observations and Modeling of Physical and Biogeochemical Processes, 2014 Ocean Sciences Meeting, Honolulu, HI
- Member, EarthCube Science Committee

- Member, American Geophysical Union
- Member, European Geophysical Union
- Member, American Meteorological Society
- Reviewer for Journal of Physical Oceanography
- Reviewer for Journal of Geophysical Research Oceans
- Reviewer for Geophysical Research Letters
- Reviewer for Ocean Modelling
- Reviewer for Nature Communications
- Reviewer for National Science Foundation

Univeristy

- Leader, LDEO Real Time Earth Strategic Initiative (2015 - present)
- Board Member, Center for Climate and Life (2015 - present)
- Member, Columbia Data Science Institute Working Group on Frontiers in Computing Systems (2016 - present)
- SRCPAC Education Committee (2017)
- DEES Curriculum Committee (2016)
- DEES Broad Search Committee (2016)
- DEES Cryosphere Search Committee (2015)
- Yeti High Performance Computing Executive Committe (2015-2016)