# Sylvia T. Cole

Woods Hole Oceanographic Institution
266 Woods Hole Road, MS #21
Woods Hole, MA 02543

scole@whoi.edu
508-289-3805 / Clark 307
www.whoi.edu/staff/scole

## RESEARCH INTERESTS

I study the ocean as a system focusing on processes that transport energy or affect the advection and diffusion of active and passive tracers. I investigate these processes in the Arctic and global oceans utilizing observations from the turbulent scale to the basin scale. I aim to understand ocean dynamics across spatial and temporal scales, including the net effects of typically smaller-scale processes (e.g., internal waves, eddies) on the ocean and climate system.

## EDUCATION

| | |
|---|---|
| 2010 | Ph. D. in Physical Oceanography, Scripps Institution of Oceanography, University of California San Diego |
| 2004 | B. S. in Physics, University of Maryland, College Park |

## APPOINTMENTS

| | |
|---|---|
| 2023-present | Associate Scientist with Tenure |
| 2019-2023* | Associate Scientist |
| 2015-2019 | Assistant Scientist |
| 2014-2015* | Research Associate III |
| 2010-2013* | Postdoctoral Scholar / Investigator<br>Woods Hole Oceanographic Institution, Woods Hole MA |
| 2004-2010 | Graduate Research Assistant<br>Scripps Institution of Oceanography, La Jolla, CA |

**Leave taken during 2013 (65% FTE), FY2015 (75%), and FY2020 (70%); official leave does not account for the full impact of these events.*

## PUBLICATIONS

*Refereed:*
*♣postdoctoral advisee; #graduate or undergraduate advisee*

**Cole ST** and #PA Roemer, 2023: The transition layer and remnant transition layer of the Western Arctic Ocean: Stratification, vertical diffusivity, and Pacific Summer Water heat fluxes, *J. Geophys. Res.*, in revision.

Son EY, Y Kawaguchi, HK Ha, **ST Cole**, JM Toole, J-H Park, 2022: Assessment of turbulent mixing associated with eddy-wave coupling based on autonomous observations

from the Arctic Canada Basin, *J. Geophys. Res.*, 127, e2022JC018489, doi: 10.1029/e2022JC018489.

*Steinberg JM, **ST Cole**, K Drushka, RP Abernathey, 2022: Seasonality of the mesoscale inverse cascade as inferred from global scale-dependent eddy energy observations, *J. Phys. Oceanogr.*, 52, 1677-1691, doi: 10.1175/JPO-D-21-0269.1.

*Fine E, and **ST Cole**, 2022: Decadal observations of internal wave energy, shear, and mixing in the western Arctic Ocean, *J. Geophys. Res.*, 127, e2021JC018056, doi: e2021JC018056.

Rabe B, C Heuze, J Regnery and 83 co-authors including **ST Cole**, 2022: Overview of the MOSAiC expedition: Physical Oceanography, *Elementa Sci. Anthrop.*, 10(1), doi: 10.1525/elementa.2021.00062.

Zhong W, **ST Cole**, J Zhang, R Lei, M Steele, 2022: Increasing winter ocean-to-ice heat flux in the Beaufort Gyre region, Arctic Ocean over 2006-2018, *Geophys. Res. Lett.*, 49, e2021GL096216.

Fine EC, JA MacKinnon, MH Alford, JB Mickett, L Middleton, J Taylor, **ST Cole**, N Couto, T Peacock, A Le Boyer, 2022: Double diffusion, shear instabilities, and heat impacts of a Pacific Summer Water intrusion in the Beaufort Sea, *J. Phys. Oceanogr.*, 52, 189-203, doi: 10.1175/JPO-D-21-0074.1.

Brenner, S, L Rainville, J Thomson, **ST Cole**, C Lee, 2021: Comparing observations and parameterizations of ice-ocean drag through an annual cycle across the Beaufort Sea, *J. Geophys. Res.,* 126, e2020JC016977, doi: 10.1029/2020JC016977.

Heorton, HDBS, M Tsamados, **ST Cole**, AMG Ferreira, A Berbellini, M Fox, and TWK Armitage, 2019: Retrieving sea ice drag coefficients and turning angles from in-situ and satellite observations using an inverse modeling framework, *J. Geophys. Res.*, 124, 6388-6413, doi: 10.1029/2018JC014881.

**Cole, ST**, and #J Stadler, 2019: Deepening of the winter mixed layer in the Canada Basin, Arctic Ocean over 2006-2017, *J. Geophys. Res.*, 124, 4618-4630, doi: 10.1029/2019JC014940.

Zhong, W, M Steele, J Zhang, and **ST Cole**, 2019: Circulation of Pacific Winter Water in the western Arctic Ocean, *J. Geophys. Res., 124*, 863-881, doi: 10.1029/2018JC014604.

**Cole, ST**, JM Toole, L Rainville, and CM Lee, 2018: Internal waves in the Arctic: Influence of ice concentration, ice roughness, and surface layer stratification, *J. Geophys. Res.*, 123, 5571-5586, doi: 10.1029/2018JC014096.

Meneghello, G, J Marshall, **ST Cole**, and M-L Timmermans, 2017: Observational inferences of lateral eddy diffusivity in the halocline of the Beaufort Gyre, *Geophys. Res. Lett.*, 44, 12331-12338, doi: 10.1002/2017GL075126.

Lee CM, Thomson J, and the **Marginal Ice Zone team** and the Arctic Sea State team, 2017: An autonomous approach to observing the seasonal ice zone in the western Arctic, *Oceanography*, 30, 56-68, doi: 10.5670/oceaong.2017.222.

**Cole, ST**, JM Toole, R Lele, M-L Timmermans, SG Gallaher, TP Stanton, WJ Shaw, B Hwang, T Maksym, JP Wilkinson, M Ortiz, H Graber, L Rainville, AA Petty, SL Farrell, JA Richter-Menge, and C Haas, 2017: Ice and ocean velocity in the Arctic marginal ice zone: Ice roughness and momentum transfer, *Elementa Sci. Anthrop., 5: 55,* doi: 10.1525/elementa.241.

Bigdeli, A, B Loose, AT Nguyen, and **ST Cole**, 2017: Numerical investigation of the Arctic ice-ocean boundary layer and implications for air-sea gas fluxes, *Ocean Sci.*, 13, 61-75, doi: 10.5194/os-13-61-2017.

Zhang, J, M Steele, K Runciman, S Dewey, J Morison, C Lee, L Rainville, **S Cole**, R Krishfield, M-L Timmermans, and J Toole, 2016: The Beaufort Gyre intensification and stabilization: A model-observation synthesis, *J. Geophys. Res*., 121, 7933-7952, doi: 10.1002/2016JC012196.

Gallaher, SG, TP Stanton, WJ Shaw, **ST Cole**, JM Toole, JP Wilkinson, T Maksym and B Hwang, 2016: Evolution of a Canada Basin ice-ocean boundary layer and mixed layer across a developing thermodynamically forced marginal ice zone, *J. Geophys. Res.*, *121*, 6223-6250, doi: 10.1002/2016JC011778.

Zhao, M, M-L Timmermans, **S Cole**, R Krishfield, and J Toole, 2016: Evolution of the eddy field in the Arctic Ocean's Canada Basin, 2005-2015, *Geophys. Res. Lett.*, *43,* 8106-8114, doi: 10.1002/2016GL069671.

**Cole, ST**, C Wortham, E Kunze, and WB Owens, 2015: Eddy stirring and horizontal diffusivity from Argo float observations: Geographic and depth variability, *Geophys. Res. Lett., 42,* 3989-3997, doi: 10.1002/2015GL063827.

Zhao, M, M-L Timmermans, **S Cole**, R Krishfield, A Proshutinsky, and J Toole, 2014: Characterizing the eddy field in the Arctic Ocean halocline, *J. Geophys. Res., 119,* 8800-8817, doi: 10.1002/2014JC010488.

**Cole, ST,** M-L Timmermans, JM Toole, RA Krishfield, and FT Thwaites, 2014: Ekman veering, internal waves, and turbulence observed under Arctic sea ice, *J. Phys. Oceanogr., 44,* 1306-1328*,* doi: 10.1175/JPO-D-12-0191.1.

Timmermans, M-L, **ST Cole**, and JM Toole, 2012: Horizontal density structure and restratification in the Arctic Ocean surface layer, *J. Phys. Oceanogr.,* 42, 659-668, doi: 10.1175/JPO-D-11-0125.1.

**Cole, ST,** and DL Rudnick, 2012: The spatial distribution and annual cycle of upper ocean thermohaline structure, *J. Geophys. Res.,* 117, C02027, doi: 10.1029/2011JC007033.

Rudnick, DL, and **ST Cole**, 2011: On sampling the ocean using underwater gliders, *J. Geophys. Res.,* 116, C08010, doi: 10.1029/2010JC006849.

Johnston, TMS, DL Rudnick, GS Carter, RE Todd, and **ST Cole**, 2011: Internal tidal beams and mixing near Monterey Bay, *J. Geophys. Res.,* 116, C03017, doi: 10.1029/2010JC006592.

**Cole, ST**, DL Rudnick, and JA Colosi, 2010: Seasonal evolution of upper ocean horizontal structure and the remnant mixed layer, *J. Geophys. Res.,* 115, C04012, doi: 10.1029/2009JC005654.

**Cole, ST**, DL Rudnick, BA Hodges, and JP Martin, 2009: Observations of tidal internal wave beams at Kauai Channel, Hawaii, *J. Phys. Oceanogr*. 39, 421-436, doi: 10.1175/2008JPO3937.1.

*Additional publications and other products:*

**Cole, ST**, K Drushka, and R Abernathey, 2020: Towards an observational synthesis of eddy energy in the global ocean, CLIVAR variations / exchanges, 18, 37-41, doi: 10.5065/g8w0-fy32.

**Cole, ST**, 2017: Investigating small-scale processes from an abundance of autonomous observations, ALPS-II white paper and final report chapter, 3 pages.

Lee, CM and 22 co-authors including **S Cole**, 2016: Stratified Ocean Dynamics of the Arctic: Science and experiment plan, Technical Report APL-UW 1601, 43 pages.

**Cole, ST,** FT Thwaites, RA Krishfield, and JM Toole, 2015: Processing of velocity observations from Ice-Tethered Profilers, *Proc. MTS/IEEE Oceans 2015 Conference, Washington DC,* 10 pages, doi: 10.23919/OCEANS.2015.7401887.

Lee, CM and 20 co-authors including **S Cole**, 2012: Marginal Ice Zone (MIZ) Program: Science and experiment plan, Technical Report APL-UW 2101, 48 pages.

**Cole, ST**, 2010: Spatial and temporal modulation of internal waves and thermohaline structure, Ph.D. Thesis, University of California San Diego, 148 pages.

*Published datasets:*

Toole, JM, RA Krishfield, JK O'Brien, A Houk, **ST Cole**, and the Woods Hole Oceanographic Institution Ice-Tethered Profiler program, 2016: Ice-Tethered Profiler observations: Vertical profiles of temperature, salinity, oxygen, and ocean velocity from an Ice-Tethered buoy system. NOAA National Centers for Environmental Information, doi: 10.7289/v5mw2f7x. Dataset.

Bliss A, JK Hutchings, and 67 co-authors including **ST Cole**, 2022: Sea ice drift tracks from the Distributed Network of autonomous buoys deployed during the Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC) expedition 2019-2021, Arctic Data Center, doi: 10.18739/A21N7XP19.

**Cole, ST**, 2021: Beaufort Gyre wintertime mixed layer depth and mixed layer properties derived from Ice-Tethered Profiler observations in the Arctic Ocean over 2006-2017, Arctic Data Center, doi: 10.18739/A2DR2P94G.

**Cole, ST**, 2021: Ocean eddy diffusivity estimate derived from Beaufort Gyre Observing System mooring observations over 2003-2018, Canada Basin, Arctic Ocean, Arctic Data Center, doi: 10.18739/A2901ZH14.

**Cole, ST**, C Wortham, E Kunze, and WB Owens, 2018: Eddy diffusivity from Argo temperature and salinity profiles, doi: 10.1575/1912/10220.

## AWARDS

Woods Hole Oceanographic Institution Early Career Scientist Award, 2021

American Meteorological Society Editor's award for excellence in reviewing, Jan. 2019

Woods Hole Oceanographic Institution Postdoctoral Scholarship, Nov. 2010 – May 2012

NSF / Scripps Institution of Oceanography G-K12 fellowship, June 2009 – May 2010

## FIELD EXPERIENCE

2013-present: PI or co-PI on projects that have deployed 14 Ice-Tethered Profilers with Velocity primarily in the Arctic Ocean. Over 20,000 temperature, salinity, and velocity profiles have been collected, along with over 10,000 records of turbulent heat, salt, and momentum fluxes just beneath the ice-ocean interface.

Dec. 2008 and April 2009: underwater glider recovery and deployment off of Hawaii

Dec 2007: R/V *Kilo Moana*, SeaSoar operations off of Hawaii

July and Oct 2007: R/V *Melville*, underwater glider, underway CTD, and CTD rosette operations off of Taiwan

Aug 2006: R/V *Wecoma*, SeaSoar and microstructure operations off of Monterey Bay, California

Aug. 2004: R/V *Melville*, CTD rosette operations in the North Pacific

## EDUCATIONAL ACTIVITIES

*Advising:*

| | |
|---|---|
| Lilli Hirth, US Navy Master's student | Aug. 2023–present |
| Jacob Steinberg, Postdoctoral Investigator | May 2020 –Mar. 2023 |
| Elizabeth Fine, Postdoctoral Scholar | Oct. 2019–May 2021 |
| Lt. Peter Roemer, US Navy Master's student | Jun. 2019–Aug. 2021 |
| James Stadler, Summer Student Fellow | Summer 2017 |
| Committee Member, Deshuai Wang, U. Mass. Dartmouth | 2017–2021 |

*Lectures and teaching:*

| | |
|---|---|
| Guest Lecture, US Coast Guard Academy, Polar Oceanography | Feb 2019, Oct. 2020 |
| Guest Lecture, WHOI/MIT Data Analysis in Physical Oceanography | May 2017 |
| Partnership Education Program, Woods Hole, MA<br>Co-developed and co-instructed a 20-hour physical oceanography unit for underrepresented undergraduate science majors | 2012 and 2013 |
| NSF / Scripps Institution of Oceanography G-K12 fellowship, San Diego, CA | 2009 |

Developed lessons for and instructed two 9th grade earth science classes once per week

## PROFESSIONAL ACTIVITIES

*External:*

Editor, *Journal of Physical Oceanography*, 2021-present

Associate Editor, *Journal of Physical Oceanography*, 2020

Reviewer: National Science Foundation, Natural Environment Research Council

Reviewer: *Elementa Science of the Anthropocene, Geophysical Research Letters, Geoscientific Model Development, International Journal of Remote Sensing, Journal of Atmospheric and Oceanic Technology, Journal of Geophysical Research, Journal of Marine Research, Journal of Physical Oceanography, Nature Communications, Ocean Modeling, Ocean Science, Oceanography, Progress in Oceanography, Tellus A*

Steering committee member, Ocean transport and eddy energy CPT, 2019-present

Steering committee member, Stratified Ocean Dynamics of the Arctic (SODA) DRI, 2017-2022

Organizer / local host, Ocean Transport and Eddy Energy Annual Meeting, Woods Hole MA and online, May 2023; ~100 participants, 50% virtual

Co-convener, Air-ice-ocean interactions in a changing Arctic, Ocean Sciences Meeting, virtual, Feb 2022

Co-convener, Ocean transport and eddy energy, Ocean Sciences Meeting, San Diego CA, Feb. 2020

Mentor / Senior participant, Pattullo Conference, Warrenton Virginia, Sept. 2019

Organizer / local host, Stratified Ocean Dynamics of the Arctic DRI PI meeting, Woods Hole MA, March 2018; ~25 participants

Panel Member, The role of small-scale processes, Forum for Arctic Modeling and Observational Synthesis, Nov. 2016

Organizer, International Meeting of Students in Physical Oceanography, San Diego CA, 2008

*WHOI:*

Supervisor, Adam Houk, Research Associate III, 2021 - present

Member, PO Department Recruitment Committee, 2023 - present

Coordinator, Physical Oceanography Department Summer Student Fellow program, 2020-2022

Member, Scientific Staff Executive Committee (SciSEC), 2018-2020

Member, Physical Oceanography Department chair search committee, 2018, 2022

Coordinator, Physical Oceanography seminar, 2015-2016

Member, Postdoctoral Association, 2012

Member, Women's Committee, 2012

*Professional Affiliations:*

Member, American Geophysical Union

Member, The Oceanography Society

## RECENT PRESENTATIONS

**ST Cole (invited)**, Dynamics of the Arctic Ocean: Observations across scales and seasons. Arctic Ocean Dynamics Workshop, Oslo Norway, November 2023.

**ST Cole**, Stratification, heat, and mixing through the Arctic Ocean's transition layer and remnant transition layer. AWI seminar, Bremerhaven Germany, November 2023.

**ST Cole** and PA Roemer, Heat, stratification, and the transition layer of the Beaufort Gyre. Poster presentation, The changing Beaufort Gyre workshop, Woods Hole MA, March 2023.

**ST Cole (invited)**, Stratification, heat, and diffusivity of the Western Arctic Ocean's transition layer. URI PO seminar, Kingston RI, October 2022.

**ST Cole,** Stratification of the Western Arctic Ocean's transition layer and remnant transition layer. WHOI PO seminar, Woods Hole MA, September 2022.

**ST Cole**, Kinetic energy in the Western Arctic Ocean. Oral presentation, Arctic Ocean Circulation workshop, virtual, June 2022.

**ST Cole (invited)**, The Arctic sea ice-cover and ocean mixing on daily to decadal timescales. Oral presentation, Gordon Conference on Ocean Mixing, Holyoke MA, June 2022.

**ST Cole**, M Doble, J Hargrove, L Rainville, W Shaw, T Stanton, J Toole, J Wilkinson, Ice-ocean interactions observed during fall and winter storms in the Western Arctic. Oral presentation, Ocean Sciences Meeting, virtual, Feb. 2022.

**ST Cole (invited)**, The Arctic Ocean mixed layer in winter. URI PO seminar, virtual, April 2021.

**ST Cole**, JM Toole, and RA Krishfield, Observations from the edge of the Beaufort Gyre: Ice-Tethered Profilers in 2018-2019. Poster presentation, Ocean Sciences Meeting, San Diego CA, Feb. 2020.

**ST Cole (invited)**, The changing Arctic Ocean mixed layer from basin scales to submesoscales. Brown University DEEPS seminar, Providence RI, Feb. 2020.

**ST Cole (invited)**, What can horizontal stirring tell us about vertical mixing? Oral presentation, Japan Geophysical Union Meeting, Tokyo Japan, May 2019.

**ST Cole (invited)**, An update on eddy diffusivity from Argo observations and insights into vertical mixing. Oral presentation, Ocean mixing processes workshop, Tokyo Japan, May 2019.

**ST Cole**, The Arctic Ocean mixed layer from basin scales to submesoscales. WHOI PO seminar, Woods Hole MA, May 2019.

**ST Cole (invited)**, An update on eddy diffusivity in the global ocean from Argo observations. Oral presentation, AGU Fall Meeting, Washington D.C., Dec. 2018.

**ST Cole (invited)**, Recent deepening of the Beaufort Gyre mixed layer. Oral presentation, AGU Fall Meeting, Washington D.C., Dec. 2018.

**ST Cole**, Internal wave dynamics and Arctic sea ice: from winter to open water. Poster presentation, Gordon conference on ocean mixing, Andover NH, June 2018.

**ST Cole (invited)**, Ice and ocean velocity in the Arctic: near-inertial to seasonal timescales. Scripps Institution of Oceanography CASPO seminar, La Jolla CA, May 2018.

**ST Cole**, Observations of horizontal stirring and eddy diffusivity in the Arctic Ocean. Poster presentation, Ocean Sciences meeting, Portland OR, Feb. 2018.