PATRICK A. RAFTER

Keck Carbon Cycle Lab Research Scientist
Dept. of Earth System Science
UC Irvine
prafter@uci.edu
858 405 0539
www.prafter.com
<2020-12 vintage>

EDUCATION / APPOINTMENTS / EMPLOYMENT

Keck Carbon Cycle Laboratory Research Scientist. UC Irvine. Apr 2014-present
Postdoctoral Research Associate & Associate Research Scholar. Princeton University. 2009-2014
PhD in Oceanography. Scripps Institution of Oceanography. Sept 2002-Sept 2009
BS Environmental Science & BS Marine Environmental Studies. Florida Inst. of Technology 2000

PUBLICATIONS

Cruz, A.P.S., … P.A. Rafter, et al. (In Review) Neodymium Isotope Response to Hydrologic and Water Masses Changes in the Tropical-Subtropical Western Atlantic During the Last 40kyr. *Earth and Planetary Science Letters*

Gajurel, A.P., … P.A. Rafter, et al. (In Review) Climatic and Tectonic Significance of Taboche Lake, Khumbu Region, Nepal. *iScience*

Horner, T.J., … P.A. Rafter, et al. (In Review) Bioactive trace metals and their isotopes as paleoproductivity proxies: An assessment using GEOTRACES-era data. *Global Biogeochemical Cycles*

Farmer, J.R., … P.A. Rafter, et al. (In Review) Major element isotope tracers associated to past ocean productivity. *Global Biogeochemical Cycles*

Dao, Y., J. Yu, and P.A. Rafter (In Review) Deglacial ventilation changes in the deep southwest Pacific. *Paleoceanography*.

23. Rae, J., … P.A. Rafter, et al. (2020) Overturning circulation, nutrient limitation, and warming in the Glacial North Pacific. *Science Advances.* DOI: 10.1126/sciadv.abd1654

22. Díaz-Asencio, M. … , P.A. Rafter. (2020) Sediment accumulation rates and vertical mixing of deep-sea sediments derived from ^{14}C and ^{210}Pb in the southern Gulf of Mexico. Marine Geology. https://doi.org/10.1016/j.margeo.2020.106288

21. Robinson, R.S., … P.A. Rafter, et al. (2020) A Test of the Diatom-Bound Paleoproxy: Tracing the Isotopic Composition of Nutrient-Nitrogen Into Southern Ocean Particles and Sediments. *Global Biogeochemical Cycles*. https://doi.org/10.1029/2019GB006508.

20. Saito, M., … P.A. Rafter et al. (2020) Abundant nitrite oxidoreductase metalloenzyme in the mesopelagic metaproteome of Pacific OMZ extremities. *Nature Geoscience*. https://doi.org/10.1038/s41561-020-0565-6

19. Rafter, P.A., et al. (2019) Anomalous >2000 year old surface ocean reservoir age as evidence for deglacial geologic carbon release. *Geophysical Research Letters*. http://dx.doi.org/10.1029/2019GL085102

18. White, M., P.A. Rafter et al. (2019) Recent increases in water column denitrification in the seasonally suboxic bottom waters of the Santa Barbara Basin. *Geophysical Research Letters*. http://dx.doi.org/10.1029/2019GL082075

17. Rafter, P.A., A. Bagnell, D. Marconi, T. DeVries (2019) Global trends in marine nitrate N isotopes from observations and a neural network-based climatology. *Biogeosciences*. https://doi.org/10.5194/bg-16-2617-2019

16. Robinson, R. S., P.A. Rafter, et al. (2019) Contraction of the eastern equatorial Pacific high productivity zone across the Mid-Pleistocene Transition. *Geophysical Research Letters*.

15. Lund, D., … P.A. Rafter, … & R. Anderson. (2019) Hydrothermal scavenging of ^{230}Th on the Southern East Pacific Rise during the last deglaciation. *Earth and Planetary Sciences Letters*.
14. Smart, S. …, P.A. Rafter, D. Sigman, G. Haug (2018) Ground-truthing the planktic foraminifer-bound nitrogen isotope paleo-proxy in the Sargasso Sea. *Geochimica et Cosmochimica Acta*.
13. Rafter, P.A., J-C. Herguera, and J. R. Southon (2018) Extreme deglacial ^{14}C depletion observed in epifaunal and infaunal benthic foraminifera. *Climate of the Past*.
12. Lehmann, N., J. Granger, and P.A. Rafter, et al. (2018) Nitrate Isotope Evidence of the Origin of Subsurface Nitrate in the Western Equatorial Pacific. *JGR-Oceans*.
11. Rafter, P.A., D.M. Sigman, K.R.M. Mackey. (2017) New production requires recycled iron in the eastern equatorial Pacific. *Nature Communications.*
10. Rafter, P.A., S.C. Sanchez, E. Druffel, J. Southon and others. (2017) Eastern tropical North Pacific coral radiocarbon reveals North Pacific Gyre Oscillation variability. *Quaternary Science Reviews*.
09. Marconi, D., D.M. Sigman, P.A. Rafter, et al. (2017) Tropical Dominance of N_2 Fixation in the North Atlantic Ocean. *Global Biogeochemical Cycles*.
08. Marconi, D., S. Kopf, P.A. Rafter, and D.M. Sigman. (2017) Aerobic respiration along isopycnals leads to overestimation of the isotope effect of denitrification in the ocean water column. *Geochimica et Cosmochimica Acta*.
07. Rafter, P.A. and D.M. Sigman. (2016) The spatial and temporal variation of upper equatorial Pacific nitrate utilization. *Limnology and Oceanography*.
06. Marconi, D., D.M. Sigman, P.A. Rafter et al. (2015) Nitrate isotope distributions on the US GEOTRACES North Atlantic cross-basin section. *Marine Chemistry*.
05. Fripiat, F., D.M. Sigman, S.E Fawcett, P.A. Rafter, and J.L. Tison. (2014) Sea Ice nitrogen biogeochemical dynamic from an isotopic perspective. *Global Biogeochemical Cycles*.
04. Rafter, P.A., P.J. DiFiore, and D. M. Sigman. (2013) Coupled nitrate nitrogen and oxygen isotopes and organic matter remineralization in the Southern and Pacific Oceans. *JGR-Oceans*.
03. DeVries, T., C. Deutsch, P.A. Rafter, and F. Primeau. (2013), Marine denitrification rates determined from a global 3-dimensional inverse model. *Biogeosciences*.
02. Rafter, P.A. and C.D. Charles. (2012) Pleistocene equatorial Pacific dynamics inferred from zonal gradients in nitrogen isotopes. *Paleoceanography*.
01. Rafter, P.A., C.D. Charles, D.M. Sigman, G.H. Haug and J. Kaiser. (2012) Subsurface tropical Pacific nitrogen isotopic composition of nitrate: biogeochemical signals and their transport. *Global Biogeochemical Cycles*.
00. Rafter, P.A., S.L. Jaccard, E.D. Galbraith, T. Kiefer, and M. Kienast. (2011) The nitrogen cycle in the ocean, past and present: 2nd NICOPP meeting report. *PAGES Newsletter*.

MANUSCRIPTS IN PREPARATION AND AVAILABLE UPON REQUEST

Rafter, P.A., A. Martiny, and J.K. Moore. Flexible nutrition and upper ocean retention drives global marine nutrient limitation patterns and the biological pump. (available upon request)

GRANTS/FELLOWSHIPS: $735,026 total

Ocean Memory Seed Grant (Art / Science Collaboration). An analog analysis of the ocean and climate: Exploring Ocean Memory and the materiality of historic data. $10,000.

NSF MG&G. Collaborative Research with Mathis Hain (UCSC). *Uncovering marine carbon chemistry dynamics during the deglaciation with boron isotopes and radiocarbon*. $222,510

NSF OCE 2015647 *Eastern Pacific carbon chemistry after the ice age: gaining insight to a persistent mystery* $326,148.

UCI Undergraduate Research Opportunities Program with Ryan Owings $400. 2020. Current.
UCI Undergraduate Research Opportunities Program with Megan Ngo $400. 2020. Current.
UCI Undergraduate Research Opportunities Program with Alan Yue $400. 2020. Current.
UCI Undergraduate Research Opportunities Program with Jazmin Sanchez. $500. 2019.
UC-MEXUS. Is the Gulf of California a source of the greenhouse gas carbon dioxide to the atmosphere? $1,000. 2018. CURRENT.
GEOTRACES / PAGES. Trace element and isotope proxies in paleoceanography: $3,000. 2018.
NSF MG&G Research Experience for Undergrads. $15,000. 2018.
UCI UNDERGRADUATE RESEARCH OPPORTUNITIES PROGRAM with Chassidy Manlapid and Matthew Chan. $500. 2018.
NSF OCE-16-36005. Analytical and modeling training program for paleo-pCO_2 reconstructions. $1,500. 2018.
COMER Science and Education Foundation. Searching for enhanced seafloor volcanism and carbon flux during the last deglaciation. $14,000. 2017.
NSF MG&G (1635610). Targeted equatorial Pacific foraminifera-bound N isotope measurements: implications for a rare record of nutrient dynamics and the El Niño-Southern Oscillation. $99,000. CURRENT.
UCI Undergraduate Research Opportunities Program with Diana Nguyen. $468. 2016.
UCI Undergraduate Research Opportunities Program with Gabrielle Lee. $500. 2015.
UCI Undergraduate Research Opportunities Program with Johann Lopez. $1,200. 2015.
Ocean Drilling Program Schlanger Fellowship (NSF-sponsored). $30,000. 2005.
California Space Institute Fellowship (UC-sponsored). $5,000. 2004.

PENDING GRANTS: N/A

SCIENTIFIC COMMUNITY / OUTREACH

UCI Inclusive Excellence Committee
Ocean Carbon Biogeochemistry Scientific Steering Committee (2020-2023, minimum)
Founder and Co-conspirator (2020-present) of Southern California BOOM Symposium (Biogeochemical Ocean Obs & Models)— symposium for graduate students
The Ocean Memory Project (National Academies sponsored art-science collaboration) (2018-present) Founding member.
First-Generation BEES (Becoming an Environmental & Earth Scientist) (2020-present) Founding member along with Prof. Katherine Mackey

HONORS, AWARDS, ETC.

UROP Faculty Mentor of the Month February 2019.
Plenary speaker for GEOTRACES/PAGES synthesis workshop. Aix, France. 2018.
US CLIVAR Tropical Pacific Observing System 2020 workshop. Boulder, CO. 2018
AGU Outstanding Reviewer for *GBC* and *GRL* (1 of 4 total awardees). 2017.
NSF Expert Witness Training Academy. 2014.
NSF Marine Geoscience Leadership Symposium. 2013.
NSF Ocean Leadership Early Career Geoscience Symposium. 2011.

TEACHING EXPERIENCE

UCI ESS15: Introduction to Global Climate Change. 2020.
UCI Seminar: Where are the marine biogeochemical feedbacks on climate? FA2019; WI2020; SP2020.
Guest Lecture for K. Johnson at UCI: “Isotope Geochemistry”. 2018.
Guest Lecture for J. Ferguson at UCI: “The Ocean and Atmosphere”. 2018.

Guest Lectures for Kathleen Johnson at UCI: “Introduction to Paleoclimatology”. 2015.
Teaching Assistant for Chris Charles, Intro. Environmental Systems, SIO, UCSD. 2008.
Teaching Assistant, Lihini Aluwihare, CA Coastal Oceanography, SIO, UCSD. 2007.
Teaching Assistant, Chris Charles, Intro. to Environmental Systems, SIO, UCSD. 2007.
Teaching Assistant, Lynne Talley, Intro. to Environmental Systems, SIO, UCSD. 2006.
Teaching Assistant, Gabi Laske, ERTH/SIO 10: Natural Disasters, SIO, UCSD. 2005.
Teaching Assistant, Gabi Laske, ERTH/SIO 10: The Earth, SIO, UCSD. 2004.
Teaching Assistant, Sam Iacobellis, The Atmosphere, SIO, UCSD. 2003.
Training at the UCSD Center for Teaching Development (CTD). 2003.

MENTORING EXPERIENCE

32. Mentor: Anthony Meza. Undergraduate research 2019-2020.
31. Mentor: Ryan Wong Owings. Undergraduate research 2019-2020.
30. Mentor: Lucas Verde. Undergraduate research 2019-2020.
29. Mentor: Franklin Duffy. Undergraduate research. 2019.
28. Mentor: Megan Lynn Ngo. UCI Senior Thesis. 2019-2020.
27. Mentor: Claire Socorro Weeks. Undergraduate research. 2019.
26. Mentor: Alan Yue. UCI Senior Thesis. 2019-2020.
25. Megha Rudresh. Undergraduate research 2017-2019.
24. Mentor: April Naiomi Castillo. Undergraduate research. 2019.
23. Mentor: Jazmin Amanda Sanchez. Undergraduate research & UCI Senior Thesis. 2018-2019.
22. Mentor: Chassidy Manlapid. Undergraduate research. 2018.
21. Mentor: Matthew Chan. Undergraduate research. 2017-2018.
20. Mentor: Alyssa Mariah de la Rosa. Undergraduate research. 2017-2018.
19. Mentor: Juan Manuel Troncoso. Undergraduate research. 2017.
18. Mentor: Diana Nguyen. Undergraduate research & UCI Senior Thesis. 2016.
17. Mentor: Abigail Ambriz. UCI undergraduate research experience. 2015-2016.
16. Mentor: Stephanie Silva. UCI undergraduate research experience. 2015-2016.
15. Mentor: Annalysha Lafferty. UCI undergraduate research experience. 2015.
14. Mentor: Mina Nada. UCI undergraduate research experience. 2015.
13. Mentor: Philip Andre Nazareta. UCI undergraduate research experience. 2015.
12. Mentor: Franloie Cruz. UCI undergraduate research experience. 2015.
11. Mentor: Ian Kamus. UCI undergraduate research experience. 2015.
10. Mentor: Gabriella Lee. Undergraduate research and UCI Senior Thesis. 2014-2015.
9. Mentor: Araceli Serrano. UCI undergraduate research experience. 2014-2015.
8. Mentor: Rachel Coons. UCI undergraduate research experience. 2014.
7. Mentor: Johann Lopez. UCI undergraduate research experience. 2014.
6. Guest Lecture for Jorge Sarmiento at Princeton University: “Ocean Biogeochemistry”. 2012.
5. Mentor: Tyler Tamasi Princeton University, summer internship. 2012.
4. Mentor: Samantha Csik Northeastern University, summer internship. 2012.
3. Mentor (w/Daniel Sigman): Lydia Rudnick Princeton University, junior thesis. 2011.
2. Mentor (w/Daniel Sigman): Jacob Kim Princeton University, summer internship. 2010.
1. Mentor (w/Lihini Aluwihare): Ulisses Barraza (SD Ocean Discovery Institute). 2008.

INVITED PRESENTATIONS

UCLA. Virtual Seminar. 2020
Woods Hole Oceanographic Institute. Virtual Seminar. G&G. 2020.
Dalhousie University. Oceanography. 2020
Laguna Woods Earth Day. *The fundamental causes of climate change and some solutions.* 2019.

Belhaven Middle School. Linwood, NJ. *How to because an Earth scientist*. 2019.
UConn. *Anomalous >2000 year old surface ocean reservoir age as evidence for deglacial geologic carbon release*. 2019.
UC Santa Cruz. *Rethinking iron fertilization & the marine biological pump on seasonal to ice age timescales*. 2019.
GEOTRACES/PAGES workshop (Aix, France). Plenary Lecture. *Rethinking iron fertilization & the marine biological pump on seasonal to ice age timescales*. 2018.
University of South Florida. *Rethinking iron fertilization & the marine biological pump on seasonal to ice age timescales*. 2018.
University of Washington. *Rethinking iron fertilization & the marine biological pump on seasonal to ice age timescales*. 2018.
University of Southern California. *Rethinking iron fertilization & the marine biological pump on seasonal to ice age timescales*. 2018.
Oregon State University. *Iron recycling is critical for new primary production in all nitrate-rich, iron-limited ocean regions*. 2018.
Changelings / Comer Foundation Climate Conference. *A song of Ice and Fire and CO_2: linking seafloor volcanism and CO_2 efflux during the deglaciation*. 2017.
Gordon Chemical Oceanography. *Iron recycling fuels nitrate consumption, new primary production, and the biological pump in most HNLC regions*. 2017.
Rutgers University. *A song of Ice and Fire and CO_2: linking seafloor volcanism and CO_2 efflux during the deglaciation*. 2017.
Pomona College. *A song of Ice and Fire and CO_2: linking seafloor volcanism and CO_2 efflux during the deglaciation*. 2017.
CICESE (Centro de Investigación Cientifica y Educación Superior de Ensenada) *A song of Ice and Fire and CO_2: linking seafloor volcanism and CO_2 efflux during the deglaciation*. 2017.
UCSD-Scripps Institution of Oceanography. *Iron recycling drives New Production in HNLC region.* 2017.
UC Riverside. *The future of ENSO from Plio-Pleistocene sediments.* 2016.
California Institute of Technology. *Iron recycling drives New Production in HNLC region.*
Stanford University. *How to survive a High Nutrient-Low Chlorophyll region: insight to the internal cycling of iron and nitrogen.* 2015.
UC Santa Barbara. *How to survive a High Nutrient-Low Chlorophyll region: insight to the internal cycling of iron and nitrogen.* 2015.
University of Southern California. *Building a new view of the Plio-Pleistocene tropical climate.* 2015.
Richard Stockton State University of NJ. *The past and future of El Niño*. 2014.
UCSD-Scripps Institution of Oceanography. *South Pacific respiration and the dual isotopic composition of nitrate*. 2014.
California Institute of Technology. *3-Myr history of equatorial Pacific upwelling and Permanent El Niño*. 2014.
UC Irvine. *3-Myr history of equatorial Pacific upwelling and Permanent El Niño*. 2014.
Ocean Sciences. *A 3-Myr history of equatorial Pacific upwelling, Permanent El Niño, and a summary of the session's results.* 2014.
Columbia University-Lamont Doherty Earth Observatory. *3-Myr history of equatorial Pacific upwelling and Permanent El Niño*. 2014.
Yale University. *3-Myr history of eq. Pacific upwelling and Permanent El Niño*. 2013.
Woods Hole Oceanographic Institution. *South Pacific respiration and the dual isotopic composition of nitrate*. 2013.
Goldschmidt Conference. Florence, Italy. *South Pacific respiration and the dual isotopic composition of nitrate.* 2013.

Woods Hole Oceanographic Institution. Nitrate isotopes as a pseudo-sediment trap. 2013.
Middle Township High School. *Science is NOT boring: isotopes and the ice ages*. 2013.
UNC-Wilmington. *Science from the Sea Surface through the Seafloor*. 2013.
Coastal Carolina University. *Science from the Sea Surface through the Seafloor*. 2013.
Dalhousie University. Nitrogen Cycle in the Ocean, Past and Present Workshop. 2011.
Rutgers University. *Tropical reign? A 1.2 million year record of nutrient dynamics in the eastern equatorial Pacific*. 2010.
CICESE (Centro de Investigación Cientifica y Educación Superior de Ensenada) (Ensenada, Mexico). *A 1.2-Myr record of eastern equatorial Pacific thermocline depth from sediment nitrogen isotopes*. 2010.
UCLA. *New insight to tropical Pacific circulation using isotopic tracers*. 2009.
University of Southern California. *Tropical Pacific nutrient dynamics of the past 1-Myr*. 2008.

RESEARCH FIELD EXPERIENCE (Select)

Project director. Sargasso Sea. CTD, plankton tows, *in-situ* filtering and more (November BATS cruise). 7 days on *RV Atlantic Explorer*. 2013.
Project director. Sargasso Sea. CTD, plankton tows, *in-situ* filtering and more (April BATS cruise). 7 days on *RV Atlantic Explorer*. 2013.
Project director. Sargasso Sea. CTD, plankton tows, *in-situ* filtering and more (November BATS cruise). 5 days on *RV Atlantic Explorer*. 2012.
Project director. Sargasso Sea. CTD, plankton tows, *in-situ* filtering and more (July BATS cruise). 5 days on *RV Atlantic Explorer*. 2012.
Project director. Sargasso Sea. CTD, plankton tows, *in-situ* filtering and more (April Bermuda Atlantics Time Series (BATS) cruise). 5 days on *RV Atlantic Explorer*. 2012.
Multi-coring, box-coring, seawater sampling in the Santa Barbara Basin. 5 days on the *RV Sproul*. 2008.
Gravity-coring, dredge recovery, seawater sampling in the Arabian Sea. 21 days on the *RV Roger Revelle*. 2007.
Lacustrine sediment freeze-coring on Swamp Lake, Yosemite National Park. 4 days remote field-work. 2006.
CTD technician, seawater sampling in the eastern tropical Pacific. 40 days on the *RV Ka'imimoana*. 2005.
Sediment pore-water and seawater preparation. 8 days on the *RV Atlantis*. 2002.

TEACHING & INCLUSIVE EXCELLENCE TRAINING

Improving Student Learning Outcomes Assessment: Diversity, Efficiency, and Effectiveness. Workshop Participant. 2018
Inclusive Teaching for Non-Native English Speakers and International Students. Workshop Participant. 2017.
Helping Promote Academic Success for First Generation Undocumented Students. Workshop Participant. 2017.
UC Irvine First Generation Faculty Initiative. Member. 2017.
UCSD Center for Teaching Development Training. 2003.

PROFESSIONAL SERVICE

Chair: Goldschmidt Geochemistry Meeting 2020. 14a: Using Multiple Proxies and/Or Multiple Archives to Constrain Earth System Processes
Organizer: So. California Modeling Ocean Biogeochemistry Symposium (SoCal MOB) 2020. USC.
Organizer: Ocean Memory SEED Workshop (Ocean & Cognition) (June 2020). Location Lewes, DE.

Chair: Ocean Sciences 2020: *Linking microbial, isotope, micro-nutrient, and other approaches to understand carbon and nutrient cycling in the ocean*

Organizer: Ocean Memory Workshop 3.0. Catalina Island, California. 2019.

Chair: Ocean Sciences 2018: *Building biogeochemical bonds: Identifying the influence of macro and micro-nutrient cycling on marine carbon and nitrogen*

Chair: AGU 2017: *Linking the fluid and solid Earth: The role of terrestrial and submarine volcanism in the Plio-Pleistocene ice ages*

Chair: Goldschmidt 2016: Goldschmidt Geochemistry: *Marine Biogeochemistry at a Range of Scales: The Global Ocean and Polar Atmosphere-Sea Ice-Ocean Systems.*

Chair: Ocean Sciences 2016: *Mode and Intermediate Waters: Their Contributions to Physical, Biological, Chemical, and Climate Processes*.

Chair: Goldschmidt 2013 (17c: Changing ocean oxygen: Past, present, future)

Reviewer: AGU-Geophysical Research Letters (>15), AGU-Global Biogeochemical Cycles (>10), AGU-Journal of Geophysical Research-Oceans (>5), AGU-Paleoceanography (>10), Deep Sea Research (2), Earth and Planetary Science Letters (2), EGU-Biogeosciences (2), Limnology and Oceanography (>5), Marine Chemistry (2), National Geographic Society (1), National Research Foundation-South Africa (2), Nature Geoscience (1), NSF OCE-Marine Geology and Geochemistry (>10), NSF OCE-Chemical Oceanography (>5), NSF-International Ocean Discovery Program (2), Philosophical Transactions of the Royal Society A (1). Nature Geoscience (2).

MEDIA

Environmental Monitor (March 7, 2018). *Iron Hoarding and Recycling by Aquatic Plants in the Pacific*

Geochemical News (Feb 20, 2018). Top Story: *Oceanographers solve mystery of phytoplankton survival in nutrient-poor Pacific*

UC Irvine News (Feb 14, 2018). *UCI oceanographers solve mystery of phytoplankton survival in nutrient-poor Pacific; Essential iron is hoarded and recycled by the climate-regulating aquatic plants*