

# UNIVERSITY OF CALIFORNIA, SANTA CRUZ

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## Curriculum Vitae

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### Employment

- 2024/25 **Harry H. Hess Visiting Faculty**, Princeton University Geosciences, USA  
2018+ **Assistant/Associate Professor**, University of California, Santa Cruz  
2013–18 **NERC Independent Research Fellow**, University of Southampton, UK  
2008–13 **Graduate Student and Assistant in Instruction**, Princeton University, USA  
2007–08 **Research Assistant and Assistant in Instruction**, University of Potsdam, Germany  
2006–07 **Research Assistant**, GeoForschungsZentrum Potsdam, Germany  
2004–06 **Undergraduate Assistant**, University of Potsdam, Germany

### Education

- 2010–13 **PhD in Geosciences**, Princeton University, U.S.A.  
2003–08 **Dipl. in Geology**, University of Potsdam, Germany

### Honors and Awards

- 2017 **Editors' Citation for Excellence in Refereeing** – American Geophysical Union  
2014 **Dean's Prize for Research** – University of Southampton  
2014 **XXIV. Dissertations Symposium in Chemical Oceanography Delegate**  
2012-13 **Charlotte E. Procter Honorific Fellowship** – Princeton University  
2009/12 **Hriskevich Fellow/Arnold Guyot Teaching Award** – Princeton University

### Students and Mentees:

2021+	advisor	<b>Terra Ganey</b>	PhD	UC Santa Cruz, EPS
2019+	advisor	<b>Ryan Green</b>	PhD	UC Santa Cruz, EPS
2018+	co-advisor	<b>Yan Zhang</b>	PhD	UC Santa Cruz, OS
2022-24	advisor	<b>David McCurdy</b>	BA	UC Santa Cruz, EPS
2019-24	co-advisor	<b>Madison Wood</b>	PhD	UC Santa Cruz, EPS
2018-23	co-advisor	<b>Johana Holo</b>	MA	UC Santa Cruz, EPS
2018-19	co-advisor	<b>Shannon McClish</b>	BA	UC Santa Cruz, EPS
2017-18	co-advisor	<b>Rachael Shuttleworth</b>	PhD	University of Southampton
2014-16	co-advisor	<b>Preston Kemeny</b>	BA	Princeton University
2020-21	mentor	<b>Gracie Pearsall</b>	PhD	UC Santa Cruz, EPS
2020-23	mentor	<b>Gavin Piccione</b>	PhD	UC Santa Cruz, EPS
2020-22	mentor	<b>Vinicius Amaral</b>	PhD	UC Santa Cruz, OS

## **Teaching**

- 2022+ EART 119B/219: **Advanced Scientific Programing**  
Upper division elective course in the Geoscience and Environmental Science degree program at UC Santa Cruz; fulfills capstone requirements for the geophysics concentration.
- 2019+ ESCI 100A: **Introduction to Environmental Science**  
Core course of Environmental Science degree program at UC Santa Cruz. Class is using online modeling tools for numerical simulation of environmental grand challenges, such as sea-level rise, global warming, ocean acidification, eutrophication, land degradation, pollution.
- 2019+ EART 119A: **Introduction to Scientific Programing**  
Upper division elective course in the Geoscience and Environmental Science degree program at UC Santa Cruz.
- 2019+ EART 290L: **Topics in Climate Science**  
Graduate seminar focused on skills-development in isotope biogeochemical modeling, with changing topics at the interface of climate science and Earth system biogeochemistry.
- 2016-17 NATS 1004: **Independent Learning Skills in Science**  
Core course of Natural Sciences degree program at the University of Southampton. Co-taught.

## **Peer-reviewed publications (\* indicates student-led paper)**

- [39]\* Green, R. A., Hain, M. P., & Rafter, P. A. (2024). **Deglacial Pulse of Neutralized Carbon from the Pacific Seafloor: A Natural Analog for Ocean Alkalinity Enhancement?** *Geophysical Research Letters*, 51(8), e2024GL108271. <https://doi.org/10.1029/2024GL108271>
- [38] Hain, M. P., Allen, K. A., & Kirtland Turner, S. (2024). **Earth system carbon cycle dynamics through time.** In *Reference Module in Earth Systems and Environmental Sciences* (p. B9780323997621000802). Elsevier. <https://doi.org/10.1016/B978-0-323-99762-1.00080-2>
- [37] Hain, M. P., & Chalk, T. B. (2024). **Greenhouse gas effects on Quaternary climates.** In *Reference Module in Earth Systems and Environmental Sciences* (p. B9780323999311002713). Elsevier. <https://doi.org/10.1016/B978-0-323-99931-1.00271-3>
- [36] Hain, M. P., & Sigman, D. M. (2024). **CO<sub>2</sub> in Earth's ice age cycles.** In *The role of CO<sub>2</sub> in the Earth's radiative budget.*
- [35] Sigman, D. M., & Hain, M. P. (2024). **Ocean Oxygen, Preformed Nutrients, and the Cause of the Lower Carbon Dioxide Concentration in the Atmosphere of the Last Glacial Maximum.** *Paleoceanography and Paleoclimatology*, 39(1), e2023PA004775. <https://doi.org/10.1029/2023PA004775>
- [34] De La Vega, E., Chalk, T. B., Hain, M. P., Wilding, M. R., Casey, D., Gledhill, R., Luo, C., Wilson, P. A., & Foster, G. L. (2023). **Orbital CO<sub>2</sub> reconstruction using boron isotopes during the late Pleistocene, an assessment of accuracy.** *Climate of the Past*, 19(12), 2493–2510. <https://doi.org/10.5194/cp-19-2493-2023>
- [33] Henahan, M. J., Klein Gebbinck, C. D., Wyman, J. V. B., Hain, M. P., Rae, J. W. B., Hönisch, B., Foster, G. L., & Kim, S.-T. (2022). **No ion is an island: Multiple ions influence boron**

- incorporation into CaCO<sub>3</sub>.** *Geochimica et Cosmochimica Acta*, 318, 510–530. <https://doi.org/10.1016/j.gca.2021.12.011>
- [32]\* Piccione, G., Blackburn, T., Tulaczyk, S., Rasbury, E. T., Hain, M. P., Ibarra, D. E., Methner, K., Tinglof, C., Cheney, B., Northrup, P., & Licht, K. (2022). **Subglacial precipitates record Antarctic ice sheet response to late Pleistocene millennial climate cycles.** *Nature Communications*, 13(1), 5428. <https://doi.org/10.1038/s41467-022-33009-1>
- [31] Rafter, P. A., Gray, W. R., Hines, S. K. V., Burke, A., Costa, K. M., Gottschalk, J., Hain, M. P., Rae, J. W. B., Southon, J. R., Walczak, M. H., Yu, J., Adkins, J. F., & DeVries, T. (2022). **Global reorganization of deep-sea circulation and carbon storage after the last ice age.** *Science Advances*, 8(46), eabq5434. <https://doi.org/10.1126/sciadv.abq5434>
- [30] Ezat, M. M., Rasmussen, T. L., Hain, M. P., Greaves, M., Rae, J. W. B., Zamelczyk, K., Marchitto, T. M., Szidat, S., & Skinner, L. C. (2021). **Deep Ocean Storage of Heat and CO<sub>2</sub> in the Fram Strait, Arctic Ocean During the Last Glacial Period.** *Paleoceanography and Paleoclimatology*, 36(8), e2021PA004216. <https://doi.org/10.1029/2021PA004216>
- [29] Paytan, A., Griffith, E. M., Eisenhauer, A., Hain, M. P., Wallmann, K., & Ridgwell, A. (2021). **A 35-million-year record of seawater stable Sr isotopes reveals a fluctuating global carbon cycle.** *Science*, 371(6536), 1346–1350. <https://doi.org/10.1126/science.aaz9266>
- [28] Sigman, D. M., Fripiat, F., Studer, A. S., Kemeny, P. C., Martínez-García, A., Hain, M. P., Ai, X., Wang, X., Ren, H., & Haug, G. H. (2021). **The Southern Ocean during the ice ages: A review of the Antarctic surface isolation hypothesis, with comparison to the North Pacific.** *Quaternary Science Reviews*, 254, 106732. <https://doi.org/10.1016/j.quascirev.2020.106732>
- [27] Studer, A. S., Mekik, F., Ren, H., Hain, M. P., Oleynik, S., Martínez-García, A., Haug, G. H., & Sigman, D. M. (2021). **Ice Age-Holocene Similarity of Foraminifera-Bound Nitrogen Isotope Ratios in the Eastern Equatorial Pacific.** *Paleoceanography and Paleoclimatology*, 36(5), e2020PA004063. <https://doi.org/10.1029/2020PA004063>
- [26] Chen, T., Robinson, L. F., Burke, A., Claxton, L., Hain, M. P., Li, T., Rae, J. W. B., Stewart, J., Knowles, T. D. J., Fornari, D. J., & Harpp, K. S. (2020). **Persistently well-ventilated intermediate-depth ocean through the last deglaciation.** *Nature Geoscience*, 13(11), 733–738. <https://doi.org/10.1038/s41561-020-0638-6>
- [25] Rafter, P. A., Carriquiry, J. D., Herguera, J., Hain, M. P., Solomon, E. A., & Southon, J. R. (2019). **Anomalous > 2000-Year-Old Surface Ocean Radiocarbon Age as Evidence for Deglacial Geologic Carbon Release.** *Geophysical Research Letters*, 46(23), 13950–13960. <https://doi.org/10.1029/2019GL085102>
- [24]\* Wu, Y., Hain, M. P., Humphreys, M. P., Hartman, S., & Tyrrell, T. (2019). **What drives the latitudinal gradient in open-ocean surface dissolved inorganic carbon concentration?** *Biogeosciences*, 16(13), 2661–2681. <https://doi.org/10.5194/bg-16-2661-2019>
- [23] De Souza, G. F., Khatiwala, S. P., Hain, M. P., Little, S. H., & Vance, D. (2018). **On the origin of the marine zinc–silicon correlation.** *Earth and Planetary Science Letters*, 492, 22–34. <https://doi.org/10.1016/j.epsl.2018.03.050>
- [22] Hain, M. P., Foster, G. L., & Chalk, T. (2018). **Robust Constraints on Past CO<sub>2</sub> Climate Forcing from the Boron Isotope Proxy.** *Paleoceanography and Paleoclimatology*, 33(10), 1099–1115. <https://doi.org/10.1029/2018PA003362>
- [21] Hain, M. P., Sigman, D. M., Higgins, J. A., & Haug, G. H. (2018). **Response to Comment by Zeebe and Tyrrell on “The Effects of Secular Calcium and Magnesium Concentration Changes on the Thermodynamics of Seawater Acid/Base Chemistry: Implications for the Eocene and Cretaceous Ocean Carbon Chemistry and Buffering.”** *Global Biogeochemical Cycles*, 32(5), 898–901. <https://doi.org/10.1002/2018GB005931>

- [20] Hawkings, J. R., Hatton, J. E., Hendry, K. R., De Souza, G. F., Wadham, J. L., Ivanovic, R., Kohler, T. J., Stibal, M., Beaton, A., Lamarche-Gagnon, G., Tedstone, A., Hain, M. P., Bagshaw, E., Pike, J., & Tranter, M. (2018). **The silicon cycle impacted by past ice sheets.** *Nature Communications*, 9(1), 3210. <https://doi.org/10.1038/s41467-018-05689-1>
- [19]\* Kemeny, P. C., Kast, E. R., Hain, M. P., Fawcett, S. E., Fripiat, F., Studer, A. S., Martínez-García, A., Haug, G. H., & Sigman, D. M. (2018). **A Seasonal Model of Nitrogen Isotopes in the Ice Age Antarctic Zone: Support for Weakening of the Southern Ocean Upper Overturning Cell.** *Paleoceanography and Paleoclimatology*, 33(12), 1453–1471. <https://doi.org/10.1029/2018PA003478>
- [18] Sosdian, S. M., Greenop, R., Hain, M. P., Foster, G. L., Pearson, P. N., & Lear, C. H. (2018). **Constraining the evolution of Neogene ocean carbonate chemistry using the boron isotope pH proxy.** *Earth and Planetary Science Letters*, 498, 362–376. <https://doi.org/10.1016/j.epsl.2018.06.017>
- [17] Chalk, T. B., Hain, M. P., Foster, G. L., Rohling, E. J., Sexton, P. F., Badger, M. P. S., Cherry, S. G., Hasenfratz, A. P., Haug, G. H., Jaccard, S. L., Martínez-García, A., Pälike, H., Pancost, R. D., & Wilson, P. A. (2017). **Causes of ice age intensification across the Mid-Pleistocene Transition.** *Proceedings of the National Academy of Sciences*, 114(50), 13114–13119. <https://doi.org/10.1073/pnas.1702143114>
- [16] Greenop, R., Hain, M. P., Sosdian, S. M., Oliver, K. I. C., Goodwin, P., Chalk, T. B., Lear, C. H., Wilson, P. A., & Foster, G. L. (2017). **A record of Neogene seawater  $\delta^{11}\text{B}$  reconstructed from paired  $\delta^{11}\text{B}$  analyses on benthic and planktic foraminifera.** *Climate of the Past*, 13(2), 149–170. <https://doi.org/10.5194/cp-13-149-2017>
- [15]\* Fry, C. H., Tyrrell, T., Hain, M. P., Bates, N. R., & Achterberg, E. P. (2015). **Analysis of global surface ocean alkalinity to determine controlling processes.** *Marine Chemistry*, 174, 46–57. <https://doi.org/10.1016/j.marchem.2015.05.003>
- [14] Galbraith, E. D., Kwon, E. Y., Bianchi, D., Hain, M. P., & Sarmiento, J. L. (2015). **The impact of atmospheric  $p\text{CO}_2$  on carbon isotope ratios of the atmosphere and ocean.** *Global Biogeochemical Cycles*, 29(3), 307–324. <https://doi.org/10.1002/2014GB004929>
- [13] Hain, M. P., Sigman, D. M., Higgins, J. A., & Haug, G. H. (2015). **The effects of secular calcium and magnesium concentration changes on the thermodynamics of seawater acid/base chemistry: Implications for Eocene and Cretaceous ocean carbon chemistry and buffering.** *Global Biogeochemical Cycles*, 29(5), 517–533. <https://doi.org/10.1002/2014GB004986>
- [12] Hain, M. P., Sigman, D. M., & Haug, G. H. (2014a). **Distinct roles of the Southern Ocean and North Atlantic in the deglacial atmospheric radiocarbon decline.** *Earth and Planetary Science Letters*, 394, 198–208. <https://doi.org/10.1016/j.epsl.2014.03.020>
- [11] Hain, M. P., Sigman, D. M., & Haug, G. H. (2014b). **The Biological Pump in the Past.** In *Treatise on Geochemistry* (pp. 485–517). Elsevier. <https://doi.org/10.1016/B978-0-08-095975-7.00618-5>
- [10] Straub, M., Sigman, D. M., Ren, H., Martínez-García, A., Meckler, A. N., Hain, M. P., & Haug, G. H. (2013). **Changes in North Atlantic nitrogen fixation controlled by ocean circulation.** *Nature*, 501(7466), 200–203. <https://doi.org/10.1038/nature12397>
- [9] Kwon, E. Y., Hain, M. P., Sigman, D. M., Galbraith, E. D., Sarmiento, J. L., & Toggweiler, J. R. (2012). **North Atlantic ventilation of “southern-sourced” deep water in the glacial ocean.** *Paleoceanography*, 27(2), 2011PA002211. <https://doi.org/10.1029/2011PA002211>
- [8] Sigman, D. M., & Hain, M. P. (2012). **The Biological Productivity of the Ocean.** *Nature Education Knowledge*, 3(6), 1–16. <https://doi.org/10.5281/ZENODO.13370236>
- [7] Hain, M. P., Sigman, D. M., & Haug, G. H. (2011). **Shortcomings of the isolated abyssal reservoir model for deglacial radiocarbon changes in the mid-depth Indo-Pacific Ocean.** *Geophysical Research Letters*, 38(4). <https://doi.org/10.1029/2010GL046158>

- [6] Hain, M. P., Strecker, M. R., Bookhagen, B., Alonso, R. N., Pingel, H., & Schmitt, A. K. (2011). **Neogene to Quaternary broken foreland formation and sedimentation dynamics in the Andes of NW Argentina (25°S)**. *Tectonics*, 30(2), 2010TC002703. <https://doi.org/10.1029/2010TC002703>
- [5] Hain, M. P., Sigman, D. M., & Haug, G. H. (2010). **Carbon dioxide effects of Antarctic stratification, North Atlantic Intermediate Water formation, and subantarctic nutrient drawdown during the last ice age: Diagnosis and synthesis in a geochemical box model**. *Global Biogeochemical Cycles*, 24(4). <https://doi.org/10.1029/2010GB003790>
- [4] Sigman, D. M., Hain, M. P., & Haug, G. H. (2010). **The polar ocean and glacial cycles in atmospheric CO<sub>2</sub> concentration**. *Nature*, 466(7302), 47–55. <https://doi.org/10.1038/nature09149>
- [3] Sigman, D. M., DiFiore, P. J., Hain, M. P., Deutsch, C., & Karl, D. M. (2009). **Sinking organic matter spreads the nitrogen isotope signal of pelagic denitrification in the North Pacific**. *Geophysical Research Letters*, 36(8), 2008GL035784. <https://doi.org/10.1029/2008GL035784>
- [2] Sigman, D. M., DiFiore, P. J., Hain, M. P., Deutsch, C., Wang, Y., Karl, D. M., Knapp, A. N., Lehmann, M. F., & Pantoja, S. (2009). **The dual isotopes of deep nitrate as a constraint on the cycle and budget of oceanic fixed nitrogen**. *Deep Sea Research Part I: Oceanographic Research Papers*, 56(9), 1419–1439. <https://doi.org/10.1016/j.dsr.2009.04.007>
- [1] Strecker, M. R., Alonso, R., Bookhagen, B., Carrapa, B., Coutand, I., Hain, M. P., Hilley, G. E., Mortimer, E., Schoenbohm, L., & Sobel, E. R. (2009). **Does the topographic distribution of the central Andean Puna Plateau result from climatic or geodynamic processes?** *Geology*, 37(7), 643–646. <https://doi.org/10.1130/G25545A.1>

### **Invited Talks and Seminars**

**University of Bern**, Aug. 2023: “The coupled climate and carbon cycle of the Earth System”

**Tufts University**, Jan. 2023: “The role of CO<sub>2</sub> in climate: from Ice Ages to Earth System theory”

**University of California, Los Angeles**, Nov. 2022: “Atmospheric CO<sub>2</sub>: Feedback or driver of climate?”

**University of California, Santa Barbara**, Feb. 2020: “The other ice age CO<sub>2</sub> problem: Did the carbon cycle drive climate?”

**University of California, Berkeley**, Apr. 2019: “Boron isotopes, CO<sub>2</sub> climate forcing, and the Mid-Pleistocene Transition”

**University of California, Riverside**, Oct. 2018: “Boron isotopes, CO<sub>2</sub> climate forcing, and the Mid-Pleistocene Transition”

**Dust Impact on Climate and Environment, PAGES working group meeting**, Jan. 2018, invited talk: Dust-driven CO<sub>2</sub> drawdown as a driver of the Mid-Pleistocene Transition (Las Cruces, Chile)

**University of California, Santa Cruz**, Feb. 2017: “Why study ice age CO<sub>2</sub> change?”

**International Conference on Paleoceanography**, Sep. 2016: “Glacial/Interglacial CO<sub>2</sub> change: Beyond the ice core record”

**Wessex DTP conference**, Apr. 2016: “Tips to convert your PhD into a science career”

**Princeton University**, Feb. 2016: “The ocean’s carbon and nutrient biogeochemistry: From greenhouse world into the ice ages”

**McGill University**, Nov. 2015: “The ocean’s carbon and nutrient biogeochemistry: From greenhouse world into the ice ages”

**Heidelberg University**, Nov. 2015: “The carbon cycle and ocean circulation from Last Glacial Maximum through Deglaciation”

**German National Academy of Science Leopoldina**, Invited Speaker, Mar. 2015: Symposium: Global Carbon Transfer between Ocean, Atmosphere, and Land – Today, during peak Glacial and Deglacial Times, “Simulating Atmospheric Radiocarbon through Deglaciation”

**Imperial College London**, Mar. 2015: “The Biological Pump during Glacial/Interglacial cycles”

**Cambridge University**, Nov. 2014: “Simulating deglacial radiocarbon changes in ocean and atmosphere: Implications for LGM and deglacial ocean circulation”

**LDEO, Columbia University**, Jul. 2014: “Simulating deglacial radiocarbon changes in ocean and atmosphere: Implications for LGM and deglacial ocean circulation”

**University College London**, Jan. 2014: “Distinct roles of Southern Ocean and North Atlantic in glacial CO<sub>2</sub> drawdown and deglacial atmospheric radiocarbon decline”

**ETH Zürich**, Oct. 2012: “Ice Age CO<sub>2</sub> cycles: Recipes for glacial ocean carbon storage and deglacial release”

**Cardiff University**, Aug. 2012: “The Biological Pumps & the glacial cycles of atm. CO<sub>2</sub>”

**Bristol University**, Aug. 2012: “The Biological Pumps & the glacial cycles of atm. CO<sub>2</sub>”

**National Oceanography Center Southampton**, Aug. 2012: “The Biological Pumps & the glacial cycles of atm. CO<sub>2</sub>”

**Goldschmidt Conference**, Prague, Aug. 2011: “Session Keynote: A deglacial <sup>14</sup>C budget”

**University of Southern California**, April 2011: “Glacial/Interglacial CO<sub>2</sub> cycles: a carbon chemistry perspective”

**Cambridge University**, Oct. 2010: “The polar ocean, deep carbonate ion & the ice age cycles of atm. CO<sub>2</sub>”

**Princeton University**, April 2010: “Antarctic mechanisms for lower ice age CO<sub>2</sub>: What else is needed?”

**Conference presentations (not including presentations by students and collaborators)**

**Past Global Changes (PAGES) Open Science Meeting** (2017 - talk): Simulating MPT CO<sub>2</sub> (Zaragoza, Spain)

**Goldschmidt Conference** (2015 - poster): Ca<sup>2+</sup>, Mg<sup>2+</sup> changes seawater carbon chemistry and buffering (Prague, Czech Republic)

**Goldschmidt Conference Boron Workshop** (2015 - talk): BoronMC: A Monte-Carlo tool for reconstructing seawater δ<sup>11</sup>B and carbon chemistry (Prague, Czech Republic)

**XXIV. Dissertations Symposium in Chemical Oceanography** (2014 – talk): Glacial/Interglacial and deglacial changes in ocean circulation and their consequences for the global carbon cycle (Lihue, HI, U.S.A.)

**iPODS-OC3 Joint Meeting** (2014 - talk): Distinct roles of the Southern Ocean and the North Atlantic in the deglacial atmospheric radiocarbon decline (Bern, Switzerland)

**Goldschmidt Conference** (2013 - talk): Carbon isotope gradients in the Eocene as a constraint on the biological pump, atmospheric CO<sub>2</sub> and the oceans major ion composition (Florence,

Italy)

**Goldschmidt Conference** (2013 - talk): Complete simulation of deglacial changes in atmospheric  $^{14}\text{C}/\text{C}$ : Implications for ocean circulation changes and  $\text{CO}_2$  release (Florence, Italy)

**International Union for Quaternary Research Congress** (2011 - talk): No deglacial release of severely  $^{14}\text{C}$  deplete “Mystery Reservoir” (Bern, Switzerland)

**International Union for Quaternary Research Congress** (2011 - poster): A two-step ocean recipe for  $\text{CO}_2$  drawdown during the last ice age (Bern, Switzerland)

**International Conference on Paleooceanography** (2010 - poster): No deglacial release of “Mystery Reservoir” to mid-depth Pacific, (San Diego, U.S.A)

**WHOI Ocean Carbon & Biogeochemistry workshop** (2009 - poster): Analyzing the carbon cycle: A diagnostic tool for parsing of soft-tissue, carbonate and solubility pumps, whole ocean alkalinity, gas-exchange limitation and their impact on atmospheric  $\text{CO}_2$  (Woods Hole, U.S.A.)

**Congreso Geológico Argentino** (2008 - talk): The control of Cretaceous extension and pre-existing basement structures upon position and style of Andean shortening – A case study from the Valle de Lerma, Salta, NW Argentina (San Salvador de Jujuy, Argentina).

### **Memberships and Committees**

**American Geophysical Union, Geochemical Society**

**Joint Committee on the Properties of Seawater, Chemical Speciation, IAPWS/SCOR/IAPSO**