Dan Amrhein

NSF Postdoctoral Fellow
University of Washington

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My research combines numerical models and observations of the natural world to learn about the dynamics of Earth's oceans and climate in the present, future, and geologic past.

INTERESTS: CLIMATE DYNAMICS, PHYSICAL OCEANOGRAPHY, INVERSE MODELING, DATA ASSIMILATION, NUMERICAL MODELING, PALEOCLIMATOLOGY

Education

2016 MASSACHUSETTS INSTITUTE OF TECHNOLOGY
WOODS HOLE OCEANOGRAPHIC INSTITUTION
Ph.D. in Physical Oceanography: Inferring Ocean Circulation during the Last Glacial Maximum and Last Deglaciation Using Data and Models
Adviser: Carl Wunsch

2014 MASSACHUSETTS INSTITUTE OF TECHNOLOGY
WOODS HOLE OCEANOGRAPHIC INSTITUTION
M.S. in Physical Oceanography: An inverse approach to understanding benthic oxygen isotope records from the last deglaciation
Adviser: Carl Wunsch

2009 COLUMBIA COLLEGE, COLUMBIA UNIVERSITY
Bachelor of Arts in Physics with a Concentration in Mathematics, May 2009

Employment

2017– NSF Postdoctoral Fellow, University of Washington
Dept. of Atmospheric Sciences and School of Oceanography
Mentors: Greg Hakim and LuAnne Thompson

2016–17 Postdoctoral Research Associate, University of Washington
Dept. of Atmospheric Sciences and School of Oceanography
Mentors: Greg Hakim and LuAnne Thompson

2009-10 Research Assistant, Lamont-Doherty Earth Observatory, Columbia University
Supervisors: Jason Smerdon and Alexey Kaplan

Grants and Awards

pending NSF Paleoclimate Perspectives on Climate Change. *Quantifying spatial footprints of planktic foraminifera in marine sediments and exploring implications for past ocean variability and model-data synthesis*. Could not be Co-PI because of departmental policy, but contributed to ideas and writing.

pending NASA ROSES Physical Oceanography. *Beyond budgets: Inferring sensitivities of North Atlantic heat and salt contents to atmospheric variability using ECCO and its adjoint.* Co-I.

2017-19 NSF Atmospheric and Geospace Sciences Postdoctoral Fellowship:
Inferring Predictability and Dynamics of Atlantic Multidecadal Climate Variability from Marine and Terrestrial Paleoclimate Records. $172,000

2017 Ocean Outlook Fellow at the University of Bergen

2012-15 NSF Graduate Research Fellow

2010-11 MIT Presidential Fellow

2007 AGU travel grant, IUGG meeting, Perugia, Italy.

2006 George William Curtis Prize in Oration at Columbia College

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Teaching Experience

2018 Guest lecturer on adjoint modeling, *Ensemble Prediction Systems*, ATM S 544

2014-16 Developed and taught MIT 12.091 *MATLAB Bootcamp*

2014-16 Organized a department graduate mentorship program at MIT

2015 Taught classes in Statistics, Linear Algebra, and MATLAB as a WHOI summer instructor

2014 Completed the MIT Teaching Certification Program

2013-14 Mentored a junior graduate student through MIT departmental program

2009 Teaching Assistant for Earth and Environmental Sciences W2330, *Science for Sustainable Development,* Columbia University

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Peer-Reviewed Research Publications

subm. **Amrhein, D. E.** How large are temporal representativeness errors in paleoclimatology? Submitted to *Climate of the Past*.

subm. P. Moffa-Sánchez, E. Moreno-Chamarro, D. J. Reynolds, P. Ortega, L. Cunningham, D. Swingedouw, **D. E. Amrhein**, J. Halfar, L. Jonkers, J. H. Jungclaus, K. Perner, A. Wanamaker and S. Yeager. Variability in the northern North Atlantic and Arctic oceans across the last two millennia: A review. Subm. to *Paleoceanography and Paleoclimatology*.

subm. Zhang, R., R. Sutton, G. Danabasoglu, Y.-O. Kwon, R. Marsh, S. Yeager, **D. E. Amrhein**, and C. Little. A Review of the Role of AMOC Variability in Atlantic Multidecadal Variability and Associated Climate Impacts. Submitted to *Rev. Geophysics*.

2018 **Amrhein, D. E.**, C. Wunsch, O. Marchal, and G. Forget. A global glacial state estimate constrained by upper-ocean temperature proxies. *Journal of Climate*, https://doi.org/10.1175/JCLI-D-17-0769.1.

2018 Zhao, Ning, O. Marchal, L. Keigwin, **D. E. Amrhein**, and G. Gebbie. A synthesis of deglacial deep-sea radiocarbon records and a test of their (in)consistency with modern ocean circulation. *Paleoceanography and Paleoclimatology*, onlinelibrary.wiley.com/doi/10.1002/2017PA003174.

2015 **Amrhein, D. E.**, G. Gebbie, O. Marchal, and C. Wunsch. Inferring surface water equilibrium calcite δ^{18}O during the last deglacial period from benthic foraminiferal δ^{18}O records: Implications for ocean circulation. *Paleoceanography*, onlinelibrary.wiley.com/doi/10.1002/2014PA002743.

2013 Smerdon, J.E., A. Kaplan, and **D. E. Amrhein**. Reply to Comment on "Erroneous Model Field Representations in Multiple Pseudoproxy Studies: Corrections and Implications," *Journal of Climate*., https://doi.org/10.1175/JCLI-D-12-00165.1.

2013 Bower, A.S., R. M. Hendry, **D. E. Amrhein**, and J. M. Lilly. Direct Observations of Formation and Propagation of Subpolar Eddies into the Subtropical North Atlantic, *Deep Sea Research Part II: Topical Studies in Oceanography,* http://dx.doi.org/10.1016/j.dsr2.2012.07.029.

2010 Smerdon, J.E., A. Kaplan, and **D.E. Amrhein**. Erroneous Model Field Representations in Multiple Pseudoproxy Studies: Corrections and Implications, *Journal of Climate*, https://doi.org/10.1175/2010JCLI3742.1.

Publications in preparation

in prep. **Amrhein, D.E.** and G. Hakim. Quantifying knowability in paleoclimate data assimilation. In prep. for *Climate of the Past.*

in prep. **Amrhein, D.E.**, C. Wunsch, and L. Thompson. Dynamical controls on the depth of the boundary between bottom and deep waters in the Last Glacial Maximum Atlantic. In prep. for *J. of Geophysical Research: Oceans.*

in prep. **Amrhein, D.E.** and L. Thompson. Methods for accelerating and extrapolating tracer equilibration in numerical ocean models. In prep. for *Ocean Modeling.*

in prep. Hakim, G., **D. E. Amrhein**, C. Snyder, D. N. Anderson, J. Emile-Geay, D. Noone, and R. Tardif. Quantifying Proxy Influence in the Last Millennium Reanalysis. In prep. for *Climate of the Past.*

Invited talks and seminars

2018 Quantifying uncertainty in data and models towards reconstructing past AMOC variability. AMOC Paleo Task Team webinar.

2018 Estimating the abyssal ocean state at the Last Glacial Maximum by assimilating ocean tracer measurements into numerical models. Oregon State University Quaternary Science Tea, Corvallis, OR.

2017 How large are aliasing errors due to sampling paleoclimate records discontinuously? Climate and Paleoclimate Seminar, Woods Hole Oceanographic Institution, Woods Hole, MA.

2017 A glacial ocean state estimate constrained by upper ocean temperature proxies. Physical Oceanography Department Seminar, University of Washington, Seattle, WA.

2017 Connecting the future to the past using ocean models. Ocean Outlook Meeting, Bergen, Norway.

2016 Inferring Circulation During the Last Glacial Maximum and Last Deglaciation using Data and Models. Physical Oceanography Dissertation Symposium, Honolulu, HI.

Conference Presentations

2019 Quantifying errors in paleoclimate reconstructions arising from assumed spatial covariances. D. E. Amrhein and G. Hakim. Climate Variability Across Scales (CVAS) meeting, Seattle, WA.

2018 Dynamical controls on the depth of the boundary between bottom and deep waters in the Last Glacial Maximum Atlantic. D. E. Amrhein and L. Thompson. AMOC Science Team meeting, Miami, FL.

2018 Probing the limits of knowability in paleoclimate reconstructions of the last millennium. (Oral presentation) D. E. Amrhein and G. Hakim. University of Washington Program on Climate Change Spring Symposium, Seattle, WA.

2018 Reconstruction of last-millennium atmosphere and ocean quantities and quantification of spatiotemporal uncertainty. (Oral presentation) D. E. Amrhein, G. Hakim, and L. Thompson. European Geophysical Union meeting, Vienna, Austria.

2018 Dynamical controls on the depth of the boundary between bottom and deep waters in the Last Glacial Maximum Atlantic. D. E. Amrhein, L. Thompson, and C. Wunsch. PALMOD International Open Science Conference, Vienna, Austria.

2018 Dynamical controls on the depth of the boundary between bottom and deep waters in the Last Glacial Maximum Atlantic. (Oral presentation) D. E. Amrhein, L. Thompson, and C. Wunsch. Ocean Sciences meeting, Portland, OR.

2018 Connecting deep ocean tracer observations to surface temperature, precipitation, and wind stress. (Oral presentation). D. E. Amrhein, L. Thompson, and C. Wunsch. Workshop on Using Past Observations to Constrain Future Climate Variability, Seattle, WA.

2017 Discontinuous sampling aliases paleoclimate records. D. E. Amrhein. PAGES Workshop on Data Assimilation and Proxy System Modeling, Louvain-la-Neuve, Belgium.

2017 Annual to multidecadal coherence of Atlantic meridional heat transport in last-millennium CMIP5 simulations and the Last Millennium Reanalysis. D. E. Amrhein, G. Hakim, L. Thompson, and K. Armour. CLIVAR AMOC Science Team Meeting, Santa Fe, NM.

2016 Estimating past ocean states using data and models. (Oral Presentation). D. E. Amrhein. Physical Oceanography Department Seminar, Woods Hole Oceanographic Institution, Woods Hole, MA

2016 Constructing simple predictive models from paleoclimate records. D. E. Amrhein, G. Hakim, and L. Thompson. AGU Fall Meeting, San Francisco, CA.

2016 Towards an LGM state estimate. (Oral Presentation). D. E. Amrhein. ECCO Joint Project Meeting, Cambridge, MA.

2015 GOSE: A Glacial Ocean State Estimate. (Oral Presentation). D. E. Amrhein and C. Wusnch. AGU Fall Meeting, San Francisco, CA.

2015 GOSE: A Glacial Ocean State Estimate. (Oral Presentation). D. E. Amrhein and C. Wusnch. Graduate Climate Conference, Woods Hole, MA.

2014 Inferring surface water equilibrium calcite δ^{18}O during the last deglacial period from benthic foraminiferal δ^{18}O records: Implications for ocean circulation. D. E. Amrhein, G. Gebbie, O. Marchal, and C. Wunsch. AGU Fall Meeting, San Francisco, CA.

2014 Inferring surface water equilibrium calcite δ^{18}O during the last deglacial period from benthic foraminiferal δ^{18}O records: Implications for ocean circulation. (Oral presentation) D. E. Amrhein, G. Gebbie, O. Marchal, and C. Wunsch. iPODS-OC3 meeting, Bern, Switzerland.

2013 Constraining Deglacial Climate Using Sediment Core Records of δ^{18}O: An Inverse Methods Approach. (Oral Presentation) D. E. Amrhein and C. Wunsch. Advanced Climate Dynamics Course Summer School, Nyksund, Norway.

2009 A Pseudoproxy-Ensemble Study of Late-Holocene Climate Field Reconstructions Using CCA. D. E. Amrhein, J. Smerdon, and A. Kaplan. AGU Fall Meeting, San Francisco, CA.

2008 How do distinct physical phenomena and processes affect spectral slopes of climate variables? D. E. Amrhein and A. Kaplan. Ocean Sciences Meeting, Orlando, FL.

2007 How do weather, insolation, and interannual phenomena affect spectral slopes of climate variables? D. E. Amrhein and A. Kaplan. IUGG General Assembly Meeting, Perugia, Italy.

2006 Characterization of climatological power laws via ratios of interannual to subannual variance. D. E. Amrhein and A. Kaplan. AGU Fall Meeting, San Francisco, CA.

Professional Training

2017 GeoHackWeek participant: one-week course on Python and data science, Seattle, WA

2013 Advanced Climate Dynamics Course, Nyksund, Versterålen, Norway

2008 Summer Student Fellow, Woods Hole Oceanographic Institution
Supervisor: Amy Bower (Physical Oceanography)

2007 Summer School in the Physics of the Climate System, Utrecht University, Utrecht, Netherlands

2006–09 Undergraduate Research Assistant, LDEO, Columbia University
Supervisor: Alexey Kaplan (Ocean and Climate Physics)

Field Experience

2017 Cruise from Woods Hole, MA to Azores, Portugal. Piston, gravity, and multicore sediment sampling to study glacial carbon isotopes

2015 Field course on the US East Coast. Coastal geomorphology and anthropogenic changes

2014 Field course in Massif Central, France and Iceland. Volcanism and mid-ocean ridges

2013 Field course in Kona, HI. Earth's gravitational field

2010 Cruise from Bermuda to Woods Hole. Physical and biological oceanographic sampling

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Professional Service

2018 Co-organizer, AGU Session PP41F. *New Perspectives on Past Climates: Progress in Proxy System Modeling, Reconstruction Algorithms, and Uncertainty Quantification.*

2018 - Past Global Changes (PAGES) early career liaison

2017 - Participant, AMOC Science Team

2017 - Participant, Data Assimilation and Proxy System Modeling working group, PAGES

2012-14 Organizing Committee, Annual retreat for the MIT Program on Atmospheres, Oceans, and Climate

Reviewer for *Journal of Climate* and *Climate Dynamics*

Recent Outreach Activities

2018 STEM Ambassador, Edmonds School District's 6th Annual STEM Expo

2018 Lecture on climate change and ocean acidification, Shoreline Community College, Shoreline, WA

2018 Demonstration volunteer, Shoreline STEMfest, Shoreline, WA

2017 - Script writer for UW Atmospheric Sciences Video Outreach

Professional Skills

Highly proficient with the MITgcm, MATLAB, Python, Linux/Unix, LaTeX

SCUBA open water certified