

# Michael P. Erb

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## RESEARCH INTERESTS

Climate models and physical proxy archives provide important perspectives on past climate. Exploration of these sources of information can illuminate key climate relationships over multiple timescales, data which is vital for understanding our climate system and potential future changes. Hydroclimate variations such as drought and monsoons are of particular relevance due to their impacts on water availability, which affects people across the world.

## EDUCATION

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| 2014 | Ph.D., Rutgers, The State University of New Jersey, Atmospheric Science.<br>Advisor: Dr. Anthony J. Broccoli                       |
| 2011 | M.S., Rutgers, The State University of New Jersey, Atmospheric Science.<br>Advisor: Dr. Anthony J. Broccoli                        |
| 2007 | B.S., University of North Carolina at Asheville, Atmospheric Sciences.<br>Graduated with honors.<br>Advisor: Dr. Douglas K. Miller |

## EMPLOYMENT

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| 2017-present | <b>Northern Arizona University</b><br>Assistant Research Professor, 2019-present<br>Postdoctoral Scholar, 2017-2019 |
| 2016-2017    | <b>University of Southern California</b><br>Postdoctoral Scholar  |
| 2014-2016    | <b>University of Texas at Austin</b><br>Postdoctoral Fellow   |
| 2007-2013    | <b>Rutgers, The State University of New Jersey</b><br>Graduate Research Assistant                                   |

## TEACHING EXPERIENCE

- 2020 **Climate Dynamics** – Instructor of record for a graduate-level course about Earth’s energy balance, general circulation, and modes of variability on a variety of timescales. The course consists of lectures, student-led paper discussions, data analysis assignments, and quizzes and tests meant to assess knowledge and encourage robust understanding of material.
- 2018 Fill-in lecturer, Northern Arizona University, in Global Climate Change, a graduate-level course.
- 2009-2012 Teaching Assistant, Rutgers University, for the following classes:
- Meteorological Analysis I, a sophomore level class about how to interpret and present meteorological information.
  - Meteorological Analysis II, a continuation of the above.
  - Dynamics of the Atmosphere, a junior level class which focused on hydrodynamics, equations of motion on a rotating Earth, vorticity, and boundary layer dynamics.
  - Atmospheric Thermodynamics, a junior level class on heat and moisture processes in the Earth’s atmosphere.
  - Fill in lecturer for Physical Principles of Climate Change, on the instrumental record and the greenhouse effect.
  - Fill in lecturer for a Byrne Seminar on global climate change.
- Responsibilities for the above classes included preparing and presenting occasional lectures, proctoring exams, grading and going over homework, and helping students.
- I also received certificates for participating in the “Professional Development: Tips for Future Faculty” and “Creative Teaching Practices” workshops offered by the Rutgers Teaching Assistant Project.

## MEMBERSHIPS IN PROFESSIONAL ORGANIZATIONS

American Meteorological Society  
American Geophysical Union  
American Association for the Advancement of Science

## AWARDS AND NOMINATIONS

2020 | *Nominated* as part of a team for “Most Significant Research/Scholarly Work,” a Research and Creative Activity (RCA) award at Northern Arizona University.

## FUNDED GRANTS

2019-2022 | “Collaborative Research: Quantifying Holocene Climate Variations through Data Assimilation using Proxies and GCM output”. PIs: Michael P. Erb, Nicholas P. McKay, Nathan J. Steiger, and Sylvia G. Dee. Funded by NSF’s Paleo Perspectives on Climate Change (P2C2).

2020-2023 | “Collaborative Research: Patterns and processes of abrupt Arctic warming based on paleoclimate observations and models”. PIs: Elizabeth K. Thomas, Nicholas P. McKay, Michael P. Erb, and Darrell S. Kaufman. Funded by NSF’s Arctic System Science (ARCSS).

2020-2023 | “Collaborative Research: PReSto: A Paleoclimate Reconstruction Storehouse to broaden access and accelerate scientific inference”. PIs: Nicholas P. McKay, Michael P. Erb, Cody C. Routson, Julien Emile-Geay, and Deborah Khider. Funded by NSF’s Geoinformatics (GI).

2020-2023 | “Monsoon 21k: A global monsoon synthesis, reconstruction, and data-model comparison”. PIs: Cody C. Routson, Darrell S. Kaufman, Nicholas P. McKay, and Michael P. Erb. Funded by NSF’s Paleo Perspectives on Climate Change (P2C2).

## ADDITIONAL SUBMITTED PROPOSALS

2017 | “Collaborative Research: Quantifying Holocene climate variations through data assimilation using proxies and GCM output”. PIs: Michael P. Erb, Nicholas P. McKay, Cody C. Routson, Shaun A. Marcott, and Nathan J. Steiger. Submitted to NSF’s Paleo Perspectives on Climate Change (P2C2) solicitation. *Declined*.

2014 | “Collaborative Research: Fingerprints of tropical radiative feedbacks affecting Quaternary proxies”. PIs: Charles S. Jackson, Michael P. Erb, David W. Lea, and Anthony J. Broccoli. Submitted to NSF’s Paleo Perspectives on Climate Change (P2C2) solicitation. *Declined*.

## PUBLICATIONS

### In Preparation

Erb, M. P., C. S. Jackson, A. J. Broccoli, D. W. Lea, and P. N. DiNezio: Detection and attribution of paleoclimate forcings in long proxy records.

Partin, J. W., P. D. DiNezio, M. P. Erb, k. Thirumalai, T. M. Quinn, C.-C. Shen, C. S. Jackson, M. B. Cardenas, F. P. Siringan, M. Puy, J. L. Banner, K. Lin, Y. Okumura, H.-M. Hu, and F. W. Taylor: Indirect forcing of the oceanic subsystem of the Asian Monsoon.

### Submitted

Routson, C. C., D. S. Kaufman, N. P. McKay, M. P. Erb, et al.: A multiproxy database of weather North American Holocene paleoclimate records.

### Refereed Journal Articles

- 2020 Brierley, C. M., et al.: Large-scale features and evaluation of the PMIP4-CMIP6 *midHolocene* simulations. *Clim. Past*, **16**, 1847-1872, doi:10.5194/cp-16-1847-2020.
- 2020 Erb, M. P., J. Emile-Geay, G. J. Hakim, N. Steiger, and E. J. Steig: Atmospheric dynamics drive most interannual U.S. droughts over the last millennium. *Sci. Adv.*, **6**, 12 pp, doi:10.1126/sciadv.aay7268.
- 2020 Kaufman, D., N. McKay, C. Routson, M. Erb, C. Dätwyler, P. S. Sommer, O. Heiri, and B. Davis: Holocene global mean surface temperature, a multi-method reconstruction approach. *Sci. Data*, **7**, 13 pp, doi:10.1038/s41597-020-0530-7.
- 2020 Kaufman, D., N. McKay, C. Routson, M. Erb, et al.: A global database of Holocene paleotemperature records. *Sci. Data*, **7**, 34 pp, doi:10.1038/s41597-020-0445-3.
- 2019 Broadman, E., L. L. Thurston, E. Schiefer, N. P. McKay, D. Fortin, J. Geck, M. G. Loso, M. Nolan, S. H. Arcusa, C. W. Benson, R. A. Ellerbroek, M. P. Erb, C. C. Routson, C. Wiman, A. J. Wong, and D. Kaufman: An Arctic watershed observatory at Lake Peters, Alaska: weather-glacier-river-lake system data for 2015-2018. *Earth Syst. Sci. Data*, **11**, 1957-1970, doi:10.5194/essd-11-1957-2019.

- 2019 Khider, D., J. Emile-Geay, N. P. McKay, Y. Gil, D. Garijo, V. Ratnakar, et al.: PaCTS v1.0: A crowdsourced reporting standard for paleoclimate data. *Paleoceanography and Paleoclimatology*, **34**, 27 pp, doi:10.1029/2019PA003632.
- 2019 Neukom, R., L. A. Barboza, M. P. Erb, F. Shi, J. Emile-Geay, M. N. Evans, J. Franke, D. S. Kaufman, L. Lücke, K. Rehfeld, A. Schurer, F. Zhu, S. Brönnimann, G. J. Hakim, B. J. Henley, F. C. Ljungqvist, N. McKay, V. Valler, and L. von Gunten: Consistent multidecadal variability in global temperature reconstructions and simulations over the Common Era. *Nature Geoscience*, **12**, 643-649, doi:10.1038/s41561-019-0400-0.
- 2019 Tardif, R., G. J. Hakim, W. A. Perkins, K. A. Horlick, M. P. Erb, J. Emile-Geay, D. M. Anderson, E. J. Steig, and D. Noone: Last Millennium Reanalysis with an expanded proxy database and seasonal proxy modeling. *Clim. Past*, **15**, 1251-1273, doi:10.5194/cp-15-1251-2019.
- 2019 Routson, C. C., N. P. McKay, D. S. Kaufman, M. P. Erb, H. Goosse, B. N. Shuman, J. R. Rodysill, and T. Ault: Mid-latitude net precipitation decreased with Arctic warming during the Holocene. *Nature*, **568**, 83-87, doi:10.1038/s41586-019-1060-3.
- 2019 Anderson, D. M., R. Tardif, K. Horlick, M. P. Erb, G. J. Hakim, D. Noone, W. A. Perkins, and E. Steig: Additions to the Last Millennium Reanalysis multi-proxy database. *Data Science Journal*, **18**(2), 1-11, doi:10.5334/dsj-2019-002.
- 2018 McKay, N. P., D. S. Kaufman, C. C. Routson, M. P. Erb, and P. D. Zander: The onset and rate of Holocene Neoglacial cooling in the Arctic. *Geophys. Res. Lett.*, **45**, 12487-12496, doi:10.1029/2018GL079773.
- 2018 Tabor, C. R., B. L. Otto-Bliesner, E. C. Brady, J. Nusbaumer, J. Zhu, M. P. Erb, T. E. Wong, Z. Liu, and D. Noone: Interpreting precession-driven  $\delta^{18}\text{O}$  variability in the South Asian monsoon region. *J. Geophys. Res.-Atmos.*, **123**, 20 pp, doi:10.1029/2018JD028424.
- 2018 Bosmans, J. H. C., M. P. Erb, A. M. Dolan, S. S. Drijfhout, E. Tuenter, F. J. Hilgen, D. Edge, J. O. Pope, and L. J. Lourens: Response of the Asian summer monsoons to idealized precession and obliquity forcing in a set of GCMs. *Quaternary Sci. Rev.*, **188**, 121-135, doi:10.1016/j.quascirev.2018.03.025.
- 2018 Erb, M. P., C. S. Jackson, A. J. Broccoli, D. W. Lea, P. J. Valdes, M. Crucifix, and P. N. DiNezio: Model evidence for a seasonal bias in Antarctic ice cores. *Nature Communications*, **9**, 10 pp, doi:10.1038/s41467-018-03800-0.

- 2015 Erb, M. P., C. S. Jackson, and A. J. Broccoli: Using single-forcing GCM simulations to reconstruct and interpret Quaternary climate change. *J. Climate*, **28**, 9746-9767, doi:10.1175/JCLI-D-15-0329.1.
- 2015 Erb, M. P., A. J. Broccoli, N. T. Graham, A. C. Clement, A. T. Wittenberg, and G. A. Vecchi: Response of the equatorial Pacific seasonal cycle to orbital forcing. *J. Climate*, **28**, 9258-9276, doi:10.1175/JCLI-D-15-0242.1.
- 2014 Mantsis, D. F., B. R. Lintner, A. J. Broccoli, M. P. Erb, A. C. Clement, H.-S. Park: The response of large-scale circulation to obliquity-induced changes in meridional heating gradients. *J. Climate*, **27**, 5504-5516, doi:10.1175/JCLI-D-13-00526.1.
- 2013 Erb, M. P., A. J. Broccoli, and A. C. Clement: The contribution of radiative feedbacks to orbitally-driven climate change. *J. Climate*, **26**, 5897-5914, doi:10.1175/JCLI-D-12-00419.1.
- 2013 Mantsis, D. F., A. C. Clement, B. Kirtman, A. J. Broccoli, and M. P. Erb: Precessional cycles and their influence on the North Pacific and North Atlantic summer anticyclones. *J. Climate*, **26**, 4596-4611, doi:10.1175/JCLI-D-12-00343.1.
- 2011 Mantsis, D. F., A. C. Clement, A. J. Broccoli, and M. P. Erb: Climate feedbacks in response to changes in obliquity. *J. Climate*, **24**, 2830-2845, doi:10.1175/2010JCLI3986.1.

## Other Publications

- 2017 Emile-Geay, J., M. P. Erb, G. J. Hakim, E. J. Steig. And D. C. Noone: Workshop Report: Climate dynamics with the Last Millennium Reanalysis. *PAGES Magazine*, **25**, 1 pp.
- 2006 Erb, M. P., and C. C. Hennon: A case study of Hurricane Katrina: rapid intensification in the Gulf of Mexico. *Proceedings of the National Conference of Undergraduate Research (NCUR)*, 8 pp.

## Books

- 2012 “Kelvin McCloud and the Seaside Storm” by Michael Erb, *Tumblehome Learning, Inc.*, 244 pp. – A fiction book for kids, ages 9-12, which discusses real weather and other science, written to get kids interested in these topics.

## WORKSHOPS

- 2017 | “LMR Hackathon,” Third Annual LMR Workshop, Boulder, CO, October. A one-day hands-on workshop for attendees to become more familiar with the Last Millennium Reanalysis (LMR) output and code. I ran the Hackathon, showing attendees how to analyze LMR output and run the code.

## MEDIA OUTREACH

- 2019 | Radio interview with “This Green Earth” on KPCW about our recent Nature Geoscience paper, “Consistent multidecadal variability in global temperature reconstructions and simulations over the Common Era.”

## PAPER REVIEWS FOR JOURNALS

Climate Dynamics, Climate of the Past, Earth and Planetary Science Letters, Journal of Climate, Journal of Geophysical Research: Oceans, Journal of Quaternary Science, Nature Geoscience, Paleoceanography

## SCIENTIFIC PRESENTATIONS

- 2019 | “Synthesizing Climate12k data,” CLIMATE-12k workshop: How hot was the Holocene?, Sainte-Croix, Switzerland, June, *talk*.
- 2018 | “Incorporating low resolution proxy records into paleoclimate data assimilation,” American Geophysical Union Fall Meeting, Washington, D.C., December, *poster* with N. McKay.
- 2018 | “Exploring drought and climate over the past 1000 years through paleoclimate data assimilation,” SESES Seminar, Northern Arizona University, Flagstaff, AZ, February, *invited talk* with J. Emile-Geay, G. J. Hakim, R. Tardif, K. Horlick, W. A. Perkins, D. Noone, E. J. Steig, and D. M. Anderson.
- 2017 | “Is recent warming unprecedented in the Common Era? Insights from PAGES2k v.2 data and the Last Millennium Reanalysis,” American Geophysical Union Fall Meeting, New Orleans, LA, December, *talk* with J. Emile-Geay, N. McKay, G. Hakim, E. Steig, and K. Anchukaitis.
- 2017 | “Constraints on U.S. drought dynamics from the Last Millennium Reanalysis,” Third Annual LMR Workshop, Boulder, CO, October, *talk* with J. Emile-Geay, G. J.

- Hakim, R. Tardif, K. Horlick, W. A. Perkins, D. Noone, E. J. Steig, and D. M. Anderson.
- 2017 “Climate and drought over the past 1000 years in the Last Millennium Reanalysis,” 5<sup>th</sup> Past Global Changes (PAGES) Open Science Meeting (OSM), Zaragoza, Spain, May, *poster* with J. Emile-Geay, G. J. Hakim, R. Tardif, K. Horlick, W. A. Perkins, D. Noone, E. J. Steig, and D. M. Anderson.
- 2017 “Climate and drought over the past 1000 years in the Last Millennium Reanalysis,” European Geosciences Union General Assembly 2017, Vienna, Austria, April, *talk* with J. Emile-Geay, G. J. Hakim, R. Tardif, K. Horlick, W. A. Perkins, D. Noone, E. J. Steig, and D. M. Anderson.
- 2016 “Climate and drought over the past 1000 years in the Last Millennium Reanalysis,” American Geophysical Union Fall Meeting, San Francisco, CA, December, *talk* with J. Emile-Geay, G. J. Hakim, R. Tardif, K. Horlick, W. A. Perkins, D. Noone, E. J. Steig, and D. M. Anderson.
- 2016 “Climate and drought over the past 1000 years in the Last Millennium Reanalysis,” Paleoenvironmental seminar, University of Southern California, Los Angeles, CA, November, *talk* with J. Emile-Geay, D. M. Anderson, G. J. Hakim, K. Horlick, D. Noone, W. A. Perkins, E. J. Steig, and R. Tardif.
- 2015 “Obliquity and Precession in the Quaternary: Analyzing Climate Responses Using Single-Forcing GCM Simulations and Bayesian Model-Proxy Comparison,” American Geophysical Union Fall Meeting, San Francisco, CA, December, *poster* with C. S. Jackson, A. J. Broccoli, and D. W. Lea.
- 2015 “Simulating the Response to Astronomical Forcing with a Coupled Atmosphere-Ocean Model,” American Geophysical Union Fall Meeting, San Francisco, CA, December, *poster* with A. J. Broccoli and B. Raney.
- 2015 “Using single-forcing simulations and proxy data to explore Quaternary climate change,” Pacific Northwest National Laboratory, Richland, WA, October, *invited talk* with C. S. Jackson, A. J. Broccoli, and D. W. Lea.
- 2015 “Impacts of orbital, greenhouse gas, and ice sheet variations on Quaternary climate change,” University of Texas Institute for Geophysics Brown Bag talk, Austin, TX, October, *talk* with C. S. Jackson, A. J. Broccoli, and D. W. Lea.
- 2015 “Is linearity a sufficient model for interpreting long-term climate variability of the late Quaternary?” XIX INQUA 2015, Nagoya, Japan, July-August, *poster* with C. S. Jackson, A. J. Broccoli, and P. J. Valdes.



- 2015 “Using idealized GCM simulations and proxy data to investigate the Quaternary response to obliquity,” XIX INQUA 2015, Nagoya, Japan, July-August, *talk* with C. S. Jackson, A. J. Broccoli, and D. W. Lea.
- 2015 “The influence of obliquity on Quaternary climate,” 20<sup>th</sup> Annual CESM Workshop, Breckenridge, CO, June, *talk* with C. S. Jackson and A. J. Broccoli.
- 2014 “Using idealized GCM simulations to reconstruct and interpret past precipitation and temperature changes,” American Geophysical Union Fall Meeting, San Francisco, CA, December, *poster* with C. S. Jackson, A. J. Broccoli, and D. W. Lea.
- 2014 “Climate change in the United States: Findings of the U.S. National Climate Assessment and the IPCC,” Rotary Club, Austin, TX, June, *talk*.
- 2014 “Using idealized GCM simulations to reconstruct (and interpret) past climate change,” 19<sup>th</sup> Annual CESM Workshop, Breckenridge, CO, June, *talk* with C. S. Jackson, A. J. Broccoli, and D. W. Lea.
- 2014 “The response of radiative feedbacks and equatorial Pacific seasonality to orbital forcing,” University of Texas Institute for Geophysics Seminar Series, Austin, TX, March, *talk* with A. J. Broccoli, B. R. Lintner, N. T. Graham, A. C. Clement, A. T. Wittenberg, and G. A. Vecchi.
- 2013 “The response of radiative feedbacks, equatorial Pacific seasonality, and wetlands to orbital forcing in model simulations,” Rutgers University Ph.D. defense, New Brunswick, NJ, November, *talk* with A. J. Broccoli, B. R. Lintner, N. T. Graham, Y. F. Reinfeldler, H. Li, A. C. Clement, A. T. Wittenberg, G. A. Vecchi, and Y. Rosenthal.
- 2012 “Response of the Equatorial Pacific Seasonal Cycle to Orbital Forcing,” American Geophysical Union Fall Meeting, San Francisco, CA, December, *talk* with A. J. Broccoli, A. T. Wittenberg, and G. A. Vecchi.
- 2012 “The Influence of Orbital Forcing on Past Climate Change,” The Rutgers Climate Symposium, New Brunswick, NJ, November, *poster* with A. J. Broccoli, A. C. Clement, A. T. Wittenberg, and G. A. Vecchi.
- 2012 “The Effect of Orbital Forcing on Seasonality in the Equatorial Pacific,” Paleoclimate Modelling Intercomparison Project, Phase 3, 2<sup>nd</sup> General Meeting, Crewe, UK, May, *talk* with A. J. Broccoli, G. A. Vecchi, A. T. Wittenberg, D. W. Oppo, and M. Khodri.

- 2011 "The Role of Feedbacks in Precession and Obliquity-driven Climate Change," American Geophysical Union Fall Meeting, San Francisco, CA, December, *poster* with A. J. Broccoli and A. C. Clement.
- 2011 "The Role of Feedbacks in Precession and Obliquity-driven Climate Change," Princeton Geosciences Graduate Research Symposium, Princeton, NJ, November, *invited talk* with A. J. Broccoli and A. C. Clement.
- 2011 "The Role of Feedbacks in Precession and Obliquity-driven Climate Change," Graduate Climate Conference, Woods Hole, MA, October, *talk* with A. J. Broccoli and A. C. Clement.
- 2011 "4.5 Billion Years of Extremes: A (Brief) Introduction to the Study of Past Climates," Rutgers University, New Brunswick, NJ, May, *talk*.
- 2010 "The Astronomical Forcing of Climate Change: Forcing and Feedbacks," Paleoclimate Modelling Intercomparison Project, Phase 3, 1<sup>st</sup> General Meeting, Kyoto, Japan, December, *poster* with A. J. Broccoli and A. C. Clement.
- 2010 "Orbital Forcing of Climate: The Role of Obliquity in Driving Natural Climate Change," Urbino Summer School in Paleoclimatology, Urbino, Italy, July, *poster* with A. J. Broccoli and A. C. Clement.
- 2009 "Orbital Forcing of Climate: The Role of Obliquity in Driving Natural Climate Change," American Geophysical Union Fall Meeting, San Francisco, CA, December, *poster* with A. J. Broccoli and A. C. Clement.
- 2006 "A Case Study of Hurricane Katrina: Rapid Intensification in the Gulf of Mexico," National Conference on Undergraduate Research, Asheville, NC, April, *talk* with C. C. Hennon.