LORETTA J. MICKLEY

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Professional experience

Harvard University. Senior Research Fellow, 2011-present
Harvard University. Research associate, 1999-2011; Postdoctoral fellow, 1996-1999
Main research topics:

- Influence of wildfires and agricultural fires on air quality.
- Effects of climate change on wildfire activity and smoke exposure.
- Response of $PM_{2.5}$ and ozone to meteorological variability and climate change.
- Impacts of changing aerosol load on regional climate.
- Effects of climate change on the chemical composition of the troposphere.
- Oxidation capacity and aerosol radiative forcing in paleo and preindustrial atmospheres.

Education

PhD, Geophysical Sciences, University of Chicago, 1996
Primary research advisor: Jonathan P. D. Abbatt (now at Toronto)

- Analysis of HALOE satellite measurements of stratospheric ozone and other trace gases.

MS, Chemistry, University of Illinois at Chicago, 1990

- Ab initio calculations to determine molecular structure and vibrational force fields of biopolymers.

Honors and fellowships

- Science Scholars Fellowship, Bunting Institute (now Radcliffe Institute), 1998-1999
- Participant in ACCESS IV (Atmospheric Chemistry Colloquium for Emerging Senior Scientists), Boston College, 1997
- Postdoctoral Fellowship in Climate and Global Change, NOAA, 1996-1998
- Clare Boothe Luce Fellowship, University of Chicago, 1990-1992
- University Fellowship, University of Illinois at Chicago, 1988-1989

Students and postdocs advised

As primary research advisor.
Xu Feng, postdoc, 2021 – present.
Makoto M. Kelp (two projects), PhD 2023, postdoc 2023, now NOAA postdoc at Stanford.
Eimy X. Bonilla, PhD, 2022, now postdoc at Howard University and at EPA.
Tianjia (Tina) Liu, PhD 2022, postdoc 2022, now NOAA postdoc at UC Irvine.
Jonathan M. Moch, PhD, 2020, postdoc 2020-2022, now AAAS fellow in US State Department.
Pengfei Liu, postdoc, 2017-2020, now faculty at Georgia Tech.
Daniel H. Cusworth (two projects), PhD 2018, now project scientist at Carbon Mapper.
Yang Li, postdoc, 2017-2020, now faculty at Baylor University.

Ploy (Pattanun) Achakulwisut, PhD 2017, now research fellow at Stockholm Environment Initiative.
Lu Shen, PhD 2017, now faculty at Peking University.
Shanon Koplitz (two projects), PhD 2016, now physical scientist at EPA.
Lee Murray (one project), PhD 2013, now faculty at University of Rochester.

As co-advisor.
Rachel Silvern, PhD 2019, now program officer at National Academy of Sciences.
Lei Zhu, PhD 2016, now faculty at Southern University of Science and Technology, Shenzhen.
Tom Breider, postdoc, 2011-2016, now in industry.
Xu Yue, postdoc, 2010-2012, now faculty at Nanjing University.
Amos Tai, PhD 2012, now faculty at the Chinese University of Hong Kong.
Justin Parrella, PhD 2012, now in industry.
Eric Leibensperger, PhD 2011, now faculty at Ithaca College.
Rynda Hudman, postdoc, 2007-2008, now physical scientist at EPA.
Shiliang Wu, PhD 2007, postdoc 2007-2008, now faculty at Michigan Tech.

As mentor for undergraduates.
Miah Caine (Harvard), Tina Chen (Harvard), Christian Chiu (Harvard), Karina Chung (Harvard), Timothy Fargiano (Harvard), Lucille Gagnon (Williams), Sanjna Kedia (Harvard), Samuel Lin (Harvard), Alison Mangano (De Anza Community College), Frances Marie Panday (Univ. of Maryland), Greta Schultz (Univ. of Wisconsin-Madison), Margaret Schultz (senior thesis advisor, Harvard), Kent Toshima (Harvard), Maggie Hilda Vallejo (Harvard).

Selected synergistic activities

Board Member, Conservation Law Foundation, 2019-present.
Co-organizer, Summer Program on Earth and Environmental Research (SPHEER), an NSF-funded REU program at Harvard, 2023-present.
Chair, Greenhouse gas emissions from wildfires: Toward improved monitoring, modeling, and management, planning committee for NAS, 2023.
Coauthor, Chapter 14, Air Quality, in *Fifth National Climate Assessment*, 2021-2023.
Lead author, *Effects on Climate*, Section 13.3 in the *Integrated Science Assessment of Particulate Matter*, EPA National Center for Environmental Assessment, 2020. https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter
Reviewer on NAS panel for the *Climate Science Special Report*, U.S. Global Change Research Program, 2016-2017. https://nap.nationalacademies.org/catalog/24712/review-of-the-draft-climate-science-special-report
Member, Board on Atmospheric Biogeosciences, American Meteorological Society, 2010-2013.
Coauthor, Role of tropospheric ozone in climate change and UV-B shielding effects (Chapter 10), *Integrated Science Assessment of Ozone and Related Photochemical Oxidants*, EPA National Center for Environmental Assessment, 2013. https://cfpub.epa.gov/ncea/isa/recordisplay.cfm?deid=247492
Co-chair, GEOS-Chem chemistry-climate working group, and member, GEOS-Chem steering committee, 2011-2013.

Publications

* denotes first author advised by LJM.

In review.

East, J. D., Jacob, D. J., Balasus, N., Bloom A. A., Bruhwiler, L., Chen, Z., Kaplan, J. O., Mickley, L. J., Mooring, T. A., Penn, E., Poulter, B., Sulprizio, M. P., Yantosca, R. M., Worden J. R., & Zhang, Z. (2024), Interpreting the seasonality of atmospheric methane [Preprint]. https://essopenarchive.org/users/741542/articles/713787-interpreting-the-seasonality-of-atmospheric-methane

* Christiansen, A., Mickley, L. J., & Hu, L. (2023). Constraining long-term NO_x emissions over the United States and Europe using nitrate wet deposition monitoring networks, *Atmos. Chem. Phys.,* in review. https://doi.org/10.5194/egusphere-2023-1249

* Feng, X., Mickley, L. J., Bell, M. L., Liu, T., Fisher, J. A., & Val Martin, M. (2023). Improved estimates of smoke exposure during Australia fire seasons: Importance of quantifying plume injection heights, *Atmos. Chem. Phys.,* in review. https://doi.org/10.5194/egusphere-2023-1331

* Liu, T., Panday, F., Caine, M., Kelp, M., Pendergrass, D., & Mickley, L. (2023). Is the smoke aloft? Caveats regarding the use of the Hazard Mapping System (HMS) smoke product as a proxy for surface smoke presence across the United States [Preprint]. https://doi.org/10.31223/X51963

Published.

Fiore, A. M., Mickley, L. J., Zhu, Q., & Baublitz, C. B. (2024). Climate and tropospheric oxidizing capacity. *Annual Review of Earth and Planetary Sciences*, *52*(1), annurev-earth-032320-090307. https://doi.org/10.1146/annurev-earth-032320-090307

* Bonilla, E. X., Mickley, L. J., Beaudon, E. G., Thompson, L. G., Rodriguez, W. E., Encarnación, R. C., Whicker, C. A., Flanner, M. G., Schmitt, C. G., & Ginot, P. (2023). Contribution of biomass burning to black carbon deposition on Andean glaciers: Consequences for radiative forcing. *Environmental Research Letters*, *18*(2), 024031. https://doi.org/10.1088/1748-9326/acb371

* Bonilla, E. X., Mickley, L. J., Raheja, G., Eastham, S. D., Buonocore, J. J., Alencar, A., Verchot, L., Westervelt, D. M., & Castro, M. C. (2023). Health impacts of smoke exposure in South America: Increased risk for populations in the Amazonian Indigenous territories. *Environmental Research: Health*, *1*(2), 021007. https://doi.org/10.1088/2752-5309/acb22b

Dang, R., Jacob, D. J., Shah, V., Eastham, S. D., Fritz, T. M., Mickley, L. J., Liu, T., Wang, Y., & Wang, J. (2023). Background nitrogen dioxide (NO_2) over the United States and its implications for satellite observations and trends: Effects of nitrate photolysis, aircraft, and open fires. *Atmospheric Chemistry and Physics*, *23*(11), 6271–6284. https://doi.org/10.5194/acp-23-6271-2023

* Feng, X., Mickley, L. J., Bell, M. L., Liu, T., Fisher, J. A., & Val Martin, M. (2023). Improved estimates of smoke exposure during Australia fire seasons: Importance of quantifying plume injection heights, *Atmos. Chem. Phys.,* in review. https://doi.org/10.5194/egusphere-2023-1331

Gautam, R., Patel, P. N., Singh, M. K., Liu, T., Mickley, L. J., Jethva, H., & DeFries, R. S. (2023). Extreme smog challenge of India intensified by increasing lower tropospheric stability. *Geophysical Research Letters*, *50*(11), e2023GL103105. https://doi.org/10.1029/2023GL103105

* Kelp, M. M., Carroll, M. C., Liu, T., Yantosca, R. M., Hockenberry, H. E., & Mickley, L. J. (2023). Prescribed burns as a tool to mitigate future wildfire smoke exposure: Lessons for states and rural environmental justice communities. *Earth's Future*, *11*(6), e2022EF003468. https://doi.org/10.1029/2022EF003468

* Kelp, M. M., Fargiano, T. C., Lin, S., Liu, T., Turner, J. R., Kutz, J. N., & Mickley, L. J. (2023). Data-driven placement of $PM_{2.5}$ air quality sensors in the United States: An approach to target urban environmental injustice. *GeoHealth*, *7*(9), e2023GH000834. https://doi.org/10.1029/2023GH000834

* Moch, J. M., Mickley, L. J., Eastham, S. D., Lundgren, E. W., Shah, V., Buonocore, J. J., Pang, J. Y. S., Sadiq, M., & Tai, A. P. K. (2023). Overlooked long-term atmospheric chemical feedbacks alter the impact of solar geoengineering: Implications for tropospheric oxidative capacity. *AGU Advances*, *4*(5), e2023AV000911. https://doi.org/10.1029/2023AV000911

* Christiansen, A., Mickley, L. J., Liu, J., Oman, L. D., & Hu, L. (2022). Multidecadal increases in global tropospheric ozone derived from ozonesonde and surface site observations: Can models reproduce ozone trends? *Atmospheric Chemistry and Physics*, *22*(22), 14751–14782. https://doi.org/10.5194/acp-22-14751-2022

Dovrou, E., Bates, K. H., Moch, J. M., Mickley, L. J., Jacob, D. J., & Keutsch, F. N. (2022). Catalytic role of formaldehyde in particulate matter formation. *Proceedings of the National Academy of Sciences*, *119*(6), e2113265119. https://doi.org/10.1073/pnas.2113265119

* Kelp, M. M., Lin, S., Kutz, J. N., & Mickley, L. J. (2022). A new approach for determining optimal placement of $PM_{2.5}$ air quality sensors: Case study for the contiguous United States. *Environmental Research Letters*, *17*(3), 034034. https://doi.org/10.1088/1748-9326/ac548f

* Liu, T., Mickley, L. J., Patel, P. N., Gautam, R., Jain, M., Singh, S., Balwinder-Singh, DeFries, R. S., & Marlier, M. E. (2022). Cascading delays in the monsoon rice growing season and postmonsoon agricultural fires likely exacerbate air pollution in north India. *Journal of Geophysical Research: Atmospheres*, *127*(24). https://doi.org/10.1029/2022JD036790

Marlier, M. E., Brenner, K. I., Liu, J. C., Mickley, L. J., Raby, S., James, E., Ahmadov, R., & Riden, H. (2022). Exposure of agricultural workers in California to wildfire smoke under past and future climate conditions. *Environmental Research Letters*, *17*(9), 094045. https://doi.org/10.1088/1748-9326/ac8c58

* Moch, J. M., Mickley, L. J., Keller, C. A., Bian, H., Lundgren, E. W., Zhai, S., & Jacob, D. J. (2022). Aerosol-radiation interactions in China in winter: Competing effects of reduced shortwave radiation and cloud-snowfall-albedo feedbacks under rapidly changing emissions. *Journal of Geophysical Research: Atmospheres*, *127*(9). https://doi.org/10.1029/2021JD035442

Peng, R. D., Liu, J. C., McCormack, M. C., Mickley, L. J., & Bell, M. L. (2022). Estimating the health effects of environmental mixtures using principal stratification. *Statistics in Medicine*, *41*(10), 1815–1828. https://doi.org/10.1002/sim.9330

Vohra, K., Marais, E. A., Bloss, W. J., Schwartz, J., Mickley, L. J., Van Damme, M., Clarisse, L., & Coheur, P.-F. (2022). Rapid rise in premature mortality due to anthropogenic air pollution in fast-growing tropical cities from 2005 to 2018. *Science Advances*, *8*(14), eabm4435. https://doi.org/10.1126/sciadv.abm4435

Gunthe, S. S., Liu, P., Panda, U., Raj, S. S., Sharma, A., Darbyshire, E., Reyes-Villegas, E., Allan, J., Chen, Y., Wang, X., Song, S., Pöhlker, M. L., Shi, L., Wang, Y., Kommula, S. M., Liu, T., Ravikrishna, R., McFiggans, G., Mickley, L. J., … Coe, H. (2021). Enhanced aerosol particle growth sustained by high continental chlorine emission in India. *Nature Geoscience*, *14*(2), 77–84. https://doi.org/10.1038/s41561-020-00677-x

* Li, Y., Mickley, L. J., & Kaplan, J. O. (2021). Response of dust emissions in southwestern North America to 21st century trends in climate, CO_2 fertilization, and land use: Implications for air quality. *Atmospheric Chemistry and Physics*, *21*(1), 57–68. https://doi.org/10.5194/acp-21-57-2021

* Liu, P., Kaplan, J. O., Mickley, L. J., Li, Y., Chellman, N. J., Arienzo, M. M., Kodros, J. K., Pierce, J. R., Sigl, M., Freitag, J., Mulvaney, R., Curran, M. A. J., & McConnell, J. R. (2021). Improved estimates of preindustrial biomass burning reduce the magnitude of aerosol climate forcing in the Southern Hemisphere. *Science Advances*, *7*(22), eabc1379. https://doi.org/10.1126/sciadv.abc1379

* Liu, T., Mickley, L. J., Gautam, R., Singh, M. K., DeFries, R. S., & Marlier, M. E. (2021). Detection of delay in post-monsoon agricultural burning across Punjab, India: Potential drivers and consequences for air quality. *Environmental Research Letters*, *16*(1), 014014. https://doi.org/10.1088/1748-9326/abcc28

* Liu, T., Mickley, L. J., & McCarty, J. L. (2021). Global search for temporal shifts in fire activity: Potential human influence on southwest Russia and north Australia fire seasons. *Environmental Research Letters*, *16*(4), 044023. https://doi.org/10.1088/1748-9326/abe328

Murray, L. T., Leibensperger, E. M., Orbe, C., Mickley, L. J., & Sulprizio, M. (2021). GCAP 2.0: A global 3-D chemical-transport model framework for past, present, and future climate scenarios. *Geoscientific Model Development*, *14*(9), 5789–5823. https://doi.org/10.5194/gmd-14-5789-2021

Vohra, K., Vodonos, A., Schwartz, J., Marais, E. A., Sulprizio, M. P., & Mickley, L. J. (2021). Global mortality from outdoor fine particle pollution generated by fossil fuel combustion: Results from GEOS-Chem. *Environmental Research*, *195*, 110754. https://doi.org/10.1016/j.envres.2021.110754

Zhou, X., Josey, K., Kamareddine, L., Caine, M. C., Liu, T., Mickley, L. J., Cooper, M., & Dominici, F. (2021). Excess of COVID-19 cases and deaths due to fine particulate matter exposure during the 2020 wildfires in the United States. *Science Advances*, *7*(33), eabi8789. https://doi.org/10.1126/sciadv.abi8789

Di, Q., Amini, H., Shi, L., Kloog, I., Silvern, R., Kelly, J., Sabath, M. B., Choirat, C., Koutrakis, P., Lyapustin, A., Wang, Y., Mickley, L. J., & Schwartz, J. (2020). Assessing NO_2 concentration and model uncertainty with high spatiotemporal resolution across the contiguous United States using ensemble model averaging. *Environmental Science & Technology*, *54*(3), 1372–1384. https://doi.org/10.1021/acs.est.9b03358

* Li, Y., Mickley, L. J., Liu, P., & Kaplan, J. O. (2020). Trends and spatial shifts in lightning fires and smoke concentrations in response to 21st century climate over the national

forests and parks of the western United States. *Atmospheric Chemistry and Physics*, *20*(14), 8827–8838. https://doi.org/10.5194/acp-20-8827-2020

* Liu, T., Mickley, L. J., Marlier, M. E., DeFries, R. S., Khan, M. F., Latif, M. T., & Karambelas, A. (2020). Diagnosing spatial biases and uncertainties in global fire emissions inventories: Indonesia as regional case study. *Remote Sensing of Environment*, *237*, 111557. https://doi.org/10.1016/j.rse.2019.111557

* Liu, T., Mickley, L. J., Singh, S., Jain, M., DeFries, R. S., & Marlier, M. E. (2020). Crop residue burning practices across north India inferred from household survey data: Bridging gaps in satellite observations. *Atmospheric Environment: X*, *8*, 100091. https://doi.org/10.1016/j.aeaoa.2020.100091

Marlier, M. E., Bonilla, E. X., & Mickley, L. J. (2020). How do Brazilian fires affect air pollution and public health? *GeoHealth*, *4*(12), e2020GH000331. https://doi.org/10.1029/2020GH000331

* Moch, J. M., Dovrou, E., Mickley, L. J., Keutsch, F. N., Liu, Z., Wang, Y., Dombek, T. L., Kuwata, M., Budisulistiorini, S. H., Yang, L., Decesari, S., Paglione, M., Alexander, B., Shao, J., Munger, J. W., & Jacob, D. J. (2020). Global importance of hydroxymethanesulfonate in ambient particulate matter: Implications for air quality. *Journal of Geophysical Research: Atmospheres*, *125*(18). https://doi.org/10.1029/2020JD032706

Requia, W. J., Di, Q., Silvern, R., Kelly, J. T., Koutrakis, P., Mickley, L. J., Sulprizio, M. P., Amini, H., Shi, L., & Schwartz, J. (2020). An ensemble learning approach for estimating high spatiotemporal resolution of ground-level ozone in the contiguous United States. *Environmental Science & Technology*, *54*(18), 11037–11047. https://doi.org/10.1021/acs.est.0c01791

Woo, S. H. L., Liu, J. C., Yue, X., Mickley, L. J., & Bell, M. L. (2020). Air pollution from wildfires and human health vulnerability in Alaskan communities under climate change. *Environmental Research Letters*, *15*(9), 094019. https://doi.org/10.1088/1748-9326/ab9270

Achakulwisut, P., Anenberg, S. C., Neumann, J. E., Penn, S. L., Weiss, N., Crimmins, A., Fann, N., Martinich, J., Roman, H., & Mickley, L. J. (2019). Effects of increasing aridity on ambient dust and public health in the U.S. Southwest under climate change. *GeoHealth*, *3*(5), 127–144. https://doi.org/10.1029/2019GH000187

Di, Q., Amini, H., Shi, L., Kloog, I., Silvern, R., Kelly, J., Sabath, M. B., Choirat, C., Koutrakis, P., Lyapustin, A., Wang, Y., Mickley, L. J., & Schwartz, J. (2019). An ensemble-based model of $PM_{2.5}$ concentration across the contiguous United States with high spatiotemporal resolution. *Environment International*, *130*, 104909. https://doi.org/10.1016/j.envint.2019.104909

Duffy, P. B., Field, C. B., Diffenbaugh, N. S., Doney, S. C., Dutton, Z., Goodman, S., Heinzerling, L., Hsiang, S., Lobell, D. B., Mickley, L. J., Myers, S., Natali, S. M., Parmesan, C., Tierney, S., & Williams, A. P. (2019). Strengthened scientific support for the Endangerment Finding for atmospheric greenhouse gases. *Science*, *363*(6427), eaat5982. https://doi.org/10.1126/science.aat5982

Henneman, L. R., Mickley, L. J., & Zigler, C. M. (2019). Air pollution accountability of energy transitions: The relative importance of point source emissions and wind fields in exposure changes. *Environmental Research Letters*, *14*(11), 115003. https://doi.org/10.1088/1748-9326/ab4861

Marais, E. A., Silvern, R. F., Vodonos, A., Dupin, E., Bockarie, A. S., Mickley, L. J., & Schwartz, J. (2019). Air quality and health impact of future fossil fuel use for electricity generation and transport in Africa. *Environmental Science & Technology*, *53*(22), 13524–13534. https://doi.org/10.1021/acs.est.9b04958

Marlier, M. E., Liu, T., Yu, K., Buonocore, J. J., Koplitz, S. N., DeFries, R. S., Mickley, L. J., Jacob, D. J., Schwartz, J., Wardhana, B. S., & Myers, S. S. (2019). Fires, smoke exposure, and public health: An integrative framework to maximize health benefits from peatland restoration. *GeoHealth*, *3*(7), 178–189. https://doi.org/10.1029/2019GH000191

Pendergrass, D. C., Shen, L., Jacob, D. J., & Mickley, L. J. (2019). Predicting the impact of climate change on severe wintertime particulate pollution events in Beijing using extreme value theory. *Geophysical Research Letters*, *46*(3), 1824–1830. https://doi.org/10.1029/2018GL080102

Silvern, R. F., Jacob, D. J., Mickley, L. J., Sulprizio, M. P., Travis, K. R., Marais, E. A., Cohen, R. C., Laughner, J. L., Choi, S., Joiner, J., & Lamsal, L. N. (2019). Using satellite observations of tropospheric NO_2 columns to infer long-term trends in US NO_x emissions: The importance of accounting for the free tropospheric NO_2 background. *Atmospheric Chemistry and Physics*, *19*(13), 8863–8878. https://doi.org/10.5194/acp-19-8863-2019

* Achakulwisut, P., Mickley, L. J., & Anenberg, S. C. (2018). Drought-sensitivity of fine dust in the US Southwest: Implications for air quality and public health under future climate change. *Environmental Research Letters*, *13*(5), 054025. https://doi.org/10.1088/1748-9326/aabf20

* Cusworth, D. H., Mickley, L. J., Sulprizio, M. P., Liu, T., Marlier, M. E., DeFries, R. S., Guttikunda, S. K., & Gupta, P. (2018). Quantifying the influence of agricultural fires in northwest India on urban air pollution in Delhi, India. *Environmental Research Letters*, *13*(4), 044018. https://doi.org/10.1088/1748-9326/aab303

* Koplitz, S. N., Mickley, L. J., Jacob, D. J., Marlier, M. E., DeFries, R. S., Gaveau, D. L. A., Locatelli, B., Reid, J. S., Xian, P., & Myers, S. S. (2018). Role of the Madden-Julian Oscillation in the transport of smoke From Sumatra to the Malay Peninsula during severe non-El Niño haze events. *Journal of Geophysical Research: Atmospheres*, *123*(11), 6282–6294. https://doi.org/10.1029/2018JD028533

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* Achakulwisut, P., Shen, L., & Mickley, L. J. (2017). What controls springtime fine dust variability in the western United States? Investigating the 2002–2015 increase in fine dust in the U.S. Southwest. *Journal of Geophysical Research: Atmospheres*, *122*(22). https://doi.org/10.1002/2017JD027208

* Breider, T. J., Mickley, L. J., Jacob, D. J., Ge, C., Wang, J., Payer Sulprizio, M., Croft, B., Ridley, D. A., McConnell, J. R., Sharma, S., Husain, L., Dutkiewicz, V. A., Eleftheriadis, K., Skov, H., & Hopke, P. K. (2017). Multidecadal trends in aerosol radiative forcing over the Arctic: Contribution of changes in anthropogenic aerosol to Arctic warming since 1980. *Journal of Geophysical Research: Atmospheres*, *122*(6), 3573–3594. https://doi.org/10.1002/2016JD025321

* Cusworth, D. H., Mickley, L. J., Leibensperger, E. M., & Iacono, M. J. (2017). Aerosol trends as a potential driver of regional climate in the central United States: Evidence from observations. *Atmospheric Chemistry and Physics*, *17*(22), 13559–13572. https://doi.org/10.5194/acp-17-13559-2017

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