MAKOTO M. KELP

Y2E2 Building Room 333, Stanford University, Stanford, CA 94305
mkelp@stanford.edu ⋄ https://makotokelp.com

EDUCATION

Harvard University 2018 – 2023
Ph.D., Earth and Planetary Sciences
S.M., Environmental Science and Engineering

Reed College 2012 – 2016
B.A., Chemistry

RESEARCH INTERESTS

My research centers on applying data-driven methods, including machine learning and compressed sensing, to uncover new perspectives in atmospheric chemistry and land-climate-human interactions. I place a special emphasis on exploring the interplay among fires, climate, and society.

PROFESSIONAL EXPERIENCE

NOAA Climate and Global Change Postdoctoral Fellow, Stanford University Sep 2023 – Present
Host: Noah Diffenbaugh
Graduate Research Assistant, Harvard University 2018 – 2023
Advisors: Daniel Jacob and Loretta Mickley
Junior Research Scientist, University of Washington 2016 – 2018
Advisor: Julian Marshall
Undergraduate Research Assistant, Colorado State University 2015
Advisor: Emily Fischer
Undergraduate Research Assistant, Reed College 2014 – 2016
Advisor: Juliane Fry

AWARDS AND FELLOWSHIPS

NOAA Climate and Global Change Postdoctoral Fellowship 2023 – 2025
Atmospheric Chemistry Colloquium for Emerging Senior Scientists (ACCESS XVII) 2023
Harvard Bok Center Certificate of Distinction in Teaching 2019, 2022
AGU Outstanding Student Presentation Award 2019
National Science Foundation STEM Scholar 2013 – 2016

PUBLICATIONS (*SUBMITTED, †UNDERGRADUATE ADVISEE)

h-index: 9 (Google Scholar)

*18. Kawano, A., **M. Kelp**, M. Qiu, K. Singh, E. Chaturvedi, I. Azevedo, and M. Burke. Improved daily PM2.5 estimates in India reveal inequalities in recent enhancement of air quality. (Submitted to *PNAS*)

*17. Qiu, M., J. Li, C.F. Gould, R. Jing, **M. Kelp**, M.L. Childs, J. Wen, Y. Xie, M. Lin, M.V. Kiang, S. Heft-Neal, N.S. Diffenbaugh, M. Burke. Wildfire smoke exposure and mortality burden in the US under future climate change. (Submitted to *Science*)

*16. Lin, H., L.K. Emmons, E.W. Lundgren, L.H. Yang, X. Feng, R. Dang, S. Zhai, Y. Tang, **M. Kelp**, N.K. Colombi, S.D. Eastham, T.M. Fritz, A.M. Fiore, and D.J. Jacob. Intercomparison of GEOS-Chem and CAM-chem tropospheric oxidant chemistry within the Community Earth System Model version 2 (CESM2). (Submitted to *Atmospheric Chemistry and Physics*)

*15. Liu, T., F.M. Panday†, M.C. Caine†, **M. Kelp**, D.C. Pendergrass, and L.J. Mickley. 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. (Submitted to *International Journal of Wildland Fire*)

14. **Kelp, M.**, C. A. Keller, K. Wargan, B.M. Karpowicz, and D. J. Jacob (2023c). Tropospheric ozone data assimilation in the NASA GEOS Composition Forecast modeling system (GEOS-CF v2.0) using satellite data for ozone vertical profiles (MLS), total ozone columns (OMI), and thermal infrared radiances (AIRS, IASI). *Environ. Res. Lett.*, 18, 094036, DOI: 10.1088/1748-9326/acf0b7.

13. **Kelp, M.**, T. C. Fargiano†, S. Lin†, T. Liu, J.R. Turner, J. N. Kutz, and L.J. Mickley (2023b). Data-driven placement of $PM_{2.5}$ air quality sensors in the United States: an approach to target urban environmental injustice, *GeoHealth*, 7, e2023GH000834, DOI: 10.1029/2023GH000834.
Special Collection on "Geospatial data applications for environmental justice"

12. Balasus, N., D. J. Jacob, A. Lorente, J. D. Maasakkers, R. J. Parker, H. Boesch, Z. Chen, **M. Kelp**, H. Nesser, and D. J. Varon (2023). A blended TROPOMI+GOSAT satellite data product for atmospheric methane using machine learning to correct retrieval biases. *Atmos. Meas. Tech.*, 16, 3787–3807, DOI: 10.5194/amt-16-3787-2023.

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

10. **Kelp, M.**, D.J. Jacob, H. Lin, and M.P. Sulprizio (2022b). An online-learned neural network chemical solver for stable long-term global simulations of atmospheric chemistry. *JAMES*, 14, e2021MS002926, DOI: 10.1029/2021MS002926.
Selected as Highlight Paper
Special Collection on "Machine learning application to Earth system modeling"

9. Yang, L. H., D.H. Hagan, J.C. Rivera-Rios, **M. Kelp**, E.S. Cross, C.Y. Peng, J. Kaiser, L.R. Williams, P. L. Croteau, J.T. Jayne, and N.L. Ng (2022). Investigating the sources of urban air pollution using low-cost air quality sensors at an urban Atlanta site. *Environ. Sci. Technol.*, 56, 11, 7063–7073, DOI: 10.1021/acs.est.1c07005.
Special Issue on "Urban Air Pollution and Human Health"

8. **Kelp, M.**, S. Lin†, J.N. Kutz, and L.J. Mickley (2022a). A new approach for optimal placement of $PM_{2.5}$ air quality sensors: case study for the contiguous United States. *Environ. Res. Lett.*, 17, 034034, DOI: 10.1088/1748-9326/ac548f.

7. **Kelp, M.**, D.J. Jacob, J.N. Kutz, J.D. Marshall, and C.Tessum (2020b). Toward stable, general machine-learned models of the atmospheric chemical system. *JGR: Atmospheres*, 125, e2020JD032759, DOI: 10.1029/2020JD032759.

6. **Kelp, M.**, T. Gould, E. Austin, J.D. Marshall, M. Yost, C. Simpson, and T. Larson (2020a). Sensitivity analysis of area-wide, mobile source emission factors to high-emitter vehicles in Los Angeles. *Atmospheric Environment*, 223, 117212, DOI: 10.1016/j.atmosenv.2019.117212.

5. Wen, Y., H. Wang, T. Larson, **M. Kelp**, S. Zhang, Y. Wu, and J.D. Marshall (2019). On-highway vehicle emission factors, and spatial patterns, based on mobile monitoring and absolute principal component score. *Science of The Total Environment*, 676, 242-251, DOI: 10.1016/j.scitotenv.2019.04.185.

4. **Kelp, M.**, C. Tessum, and J.D. Marshall (2018b). Orders-of-magnitude speedup in atmospheric chemistry modeling through neural network-based emulation. *arXiv*:1808.03874.

3. **Kelp, M.**, A.P. Grieshop, C.O. Reynolds, J. Baumgartner, G. Jain, K. Sethuramanand, and J.D. Marshall (2018a). Real-time indoor measurement of health and climate-relevant air pollution concentrations during a carbon-finance-approved cookstove intervention in rural India. *Development Engineering*, 3, 125-132, DOI: 10.1016/j.deveng.2018.05.001.

2. Brewer, J. F., M. Bishop, **M. Kelp**, C. Keller, A.R. Ravishankara, and E.V. Fischer (2017). A sensitivity analysis of key factors in the modeled global acetone budget. *J. Geophys. Res.*, 122, DOI: 10.1002/2016JD025935.

1. Jaffe, D., J. Putz, G. Hof, G. Hof, J. Hee, D.A. Lommers-Johnson, F. Gabela, J. Fry, B. Ayres, **M. Kelp**, and M. Minsk (2015). Diesel particulate matter and coal dust from trains in the Columbia River Gorge, Washington state, USA. *Atmospheric Pollution Research*, 6, 946-952, DOI: 10.1016/j.apr.2015.04.004.

IN-PREPARATION (†UNDERGRADUATE ADVISEE)

- Chung, K.†, Liu, T., **M. Kelp**, and L.J. Mickley. SMRT-FIRE: Smoke Management Risk Tool for wildland fires
- **Kelp, M.**, C. Chiu†, and L.J. Mickley. Uncovering latent VOC emissions and spatiotemporal drivers of urban ozone in changing NO_x regimes: A data-driven case study of Los Angeles and Chicago

INVITED TALKS AND SEMINARS

2024 University of Washington – Atmospheric Science and Computer Science
2024 University of Utah – Atmospheric Science
2024 AI for the Study of Environmental Risk (AI4ER) seminar, University of Cambridge
2023 Southwest Fire Science Consortium and Fire Adapted New Mexico Learning Network
2023 PSEG Institute for Sustainability Studies with The Trust for Public Land, Montclair State University
2023 Atmospheric Chemistry Colloquium for Emerging Senior Scientists (ACCESS) XVII, Brookhaven National Lab
2023 NASA GISS
2023 Columbia University
2023 Science in the News, Harvard University
2023 AGU/AMS GeoHealth Showcase
2023 MIT Atmospheric Chemistry Colloquium
2023 Stanford University
2022 Royal Meteorological Society Atmospheric Chemistry Special Interest Conference
2022 Pennsylvania Department of Environmental Protection Air Monitoring Committee Workshop
2022 Karlsruhe Institute of Technology
2022 University of Washington
2022 University of Illinois at Urbana-Champaign Advanced Environmental Engineering Seminar
2022 EPA Model Applications Team Meeting

SELECTED CONFERENCE PRESENTATIONS (*INVITED)

*2024 Health Effects Institute Annual Conference, Philadelphia, PA (Talk)
2023 AGU Fall Meeting, San Francisco, CA (Talk)
*2023 Meteorology and Climate - Modeling for Air Quality, Session: "Breakthrough Innovations in Atmospheric & Air Quality Modeling", UC Davis (Talk)
2023 AMS Annual Meeting, Denver, CO (Talk)
2022 AGU Fall Meeting, Chicago, IL (Talk)
*2022 Atmospheric Chemical Mechanisms, Session: "Mechanism Development and Reduction", UC Davis (Talk)
2022 AMS Annual Meeting, Virtual (Talk)
2022 10th International GEOS-Chem Meeting, Washington University in St. Louis (Talk)
*2022 ECMWF Machine Learning Workshop (Talk)
2021 AMS Annual Meeting, Virtual (Talk)
*2020 AGU Fall Meeting, Virtual (Talk)
2020 Atmospheric Chemical Mechanisms Conference, Virtual (Talk)
2019 AGU Fall Meeting, San Francisco, CA (Poster)
2018 AGU Fall Meeting, Washington D.C. (Poster)

TEACHING EXPERIENCE

Harvard University Department of Earth and Planetary Sciences
EPS 200: Graduate-level Atmospheric Chemistry and Physics

Teaching Fellow — **Fall 2019, Fall 2020, Fall 2022**

Guest Lecturer — **Fall 2022**

Derek Bok Center for Education & Learning

Teaching Certificate — **2023**

Reed College Department of Chemistry
Chem 101: Molecular Structure and Properties
Chem 102: Chemical Reactivity
Chem 230: Environmental Chemistry

Laboratory Teaching Assistant — **2015-2016**

Tutor, Grader — **2013-2016**

RESEARCH ADVISING

Undergraduates:

- Lyna Kim (Spring 2024 –present, Stanford University): *"Physically interpretable machine learning for climate and weather forecasting"*
- Christian Chiu (Summer 2023 – Fall 2023, Harvard University): *"Uncovering latent VOC emissions and spatiotemporal drivers of urban ozone in changing NO_x regimes"*
- Karina Chung (Summer 2023 – Fall 2023, Harvard University): *"Google Earth Engine applications for wildfire smoke risk in the Western United States"*
- Greta Schultz (Summer 2023, University of Wisconsin-Madison): *"Emergency mobile monitoring for California wildfire smoke"*
- Timothy Fargiano (Summer 2022 – Fall 2022, Harvard University): *"Optimal placement of $PM_{2.5}$ air quality sensors in the US: An approach to target environmental injustice"*
- Margaret Schultz (January 2022 – December 2022, Harvard University): *"Real-time high-resolution downscaling of fine particulate matter ($PM_{2.5}$) air quality in the United States using machine learning"*, year-long environmental engineering senior thesis (senior project spotlight)
- Sanjna Kedia (Summer 2022, Harvard University): *"Machine learning for automated detection of wildfire smoke in the US"*
- Samuel Lin (Summer 2021- Fall 2021, Harvard University): *"Optimal air quality sensor placement in the United States"*
- Marie Panday (Summer 2021, University of Maryland): *"Trends in and Reconstruction of Smoke Days across the United States"*
- Kent Toshima (Summer 2020 - Summer 2021, Harvard University): *"Application of deep learning to detection of wildfire smoke in HMS over North America"*
- Miah Caine (Summer 2020 - Spring 2021, Harvard University): *"Agreement between the HMS Product and Ground-Level Smoke in the Pacific Northwest"*

SYNERGISTIC ACTIVITIES

Session Convener at AGU Fall Meeting:

"Prescribed Fires and Land Management in North America", primary convener *(Dec 2023)*

"Data-Driven Methods for Quantifying Atmospheric Composition: Advances in Computation and Statistical Learning", co-chair *(Dec 2023)*

Co-Chair for Tropospheric Ozone Assessment Report, Phase II (TOAR-II) Machine Learning for Tropospheric Ozone (ML4O3) Working Group *(March 2023 – Present)*

Co-Chair for Atmospheric Chemistry Gordon Research Seminar (GRS) *(Summer 2025)*

DEI Liaison on behalf of postdocs in the Stanford Earth System Science Department *(Oct 2023 – Present)*

Technical Program Committee for Atmospheric Chemical Mechanisms conference *(Dec 4-6, 2024)*

OSPA Judge at AGU Fall Meeting (Dec 2023)

Proposal reviewer for *NASA Earth Science ROSES Program (2022), NSF (2023, 2024), Spark Climate Solutions (2024)*

Co-leader of Statistical Learning in Atmospheric Chemistry (SLAC) group, seminar series (2022 – Present)

Co-leader of Machine Learning & Data Science Subgroup, Harvard Atmospheric Chemistry Modeling Group (2021 – 2023)

Peer reviewer for *Atmospheric Chemistry and Physics, Environmental Research Letters, JAMES, GeoHealth, Environmental Science & Technology, Earth's Future, ACS Earth and Space Chemistry, ES&T Air, Geoscientific Model Development, Communications Earth & Environment, Environmental Research Communications, Atmospheric Pollution Research*

Organizer EPS Department G2 Quals Buddy Committee (2020-2021)

Organizer EPS Department Visiting Scholar Lecture Series Committee (2018 – 2019)

Press:

- Online machine learning in GEOS-Chem: Editor's Highlight in JAMES
- Prescribed fires: Press release, Harvard Gazette, KCRA Sacramento, CBS Newspath, Missoulian