Makoto M. Kelp

CONTACT INFORMATION

Pierce Hall G3G
Harvard University
Cambridge, Massachusetts, 02138

E-mail: mkelp@g.harvard.edu
Website: https://scholar.harvard.edu/mkelp

EDUCATION

Harvard University, Cambridge, MA **Sep 2018-May 2023 (expected)**

Ph.D. Candidate, Atmospheric Chemistry

- Thesis: Expanding the capabilities of atmospheric chemistry models using machine learning
  Advisor: Daniel J. Jacob

Reed College, Portland, OR **Sep 2012-May 2016**

B.A., Chemistry

- Thesis: Tropospheric Particle Formation in Forests: Global Modeling of Secondary Organic Aerosol Production from Reaction of NO_3 Radical with Speciated Monoterpenes
  Advisor: Juliane L. Fry

RESEARCH INTERESTS

My research blends the domains of atmospheric chemistry, air quality engineering, and machine learning/data science to lift barriers in atmospheric chemistry modeling and to uncover disparities in air pollution monitoring

RESEARCH EXPERIENCE

Graduate Research Assistant with Professor Daniel J. Jacob **Sep 2018-Present**
Harvard University Department of Earth and Planetary Sciences

- Characterizing chemical data assimilation product for NASA's GEOS-CF model
- Developed a machine learning chemical solver for GEOS-Chem chemical transport model
- With Loretta J. Mickley: Created a framework to identify the optimal placement of air pollution sensors
- Machine learning and data science subgroup co-leader within the Atmos. Chem. Modeling Group

Research Associate with Professor Julian D. Marshall **June 2016-Aug 2018**
University of Washington Department of Civil and Environmental Engineering

- Developed a machine-learning surrogate neural network to emulate the Carbon Bond Mechanism Z gas-phase chemical mechanism
- Analyzed household air pollution from field studies conducted in Koppal, India
- With Timothy V. Larson: analysis of area-wide, mobile source emission factors using absolute principal component scores on mobile campaign in Los Angeles

Undergraduate Senior Research Thesis with Professor Juliane L. Fry **Sep 2015-May 2016**
Reed College Department of Chemistry

- Employed GEOS-Chem to implement a new, speciated NO_3-Terpene VBS scheme to investigate the regional and global distribution of secondary organic aerosols; collaborated with Dr. Havala O.T. Pye (EPA) and Professor Emily V. Fischer (CSU)

Undergraduate Research Assistant with Professor Emily V. Fischer **Summer 2015**
Colorado State University Department of Atmospheric Science

- Evaluated importance of monoterpene-derived acetone production to the global acetone budget by employing GEOS-Chem

Undergraduate Research Assistant with Professor Juliane L. Fry **Summer 2014-May 2015**
Reed College Department of Chemistry

- Analyzed effects of black carbon from coal trains in the Columbia River Gorge ; collaborated on field campaign with Professor Dan A. Jaffe (University of Washington)
- Modeled local climate effects of black carbon, $PM_{2.5}$, and other pollutants in SE Portland and their effects on human health using the EPA Environmental Benefits Mapping and Analysis Program (BenMAP)
- Maintained Reed College and Brooklyn Rail Yard monitoring sites; modeled ambient air pollution in SE Portland with data from field sites in conjunction with Oregon DEQ

TEACHING EXPERIENCE

Harvard University Department of Earth and Planetary Sciences

Teaching Fellow **Fall 2019, Fall 2020**

- EPS 200: Graduate-level Atmospheric Chemistry and Physics

Reed College Department of Chemistry

Laboratory Teaching Assistant **2015-2016**

- Chem 101: Molecular Structure and Properties
- Chem 102: Chemical Reactivity

Tutor, Grader **2013-2016**

- Chem 101: Molecular Structure and Properties
- Chem 102: Chemical Reactivity
- Chem 230: Environmental Chemistry

PUBLICATIONS

h-index: 7, total citations: 94 (as of Dec 2021, Google Scholar); as first author (4), as co-author (3)

[6] **Kelp, M.**, Jacob, D.J., Kutz, J. N., Marshall, J.D., Tessum, C., 2020, "Toward stable, general machine-learned models of the atmospheric chemical system", *JGR: Atmospheres*, 125, e2020JD032759, doi: 10.1029/2020JD032759

[5] **Kelp, M.**, Gould, T., Austin, E., Marshall, J.D., Yost, M., Simpson, C., Larson, T., 2020, "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

[4] Wen, Y., Wang, H., Larson, T., **Kelp, M.**, Zhang, S., Wu, Y., Marshall, J.D., 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

[3] **Kelp, M.**, Grieshop, A.P., Reynolds, C.O., Baumgartner, J., Jain, G., Sethuramanand, K., Marshall, J.D., 2018, "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., Bishop, M., **Kelp, M.**, Keller, C., Ravishankara, A.R., Fischer, E.V., 2017, "A sensitivity analysis of key factors in the modeled global acetone budget", *J. Geophys. Res.*, 122, doi:10.1002/2016JD025935

[1] Jaffe, D., Putz, J., Hof, G., Hof, G., Hee, J., Lommers-Johnson, D. A., Gabela, F., Fry, J., Ayres, B., **Kelp, M.**, Minsk, M., 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

PREPRINTS

[1] **Kelp, M.**, Tessum, C., Marshall, J.D., 2018, "Orders-of-magnitude speedup in atmospheric chemistry modeling through neural network-based emulation", arXiv:1808.03874

PUBLICATIONS IN-PREP, IN-REVIEW

- **Kelp, M.**, Jacob, D.J., Lin, H., Sulprizio, M.P. "An online-learned neural network chemical solver for stable long-term global simulations of atmospheric chemistry", *submitted to JAMES*
- **Kelp, M.**, Lin, S.**, Kutz, J.N., Mickley, L.J. "A new approach for optimal placement of PM2.5 air quality sensors: case study for the contiguous United States", *submitted to Env. Res. Letters*
  **undergraduate advisee
- Yang, L. H., Hagan, D. H., Rivera-Rios, J. C., **Kelp, M.**, Cross, E. S., Peng C. Y., Kaiser, J., Williams, L. R., Croteau, P. L., Jayne, J. T., Ng., N. L. "Understanding the Sources of Urban Air Pollution Using Low-Cost Air Quality Sensors", *in review at ES&T*

INVITED TALKS

[1] **M. Kelp**, J. N. Kutz, J.D. Marshall, C.W. Tessum. Toward stable, general machine-learned models of the atmospheric chemical system, *AGU Virtual Fall Meeting*, December 7, 2020

CONFERENCE PRESENTATIONS

[9] **M. Kelp**, D.J. Jacob, H. Lin. An Online-Learned Neural Network Chemical Solver for Stable and Long-Term Global Simulations of Atmospheric Chemistry in S2S Applications, *AMS Annual Meeting*, January 26, 2022 *Talk upcoming*

[8] **M. Kelp**, D.J. Jacob. A recursive neural network chemical solver for fast long-term global simulations of atmospheric composition, *AMS Annual Meeting*, Virtual, January 13, 2021 *Talk*

[7]**M. Kelp**, D.J. Jacob. A recursive neural network chemical solver for fast long-term global simulations of atmospheric composition, *Atmospheric Chemical Mechanisms Conference*, Virtual, November 18, 2020 *Lightning talk*

[6] **M. Kelp**, J. N. Kutz, J.D. Marshall, C.W. Tessum. Deep Learning Emulation and Compression of an Atmospheric Chemical System using a Chained Training Regime, *AGU Fall Meeting*, San Francisco, CA, December 13, 2019

[5] **M. Kelp**, C.W. Tessum, J.D. Marshall. Orders-of-Magnitude Speedup in Atmospheric Chemistry Modeling through Neural Network-Based Emulation, *AGU Fall Meeting*, Washington D.C, December 12, 2018

[4] **M. Kelp**, A.P. Grieshop, C.O. Reynolds, J. Baumgartner, G. Jain, K. Sethuramanand, J.D. Marshall. Investigating Health-Relevant Air Pollution Concentration Linkages Across Multiple Seasons During Indoor Cookstove Campaign in Rural India, *ISES-ISEE Joint Annual Meeting*, Ottawa, CA, August 25, 2018

[3] T.W. Aung, A.P. Grieshop, **M. Kelp**, J.D. Marshall. Emission and Concentration Linkages from a Cookstove Intervention Trial in India, *International Society of Exposure Science (ISES) Annual Meeting*, Research Triangle Park, NC, October 15-19, 2017

[2] **M. Kelp**, H.O.T. Pye, E.V. Fischer, J. Brewer, and J. Fry. Global Modeling of Secondary Organic Aerosol Production from Reaction of NO_3 Radical with Speciated Monoterpenes, *AAAR Annual Conference*, Portland, OR, October 18, 2016

[1] **M. Kelp**, J. Brewer, C. Keller, and E.V. Fischer. Evaluating the Potential Importance of Monoterpene Degradation for Global Acetone Production, *AGU Fall Meeting*, San Francisco, CA, December 16, 2015

WORKSHOPS

Deep Learning for Science School, Lawrence Berkeley National Laboratory, CA **July 2019**

MENTORING

Samuel Lin, Harvard University, Summer 2021-Fall 2021
- Project: Optimal air quality sensor placement in the United States
- HUCE Summer Undergraduate Research Program (co-mentor with Dr. Loretta Mickley)

Marie Panday, University of Maryland, Summer 2021
- Project: Trends in and Reconstruction of Smoke Days across the United States
- OEB REU (co-mentor with Tina Liu, Drew Pendergrass, and Dr. Loretta Mickley)

Kent Toshima, Harvard University, Summer 2020 - Summer 2021
- Project: Application of Deep Learning to Detection of Wildfire Smoke in HMS over North America
- HUCE Summer Undergraduate Research Program (co-mentor with Tina Liu, Drew Pendergrass, and Dr. Loretta Mickley)

Miah Caine, Harvard University, Summer 2020 - Spring 2021
- Project: Agreement between the HMS Product and Ground-Level Smoke in the Pacific Northwest
- HUCE Summer Undergraduate Research Program (co-mentor with Tina Liu, Drew Pendergrass, and Dr. Loretta Mickley)

HONORS AND AWARDS

Bok Center Certificate of Distinction in Teaching Fall 2019, Harvard University	**April 2020**
AGU Outstanding Student Presentation Award	**January 2020**
Deep Learning for Science School Travel Grant	**July 2019**
National Science Foundation STEM Scholar, Reed College	**2013-2016**
Commendation for Academic Excellence, Reed College	**2012-2013, 2015-2016**
F. W. Erickson Scholarship, Reed College	**2014-2016**
Department of Chemistry Summer Research Grant, Reed College	**Summer 2014**
Ann W. Shepard Memorial Scholarship, Reed College	**2013-2014**
National Advanced Placement Scholar Award	**2012**

LEADERSHIP AND OUTREACH

Machine learning and data science subgroup co-leader in ACMG	**2021-**
Harvard EPS Department G2 Quals Buddy Committee	**2020-2021**
Harvard EPS Department Visiting Scholar Lecture Series Committee	**2018-2019**
Science-A-Thon Participant	**October 2018, 2019**
Oregon Museum of Science and Industry (OMSI) Chemistry Lab Teacher	**2012-2013**

COMMUNITY ENGAGEMENT

Harvard University Monday Jazz Band	**2019-Present**
Dudley Graduate Student Jazz Band	**2018-2019**
NPR Philosophy Talk Guest Jazz Musician	**Aired Nov 29 2015**
Reed College Jazz Ensemble and Conference Musician	**2012-2016**
Jazz Band and Music Department Assistant	**2015-2016**

PROFESSIONAL SERVICE AND AFFILIATIONS

- **Peer revewier** for *Atmos. Chem. and Phys.*, *Env. Res. Comm.*, *Atmospheric Pollution Research*, *Geoscientific Model Development*, *Env. Res. Letters*
- **Memberships:** AGU, AAAR, AMS
- Air Quality Sample Assistant (Fall 2015) at Oregon DEQ: installed and collected BGI filters and maintained an EPA validated method sampling site and helped create statewide attention towards arsenic and cadmium concentrations in SE Portland, which resulted in the Bullseye Glass Co. suspending its use of chromium

TECHNOLOGY SKILLS

Languages: Fortran 90, IDL, R, Go, Python, Matlab, Unix environments
Software: GEOS-Chem, TensorFlow, LaTeX, RStudio
Operating Systems: Linux, Mac OS X