Makoto M. Kelp

CONTACT INFORMATION

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EDUCATION

Harvard University, Cambridge, MA **May 2023 (expected)**

Ph.D. Candidate, Atmospheric Chemistry
S.M., Environmental Science and Engineerging **March 2022**

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

Reed College, Portland, OR **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 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 address disparities in air pollution monitoring.

RESEARCH EXPERIENCE

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

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

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

- Developed a machine-learning neural network solver to emulate the CBM-Z chemical mechanism
- Analyzed household air pollution from field studies conducted in Koppal, India
- With Professor Timothy Larson: analysis of area-wide, vehicle emission factors on mobile campaign in Los Angeles

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

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

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

- Evaluated importance of monoterpene-derived acetone production in GEOS-Chem

Undergraduate Research Assistant with Professor Juliane 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 Jaffe (University of Washington)
- 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

PUBLICATIONS

h-index: 7, total citations: 106 (as of March 2022, Google Scholar); as first author (5), as co-author (4)

[8] 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, N.L. Ng. Investigating the sources of urban air pollution using low-cost air quality sensors at an urban Atlanta site. *accepted at ES&T*

[7] **Kelp, M.**, S. Lin**, J.N. Kutz, and L.J. Mickley (2022). A new approach for optimal placement of $PM_{2.5}$ air quality sensors: case study for the contiguous United States. *Env. Res. Letters*, 17, 034034 doi: 10.1088/1748-9326/ac548f **undergraduate advisee

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

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

[3] **Kelp, M.**, A.P. Grieshop, C.O. Reynolds, J. Baumgartner, G. Jain, K. Sethuramanand, and J.D. Marshall (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., 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

OTHER PUBLICATIONS

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

[1] **Kelp, M.**, 2016, "Tropospheric particle formation in forests: global modeling of secondary organic aerosol production from reaction of NO_3 radical with speciated monoterpenes", Reed College

PUBLICATIONS IN-PREP, IN-REVIEW

- **Kelp, M.**, D.J. Jacob, H. Lin, and M.P. Sulprizio. An online-learned neural network chemical solver for stable long-term global simulations of atmospheric chemistry. *in review at JAMES*

INVITED TALKS

[3] **M. Kelp**, D.J. Jacob, H. Lin., and M.P. Sulprizio. An online-learned neural network chemical solver for stable long-term global simulations of atmospheric chemistry. *ECMWF Machine Learning Workshop*, Virtual, March 29, 2022

[2] **M. Kelp**, S. Lin, J.N. Kutz, and L.J. Mickley. A new approach for determining optimal placement of $PM_{2.5}$ air quality sensors,

- *University of Illinois at Urbana-Champaign Advanced Environmental Engineering Seminar*, Virtual, February 11, 2022
- *EPA Model Applications Team Meeting*, Virtual, January 12, 2022

[1] **M. Kelp**, J. N. Kutz, J.D. Marshall, and 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, and 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*

[8] **M. Kelp** and 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** and 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, and C.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, and 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, and 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**, and 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

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

MENTORING

Margaret Schultz, Harvard University, January 2022 - present
- Project: Real-time high-resolution downscaling of fine particulate matter ($PM_{2.5}$) air quality in the United States using machine learning
- Harvard ESE senior research thesis (co-mentor with Drew Pendergrass and Dr. Loretta Mickley)

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**

PROFESSIONAL SERVICE AND AFFILIATIONS

- **Peer revewier** for *Atmos. Chem. and Phys., Env. Res. Comm., Atmospheric Pollution Research, Geoscientific Model Development, Env. Res. Letters, JAMES, GeoHealth*
- **Memberships:** American Geophysical Union, American Association for Aerosol Research, American Meteorological Society
- 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

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**

TECHNICAL SKILLS

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