Makoto M. Kelp

CONTACT INFORMATION	Pierce Hall G3G Harvard University Cambridge, Massachusetts, 02138	*E-mail:* mkelp@g.harvard.edu *Website:* scholar.harvard.edu/mkelp

EDUCATION

Harvard University, Cambridge, MA   **Sep 2018-Present**

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

Atmospheric chemistry modeling; machine learning; chemical data assimilation; remote sensing; statistical modeling; data analysis and dimensionality reduction methods; physical chemistry; air pollution; climate change; secondary organic aerosols; field measurements; science communication

RESEARCH EXPERIENCE

Graduate Research Assistant with Professor Daniel J. Jacob   **Sep 2018-Present**
Harvard University Department of Earth and Planetary Sciences
- Developing a machine learning framework to emulate the coupled, nonlinear differential equations found in atmospheric chemistry mechanisms for purposes of computational speedup, implementation into Earth System Models, and implications for forecasting and chemical data assimilation

Research Associate with Professor Julian D. Marshall   **June 2016-Aug 2018**
University of Washington Department of Civil and Environmental Engineering
- Developed a machine-learning residual multi-target regression neural network to emulate Carbon Bond Mechanism Z (CBM-Z) gas-phase chemical mechanism
- Modeled and analyzed household air pollution from field studies conducted in Koppal, India
- With Timothy V. Larson: analysis of area-wide, fuel-based, mobile source emission factors using absolute principal component scores on mobile campaigns in Los Angeles

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

PEER-REVIEWED PUBLICATIONS

[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

arXiv PREPRINTS

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

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

[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, upcoming*

[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

Kent Toshima, Harvard University, Summer 2020 - present
- 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 - present
- 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

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 *Atmospheric Chemistry and Physics, Env. Research Communications*
- **Memberships:** American Geophysical Union, American Association for Aerosol Research
- 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, Unix environments
Software: GEOS-Chem, TensorFlow, LaTeX, RStudio, Igor Pro
Operating Systems: Linux, Mac OS X