

Christopher D. Holmes

Curriculum Vitae

Assistant Professor	E-mail:	cdholmes@fsu.edu
Dept. of Earth, Ocean and Atmospheric Science	Phone:	+1-850-645-0972
Florida State University	Fax:	+1-850-644-9642
Tallahassee, FL 32306	Web:	myweb.fsu.edu/cdholmes

Education

Harvard University	Earth and Planetary Science	Ph.D. 2010
Harvard University	Applied Physics	S.M. 2008
Cambridge University	History and Philosophy of Science	M.Phil. 2004
Williams College	Astrophysics, <i>magna cum laude</i>	B.A. 2003

Professional Experience

Florida State University, Department of Earth, Ocean and Atmospheric Science	2014–present
Assistant professor	
University of California, Irvine, Department of Earth System Science	2010 – 2014
Postdoctoral researcher with Michael J. Prather	
Harvard University, Department of Earth and Planetary Science	2004 – 2010
Graduate research assistant with Daniel J. Jacob	
Williams College, Department of Physics	2002 – 2003
Undergraduate research assistant with Protik K. Majumder	
University of Colorado, Cooperative Institute for Research in Environmental Sciences	2001
Undergraduate research assistant with Susan K. Avery	
Colgate University, Department of Physics	1999, 2000
Undergraduate research assistant with Enrique J. Galvez	

Honors and awards

Dissertations Initiative for the Advancement of Climate Change Research (DISCCRS)	2012
Atmospheric Chemistry Colloquium for Emerging Senior Scientists (ACCESS)	2011
US Environmental Protection Agency (EPA) STAR Graduate Research Fellowship	2006 – 2009
Cambridge Overseas Trust Scholarship, University of Cambridge	2003 – 2004
Sigma Xi Associate Member	2003
Class of 1960 Scholar in Physics, Williams College	2002
Benedict Prize in Mathematics, Williams College	2001

Teaching and mentorship

Florida State University	Instructor	
Atmospheric Chemistry (MET 6480)		2015, 2016
General Meteorology (MET 2700)		2015 – present
Biogeochemical Cycles and Global Change (MET 6480)		2017
Research supervision	Florida State, UC Irvine, Harvard	2010 – present
4 graduate students, 3 undergraduate students, culminating in 3 articles		
University of California, Irvine	Guest lecturer	2012 – 2013
Global Climate Change (ESS 112)		
Harvard Energy Journal Club	Harvard University	2006 – 2010
Led month-long seminars on Air pollution control technology, Economics of climate change, and the IPCC Fourth Assessment Report		
Harvard University	Teaching fellow	2004 – 2009
Scientific Computing (Appl. Math 111)		2008, 2009

Introduction to Environmental Science (EPS 5)	2005, 2006
Williams College	Teaching assistant
Modern Physics (PHYS 142), Quantum Physics (PHYS 301)	2001 – 2003
Milham Planetarium, Williams College	Student director
	2002 – 2003

Research Funding

NSF: Office of Polar Programs	2016 – 2019
NASA: FIREChem	2018 – 2020
NASA: Atmospheric Chemistry Modeling and Analysis Program	2017 – 2020
NASA: New Investigator Program	2016 – 2019
Florida State University: First-year Assistant Professor Award	2015
Electric Power Research Institute: Cloud-resolving simulations of mercury in thunderstorms, 2010 – 2011	
US Environmental Protection Agency (EPA): STAR Graduate Research Fellowship	2006 – 2009

Service and leadership

GEOS-Chem Steering Committee member & Hg/POPs Working Group Co-chair (2015-present)

Contributor to international scientific assessments:

Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report (2013), Contributing Author

Hemispheric Transport of Air Pollution (2010), Contributing Author

Arctic Pollution 2011 and Mercury in the Arctic (2011), Contributor

Session Convener, American Geophysical Union Fall Meeting 2012, 2013, 2014, 2015

Half-baked Seminar Series Coordinator, Dept. Earth System Science, UC Irvine, 2012-2013

Atmospheric Chemistry Graduate Student Forum Moderator, Harvard University, 2008-2009

NASA Group Achievement Award for field experiments: ARCTAS (2008), INTEX-B (2006)

Journal Reviewer: *Nature Geoscience*, *Geophysical Research Letters*, *J. Geophysical Research*, *Atmospheric Chemistry and Physics*, *Environmental Science & Technology*, *Environmental Research Letters*, *Atmospheric Environment*, *Scientific Reports*, *Geoscientific Model Development*, *Science of the Total Environment*

Grant Reviewer: NASA, NOAA, DOE

Professional society memberships

American Geophysical Union (AGU), European Geosciences Union (EGU), Geochemical Society

Peer-reviewed publications

Holmes, C.D. and M.J. Prather: An atmospheric definition of the equator and its implications for atmospheric chemistry and climate, *in prep.*

Kaulfus, A., U.S. Nair, **C.D. Holmes**, W.M. Landing: Mercury wet scavenging and deposition differences by precipitation type, *Environ. Sci. Technol.*, doi:10.1021/acs.est.6b04187, 2017.

Holmes, C.D., N.P. Krishnamurthy, J.M. Caffrey, W.M. Landing, E.S. Edgerton, K.R. Knapp, U.S. Nair: Thunderstorms increase mercury wet deposition, *Environ. Sci. Technol.*, 50, 9343-9350, doi: 10.1021/acs.est.6b02586, 2016.

Zhang, H., **C.D. Holmes**, and S. Wu: Impacts of changes in climate and land use/land cover on atmospheric mercury, *Atmos. Environ.*, 141, 230-244, doi:10.1016/j.atmosenv.2016.06.056, 2016.

Coburn, S., B. Dix, E. Edgerton, **C.D. Holmes**, D. Kinnison, Q. Liang, A. ter Schure, S. Wang, R. Volkamer: Mercury oxidation from bromine chemistry in the free troposphere over the Southeastern United States, *Atmos. Chem. Phys.*, 16, 3743-3760, doi:10.5194/acp-16-3743-2016, 2016.

Isaksen, I.S.A., T.K. Berntsen, S.B. Dalsøren, K. Eleftheratos, Y. Orsolini, B. Rognerud, F. Stordal, O.A. Søvde, C. Zerefos, **C.D. Holmes**: Atmospheric ozone and methane in a changing climate. *Atmosphere* 5, 518-535, doi:10.3390/atmos5030518, 2014.

Holmes, C.D.: Air pollution and forest water use, *Nature*, 507, E1-E2, doi:10.1038/nature13113, 2014.

- Heald, C. L., D. A. Ridley, J. H. Kroll, S. R. H. Barrett, K. E. Cady-Pereira, M. J. Alvarado, **C. D. Holmes**: Beyond direct radiative forcing: The case for characterizing the direct radiative effect of aerosols, *Atmos. Chem. Phys.*, 14, 5513-5527, doi: 10.5194/acp-14-5513-2014, 2014.
- Schnell, J.L., **C.D. Holmes**, A. Jangam, M.J. Prather: Skill in forecasting extreme ozone pollution episodes with a global atmospheric chemistry model, *Atmos. Chem. Phys.*, 14, 7721-7739, doi: 10.5194/acp-14-7721-2014, 2014.
- Holmes, C.D.**, M.J. Prather, G.C.M. Vinken: The climate impact of ship NO_x emissions: an improved estimate accounting for plume chemistry, *Atmos. Chem. Phys.*, 14, 6801-6812, doi:10.5194/acp-14-6801-2014, 2014.
- Prather, M. J. and **C. D. Holmes**: A perspective on time: loss frequencies, time scales, and lifetimes, *Environ. Chem.* 10, 73-79, doi:10.1071/EN13017, 2013.
- Ellis, R. A., D. J. Jacob, M. Payer, L. Zhang, **C. D. Holmes**, B. A. Schichtel, T. Blett, E. Porter, L. H. Pardo, and J. A. Lynch: Present and future nitrogen deposition to national parks in the United States: critical load exceedances, *Atmos. Chem. Phys.* 13, 9083-9095, doi:10.5194/acp-13-9083-2013, 2013.
- Holmes, C. D.**, M. J. Prather, O. A. Søvde, and G. Myhre: Future methane, hydroxyl, and their uncertainties: key climate and emission parameters for future predictions, *Atmos. Chem. Phys.* 13, 285-302, doi:10.5194/acp-13-285-2013, 2013.
- Nair, U. S., Y. Wu, **C. D. Holmes**, A. Ter Schure, G. Kallos, and J. T. Walters: Cloud-resolving simulations of mercury scavenging and deposition in thunderstorms, *Atmos. Chem. Phys.* 13, 10143-10157, doi:10.5194/acp-13-10143-2013, 2013.
- Harris, R., C. Pollman, W. Landing, D. Evans, D. Axelrad, D. Hutchinson, S.L. Morey, D. Rumbold, D. Dukhovskoy, D. Adams, K. Vijayaraghavani, **C. Holmes**, R. D. Atkinson, T. Myers, and E. Sunderland: Mercury in the Gulf of Mexico: Sources to consumers, *Environ. Res.*, 119, 42-52, doi:10.1016/j.envres.2012.08.001, 2012.
- Costa, M.F., W. M. Landing, H. A. Kehrig, M. Barletta, **C. D. Holmes**, P. R. G. Barrocas, D. C. Evers, D. G. Buck, A. C. Vasconcellos, S. S. Hacon, J. C. Moreira, O. Malm: Mercury in tropical and subtropical coastal environments. *Environ. Res.*, 119, 88-100, doi:10.1016/j.envres.2012.07.008, 2012.
- Søvde, A. O., M. J. Prather, I. S. A. Isaksen, T. K. Berntsen, F. Stordal, X. Zhu, **C. D. Holmes**, and J. Hsu: The chemical transport model Oslo CTM3. *Geosci. Model Dev.* 5, 1441-1469, doi:10.5194/gmd-5-1441-2012, 2012.
- Müller, D., D. Wip, T. Warneke, **C. D. Holmes**, A. Dastoor, and J. Notholt: Sources of atmospheric mercury in the tropics: continuous observations at a coastal site in Suriname. *Atmos. Chem. Phys.* 12, 7391-7397, doi:10.5194/acp-12-7391-2012, 2012.
- Holmes, C. D.**: Quick cycling of quicksilver. *Nature Geosci.* 5, 95-96, doi:10.1038/ngeo1389, 2012.
- Prather, M. J., **C. D. Holmes**, and J. Hsu: Reactive greenhouse gas scenarios: Systematic exploration of uncertainties and the role of atmospheric chemistry. *Geophys. Res. Lett.* 39, L09803, doi:10.1029/2012GL051440, 2012.
- Zhang, Y., L. Jaeglé, A. van Donkelaar, R. V. Martin, **C. D. Holmes**, H. M. Amos, Q. Wang, R. Talbot, F. Artz, S. Brooks, W. Luke, T. M. Holsen, D. Felton, E. K. Miller, K. D. Perry, D. Schmeltz, A. Steffen, R. Tordon, P. Weiss-Penzias, and R. Zsolway: Nested-grid simulation of mercury over North America. *Atmos. Chem. Phys.* 12, 6095-6111, doi:10.5194/acp-12-6095-2012, 2012.
- Amos, H., D. J. Jacob, **C. D. Holmes**, J. A. Fisher, Q. Wang, R. M. Yantosca, E. S. Corbitt, E. Galarneau, A. P. Rutter, M. S. Gustin, A. Steffen, J. J. Schauer, J. A. Graydon, V. L. St. Louis, R. W. Talbot, E. S. Edgerton, E. M. Sunderland: Gas-particle partitioning of atmospheric Hg(II) and its effect on global mercury deposition, *Atmos. Chem. Phys.* 12, 591-603, doi:10.5194/acp-12-591-2012, 2012.
- Corbitt, E. S., D. J. Jacob, **C. D. Holmes**, D. G. Streets, and E. M. Sunderland: Global source-receptor relationships for mercury deposition under present-day and 2050 emissions scenarios. *Environ. Sci. Technol.* 45, 10477-10484, doi:10.1021/es202496y, 2011.

- Hezel, P. J., B. Alexander, C. M. Bitz, E. J. Steig, **C.D. Holmes**, X. Yang and J. Sciare: Modeled methanesulfonic acid (MSA) deposition in Antarctica and its relationship to sea ice. *J. Geophys. Res.* 116, D23214, doi:10.1029/2011JD016383, 2011.
- Holmes, C. D.**, M. J. Prather, and Q. Tang: Uncertainties in climate assessment for the case of aviation NO. *Proc. Natl. Acad. Sci. USA* 108, 10997-11002, doi:10.1073/pnas.1101458108, 2011.
- Knapp K. R., S. Ansari, C. L. Bain, M. A. Bourassa, M. J. Dickinson, C. Funk, C. N. Helms, C. C. Hennon, **C. D. Holmes**, G. J. Huffman, J. P. Kossin, H.-T. Lee, A. Loew, G. Magnusdottir: Globally gridded satellite (GridSat) observations for climate studies, *Bull. Am. Meteor. Soc.*, doi: 10.1175/2011BAMS3039.1, 2011.
- Travnikov, O., C-J. Lin, A. Dastoor and 11 others including **C. D. Holmes**: Global and regional modeling, in *Hemispheric Transport of Air Pollution 2010, Part B: Mercury*. Eds. N. Pirrone and T. Keating, United Nations Economic Commission for Europe, 2010.
- Holmes, C. D.**, D. J. Jacob, E.S. Corbitt, J. Mao, X. Yang, R. Talbot, and F. Slemr: Global atmospheric model for mercury including oxidation by bromine atoms. *Atmos. Chem. Phys.* 10, 19845-19900, doi:10.5194/acpd-10-19845-2010, 2010.
- Soerensen, A.L., E.M. Sunderland, **C.D. Holmes**, D.J. Jacob, R.M. Yantosca, H. Skov, J.H. Christensen, S.A. Strode, R.P. Mason: An improved global model for air-sea exchange of mercury: high concentrations over the North Atlantic. *Environ. Sci. Technol.* 44, 8574-8580, 2010.
- Fisher, J.A., D.J. Jacob, M.T. Purdy, M. Kopacz, P. Le Sager, C. Carouge, **C.D. Holmes**, R.M. Yantosca, R.L. Batchelor, K. Strong, G.S. Diskin, H.E. Fuelberg, J.S. Holloway, E.J. Hyer, W.W. McMillan, J. Warner, D.G. Streets, Q. Zhang, Y. Wang, S. Wu: Source attribution and interannual variability of Arctic pollution in spring constrained by aircraft (ARCTAS, ARCPAC) and satellite (AIRS) observations of carbon monoxide, *Atmos. Chem. Phys.* 10, 977-996, 2009.
- Holmes, C.D.**, D.J. Jacob, R.P. Mason, D.A. Jaffe: Sources and deposition of reactive gaseous mercury in the marine atmosphere, *Atmos. Environ.* 43, 2278-2285, doi: 10.1016/j.atmosenv.2009.01.051, 2009.
- Strode, S.A., L. Jaegle, D.A. Jaffe, P.C. Swartzendruber, N.E. Selin, **C.D. Holmes**, R.M. Yantosca: Trans-Pacific transport of mercury, *J. Geophys. Res.* 113, D15305, doi:10.1029/2007JD009428, 2008.
- Holmes, C.D.**, D.J. Jacob, and X. Yang: Global lifetime of elemental mercury against oxidation by atomic bromine in the free troposphere, *Geophys. Res. Lett.* 33, L20808, doi:10.1029/2006GL027176, 2006.
- Galvez, E.J., M.R. Cheyne, J.B. Stewart, **C.D. Holmes**, and H.I. Sztul: Variable Geometric Phase Polarization Rotators for the Visible, *Optics Comm.* 171, 7-13, 1999.
- Galvez, E.J. and **C.D. Holmes**: Geometric Phase of Optical Rotators, *J. Optical Soc. Am. A* 16, 1981-1985, 1999.

Commentary, Book chapters and other publications

- Prather, M.J. and **C.D. Holmes**: Overexplaining or underexplaining methane's role in climate change, *Proc. Natl. Acad. Sci. USA*, doi: 10.1073/pnas.1704884114, 2017.
- Holmes, C. D.** (2012) 5 book chapters on waste gasification technology, plasma gasification, applications, and environmental performance in *From Waste to Fuel*, in press.
- Dennis, K.J., **C.D. Holmes**, K.Z. House, J.J. Krich, B.G. Lee, L.T. Murray, E.A. van Nierop, J. Parella, D.M. Romps, J. Rugolo, M.T. Winkler: Should the United States resume reprocessing? A pro and con, *Bulletin of the Atomic Scientists* 65(6), 30-41, 2009.

Selected presentations at scientific meetings

- "The global warming potential of methane reassessed with combined stratospheric and tropospheric chemistry," Abstract A51N-08, presented at 2017 AGU Fall Meeting, New Orleans, LA, 11-15 Dec.
- "Where is the equator? A definition based on the atmosphere and its consequences for atmospheric chemistry," Abstract A52F-03, presented at AGU Fall Meeting 2014, San Francisco, Calif., Dec. 19.
- "Where is the equator?" presented at SPARC General Assembly 2014, Queenstown, New Zealand, Jan. 13, 2014.

- “The climate impact of ship NO_x emissions: an improved estimate accounting for plume chemistry,” Abstract A11C-0063 presented at AGU Fall Meeting 2013, San Francisco, Calif., Dec. 9, 2013.
- “Cloud-resolving simulations of mercury scavenging and deposition in thunderstorms,” 11th International Conference on Mercury as a Global Pollutant, Edinburgh, Scotland, Aug. 1, 2013.
- “Atmospheric methane lifetime 1980-2100: trends, variability and global warming potential (GWP),” Abstract A43E-0186 presented at AGU Fall Meeting 2012, San Francisco, Calif., Dec. 6, 2012.
- “Future methane, OH, and their uncertainties,” Abstract EGU2012-940 presented at EGU General Assembly 2012, Vienna, Austria, April 25, 2012.
- “Future methane, tropospheric ozone, and their uncertainties: parametric relationships with emissions and climate change,” Abstract A13K-04, 2011 Fall Meeting, AGU, San Francisco, Calif., 5-9 Dec.
- “Uncertainties in climate assessment: the case of aviation NO_x.” Gordon Research Conference on Atmospheric Chemistry. Mt. Snow, VT: July 27, 2011.
- “Thunderstorms increase mercury concentration in rainfall.” Goldschmidt 2010 conference. Knoxville, TN: June 15, 2010.
- “Impact of bromine chemistry on the global transport and deposition of atmospheric mercury.” 9th International Conference on Mercury as a Global Pollutant. Guiyang, China: June 11, 2009.
- “Mercury deposition to the Gulf Coast region from deep convection and long-range atmospheric transport.” AGU Fall Meeting. San Francisco, CA: December 19, 2008. Eos Trans. AGU 89(53), Fall Meet. Suppl., Abstract A53D-0308.
- “Hg(II) sources, sinks, and reactions with halogens in the remote atmospheric marine boundary layer.” AGU Fall Meeting. San Francisco, CA: December 13, 2007. Eos Trans. AGU 88(52), Fall Meet. Suppl., Abstract A42B-02.
- “The coupled diurnal cycles of bromine and reactive gaseous mercury in the marine boundary layer.” EGU General Assembly. Vienna, Austria: April 19, 2007. Geophysical Research Abstracts 9 (11743) SRef-ID: 1607-7962/gra/EGU2007-A-11743
- “Global lifetime of anthropogenic and background mercury against oxidation by atomic bromine in the free troposphere.” 8th International Conference on Mercury as a Global Pollutant. Madison, WI: August 10, 2006.
- “Frequency Modulation Spectroscopy of the 'Forbidden' M1 and E2 1283nm Transition in Thallium.” American Physical Society DAMOP Conference. Boulder, CO: May 2003.

Invited talks

- “Climate and clean air in the 21st century: Understanding and reducing uncertainties in atmospheric change.” University of Maryland, Baltimore County. February 12, 2014.
- “The uncertain futures of methane, climate, and clean air.” Florida State University. January 7, 2014.
- “Climate and clean air in the 21st century: Understanding and reducing uncertainties in atmospheric change.” Cambridge University. November 4, 2013.
- “Clean air in the 21st century: Methane and its uncertainties.” University of Nevada, Reno. February 27, 2013.
- “The global spread of mercury pollution from smokestack to stomachs.” University of Nevada, Reno. February 27, 2013.
- “Climate and clean air in the 21st century: Methane and mercury.” University of Illinois, Chicago. February 12, 2013.
- “Climate and clean air in the 21st century: Methane and its uncertainties.” Oxford University. February 7, 2013.
- “Future methane, OH, and their uncertainties.” University of Cambridge. April 17, 2012.
- “Processes controlling global mercury biogeochemistry.” ACCESS XI, Brookhaven National Lab, July 22, 2011.
- “Mercury deposition in rain and thunderstorms.” University of Alabama, Huntsville. September 29, 2010.

“Smoke stack to stomach: modeling the global spread of mercury pollution.” Williams College. March 12, 2010.

“Smoke stack to stomach: the role of atmospheric chemistry in mercury exposure.” Princeton University. February 19, 2010.

“Atmospheric mercury chemistry: the global role of Hg+Br reactions.” University of California, Irvine. January 22, 2010.

“Atmospheric mercury chemistry: the role of Hg+Br reactions.” University of Chicago. May 8, 2009.

“Chemistry and the fate of atmospheric mercury.” EPS Graduate Student and Post-doc Seminar. Harvard University. November 1, 2007.