

LARRY WAYNE HOROWITZ

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PROFESSIONAL EXPERIENCE

2008-present **PRINCETON UNIVERSITY**, Princeton, New Jersey
Lecturer, Department of Geosciences, Program in Atmospheric and Oceanic Sciences

2001-present **GEOPHYSICAL FLUID DYNAMICS LABORATORY**, Princeton, New Jersey
Physical Scientist

My current research focuses on tropospheric trace gases and aerosols. I use global chemical transport models to simulate the chemical and dynamical processes affecting these species.

1999-2001 **GEOPHYSICAL FLUID DYNAMICS LABORATORY**, Princeton, New Jersey
Visiting Scientist, Atmospheric and Oceanic Sciences Program, Princeton University

My work aimed to improve our understanding of the processes controlling tropospheric trace gas distributions. I used global chemical transport models to study the impact of chemistry and transport on ozone and related chemical species.

1997-1999 **NATIONAL CENTER FOR ATMOSPHERIC RESEARCH**, Boulder, Colorado
Postdoctoral Fellow, Advanced Study Program / Atmospheric Chemistry Division

My research focused on simulating the chemistry of ozone and related species in the troposphere. Using a three-dimensional global model, I studied the dependence of ozone concentrations on emissions of ozone precursors from anthropogenic and natural sources.

EDUCATION

1993-1997 **HARVARD UNIVERSITY**, Cambridge, Massachusetts
Ph.D. in Atmospheric Chemistry/Applied Mathematics, Division of Engineering and Applied Sciences, degree received November 1997
Committee: Professors Daniel Jacob (advisor), Michael McElroy, Steven Wofsy

My research focused on the tropospheric photochemistry of ozone, nitrogen oxides, and non-methane hydrocarbons. I developed a photochemical mechanism describing the reactions occurring within the continental boundary layer and the global troposphere, for use in chemical models. Using a three-dimensional chemical transport model, I examined the impact of non-methane hydrocarbon chemistry on the global distributions of ozone and nitrogen oxides. Thesis title: The influence of boundary layer chemistry on global tropospheric ozone and nitrogen oxides.

LARRY WAYNE HOROWITZ

- 1991-1993 **HARVARD UNIVERSITY**, Cambridge, Massachusetts
S.M. in Applied Physics, Division of Applied Sciences

Emphasis on the chemistry and physics of the atmosphere. Additional courses in applied mathematics, including numerical techniques.
- Summer 1990 **WEIZMANN INSTITUTE OF SCIENCE**, Rehovot, Israel

Research on spectroscopy in molecular jets, Department of Chemical Physics, Karyn Kupcinet International Science School, funded to attend.
- 1987-1991 **HARVARD COLLEGE**, Cambridge, Massachusetts
A.B. summa cum laude in Chemistry
Advisors: Professors Elias Corey, William Klemperer

Extensive coursework in physical and organic chemistry, mathematics, and physics.

HONORS AND AWARDS

- 2009 **Outstanding Scientific Paper Award**, National Oceanic and Atmospheric Administration, Office of Oceanic and Atmospheric Research
- 2009 **Silver Medal**, Department of Commerce
- 2008 **Administrator's Award**, National Oceanic and Atmospheric Administration
- 2008 **Editors' Citation** for Excellence in Reviewing, Geophysical Research Letters
- 2005 **Silver Medal**, Department of Commerce
- 1993-1996 **NASA Graduate Student Fellowship in Global Change Research**
Provided funding for tuition, stipend, and travel
- 1991-1993 **Ernst Habicht Fellowship**, Harvard University
Provided funding for tuition and stipend
- 1991 Elected to **Phi Beta Kappa**
- 1987-1991 **John Harvard Scholarship**, Harvard College, for academic achievement

TEACHING EXPERIENCE

- 2003-present **Princeton University Visiting Lecturer**, Atmospheric and Oceanic Sciences Program

Atmospheric Chemistry, graduate-level class
- 1992-1997 **Harvard University Teaching Fellow**, Department of Earth and Planetary Sciences

Environmental Sciences, Professors Brian Farrell and Michael McElroy
Chemical Oceanography, Professor Heinrich Holland, graduate-level class
Atmospheric Chemistry, Professor Daniel Jacob
Environmental Pollution, Professors Raymond Siever and Daniel Jacob

LARRY WAYNE HOROWITZ

Fall 1993 **Harvard University Teaching Fellow**, Undergraduate Core Curriculum Program

The Atmosphere, Professors Michael McElroy and Daniel Jacob

1990-1991 **Harvard University Course Assistant**, Department of Mathematics

Linear Algebra and Differential Equations, Professor Shlomo Sternberg
Multivariable Calculus, Professor David Kazhdan

PROFESSIONAL SERVICE AND AFFILIATIONS

2002-present **Science**, Reviewer

2001-present **Atmospheric Chemistry and Physics**, Reviewer

2001-present **Geophysical Research Letters**, Reviewer

1999-present **Atmospheric Environment**, Reviewer

1999-present **Journal of Atmospheric Chemistry**, Reviewer

1999-present **National Science Foundation, Division of Atmospheric Sciences**, Reviewer

1998-present **Journal of Geophysical Research - Atmospheres**, Reviewer

1998-present **NASA Office of Earth Science, Atmospheric Chemistry Modeling and Analysis Program**, Reviewer

1996-present **American Geophysical Union**, Member

PUBLICATIONS

Anenberg, S.C., L.W. Horowitz, D.Q. Tong, and J.J. West, An estimate of the global burden of anthropogenic ozone and fine particulate matter on premature human mortality using atmospheric modeling, *Environ Health Perspect.*, doi:10.1289/ehp.0901220, 2010.

Fang, Y., A.M. Fiore, L.W. Horowitz, A. Gnanadesikan, H. Levy, Y. Hu, and A.G. Russell, Estimating the contribution of strong daily export events to total pollutant export from the United States in summer, *J. Geophys. Res.*, 114, D23302, doi:10.1029/2008JD010946, 2009.

Fiore, A.M., F.J. Dentener, O. Wild, C. Cuvelier, M.G. Schultz, P. Hess, C. Textor, M. Schulz, R. Doherty, L.W. Horowitz, I.A. MacKenzie, M.G. Sanderson, D.T. Shindell, D.S. Stevenson, S. Szopa, R. Van Dingenen, G. Zeng, C. Atherton, D. Bergmann, I. Bey, G. Carmichael, B.N. Duncan, G. Faluvegi, G. Folberth, M. Gauss, S. Gong, D. Hauglustaine, T. Holloway, I.S.A. Isaksen, D.J. Jacob, J.E. Jonson, J. W. Kaminski, T.J. Keating, A. Lupu, E. Marmer, V. Montanaro, R. Park, G. Pitari, K.J. Pringle, J.A. Pyle, S. Schroeder, M.G. Vivanco, P. Wind, G. Wojcik, S. Wu, and A. Zuber, Multimodel estimates of intercontinental source-receptor relationships for ozone pollution, *J. Geophys. Res.*, 114, D04301, doi:10.1029/2008JD010816, 2009.

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- Koch, D., M. Schulz, S. Kinne, T.C. Bond, Y. Balkanski, S. Bauer, T. Berntsen, O. Boucher, M. Chin, A. Clarke, N. De Luca, F. Dentener, T. Diehl, O. Dubovik, R. Easter, D.W. Fahey, J. Feichter, D. Fillmore, S. Freitag, S. Ghan, P. Ginoux, S. Gong, L. Horowitz, T. Iversen, A. Kirkevåg, Z. Klimont, Y. Kondo, M. Krol, X. Liu, C. McNaughton, R. Miller, V. Montanaro, N. Moteki, G. Myhre, J.E. Penner, Ja. Perlwitz, G. Pitari, S. Reddy, L. Sahu, H. Sakamoto, G. Schuster, J.P. Schwarz, Ø. Seland, J.R. Spackman, P. Stier, N. Takegawa, T. Takemura, C. Textor, J.A. van Aardenne, and Y. Zhao, Evaluation of black carbon estimations in global aerosol models, *Atmos. Chem. Phys.*, *9*, 9001-9026, 2009.
- Koch, D., M. Schulz, S. Kinne, T.C. Bond, Y. Balkanski, S. Bauer, T. Berntsen, O. Boucher, M. Chin, A. Clarke, N. De Luca, F. Dentener, T. Diehl, O. Dubovik, R. Easter, D.W. Fahey, J. Feichter, D. Fillmore, S. Freitag, S. Ghan, P. Ginoux, S. Gong, L. Horowitz, T. Iversen, A. Kirkevåg, Z. Klimont, Y. Kondo, M. Krol, X. Liu, C. McNaughton, R. Miller, V. Montanaro, N. Moteki, G. Myhre, J.E. Penner, Ja. Perlwitz, G. Pitari, S. Reddy, L. Sahu, H. Sakamoto, G. Schuster, J.P. Schwarz, Ø. Seland, J.R. Spackman, P. Stier, N. Takegawa, T. Takemura, C. Textor, J.A. van Aardenne, and Y. Zhao, Corrigendum to "Evaluation of black carbon estimations in global aerosol models" published in *Atmos. Chem. Phys.*, *9*, 9001-9026, 2009, *Atmos. Chem. Phys.*, *10*, 79-81, 2010.
- Liu, J., D.L. Mauzerall, L.W. Horowitz, P. Ginoux, and A.M. Fiore, Evaluating inter-continental transport of fine aerosols: (1) Methodology, global aerosol distribution and optical depth, *Atmos. Environ.*, *43*, 4327-4338, 2009.
- Liu, J., D.L. Mauzerall, and L.W. Horowitz, Evaluating inter-continental transport of fine aerosols: (2) Global health impact, *Atmos. Environ.*, *43*, 4339-4347, 2009.
- Livingstone, P.L., K. Magliano, K. Gurer, P.D. Allen, K.M. Zhang, Q. Ying, B.S. Jackson, A. Kaduwela, M. Kleeman, L.F. Woodhouse, K. Turkiewicz, L.W. Horowitz, K. Scott, D. Johnson, C. Taylor, G. O'Brien, J. DaMassa, B.E. Croes, F. Binkowski, D. Byun, Simulating PM concentration during a winter episode in a subtropical valley: Sensitivity simulations and evaluation methods, *Atmos. Environ.*, *43*, 5971-5977, doi:10.1016/j.atmosenv.2009.07.033, 2009.
- Saikawa, E., V. Naik, L.W. Horowitz, J. Liu, and D.L. Mauzerall, Present and potential future contributions of sulfate, black and organic carbon aerosols from China to global air quality, premature mortality and radiative forcing, *Atmos. Environ.*, *43*, 2814-2822, 2009.
- West, J.J., V. Naik, L.W. Horowitz, and A.M. Fiore, Effect of regional precursor emission controls on long-range ozone transport -- Part 1: short-term changes in ozone air quality, *Atmos. Chem. Phys.*, *9*, 6077-6093, 2009.
- West, J.J., V. Naik, L.W. Horowitz, and A.M. Fiore, Effect of regional precursor emission controls on long-range ozone transport -- Part 2: steady-state changes in ozone air quality and impacts on human mortality, *Atmos. Chem. Phys.*, *9*, 6095-6107, 2009.

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- Ellingsen, K., M. Gauss, R. Van Dingenen, F.J. Dentener, L. Emberson, A.M. Fiore, M.G. Schultz, D.S. Stevenson, M.R. Ashmore, C.S. Atherton, D.J. Bergmann, I. Bey, T. Butler, J. Drevet, H. Eskes, D.A. Hauglustaine, I.S.A. Isaksen, L.W. Horowitz, M. Krol, J.F. Lamarque, M.G. Lawrence, T. van Noije, J. Pyle, S. Rast, J. Rodriguez, N. Savage, S. Strahan, K. Sudo, S. Szopa, and O. Wild, Global ozone and air quality: A multi-model assessment of risks to human health and crops, *Atmos. Chem. Phys. Discuss.*, 8, 2163-2223, 2008.
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- Liu, J., D.L. Mauzerall, and L.W. Horowitz, Source-receptor relationships between East Asian sulfur dioxide emissions and Northern Hemisphere sulfate concentrations, *Atmos. Chem. Phys.*, 8, 3721-3733, 2008.
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- Sanderson, M.G., F.J. Dentener, A.M. Fiore, C. Cuvelier, T.J. Keating, A. Zuber, C.S. Atherton, D.J. Bergmann, T. Diehl, R.M. Doherty, B.N. Duncan, P. Hess, L.W. Horowitz, D.J. Jacob, J.-E. Jonson, J.W. Kaminski, A. Lupu, I.A. MacKenzie, E. Mancini, E. Marmer, R. Park, G. Pitari, M. J. Prather, K.J. Pringle, S. Schroeder, M.G. Schultz, D.T. Shindell, S. Szopa, O. Wild, and P. Wind, A multi-model study of the hemispheric transport and deposition of oxidised nitrogen, *Geophys. Res. Lett.*, 35, L17815, doi:10.1029/2008GL035389, 2008.
- Shindell, D., H. Levy II, M.D. Schwarzkopf, L. Horowitz, J.-F. Lamarque, and G. Faluvegi, Multi-model projections of climate change from short-lived emissions due to human activities, *J. Geophys. Res.*, 113, D11109, doi:10.1029/2007JD009152, 2008.

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Shindell, D.T., M. Chin, F. Dentener, R.M. Doherty, G. Faluvegi, A.M. Fiore, P. Hess, D.M. Koch, I.A. MacKenzie, M.G. Sanderson, M.G. Schultz, M. Schulz, D.S. Stevenson, H. Teich, C. Textor, D.J. Bergmann, I. Bey, H. Bian, C. Cuvelier, B.N. Duncan, G. Folberth, L.W. Horowitz, J. Jonson, J.W. Kaminski, E. Marmer, R. Park, K.J. Pringle, S. Schroeder, S. Szopa, T. Takemura, G. Zeng, T.J. Keating, and A. Zuber, A multi-model assessment of pollution transport to the Arctic, *Atmos. Chem. Phys.*, *8*, 5353-5372, 2008.

United States Climate Change Science Program (CCSP), *Climate Projections Based on Emissions Scenarios for Long-Lived and Short-Lived Radiatively Active Gases and Aerosols*. A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research. H. Levy II, D.T. Shindell, A. Gilliland, M.D. Schwarzkopf, L.W. Horowitz, (eds.). Department of Commerce, NOAA's National Climatic Data Center, Washington, D.C., USA, 100 pp., 2008.

Donner, L.J., L.W. Horowitz, A.M. Fiore, C.J. Seman, D.R. Blake, and N.J. Blake, Transport of radon-222 and methyl iodide by deep convection in the GFDL atmospheric model AM2, *J. Geophys. Res.*, *112*, D17303, doi:10.1029/2006JD007548, 2007.

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Horowitz, L.W., A.M. Fiore, G.P. Milly, R.C. Cohen, A. Perring, P.J. Wooldridge, P.G. Hess, L.K. Emmons, and J.-F. Lamarque, Observational constraints on the chemistry of isoprene nitrates over the eastern United States, *J. Geophys. Res.*, *112*, D12S08, doi:10.1029/2006JD007747, 2007.

Mena-Carrasco, M., Y. Tang, G. Carmichael, T. Chai, N. Thongboonchoo, E. Campbell, S. Kulkarni, L. Horowitz, J. Vukovich, M. Avery, W. Brune, J. Dibb, L. Emmons, F. Flocke, G. Sachse, D. Tan, R.E. Shetter, R. Talbot, D. Streets, G. Frost, and D. Blake, Improving regional ozone modeling through systematic evaluation of errors using the aircraft observations during the International Consortium for Atmospheric Research on Transport and Transformation, *J. Geophys. Res.*, *112*, D12S19, doi:10.1029/2006JD007762, 2007.

Ming, Y., V. Ramaswamy, L.J. Donner, V.T.J. Phillips, S.A. Klein, P.A. Ginoux, and L.W. Horowitz, Modeling the interactions between aerosols and liquid water clouds with a self-consistent cloud scheme in a general circulation model, *J. Atmos. Sci.*, *64*, 1189-1209, 2007.

Naik, V., D.L. Mauzerall, L.W. Horowitz, M.D. Schwarzkopf, V. Ramaswamy, and M. Oppenheimer, On the sensitivity of radiative forcing from biomass burning aerosols and ozone to emission location, *Geophys. Res. Lett.*, *34*, L03818, doi:10.1029/2006GL028149, 2007.

Singh, H.B., L. Salas, D. Herlth, R. Kolyer, E. Czech, M. Avery, J.H. Crawford, R.B. Pierce, G.W. Sachse, D.R. Blake, R.C. Cohen, T.H. Bertram, A. Perring, P.J. Wooldridge, J. Dibb, G. Huey, R.C. Hudman, S. Turquety, L.K. Emmons, F. Flocke, Y. Tang, G.R. Carmichael, and L.W. Horowitz, Reactive nitrogen distribution and partitioning in the North American troposphere and lowermost stratosphere, *J. Geophys. Res.*, *112*, D12S04, doi:10.1029/2006JD007664, 2007.

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- Tang, Y., G.R. Carmichael, N. Thongboonchoo, T. Chai, L.W. Horowitz, R.B. Pierce, J.A. Al-Saadi, G. Pfister, J.M. Vukovich, M.A. Avery, G.W. Sachse, T.B. Ryerson, J.S. Holloway, E.L. Atlas, F.M. Flocke, R.J. Weber, L.G. Huey, J.E. Dibb, D.G. Streets, and W.H. Brune, The influence of lateral and top boundary conditions on regional air quality prediction: A multi-scale study coupling regional and global chemical transport models, *J. Geophys. Res.*, *112*, D10S18, doi:10.1029/2006JD007515, 2007.
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- West, J.J., A.M. Fiore, V. Naik, L.W. Horowitz, M.D. Schwarzkopf, and D.L. Mauzerall, Ozone air quality and radiative forcing consequences of changes in ozone precursor emissions, *Geophys. Res. Lett.*, *34*, L06806, doi:10.1029/2006GL029173, 2007.
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PRESENTATIONS

- Tropospheric chemistry and climate, Geosciences Department, Princeton University, seminar, April 2008.
- Observational constraints on the chemistry of isoprene nitrates over the eastern United States, Dept. of Environmental Sciences, Rutgers Univ., seminar, April 2007.
- Impact of meteorology and emissions on methane trends, 1990-2004, AGU Joint Assembly, Baltimore, MD, May 2006.
- MOZART Photochemistry and Transport Modeling for ICARTT, ICARTT Data Analysis Workshop, Durham, NH, August 2005.
- Tropospheric ozone and aerosols, GFDL/Hadley Centre Meeting, Princeton, NJ, November 2003.
- Tropospheric chemistry and aerosol modeling in AM2, NCAR-GFDL Model Development Meeting, Princeton, NJ, October 2003.
- MOZART-2 modeling in ITCT 2K2 and 2K4, Planning Meeting for Summer 2004 Atmospheric Research Campaigns, Durham, NH, April 2003.
- Trans-Pacific transport of pollution during ITCT 2K2, ITCT 2K2 Data Workshop, Boulder, CO, March 2003.
- Chemical weather forecasts using the MOZART-2 global model in ITCT 2K2, AGU Fall Meeting, San Francisco, CA, December 2002.
- Ozone and aerosol modeling: Radiative forcing and air quality, GFDL-NOAA Meeting, Princeton, NJ, November 2002.
- Ozone and aerosol modeling: Radiative forcing and air quality, NOAA/OAR Senior Research Council Meeting, Princeton, NJ, November 2002.
- Ozone and aerosol modeling: Radiative forcing and air quality, NCAR/GFDL Joint Atmospheric Model Development Workshop, November 2002.

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- Chemical transport models and applications, NOAA/OAR Aerosol-Tropospheric Ozone Research Workshop, Boulder, CO, October 2002.
- Budget of tropospheric ozone in MOZART-2, Max Planck Institute for Meteorology, Hamburg, Germany, June 2002.
- Overview of MOZART-2, ITCT 2K2 Planning Meeting, Boulder, CO, November 2001.
- Status of MOZART-2, MOZART Workshop, Boulder, CO, November 2001.
- Global simulation of tropospheric ozone and related tracers: Description and evaluation of MOZART, version 2, AGU Spring Meeting, Boston, MA, May 2001.
- A global simulation of tropospheric ozone and related tracers: Description and evaluation of MOZART, version 2, MOZART Workshop, NCAR, Boulder, CO, April 2001.
- MOZART-2: Recent updates and comparison with observations, MOZART Workshop, UIUC, Urbana-Champaign, IL, September 2000.
- MOZART-2: Model evaluation and recent updates, MOZART Workshop, Nederland, CO, May 2000.
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- Update on model development at NCAR and status of IPCC effort, NCAR/LLNL Model Symposium, NCAR, Boulder, CO, October 1999.
- Global simulation of tropospheric ozone using MOZART-2, NCAR/ASP Research Report, Boulder, CO, October 1999.
- Current status of MOZART-2, MOZART Workshop, NCAR, Boulder, CO, September 1999.
- Tropical tropospheric ozone: The role of biomass burning and lightning, NCAR/ACD Research Report, Boulder, CO, July 1999
- Model Simulation of Tropical Tropospheric Ozone, and Its Dependence on Biomass Burning, Lightning, and Convection, AGU Spring Meeting, Boston, MA, June 1999.
- Tropospheric ozone in the tropics: The role of biomass burning and lightning, NCAR/ASP Presentation, Boulder, CO, May 1999.
- 2-D and 3-D chemical transport modelling: Preliminary results and future plans for the MOZART-2 model, NCAR/ASP Research Report, Boulder, CO, October 1998.
- Tropospheric ozone in the tropics: The role of convection, NCAR/ASP Research Report, Boulder, CO, May 1998.
- Update on recent work on the MOZART model, NCAR/ACD Presentation, Boulder, CO, March 1998.
- The impact of fossil fuel combustion on the global distributions of tropospheric nitrogen oxides and ozone, AGU Fall Meeting, San Francisco, CA, December 1997.
- The effect of non-methane hydrocarbons on the export of reactive nitrogen from North America during summertime, AGU Fall Meeting, San Francisco, CA, December 1996.