

Curriculum Vitae

LOUISA K. EMMONS

Atmospheric Chemistry Observations and Modeling Laboratory

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Education

1986 B.S., Physics, Haverford College, Haverford, PA

1989 M.A., Physics, State University of New York, Stony Brook, NY

1994 Ph.D., Physics, State University of New York, Stony Brook, NY

Thesis: *Measurement and Analysis of Polar Stratospheric ClO and N₂O by Ground-based mm-Wave Spectroscopy*

Work History

2010-present National Center for Atmospheric Research, Boulder, CO.

Scientist III, Atmospheric Chemistry Observations and Modeling Lab:

Development and evaluation of CESM/CAM-chem; Chemical weather forecasting; ACRESP group leader (since 2013); CESM chemistry-climate working group co-chair (since 2/2014).

Research Interests: Analysis of atmospheric composition using chemistry models, aircraft observations and satellite retrievals; aircraft field campaign design and support; improving tropospheric chemical mechanisms, particularly of VOC oxidation.

2003-2010 National Center for Atmospheric Research, Boulder, CO.

Scientist I and II, Atmospheric Chemistry Division: Development of MOZART-4; Chemical forecasting for field campaigns and regional air quality forecasting.

Research Interests: Analysis of aircraft field campaigns with models and satellite observations.

2001-2003 National Center for Atmospheric Research, Boulder, CO.

Associate Scientist III, MOPITT group, Atmospheric Chemistry Division: Validation of MOPITT CO retrievals with in situ aircraft observations.

2000-2001 National Center for Atmospheric Research, Boulder, CO.

Associate Scientist III, Global Modeling group, Atmospheric Chemistry Division: Chemical weather forecaster and data manager for the NCAR/NSF TOPSE aircraft campaign.

1997-1999 National Center for Atmospheric Research, Boulder, CO.

Scientific Visitor, Atmospheric Chemistry Division: Development of data-based climatologies of ozone and its precursors.

1994-1998 University of Michigan, Ann Arbor, MI.

Post-doctoral Research Fellow, Department of Atmospheric, Oceanic and Space Sciences: Developed data-based climatologies of tropospheric NO_x; assisted with

NO, NO₂ and O₃ aircraft measurements in PEM-Tropics-A; development of the PROPHET tower site in Pellston, MI.

Scientific and Technical Accomplishments

Advances in understanding of stratospheric and tropospheric chemistry and dynamics using ground-based, aircraft and satellite observations along with chemical transport models.

Stratospheric chemistry and dynamics

- Member of the team making one of the first measurements of stratospheric ClO over Antarctica, identifying the cause of the Ozone Hole.
- Retrieval and analysis of N₂O stratospheric observations documenting descent of air within the Arctic and Antarctic polar vortices.

Tropospheric chemistry modeling and evaluation

- Creation of data-based climatologies of tropospheric ozone and its precursors for model evaluation.
- Development and evaluation of the first versions of the global model for tropospheric chemistry and transport, Model of Ozone and Related chemical Tracers (MOZART).
- Development, evaluation, publication and release of the community model MOZART-4.
- Production of real-time MOZART-4 simulations for chemical forecasts and for chemical boundary conditions for regional air quality models.
- Development and evaluation of tropospheric chemistry in CESM/CAM-chem.
- Contribution to global model intercomparisons (CCMI: Chemistry-Climate Model Initiative, HTAP2: Hemispheric Transport of Air Pollutants)

Satellite observations

- Validation of the carbon monoxide retrievals from the MOPITT satellite instrument using airborne in situ measurements.
- Analysis of inter-annual variability of MOPITT CO observations to show impact of fires on tropospheric composition.
- Analysis of upper tropospheric and lower stratospheric satellite observations of chemical tracers, in conjunction with MOZART results, to identify transport pathways from the troposphere to the stratosphere through the Asian monsoon.

Field campaign support and analysis

- Development of chemical forecasts using MOZART simulations and MOPITT CO retrievals to guide flight planning in aircraft field experiments led by NASA and NCAR.
- Analysis of the ozone budget during the NSF/TOPSE field campaign using MOZART and the aircraft observations.
- Analysis of ozone production and evolution of pollution from Mexico City in support of the MIRAGE field campaign.
- Comparison and evaluation of multiple models of their performance in the Arctic using POLARCAT observations.

Field campaigns

Ground-based remote sensing observations:

Mauna Kea, Hawaii, 1988

McMurdo, Antarctica, Aug-Oct 1987, Aug-Oct 1991, Aug-Oct 1992

Thule Greenland, Feb-Mar 1991; Feb 1992

Aircraft-based in situ measurements, NASA/GTE PEM-Tropics-A, Aug-Oct 1996.
Ground-based in situ measurements, PROPHET site, Pellston, MI, 1997.
Flight planning support, NASA INTEX-A, Jul-Aug 2004.
Flight planning support, NSF MIRAGE-Mex, March 2006.
Flight planning support, NASA INTEX-B, May 2006.
Flight planning support, NASA ARCTAS, April, June 2008.
Flight planning support, NSF DC3, May-Jun 2012.
Flight planning support, NSF NOMADSS, Jun-Jul 2013.
Flight planning support, NASA SEAC4RS, Aug-Sep 2013.
Flight planning support, NSF FRAPPE, Jul-Aug 2014.
Leadership team and flight planning support, NASA KORUS-AQ, May-Jun 2016.

Community Service

Institutional Service

ACD Seminar coordinator (2004-2006)
ASP post-doc selection committee (2008-2011)
ACD Global Tropospheric Modeling group interim leader (2008-2009)
ACOM ACRESP group leader (2013-present)
CESM Chemistry Climate Working Group co-chair (Feb 2014-present)
Data Stewardship and Engineering Team (Aug 2014-present)

Scientific Community Service

TOPSE field experiment data manager (2000)
Science Team member of NASA field campaigns (INTEX-A, INTEX-B, ARCTAS, SEAC⁴RS); participating actively in field experiment and science team meetings, including chairing working groups (2004-present)
NASA EOS Validation Contact for MOPITT and member of MOPITT Science Team; resource for interpretation and use of MOPITT CO retrievals (2001-present)
MILAGRO field experiment data manager (2006)
Coordinator of the release of the community model MOZART-4 (Model of Ozone and Related chemical Tracers, version 4) (2010)
Scientific contact for new users of MOZART-4, providing guidance on use of model and its output (2010-present)
Provider of MOZART-4 chemical forecasts and regional model boundary conditions to the university and broader community (2010-present)
Member of the Tropospheric Measurement Evaluation Panel (TAbMEP), a project funded by NASA's MEaSUREs (Making Earth System data records for Use in Research Environments) program, coordinated by Gao Chen, NASA Langley (2008-2010)
Atmospheric Environment Editorial Advisory Board (2013-present)
Guest editor for *Atmospheric Environment* special issue on MAPS-Seoul 2015 campaign (2016)

Workshops Hosted

Workshop on Health Impacts of Air Quality and Climate in Asia, Sun Yat-sen University, Guangzhou, China, April 9-11, 2012.

Workshop on Health, Agricultural and Water Risks Associated with Air Quality and Climate in Asia, NCAR, Boulder, Colorado, July 9-12, 2013.

Modeling Air Quality from the Global to Local Scale, joint workshop of HTAP2 Global and Regional Model Evaluation and 2015 Western Air Quality Modeling, NCAR, Boulder, Colorado, May 11-15, 2015.

Professional Reviews, Journals

Atmospheric Chemistry and Physics Discussions; Atmospheric Environment; Environmental Chemistry; Geophysical Research Letters; Journal of Atmospheric and Oceanic Technology; Journal of Geophysical Research-Atmospheres; Royal Meteorological Society Quarterly Journal

Professional Reviews, Funding Agencies

EPA (including panel review in 2009); NASA (including panel reviews in 2000, 2005, 2007); NOAA; NSF; Hong Kong Research Grants Council

NCAR Staff Supervision and Mentoring

Pablo Saide, ASP post-doc (2015-present)
Rebecca Buchholz post-doc (2014-present)
Helen Worden, Project Scientist III (2014-present)
Christine Wiedinmyer, Scientist III (2014-present)
Gabriele Pfister, ASP post-doc, Project Scientist I, Scientist I, II, III (2004-present)
Simone Tilmes, Project Scientist I, II (2008-present)
Marielle Saunois, ASP post-doc (2009-2011)
Catherine Wespes, post-doc (2010-2011)

Graduate Student Supervision and Mentoring

Key Hong Park, Stony Brook University (2005-2010, Thesis committee)
Roni Drori, Hebrew University of Jerusalem (2006-2014)
Michelle Hawkins, Howard University (2006)
Gabriela Santos, Max-Planck-Institute for Meteorology (2006)
Gwendoline Lacrosonnière, L'Ecole Normale Supérieure (Masters 1 internship, 2008) and University of Toulouse (Masters 2 internship, 2009)

Undergraduate and Elementary Student Supervision and Outreach

Significant Opportunities in Atmospheric Research and Science (SOARS): Writing Mentor, 1999, 2000, 2003
Supervisor of Tyler Collier (2003-2004), Sara Harrold (2004-2006)
Letter writing with 4th grade girls science class, Nashoba Brooks School, Concord, MA (2004-2009)

Honors and Awards

- 1987 Antarctic Service Medal
- 1993 Invited participant to ACCESS II (Atmospheric Chemistry Colloquium for Emerging Senior Scientists, in conjunction with the Atmospheric Chemistry Gordon Research Conference)
- 2001 NCAR Incentive Award for support of TOPSE
- 2004 Editor's Citation for Excellence in Refereeing for JGR-Atmospheres
- 2005 NASA Group Achievement Award to Intercontinental Chemical Transport Experiment North America Science Team
- 2006 NCAR Outstanding Accomplishment Award, Scientific and Technical Advancement Award to the MOPITT Team
- 2007 NASA Group Achievement Award to Intercontinental Chemical Transport Experiment

- 2009 NASA Group Achievement Award to ARCTAS
2012 NCAR Outstanding Publication Award to Thomas Karl and co-authors
2012 NESL Special Recognition Award to Bill Randel and co-authors
2014 Thomson Reuters Highly Cited Researcher
2014 NASA Group Achievement Award to SEAC4RS
2015 Thomson Reuters Highly Cited Researcher

Proposals and Grants

- Co-Investigator (Univ. Michigan): *Continued Data Archive: Budget of Nitrogen Compounds in the Global Atmosphere - Observations-based climatologies and 3-D chemical transport model simulations*, PI: G. Brasseur (NCAR), NASA AEAP/SASS, 1996-1999.
- Co-Investigator: *Data-Based Climatologies and Study of the Ozone Budget near the Tropopause*, PI: G. Brasseur (NCAR), NASA/ACMAP 1999-2002.
- Co-Investigator: *Using satellite tropospheric trace gas remote sensing to link chemistry and transport between the local and global scales*, PI: D. Edwards (NCAR), NASA 2003-2005.
- Principal Investigator: *Closing the Carbon Monoxide Budget: Variability in CO Emissions*, NASA 2004-2007.
- Co-Investigator: *Terra/MOPITT Measurements of Tropospheric Carbon Monoxide and Data Analysis in Support of INTEX-NA*, PI: D. Edwards (NCAR), NASA 2005-2008.
- Collaborator: *Oxidation of Organics in the Atmosphere at Low Temperatures*, PI: G. Tyndall (NCAR), NASA, 2006-2009.
- Co-Principal Investigator: *Connections between Regional Processes and Intercontinental Transport of Air Pollution*, PI: T. Holloway (U. Wisconsin), NASA, 2007-2010.
- Co-Investigator: *Air Quality Measurements from Space: Defining an Optimum Observing Strategy*, PI: D. Edwards (NCAR), NASA 2007-2010.
- Co-Principal Investigator: *A Comprehensive Regional Air Quality Decision Support System in the Pacific Northwest*, PI: B. Lamb (Washington State University), NASA, 2006-2009.
- Principal Investigator: *Chemical Forecasting and Analysis for ARCTAS using MOPITT measurements and the Community Atmosphere Model with Chemistry (CAM-Chem)*, NASA 2008-2011.
- Co-Investigator: *Deployment of the Trace Organic Gas Analyzer to Measure OVOCs, NMHCs, Halocarbons, and Acetonitrile aboard the NASA DC-8 during ARCTAS*, PI: E. Apel (NCAR), NASA 2008-2011.
- Collaborator: *Analysis of the Co-benefits of Greenhouse Gas Abatement from Global and US Air Quality under Future Climate Scenarios*, PI: Jason West (U. North Carolina), EPA STAR, 2009-2013.
- Co-Investigator: *The Informational Gain of Satellite Products in Analyzing and Predicting Chemical Weather*, PI: Gabriele Pfister (NCAR), NASA 2010-2013.
- Co-Principal Investigator: *Type I Proposal on Chemistry and Climate over Asia: Understanding the Impacts of Changing Climate and Emissions on Atmospheric Composition and Society*, PI: M. Barth (NCAR), NSF 2011-2014.
- Co-Principal Investigator: *Use of satellite data products with the AIRPACT regional air quality model to improve emissions estimates and to quantify the effects of long-range transport of*

trace gases and aerosols in the Pacific Northwest, PI: G. Mount (Washington State University), NASA 2011-2014.

Principal Investigator: *NCAR Chemical Forecasting and Analysis for SEAC4RS*, NASA 2012-2014.

Collaborator: *Assimilation and Analysis of Terra Observations of Amazonian Biomass Burning Emissions*, PI: Merritt Deeter (NCAR), NASA 2014-2017.

Co-Principal Investigator: *Atmospheric VOCs from Fossil Fuel Extraction Activities: Analysis and Modeling of More Than Twenty Years of Surface and Airborne Campaign Data*, PI: Donald Blake (UC-Irvine), NASA 2014-2015.

Collaborator: *Tackling Atmospheric Chemistry Grand Challenges in the Southern Hemisphere*, PI: David Griffith (University of Wollongong), Australian Research Council, 2015-2020.

Principal Investigator: *Global and Regional Chemical Forecasting and Analysis using CAM-chem, Data Assimilation and WRF-Chem for KORUS-AQ*, NASA 2015-2018.

Publications List

Thesis

Emmons, L.K., *Measurement and Analysis of Polar Stratospheric ClO and N₂O by Ground-based mm-Wave Spectroscopy*, 1994. State University of New York at Stony Brook.
Advisor: Robert L. de Zafra.

Refereed Journal Articles (*indicates publication from PhD research)

1. *Barrett, J.W., P.M. Solomon, R.L. de Zafra, M. Jaramillo, L.K. Emmons, and A. Parrish, 1988: Formation of the Antarctic ozone hole by the ClO dimer mechanism. *Nature*, **336**, 455-458.
2. *de Zafra, R.L., M. Jaramillo, J. Barrett, L.K. Emmons, P.M. Solomon, and A. Parrish, 1989: New observations of large concentrations of ClO in the lower springtime stratosphere over Antarctica and its implications for ozone-depleting chemistry. *J. Geophys. Res.*, **94**, 11423-11428.
3. *Jaramillo, M., R.L. de Zafra, J. Barrett, L.K. Emmons, P.M. Solomon, A. Parrish, 1989: Measurements of stratospheric hydrogen-cyanide at McMurdo Station, Antarctica - Further evidence of winter stratospheric subsidence, *J. Geophys. Res.*, **94**, 16773-16777.
4. *de Zafra, R.L., M. Jaramillo, J. Barrett, L.K. Emmons, A. Parrish, and P.M. Solomon, 1990: Measurement of atmospheric opacity at 278 GHz at McMurdo Station, Antarctica in Austral Spring seasons, 1986 and 1987, *Int. J. IR and mm Waves*, **11**, 463-467.
5. *Emmons, L.K., and R. L. de Zafra, 1990: Observation of a strong inverse temperature dependence for the opacity of atmospheric water vapor in the mm continuum near 280 GHz. *Int. J. IR and mm Waves*, **11**, 469-488.
6. *de Zafra, R.L., W.H. Mallison, L.K. Emmons, and D. Koller, 1991: Measurement of the cooling capacity of an RMC-Cryosystems model LTS-4.5-025 closed-cycle helium refrigerator, *Rev. Sci. Instruments*, **62**, 1309-1310.

7. *Emmons, L.K., and R. L. de Zafra, 1991: Procedure for computer-controlled milling of accurate surfaces of revolution for millimeter and far-infrared mirrors, *Applied Optics*, **30**, 3163-3165.
8. *de Zafra, R.L., L.K. Emmons, J.M. Reeves, and D.T. Shindell, 1993: An overview of millimeter-wave spectroscopic measurements of chlorine monoxide at Thule, Greenland, February-March, 1992: Vertical profiles, diurnal variation, and long-term trends. *Geophys. Res. Lett.*, **21**, 1271-1274.
9. *Emmons, L.K., J.M. Reeves, D.T. Shindell, and R.L. de Zafra, 1994: N₂O as an indicator of Arctic vortex dynamics: Correlations with O₃ over Thule, Greenland in February and March, 1992. *Geophys. Res. Lett.*, **21**, 1275-1278.
10. *Shindell, D.T., J.M. Reeves, L.K. Emmons, and R.L. de Zafra, 1994: Arctic chlorine monoxide observations during spring 1993 over Thule, Greenland, and implications for ozone depletion. *J. Geophys. Res.*, **99**, 25697-25704.
11. *Emmons, L.K., D.T. Shindell, J.M. Reeves, and R.L. de Zafra, 1995: Stratospheric ClO profiles from McMurdo Station, Antarctica, spring 1992. *J. Geophys. Res.*, **100**, 3049-3055.
12. Emmons, L.K., M.A. Carroll, D.A. Hauglustaine, G.P. Brasseur, C. Atherton, J. Penner, S. Sillman, H. Levy II, F. Rohrer, W.M.F. Wauben, P.F.J. van Velthoven, Y. Wang, D. Jacob, P. Bakwin, R. Dickerson, B. Doddridge, C. Gerbig, R. Honrath, G. Hubler, D. Jaffe, Y. Kondo, J.W. Munger, A. Torres, and A. Volz-Thomas, 1997: Climatologies of NO_x and NO_y: A comparison of data and models. *Atmos. Environ.*, **31**, 1851-1904.
13. Hauglustaine, D., G.P. Brasseur, S. Walters, P.J. Rasch, J.-F. Muller, L.K. Emmons, and M. A. Carroll, 1998: MOZART. A global chemical-transport model for ozone and related chemical tracers, 2. Model results and evaluation. *J. Geophys. Res.*, **103**, 28291-28335.
14. Emmons, L.K., D. Hauglustaine, J.-F. Muller, M. Carroll, G. Brasseur, D. Brunner, J. Staehelin, V. Thouret, and A. Marengo. 2000: Data composites of airborne observations of tropospheric ozone and its precursors. *J. Geophys. Res.*, **105**, 20497-20538.
15. Tie, X.X., R. Zhang, G. Brasseur, L.K. Emmons, and W. Lei, 2001: Effects of lightning on reactive nitrogen and nitrogen reservoir species in the troposphere. *J. Geophys. Res.*, **106**, 3167-3178.
16. Hauglustaine, D., L. K. Emmons, M. Newchurch, G. Brasseur, T. Takao, K. Matsubara, J. Johnson, B. Ridley, J. Stith, and J. Dye, 2001: On the role of lightning NO_x in the formation of tropospheric ozone plumes: A global model perspective. *J. Atmos. Chem.*, **38**, 277-294.
17. Tie, X.X., G. Brasseur, L.K. Emmons, L. Horowitz, and D. Kinnison, 2002: Effects of aerosols on tropospheric oxidants: A global model study. *J. Geophys. Res.*, **106**, 22931-22964.
18. Cunnold, D.M., L.P. Steele, P.J. Fraser, P.G. Simmonds, R.G. Prinn, R.F. Weiss, L.W. Porter, S. O'Doherty, R.L. Langenfelds, P.B. Krummel, H.J. Wang, L.K. Emmons, X.X. Tie, and E.J. Dlugokencky, 2002: In situ measurements of atmospheric methane at GAGE/AGAGE sites during 1985-2000 and resulting source inferences. *J. Geophys. Res.*, **107(D14)**, doi: 10.1029/2001JD0001226.

19. Tie, X.X., L.K. Emmons, L. Horowitz, G. Brasseur, B. Ridley, E. Atlas, C. Stroud, P. Hess, A. Klonecki, S. Madronich, R. Talbot, and J. Dibb, 2003: Effect of sulfate aerosol on tropospheric NO_x and ozone budgets: Model simulations and TOPSE evidence. *J. Geophys. Res.*, **108(D4)**, 8364, doi: 10.1029/2001JD001508.
20. Emmons, L.K., P. Hess, A. Klonecki, X. Tie, L. Horowitz, J.-F. Lamarque, D. Kinnison, G. Brasseur, E. Atlas, E. Browell, C. Cantrell, F. Eisele, R. Mauldin, J. Merrill, B. Ridley, and R. Shetter, 2003: Budget of tropospheric ozone during TOPSE from two chemical transport models. *J. Geophys. Res.*, **108(D8)**, 8372, doi: 10.1029/2002JD002665.
21. Lamarque, J.-F., D. Edwards, L.K. Emmons, J. Gille, O. Wilhelm, C. Gerbig, D. Prevedel, M. Deeter, J. Warner, D. Ziskin, B. Khattatov, G. Francis, V. Yudin, S. Ho, D. Mao, J. Chen, and J. Drummond, 2003: Identification of CO plumes from MOPITT data: Application to the August 2000 Idaho-Montana forest fires. *Geophys. Res. Lett.*, **30(13)**, 1688, doi: 10.1029/2003GL017503.
22. Ridley, B., E. Atlas, D. Montzka, E. Browell, C. Cantrell, D. Blake, N. Blake, L. Cinquini, M. Coffey, L.K. Emmons, R. Cohen, R. DeYoung, J. Dibb, F. Eisele, F. Flocke, A. Fried, F. Grahek, W. Grant, J. Hair, J. Hannigan, B. Heikes, B. Lefer, R. Mauldin, J. Moody, R. Shetter, J. Snow, R. Talbot, J. Thornton, J. Walega, A. Weinheimer, B. Wert, and A. Wimmers, 2003: Ozone depletion events observed in the high latitude surface layer during the TOPSE aircraft program. *J. Geophys. Res.*, **108(D4)**, 8356, doi: 10.1029/2001JD001507.
23. Browell, E., J. Hair, C. Butler, W. Grant, R. DeYoung, M. Fenn, V. Brackett, M. Clayton, L. Brasseur, D. Harper, B. Ridley, A. Klonecki, P. Hess, L.K. Emmons, X.X. Tie, E. Atlas, C. Cantrell, A. Wimmers, D. Blake, M. Coffey, J. Hannigan, J. Dibb, R. Talbot, F. Flocke, A. Weinheimer, A. Fried, B. Wert, J. Snow, and B. Lefer, 2003: Ozone, aerosol, potential vorticity, and trace gas trends observed at high-latitudes over North America from February to May 2000. *J. Geophys. Res.*, **108(D4)**, 8369, doi: 10.1029/2001JD001390.
24. Klonecki, A., P. Hess, L.K. Emmons, L. Smith, J. Orlando, and D. Blake, 2003: Seasonal changes in the transport of pollutants into Arctic troposphere-model study. *J. Geophys. Res.*, **108(D4)**, 8367, doi: 10.1029/2002JD002199.
25. Edwards, D., J.-F. Lamarque, J.-L. Attie, L.K. Emmons, A. Richter, J.-P. Cammas, J. Gille, G. Francis, M. Deeter, J. Warner, D. Ziskin, L. Lyjak, J. Drummond, and J. Burrows, 2003: Tropospheric ozone over the tropical Atlantic: A satellite perspective. *J. Geophys. Res.*, **108(D8)**, 4237, doi: 10.1029/2002JD002927.
26. Deeter, M., L.K. Emmons, G. Francis, D. Edwards, J. Gille, J. Warner, B. Khattatov, D. Ziskin, J.-F. Lamarque, S.-P. Ho, V. Yudin, J.-L. Attie, D. Packman, J. Chen, D. Mao, and J. Drummond, 2003: Operational carbon monoxide retrieval algorithm and selected results for the MOPITT instrument. *J. Geophys. Res.*, **108(D14)**, 4399, doi: 10.1029/2002JD003186.
27. Jacob, D., J. Crawford, M. Kleb, V. Connors, R. Bendura, J. Raper, G. Sachse, J. Gille, L.K. Emmons, and C. Heald, 2003: The transport and chemical evolution over the Pacific (TRACE-P) mission: Design, execution, and first results. *J. Geophys. Res.*, **108(D20)**, 9000, doi: 10.1029/2002JD003276.
28. Horowitz, L., S. Walters, D. Mauzerall, L.K. Emmons, P. Rasch, C. Granier, X.X. Tie, J.-F. Lamarque, M. Schultz, G. Tyndall, J. Orlando, and G. Brasseur, 2003: A global simulation

- of tropospheric ozone and related tracers: Description and evaluation of MOZART, version 2. *J. Geophys. Res.*, **108(D24)**, 4784, doi: 10.1029/2002JD002853.
29. Heald, C., D. Jacob, A. Fiore, L.K. Emmons, J. Gille, M. Deeter, J. Warner, D. Edwards, J. Crawford, A. Hamlin, G. Sachse, E. Browell, M. Avery, S. Vay, D. Westberg, D. Blake, H. Singh, S. Sandholm, R. Talbot, and H. Fuelberg, 2003: Asian outflow and trans-Pacific transport of carbon monoxide and ozone pollution: An integrated satellite, aircraft, and model perspective. *J. Geophys. Res.*, **108(D24)**, 4804, doi: 10.1029/2003JD003507.
 30. Emmons, L.K., M. Deeter, J. Gille, D. Edwards, J.-L. Attie, J. Warner, D. Ziskin, G. Francis, B. Khattatov, V. Yudin, J.-F. Lamarque, S.-P. Ho, D. Mao, J. Chen, J. Drummond, P. Novelli, G. Sachse, M. Coffey, J. Hannigan, C. Gerbig, S. Kawakami, Y. Kondo, N. Takegawa, H. Schlager, J. Baehr, and H. Ziereis, 2004: Validation of Measurements of Pollution in the Troposphere (MOPITT) CO retrievals with aircraft in situ profiles. *J. Geophys. Res.*, **109**, D03309, doi: 10.1029/2003JD004101.
 31. Deeter, M., L.K. Emmons, G. Francis, D. Edwards, J. Gille, J. Warner, B. Khattatov, D. Ziskin, J.-F. Lamarque, S.-P. Ho, V. Yudin, J.-L. Attie, D. Packman, J. Chen, D. Mao, J. Drummond, P. Novelli, and G. Sachse, 2004: Evaluation of operational radiances for the Measurements of Pollution in the Troposphere (MOPITT) instrument CO thermal band channels. *J. Geophys. Res.*, **109**, D03308, doi: 10.1029/2003JD003970.
 32. Deeter, M., L.K. Emmons, D. Edwards, J. Gille, and J. Drummond, 2004: Vertical resolution and information content of CO profiles retrieved by MOPITT. *Geophys. Res. Lett.*, **31**, L15112, doi: 10.1029/2004GL020235.
 33. Lamarque, J.-F., B. Khattatov, V. Yudin, D. Edwards, J. Gille, L.K. Emmons, M. Deeter, J. Warner, D. Ziskin, G. Francis, S. Ho, D. Mao, J. Chen, and J. Drummond, 2004: Application of a bias estimator for the improved assimilation of Measurements of Pollution in the Troposphere (MOPITT) carbon monoxide retrievals. *J. Geophys. Res.*, **109**, D16304, doi: 10.1029/2003JD004466.
 34. Ridley, B., L. Ott, K. Pickering, L.K. Emmons, D. Montzka, A. Weinheimer, D. Knapp, F. Grahek, L. Li, G. Heymsfield, M. McGill, P. Kucera, M. Mahoney, D. Baumgardner, M. Schultz, and G. Brasseur, 2004: Florida thunderstorms: A faucet of reactive nitrogen to the upper troposphere. *J. Geophys. Res.*, **109**, D17305, doi: 10.1029/2004JD004769.
 35. Crawford, J., C. Heald, H. Fuelberg, D. Morse, G. Sachse, L.K. Emmons, J. Gille, D. Edwards, M. Deeter, G. Chen, J. Olson, V. Connors, C. Kittaka, and A. Hamlin, 2004: Relationship between Measurements of Pollution in the Troposphere (MOPITT) and in situ observations of CO based on a large-scale feature sampled during TRACE-P. *J. Geophys. Res.*, **109**, D15S04, doi: 10.1029/2003JD004308.
 36. Pfister, G., G. Pétron, L.K. Emmons, J. Gille, D. Edwards, J.-F. Lamarque, J.-L. Attie, C. Granier, and P. Novelli, 2004: Evaluation of CO simulations and the analysis of the CO budget for Europe. *J. Geophys. Res.*, **109**, D19304, doi: 10.1029/2004JD004691.
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Other refereed publications

1. Penkett, S.A., K.S. Law, T. Cox, and P. Kasibhatla, 2003: Atmospheric Photooxidants in *Atmospheric Chemistry in a Changing World*, G.P. Brasseur, R.G. Prinn, A.A.P. Pszenny (eds.), Springer-Verlag, Berlin. (contributing author)
2. Emmons, L., C. Granier, G. Brasseur, 2005: Importance of chemistry for climate, in *Landolt-Börnstein/New Series, Vol. V/6, Observed Global Climate*, Springer.

Journal articles submitted or in preparation

1. Emmons, L.K., J.J. Orlando, G. Tyndall, C. Knote: Expansion of the MOZART tropospheric chemistry mechanism, in preparation for *Geosci. Model Dev.*

Internally refereed publications

1. Al-Saadi, Jassim, Gregory Carmichael, James Crawford, Louisa Emmons, Saewung Kim, Chang-Keun Song, Lim-Seok Chang, Gangwoong Lee, Jhoon Kim, Rokjin Park, *NASA Contributions to KORUS-AQ: An International Cooperative Air Quality Field Study in Korea*, whitepaper, Feb 2015. (Available at: https://espo.nasa.gov/home/korus-aq/content/KORUS-AQ_Science_Overview_0).
2. Emmerson, Kathryn, Jenny Fisher, Clare Murphy, Stephen Wilson, Alex Guenther, Louisa Emmons, Eric Apel, Christine Wiedinmyer, *COALA: Characterizing Organics and Aerosol Loading over Australia, White Paper for a tropospheric chemistry field campaign in Southeast Australia*, draft July 2016. (Available at: https://www2.acom.ucar.edu/sites/default/files/accord/COALA_whitepaper_20160707.pdf).

Non-refereed publications

Invited conference presentations and seminars

1. Climatologies of NO_x, NO_y and O₃, *Combined IGAC Meeting: Global Integration and Modeling (GIM)/Global Emissions Inventory Activity (GEIA)/Global Atmospheric Chemistry Survey (GLOCHEM)*, Fairfax, VA, December 6-8, 1995.
2. Data composites of tropospheric ozone and its precursors, *GMI Meeting*, Washington, D.C., Jan 4-6, 2000.
3. Using satellite and *in situ* observations with model simulations to examine tropospheric ozone chemistry, ACD seminar for Scientist I application, Nov 26, 2002.
4. Examining the tropospheric carbon monoxide budget with MOPITT, MOZART and isotopes, State University of New York at Stony Brook, Oct. 1, 2003.
5. Identification of source contributions using carbon-13 isotopes of CO and HCs from observations and MOZART, NOAA Aeronomy Lab, Oct. 13, 2004.
6. C-13 Isotopes for the Determination of Source Contributions, Max Planck Institute for Meteorology, Hamburg, Mar 1, 2005.
7. MOZART and MOPITT in Support of MIRAGE and INTEX-B, ACD Seminar, Oct. 9, 2006.
8. Context for ARCTAS from MOPITT and MOZART, Atmospheric Sciences, Harvard University, May 22, 2009.
9. Pollution in the Arctic: Its Sources and Transport Pathways, NESL/ACD Seminar, March 8, 2010.
10. Pollution in the Arctic: Its Sources and Transport Pathways, NOAA GFDL Seminar, April 7, 2011.
11. Integration of models, satellite observations and aircraft measurements, *CARIBIC Seeheim Workshop 2011*, Seeheim, Germany, 5 October 2011.
12. Interpretation of POLARCAT observations with Models and Satellites, University of Oslo Seminar, 13 February 2012.
13. Integration of Field Campaign and Satellite Observations with Chemistry Models, Pacific Northwest National Lab Seminar, 25 October 2013.
14. Integration of Field Campaign and Satellite Observations with Chemistry Models, Washington State University Seminar, 28 October 2013.
15. Integration of Field Campaign and Satellite Observations with Chemistry Models, University of California-Irvine Seminar, 4 December 2013.

16. Characterization of sources and chemical transformations of volatile organic compounds, *AGU 2013 Fall Meeting*, San Francisco, CA, 13 December 2013.
17. Long-range transport of pollution to the Arctic, *Arctic Air Pollution – Advancing Understanding in the Next Decade, Joint IASC/IGAC Workshop*, University of Colorado, Boulder, 3 February 2015.
18. Characterizing Emissions and Chemical Evolution from Aircraft, *Atmospheric Composition & Chemistry Observations & Modelling Conference and Cape Grim Annual Science Meeting 2015*, Murrumbidgee, NSW, Australia, 11-13 Nov 2015.
19. Evaluation of emissions and chemical evolution of biogenic VOCs in global chemical models, *Gordon Research Conference on Biogenic Hydrocarbons & the Atmosphere*, Girona, Spain, Jun 26-Jul 1, 2016.

Presentations at conferences

1. Observed changes in the vertical profile of stratospheric nitrous oxide at Thule, Greenland in February-March, 1992, Ozone in the Troposphere and Stratosphere, *Proceedings of the 1992 Quadrennial Ozone Symposium*, ed. Robert D. Hudson, NASA Conference Publication 3266, 543, 1994. (poster)
2. Climatologies from the NO_x, NO_y Data Archive, *5th Annual Meeting on NASA Atmospheric Effects of Aviation Project*, Virginia Beach, VA, April 23-28, 1995. (talk)
3. Data-based climatologies of tropospheric carbon monoxide and ozone, *Eos Trans. AGU*, 79(17), Spring Meet. Suppl., S203, 1998. (talk)
4. Evidence of transport across the Indian Ocean of ozone produced from biomass burning and lightning, *Eos Trans. AGU*, 79(45), Fall Meet. Suppl., F111, 1998. (talk)
5. Data composites of tropospheric ozone and precursors, *The 1999 Conference on the Atmospheric Effects of Aviation*, Virginia Beach, VA, April 19-23, 1999. (talk)
6. The budget of tropospheric ozone during TOPSE, *Eos Trans. AGU*, 82(20), Spring Meet. Suppl., S30, 2001. (talk)
7. Validation of MOPITT Retrievals of CO and CH₄, *IGARSS 2002*, Toronto, Ont., Canada, June 24-28, 2002. (poster)
8. The distribution of tropospheric carbon monoxide observed by MOPITT, *7th Scientific Conference of the International Global Atmospheric Chemistry Project (IGAC)*, Crete, Sept. 18-25, 2002. (talk)
9. Use of carbon isotopes in the analysis of the tropospheric carbon monoxide budget, *Eos Trans. AGU*, 84(46), Fall Meet. Suppl., Abstract A42F-03, 2003. (poster)
10. Validation of four years of MOPITT CO retrievals with independent measurements, *2004 Joint Assembly*, Montreal, Canada, 17-21 May, 2004. (poster)
11. Identification of source contributions using carbon-13 isotopes of CO and HCs, *European Geosciences Union 1st General Assembly*, Nice, France, 25-30 April 2004. (talk)
12. Global modeling of C-13 isotopes of CO and VOCs, *Gordon Research Conference on Biogenic Hydrocarbons & the Atmosphere*, Il Ciocco, Barga, Italy, May 2-7, 2004. (poster)
13. Improving CO emissions using ¹³C/¹²C fractions in observations and MOZART, *8th International Global Atmospheric Chemistry Conference*, Christchurch, New Zealand, 4-9 September 2004. (poster)

14. Sensitivity of Chemical Budgets to Meteorology in MOZART-4, *AGU 2006 Fall Meeting*, San Francisco, CA, 11-15 December 2006. (poster)
15. Use of MOPITT data and modeling during the INTEX-B Pacific operation flight planning and analysis, *NASA INTEX-B Data Review Meeting*, Virginia Beach, VA, 6-8 March 2007.
16. Biomass burning (& anthropogenic) emissions, *NASA Future Activities meeting*, Virginia Beach, VA, 8-9 March 2007. (talk)
17. Impacts of Megacities on Regional Air Quality from MOPITT Observations and MOZART Model Results, *AGU 2007 Joint Assembly*, Acapulco, Mexico, 22-25 May 2007. (talk)
18. Evaluation of Air Quality Predictions from MOZART-4, *AGU 2007 Fall Meeting*, San Francisco, CA, 10-14 December 2007. (talk)
19. Impact of Mexico City on Regional Air Quality from MOZART-4 simulations and MILAGRO observations, *IGAC 10th International Conference*, Annecy, France, 7-12 September 2008. (talk)
20. Budget of Tropospheric Ozone during Spring in the Arctic, Abstract A33F-08, *AGU 2009 Fall Meeting*, San Francisco, CA, 16 December 2009. (talk)
21. Source contributions to Carbon Monoxide, Black Carbon and Ozone distributions in the Arctic, *IGAC Conference*, Halifax, NS, 12-16 July 2010. (poster)
22. Global chemical forecasts with MOZART-4 and MOPITT CO, *International Workshop on Air Quality Forecasting Research*, Quebec City, Canada, 16-18 November 2010. (talk)
23. Design and Implementation of an Integrated Study to Investigate the Regional Impact of Megacities and Biogenic Emissions in East Asia, *Regional Earth System Modeling and Analysis Symposium*, Beijing, China, 18 May 2011. (talk)
24. Evaluation of Volatile Organic Compound Emissions from Megacities and Wildfires, *AGU 2011 Fall Meeting*, San Francisco, CA, 9 December 2011. (talk)
25. Evaluating the tropospheric ozone budget as part of The POLARCAT Model Intercomparison Project (POLMIP), *AGU 2012 Fall Meeting*, San Francisco, CA, 7 December 2012. (poster)
26. Summary and evaluation of tropospheric ozone in the NCAR CESM simulations for CCMI, *Chemistry-Climate Model Initiative Workshop*, Lancaster, UK, 20-22 May 2014. (poster)
27. Evaluation of VOC Speciation in Emissions Inventories, *16th GEIA Conference: Bridging Emissions Science and Policy*, Boulder, CO, 10-11 June 2014. (poster)
28. Evaluation of Biogenic and Fire Emissions in a Global Chemistry Model with NOMADSS, DC3 and SEAC4RS Observations, *AGU 2014 Fall Meeting*, San Francisco, CA, 15-19 December 2014. (talk)
29. Model evaluation of hydrocarbons for CCMI, *IGAC/SPARC Chemistry-Climate Model Initiative Workshop*, Rome, Italy, 7-9 Oct 2015. (poster)
30. Limitations of Global models in Representing Arctic Tropospheric Ozone and its Precursors, *AGU 2015 Fall Meeting*, San Francisco, CA, 14-18 December 2015. (poster)