

Michael J. Mills

Atmospheric Chemistry Observations & Modeling Laboratory
National Center for Atmospheric Research
P.O. Box 3000, Boulder, CO 80307-3000

Telephone: (303) 497-1425
Email: mmills@ucar.edu
<http://www.acd.ucar.edu/~mmills>

EDUCATION

University of Colorado, Ph.D., Atmospheric Science, 1996

Advisor: Susan Solomon

University of Colorado, M.S., Atmospheric Science, 1993

Massachusetts Institute of Technology, S.B., Earth, Atmospheric, and Planetary Sciences, 1989

HONORS AND AWARDS

- | | |
|-----------|--|
| 2016 | Special Recognition Award
NCAR Climate and Global Dynamics Laboratory |
| 2016 | Walter O. Roberts Scientific and Technical Advancement Award
NCAR High Altitude Observatory |
| 2006 | Marinus Smith Teaching Award
University of Colorado Parents Association |
| 2005 | NASA EOS Aura Mission Contribution Award |
| 2003 | Teaching Service Award
University of Colorado at Boulder |
| 1996 | Outstanding Scientific Paper Award
NOAA Environmental Research Laboratories |
| 1995 | Atmospheric Chemistry Colloquium for Emerging Senior Scientists |
| 1993 | Outstanding Scientific Paper Award
NOAA Environmental Research Laboratories |
| 1992-1995 | NASA Global Change Fellowship |
| 1985 | Valedictorian of high school class numbering 341 |

RESEARCH/PROFESSIONAL EXPERIENCE

Project Scientist, NCAR, January 2010-present

Community Liaison for the Whole Atmosphere Community Climate Model (WACCM), Jan 2010-present

Research Scientist, LASP, University of Colorado, May 1997-January 2010

Graduate research assistant, NOAA Aeronomy Laboratory, September 1990-December 1996

RESEARCH SUMMARY

Dr. Mills is a leading expert on the microphysics of stratospheric aerosol, stratospheric ozone chemistry, and climate. He has worked on modeling chemistry, dynamics, and aerosol microphysics in the middle atmosphere for over 20 years. He served as a co-author of the 2006 SPARC Assessment of Stratospheric Aerosol Properties. He published the first paper showing how a limited nuclear war between India and Pakistan could produce catastrophic loss of stratospheric ozone globally, lasting a decade. He has also published work on the effects of black carbon emissions from planned suborbital rocket launches for space tourism and scientific research on the radiative balance of the Earth, stratospheric circulation and ozone distribution, and climate. His other work suggested that high-energy cosmic rays from dense interstellar clouds caused catastrophic ozone depletion and mass extinctions in the past, during periods of magnetic reversal on Earth. He helped develop a semi-empirical method for evaluating ozone depletion potentials, which helped insure

Michael J. Mills

that the dramatic depletions in ozone at the Earth's poles are correctly accounted for in evaluating substances controlled by the Montreal Protocol protecting the ozone layer. His work also showed how volcanic eruptions affect stratospheric ozone globally, and how their chemical impacts saturate at high aerosol loading. His work has taken him below the Antarctic Circle and above the Arctic Circle.

CLASSES TAUGHT

Fall 2004 & 2005 Air Chemistry and Pollution, University of Colorado, undergraduate
Spring 2003 Principles of Climate, University of Colorado undergraduate
Fall 2001 General Chemistry 2, University of Colorado undergraduate

FIELD CAMPAIGNS

January 2000 SAGE III Ozone Loss Validation Experiment, Kiruna, Sweden
August-October 1992 UV-visible spectroscopy measurements of the ozone hole, McMurdo Station, Antarctica

SELECTED PRESENTATIONS

Global Famine after a Regional Nuclear War: Overview of Recent Research, *Vienna Conference on the Humanitarian Implications of Nuclear Weapons*, December 2014 (invited).

SELECTED PUBLICATIONS

- Ivy, D. J., S. Solomon, D. E. Kinnison, **M. J. Mills**, A. Schmidt, and R. R. Neely III (2017), The influence of the Calbuco eruption on the 2015 Antarctic ozone hole in a fully coupled chemistry-climate model, *Geophys Res Lett*, doi:10.1002/2016GL071925.
- Hervig, M. E., C. G. Bardeen, D. E. Siskind, **M. J. Mills**, and R. Stockwell (2017), Meteoric smoke and H₂SO₄ aerosols in the upper stratosphere and mesosphere, *Geophys Res Lett*, doi:10.1002/2016GL072049.
- Solomon, S. et al. (2016), Monsoon circulations and tropical heterogeneous chlorine chemistry in the stratosphere, *Geophys Res Lett*, 43(24), 12,624–12,633, doi:10.1002/2016gl071778.
- Solomon, S., D. J. Ivy, D. E. Kinnison, **M. J. Mills**, R. R. Neely III, and A. Schmidt (2016), Emergence of healing in the Antarctic ozone layer, *Science*, 353(6296), aae0061–274, doi:10.1126/science.aae0061.
- Zanchettin, D. et al. (2016), The Model Intercomparison Project on the climatic response to Volcanic forcing (VolMIP): experimental design and forcing input data for CMIP6, *Geosci Model Dev*, 9(8), 2701–2719, doi:10.5194/gmd-9-2701-2016.
- Mills, M. J.** et al. (2016) Global volcanic aerosol properties derived from emissions, 1990–2014, using CESM1(WACCM), *J Geophys Res-Atmos*, 121, 2332–2348, doi:10.1002/2015JD024290.
- Yu, P., O. B. Toon, C. G. Bardeen, **M. J. Mills**, T. Fan, J. M. English, and R. R. Neely III (2015), Evaluations of tropospheric aerosol properties simulated by the community earth system model with a sectional aerosol microphysics scheme, *J. Adv. Model. Earth Syst.*, 7(2), 865–914, doi:10.1002/2014MS000421.
- Duderstadt, K. A., J. E. Dibb, C. H. Jackman, C. E. Randall, S. C. Solomon, **M. J. Mills**, N. A. Schwadron, and H. E. Spence (2014), Nitrate deposition to surface snow at Summit, Greenland, following the 9 November 2000 solar proton event, *J Geophys Res-Atmos*, 119(11), 6938–6957, doi:10.1002/2013JD021389.

Michael J. Mills

- Tilmes, S., **M. J. Mills**, U. Niemeier, H. Schmidt, A. Robock, B. Kravitz, J.-F. Lamarque, G. Pitari, and J. M. English (2015), A new Geoengineering Model Intercomparison Project (GeoMIP) experiment designed for climate and chemistry models, *Geosci Model Dev*, 8(1), 43–49, doi:10.5194/gmd-8-43-2015.
- Xia, L., A. Robock, **M. J. Mills**, A. Stenke, and I. Helfand (2015), Decadal reduction of Chinese agriculture after a regional nuclear war, *Earth's Future*, 3(3), 37–48, doi:10.1002/2014EF000283.
- Zhu, Y., O. B. Toon, A. Lambert, D. E. Kinnison, M. Brakebusch, C. G. Bardeen, **M. J. Mills**, and J. M. English (2015), Development of a Polar Stratospheric Cloud Model within the Community Earth System Model using constraints on Type I PSCs from the 2010–2011 Arctic winter, *J. Adv. Model. Earth Syst.*, 7(2), 551–585, doi:10.1002/2015MS000427.
- Mills, M. J.** et al. (2014), Multidecadal global cooling and unprecedented ozone loss following a regional nuclear conflict, *Earth's Future*, 2(4), 161–176, doi:10.1002/2013EF000205.
- Campbell, P., **M. J. Mills**, and T. Deshler (2014), The Global Extent of the Mid Stratospheric CN Layer: A Three-Dimensional Modeling Study, *J Geophys Res-Atmos*, 1–16, doi:10.1002/2013JD020503.
- Tilmes, S., and **M. J. Mills** (2014), Stratospheric Sulfate Aerosols and Planetary Albedo, in *Global Environmental Change*, edited by B. Freedman, pp. 771–776, Springer Netherlands, Dordrecht.
- Marsh, D. R., **M. J. Mills**, D.E. Kinnison, J.-F. Lamarque, N. Calvo, and L. M. Polvani (2013), Climate change from 1850 to 2005 simulated in CESM1(WACCM), 73727391, *Journal of Climate*, 26(19), doi:10.1175/JCLI-D-12-00558.1.
- Tilmes, S. et al. (2013), The hydrological impact of geoengineering in the Geoengineering Model Intercomparison Project (GeoMIP), *J Geophys Res-Atmos*, 118(1), 11036–11058, doi:10.1002/jgrd.50868.
- Neely, R. R., III et al. (2013), Recent anthropogenic increases in SO₂ from Asia have minimal impact on stratospheric aerosol, *J Geophys Res*, 40(5), 999–1004, doi:10.1002/grl.50263.
- English, J. M., O. B. Toon, and **M. J. Mills** (2013), Microphysical simulations of large volcanic eruptions: Pinatubo and Toba, *J Geophys Res-Atmos*, 118(4), 1–16, doi:10.1002/jgrd.50196.
- Calvo, N., R. R. Garcia, D. R. Marsh, **M. J. Mills**, D. E. Kinnison, and P. J. Young (2012), Reconciling modeled and observed temperature trends over Antarctica, *Geophys Res Lett*, 39(16), n/a–n/a, doi:10.1029/2012GL052526.
- English, J. M., O. B. Toon, and M. J. Mills (2012), Microphysical simulations of sulfur burdens from stratospheric sulfur geoengineering, *Atmos Chem Phys*, 12(1), 4775–4793, doi:10.5194/acp-12-4775-2012.
- English, J. M., O. B. Toon, M. J. Mills, and F. Yu (2011), Microphysical simulations of new particle formation in the upper troposphere and lower stratosphere, *Atmos Chem Phys*, 11(1), 9303–9322, doi:10.5194/acp-11-9303-2011.
- Neely, R. R., III, J. M. English, O. B. Toon, S. Solomon, **M. J. Mills**, and J. P. Thayer (2011), Implications of extinction due to meteoritic smoke in the upper stratosphere, *Geophys Res Lett*, 38(2), 24808–n/a, doi:10.1029/2011GL049865.
- Wheeler, D. D., V. L. Harvey, D. E. Atkinson, R. L. Collins, and **M. J. Mills** (2011), A climatology of cold air outbreaks over North America: WACCM and ERA-40 comparison and analysis, *J Geophys Res-Atmos*, 116(D), 12107, doi:10.1029/2011JD015711.
- Ross, M., **M. Mills**, and D. Toohey (2010), *Geophys. Res. Lett.*, Potential climate impact of black carbon emitted by rockets, 37, L24810, doi:10.1029/2010GL044548.

Michael J. Mills

- Fang, X., C. E. Randall, D. Lummerzheim, S. C. Solomon, **M. J. Mills**, D. R. Marsh, C. Jackman, W. Wang, and G. Lu (2008), Electron impact ionization: A new parameterization for 100 eV to 1 MeV electrons, *J Geophys Res*, 113.
- Karlsson, B., C. E. Randall, S. Benze, **M. J. Mills**, V. L. Harvey, S. M. Bailey, and J. M. Russell III (2009), Intra-seasonal variability of polar mesospheric clouds due to inter-hemispheric coupling, *Geophys Res Lett*, 36(20), 20802, doi:10.1029/2009GL040348.
- Mills, M.J.** et al. (2008), Massive global ozone loss predicted following regional nuclear conflict, *Proceedings of the National Academy of Sciences*, doi:10.1073/pnas.0710058105.
- Kjaergaard, H. G., J. R. Lane, A. L. Garden, D. P. Schofield, T. W. Robinson, and **M. J. Mills** (2008), Atmospheric photolysis of sulfuric acid, *Adv Quantum Chem*, 55, 137–158, doi:10.1016/S0065-3276(07)00208-0.
- SPARC (2006), *SPARC Assessment of stratospheric aerosol properties (ASAP)*, edited by L. W. Thomason and T. Peter.
- Mills, M.J.**, O. B. Toon, G. E. Thomas (2005), Mesospheric sulfate aerosol layer, *J. Geophys. Res.*, 110, D24208, doi:10.1029/2005JD006242.
- Pavlov, A.A., **M.J. Mills**, O.B. Toon (2005), Sulfur mass independent fractionation in the oxidizing atmosphere, *Geophys. Res. Lett.*, 32 (L12816), doi:10.1029/2005GL022784.
- Mills, M. J.** et al. (2005), Photolysis of sulfuric acid vapor by visible light as a source of the polar stratospheric CN layer, *J. Geophys. Res.*, 110 (D08201), doi:10.1029/2004JD005519.
- Pavlov, A. A., A. K. Pavlov, **M. J. Mills**, V. M. Ostryakov, G. I. Vasilyev, and O. B. Toon (2005), Catastrophic ozone loss during passage of the Solar system through an interstellar cloud, *Geophys Res Lett*, 32, 01815, doi:10.1029/2004GL021601.
- Mills, M.J.**, Volcanic aerosol and global atmospheric effects, *Encyclopedia of Volcanoes*, Haraldur Sigurdsson, ed., 1999.
- Mills, M.J.**, O.B. Toon, and S. Solomon, A 2D microphysical model of the polar stratospheric CN layer, *Geophys. Res. Lett.*, 26 (8), 1133-1136, 1999.
- Ravishankara, A. R., A. A. Turnipseed, N. R. Jensen, S. Barone, **M. J. Mills**, C. J. Howard, and S. Solomon (1994), Do Hydrofluorocarbons Destroy Stratospheric Ozone? *Science*, 263(5143), 71–75, doi:10.1126/science.263.5143.71.
- Mills, M.J.** et al., On the relationship between stratospheric aerosols and nitrogen dioxide, *Geophys. Res. Lett.*, 20, 1187-1190, 1993.
- Mellouki, A., R. Talkadar, A. Schmoltner, T. Gierczak, **M. J. Mills**, S. Solomon, And A. R. Ravishankara (1992), Atmospheric Lifetimes and Ozone Depletion Potentials of Methyl-Bromide (CH₃Br) and Dibromomethane (CH₂Br₂), *Geophys Res Lett*, 19(20), 2059–2062.
- Pollock, W. H., L. Heidt, R. Lueb, J. Vedder, **M. J. Mills**, And S. Solomon (1992), On the Age of Stratospheric Air and Ozone Depletion Potentials In Polar-Regions, *J Geophys Res*, 97(D12), 12993–12999.
- Solomon, S., A. F. Tuck, **M. J. Mills**, L. E. Heidt, and W. H. Pollock (1992), On the evaluation of ozone depletion potentials, *Journal of Geophysical Research*, 97, 825.