Akkihebbal Ramaiah RAVISHANKARA

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Education

Ph.D., Physical Chemistry, University of Florida, Gainesville, FL	1975
M.Sc., Physical Chemistry, University of Mysore, India	1970
B.Sc., Physics and Chemistry, University of Mysore, India	1968

Employment History

University Distinguished Professor, Colorado State University	2017- to present
Professor, Colorado State University	Jan 2014- to present
National Oceanic and Atmospheric Administration	
Director, Chemical Sciences Division,	
Earth System Research Laboratory	Apr 2007–Jan 2014
Acting Director, Chemical Sciences Division, ESRL	Mar 2006–Apr 2007
Senior Executive Service (SES)	Mar 2007–Jan 2014
Senior Scientist (ST)	1997–Mar 2007
Chief, Atmospheric Chemical Kinetics Program	1993–Oct 2007
Supervisory Research Chemist	1992–1997
Research Chemist	1984–1992
University of Colorado–Boulder	
Professor of Chemistry, Adjoint	1989–2012
Georgia Institute of Technology	
Head of Molecular Sciences Branch, Georgia Tech Research Inst	1979–1985
Principal Research Scientist (equivalent to Professor)	1983–1985
Senior Research Scientist (equivalent to Associate Prof.)	1980–1983
Research Scientist II (equivalent to Assistant Prof.)	1976–1980
University of Maryland, Research Associate (post-doc)	1976

Current Fields of Interest

Atmospheric chemistry; chemical kinetics; photochemistry; heterogeneous and multiphase chemistry; aerosol formation and properties; measurement of atmospheric constituents; interpretation of atmospheric models; health and air quality; scientific information for policy decisions

Awards and Recognition over the past 25 years

Foreign Fellow of the Indian National Science Academy	2021
Walter Orr Roberts Lecture, UCAR, Boulder	2020
InfoSys Research Professor, Indian Institute of Science, India	2019-present
Foreign Member of the Royal Society (London)	2019

Fudan Distinguished Scholar, Fudan University, Shanghai, China	2019
Marie Curie-Sklodowska Research Professor, Le Studium Loire Valley Advanced Research Institute,	2017-present
Scientific Leadership award:Montreal Protocol(30th Anniversary)	2017
Honorary Doctorate, University of York, UK	2017
Gordon Lecturer, University of Toronto, Toronto, Canada	2015
York University Public Lecturer, York, UK	2014
NOAA Administrator's Award	2014
Crandell Lecturer, University of Texas, Arlington	2013
Harold Schiff Memorial Lecturer, Univ. of York	2012
US Department of Commerce, Bronze Medal	2012
Hinshelwood Lecturer, University of Oxford, UK	2010
Morino Foundation Fellow, Japan	2009
Welch Foundation Lecturer, Texas	2009
Centenary Lecturer, Indian Institute of Science, India	2008
Fellow, International Union of Pure and Applied Chemistry	2008
NOAA Administrator's award	2008
US Department of Commerce, Bronze Medal	2008
US Department of Commerce, Bronze Medal	2007
Fellow, Royal Society of Chemistry (United Kingdom)	2005
Chancellor Lecturer, Louisiana State University	2005
American Chemical Society's Award on Creative Advances in Environmental Sciences	2005
US Presidential Rank Meritorious Award for a senior professional	2004
Royal Society of Chemistry (UK) Centenary Lecturer	2003
Crawford Lecture, University of Minnesota	2003
Fellow, American Association for the Advancement of Science	2001
Elected to US National Academy of Sciences	2000
Robertson Memorial Lecturer and medal, US National Academy of Sciences	1999
Polanyi Medal of Royal Society of Britain (Gas Kinetics Division)	1998
Fellow, American Geophysical Union	1997
US EPA, Stratospheric Ozone Protection Award	1996
US Department of Commerce, Silver Medal	1995
Multiple NOAA/OAR Outstanding Scientific Paper Awards	1995–2011

Major External Activities over the past 25 years

Member, Physical Sciences Prize InfoSys Prize, Bengaluru, India	2017-present
Co-Chair, NSF Site Visit Committee to review University Corporation for Atmospheric Research	2016
Member of Editorial Board of PNAS, US National Academy of Sciences	2016-present
Chair, Vienna Trust Fund Advisory Panel, UNEP	2015-present
Chair, Board on Atmospheric Science and Climate of the US National Academy of Science	2015- 2020
Member Editorial Board, CHEM	2015- 2018

Member Editorial Advisory Board, ACS Central Science	2015-2016
Member Editorial Advisory Board, Current Science, India	2014-present
Member, National Academy of Sciences Committee on "A strategic vision for NSF investments in Antarctic and southern ocean research, NRC	2008–2010
Member, Science Advisory Panel Climate and Clean Air Coalition (CCAC) of United Nations Environment Programme	2013- present
Chair, Review panel on climate and atmosphere, Helmholtz Association, Germany	2012-2013
Air Quality Research Subcommittee of the Committee on Environment and Natural Resources, US Government	2012-2014
Co-chair, Scientific Assessment Panel of the Montreal Protocol	2007–2015
Member, Advisory Editorial Board, *Physical Chem. Chem. Phys.*	2003–2015
Member, Board of the International Atmospheric Chemistry Society	2010–2018
Guest Editor, *Chemical Reviews*, Issue on Role of Chemistry in Climate	2014-2015
Co-Chair, Interagency Working Group on Atmospheric Composition, US Climate Change Science Program (CCSP)	2005–2011
Member, National Academy of Sciences Committee on America's Climate Choices, Panel on Advancing the Science of Climate Change	2008–2010
Co-Chair (founding), Atmospheric Chemistry and Climate (ACC) joint project between WCRP/SPARC and IGBP/IGAC	2007–2009
Co-Chair, SPARC/WCRP Group on Upper Troposphere/ Lower Stratosphere Chemistry	1995–2009
Member, Scientific Steering Committee, Montreal Protocol Scientific Assessment Panel for *Scientific Assessment of Ozone Depletion: 2006*	2005–2007
Co-Lead, US CCSP Synthesis and Assessment Product 2.4 ("Trends in Emissions of Ozone-Depleting Substances, Ozone Layer Recovery, and Implications for Ultraviolet Radiation Exposure")	2005–2008
Co-Chair, SPARC Scientific Steering Group (SSG)	2004–2007
Member of the Scientific Steering Group, SPARC/WCRP	2000–2007
Co-Chair, SPARC/IGAC initiative on Laboratory Atmospheric Chemistry, Joint with IGAC/IGBP	1998–2008
Member, NASA Panel for Evaluation of Chemical Kinetics and Photochemical Data for Use in Stratospheric Modeling	1982–2007
Member, National Research Council Committee on Aeronautics Research and Technology for Environmental Compatibility	2000–2006
Advisory Editor, Chemical Physics Letter	1994–2005
Member, International Council on Middle Atmosphere	1999–2004
Guest Editor, *Chemical Reviews*, Issue on Atmospheric Chemistry—Long-Term Issues	2003
Editor, *Geophysical Research Letters*-Atmospheric Chemistry	1999–2001

Associate Editor, *Journal of Geophysical Research -Atmospheres*	1996–1998
Member, National Academy of Sciences Committee on Use of Halons in the Navy	1996–1997
Member, NASA Advisory Panel on Atmospheric Effects of High-speed Aircraft	1989–1995
Member, Editorial board, *International Journal of Chemical Kinetics*	1993–1995
Member, NAS/NRC Committee on Atmospheric Chemistry	1991–1995
Associate Editor, *Journal of Geophysical Research -Atmospheres*	1984–1993

Dr. Ravishankara has worked over the past four decades on the chemistry of the Earth's atmosphere as it relates to stratospheric ozone depletion, climate change, and regional air quality. His measurements in the laboratory and in the atmosphere along with model calculations have contributed to deciphering the ozone layer depletion, including the ozone hole; to quantifying the role of chemically active species on climate; and to advancing understanding of the formation, removal, and properties of air pollutants. He is an author or coauthor of nearly 400 peer-reviewed publications with more than 22-thousand citations and an H-Index of 79 (according to Web of Science) and with over thirty thousand citations and an H-Index of 94 (according to Google Scholar) with more than 37,000 citations. One of his papers has more nearly three thousand citations.

Ravishankara's Publications:

1. Ravishankara, A.R., L.M. David, J.P. Pierce, and C. Venkataraman, Outdoor air pollution in India is not only an urban problem, Proc. Natl. Acad. Science (USA), DOI:10.1073/pnas.2007236117, 2020.
2. Solomon, S., J. Alcamo, and A.R. Ravishankara, Unfinished business after five decades of ozone-layer science and policy, Nature Communications, 11, Article #4272, 26 August 2020.
3. Thanh Lam Nguyen, A.R. Ravishankara, and J.F. Stanton, Reaction of N2O with the prototype singlet biradical CH2: A theoretical study, Chem. Phys. Letts., 749, Article No. 137446, June 16, 2020.
4. Agrawala, S., et al. (19 coauthors), Call for Comments: Climate and clean air responses to covid-19, Intl. J. Public Health, 65, 525-528, 2020.
5. Brewer, J.F., E.V. Fischer, R. Commane, S.C. Wofsy, B.C. Daube, E.C. Apel, A.J. Hill, R.S. Hornbrook, B. Barletta, S. Meinardi, D.R. Blake, E.A. Ray, and A.R. Ravishankara, Evidence for an Oceanic Source of Methyl Ethyl Ketone to the Atmosphere, Geophys. Res. Lett., 47, DO: 10.1029/2019GL086045, 2020.
6. David, L.M., A.R. Ravishankara, J.F. Brewer, B. Sauvage, V. Thouret, S. Venkataramani, and V. Sinha, Atmospheric Environment, 219, DOI: 10.1016/j.atmosenv.2019.117039, 2019.
7. Ravishankara, A.R., A-L. Pele, Li Zhou, Y G Ren, A. Zogka, V. Daele, M. Idir, SS Brown, MN Romanais, A. Mellouki, Atmospheric loss of nitrous oxide (N2O) is not influenced by its potential reactions with OH and NO3 radicals, Phys. Chem. Chem. Phys., 21, 24592-24600, 2019.
8. David, Liji M. and A.R. Ravishankara, Boundary Layer Ozone Across the Indian Subcontinent: Who Influences Whom? Geophys. Res. Lett.,46, 10008-10014, 2019.
9. Thanh Lam Nguyen, Manolis N. Romanias, A.R. Ravishankara, Aristotelis M. Zaras, Philippe Dagaut, John F. Stanton, The atmospheric impact of the reaction of N2O with NO3:A theoretical study, Chem. Phys. Lett., 731, 136605, 2019.
10. Ravishankara, AR., A question of balance: weighing the options for controlling ammonia, sulfur dioxide, and nitrogen oxides, Research Highlight Environment/Ecology, doi.org/10.1093/nsr/nwz088.
11. Brewer, JF, Papanastasiou, DK, Burkholder, JB, Fischer, EV, Ren, YG, Mellouki, A , Ravishankara, AR, Atmospheric Photolysis of Methyl Ethyl, Diethyl, and Propyl Ethyl Ketones: Temperature-Dependent UV Absorption Cross Sections J. Geophys. Res.-Atmospheres, 124 (11), 5906-5918, DOI: 10.1029/2019JD030391, 2019.
12. Li Zhou, A.R. Ravishankara, Steven S.Brown, Kyle J. Zarzana, Mahmoud Idir, Véronique Daële, and Abdelwahid Mellouki, Kinetics of the reactions of NO_3 radical with alkanes, Phys.Chem.Chem.Phys., 21, 424, 2019.
13. Liji M. David, A R Ravishankara, John K Kodros, Jeffrey R Pierce, Chandra Venkataraman, and Pankaj Sadavarte, Premature Mortality due to PM2.5 over India: Effect of Atmospheric Transport and Anthropogenic Emissions, *GeoHealth*, 3 (1), 2-10, doi: 10.1029/2018GH000169, 2019.
14. D. M. Murpy and A.R. Ravishankara, Trends and patterns in the contributions to cumulative radiative forcing from different regions of the world, *Proc Natl Acad Sci USA*, 115, 13192-13197, 2018.

15. Fang, Xuekun; Ravishankara, A. R.; Velders, Guus J. M.; et al., Changes in Emissions of Ozone-Depleting Substances from China Due to Implementation of the Montreal Protocol, Env. Scie. Technol, 52 (19),11359-11366, 2018.
16. Thanh Lam Nguyen; Ravishankara, A. R.; J. S. Stanton, Analysis of the potential atmospheric impact of the reaction of N2O with OH, Chem. Phys. Lett., 708, 100-105, 2018.
17. Munkhbayar Baasandorj, Paul Marshall, Robert L. Waterland, A.R. Ravishankara, and James B. Burkholder (2018), Rate Coefficient Measurements and Theoretical Analysis of the OH + (E)-CF3CH,ïêCHCF3 Reaction, J. Phys. Chem. A, 122 (19), 4635-4646, DOI: 10.1021/acs.jpca.8b02771
18. David LM, A. R. Ravishankara, J. K. Kodros, C. Venkataraman, P. Sadavarte, J. R. Pierce, S. Chaliyakunnel, and D.B. Millet (2018), Aerosol Optical Depth Over India, J. Geophys. Res: Atmospheres, DOI: 10.1002/2017JD027719, 2017.
19. Carpenter, LJ, S. R. Arnold, C. L. Heald, A. R. Ravishankara and J. Williams, (2017) Highlights from the Faraday Discussion meeting "Atmospheric chemistry in the Anthropocene", York, *Chemical Communications*, 53, 12494-12498, 2017.
20. Edwards, P.M., et al., (2017), Transition from high NOx to low- to-low-NOx control of night-time oxidation in the southeastern US, *Nature Geoscience*, 10, 490, DOI: 10.1038/NGE02976.
21. Zhou, L., A.R. Ravishankara, S.S. Brown, M. Idir, K.J. Zarzana, V. Daele, A. Mellouki, Kinetics of the reaction of NO3 radical with methacrylate esters, J. Phys. Chem., 121, 4464-4474, DOI: 10.1021/acs.jpca.7b02332, 2017..
22. Brewer, J.F., M. Bishop, M. Kelp, C.A. Keller, A.R. Ravishankara, and E.V. Fischer, (2017) A sensitivity analysis of key natural factors in the modeled global acetone budget, J. Geophys. Res., 122, 2043, DOI: 10.1002/2016JD025935.
23. Shindell, D., N. Borgford-Parnell, M. Brauer, A. Haines, J. C. I. Kuylenstierna, S. A. Leonard, V. Ramanathan, A. Ravishankara, M. Amann, and L. Srivastava (2017), A climate policy pathway for near- and long-term benefits: Climate actions can advance sustainable development, Science, 356, 493-494.
24. Butler, A.H., J.S. Daniel. R.W. Portmann, A.R. Ravishankara, P.J. Young, D.W. Fahey, K.H. Rosenlof, (2106) Diverse policy implications for future ozone and surface UV in a changing climate, Env. Res. Lett., 11, DOI: 10.1088/1748-9326/11/6/064017
25. Seinfeld, J. H. et al (22 authors) (2016), Improving our fundamental understanding of the role of aerosol-cloud interactions in the climate system, Proc. Nat. Acad. Scie., 113, 5781-5790.
26. Warnecke, C., M. Trainer, J.A. de Gouw, D.D. Parrish, D.W. Fahey, A.R. Ravishankara, et al. (51 authors), Instrumentation and measurement strategy for the NOAA SENEX aircraft campaign as part of the Southeast Atmosphere Study 2013, Atmos. Meas. Tech., 9, 30163-3093
27. X. Fang, G. J. M Velders, A.R. Ravishankara, M. J. Molina, J. Hu, and R. G. Prinn (2016), Hydrofluorocarbons (HFCs) emissions in China: an inventory for 2005–2013 and projections to 2050, Env. Scie.&Tech., DOI: 10.1021/acs.est.5b04376
28. Ravishankara, A. R.(2015) Why do we do the science we do, *Current Science*, 2015.
29. Ravishankara, AR, Y. Rudich, J.A. Pyle, JA (2015), Role of Chemistry in Earth's Climate, *Chem. Rev.*, 115, 3679-3681, DOI: 10.1021/acs.chemrev.5b00226
30. Ravishankara, AR, Y. Rudich, D.J. Wuebbles (2015), Physical Chemistry of Climate Metrics, *Chem. Rev.*, 115, 3682-3703, DOI: 10.1021/acs.chemrev.5b00010
31. Burkholder, J. B., R.A. Cox, and A.R. Ravishankara (2015), Atmospheric Degradation of Ozone Depleting Substances, Their Substitutes, and Related Species, Chem. Rev., 115, 3704-3759.
32. Moortgat, G., and A. R. Ravishankara, (2015), Ozone: Photochemistry of ozone, Encyclopedia

of Atmospheric Sciences (2nd Edition), Vol.4, pp370-379.

33. Frank Sauer,F., R. W. Portmann, A. R. Ravishankara, and J. B. Burkholder, (2014), Temperature Dependence of the Cl Atom Reaction with Deuterated Methanes, *J. Phys.Chem. A*. DOI doi.org/10.1021/jp508721hI
34. Monks, P.S., G. Brasseur, J.P. Burrows, M.C. Facchini, S. Fuzzi, D. Fowler, C. Granier, M. Maione, A.R. Ravishankara, Y. Rudich, and J. Slowik, European pollution: Investigate smog to inform policy, *Nature*, doi:10.1038/509427a, 2014.
35. Kazil1, J., S. McKeen, S.-W. Kim, R. Ahmadov, G. A. Grell, R. K. Talukdar, and A. R. Ravishankara (2014) Deposition and rainwater concentrations of trifluoroacetic acid in the United States from the use of HFO-1234yf, *J. Geophys. Res.*, 2014, DOI:10.1002/2014JD022058.
36. Loukhovitskaya EE, Talukdar RK, and Ravishankara AR (2013) Uptake of HNO3 on Aviation Kerosene and Aircraft Engine Soot: Influences of H2O or/and H2SO4. *J. Phys. Chem. A* 117(23):4928-4936.
37. Brown, SS., et al. (2013) Biogenic VOC oxidation and organic aerosol formation in an urban nocturnal boundary layer: aircraft vertical profiles in Houston, TX, Atm. Phys. Chem, Volume: 13 Issue: 22 Pages: 11317-11337DOI: 10.5194/acp-13-11317-2013 (2013)
38. Kanter D*, et al.* (2013) A post-Kyoto partner: Considering the stratospheric ozone regime as a tool to manage nitrous oxide. *Proceedings of the National Academy of Sciences of the United States of America* 110(12):4451-4457.
39. Cappa CD, Lovejoy ER, and Ravishankara AR (2013) Evaporation Rates and Vapor Pressures of the Even-Numbered C-8-C-18 Monocarboxylic Acids (vol 112, pg 3959, 2008). *J. Phys. Chem. A* 117(10):2285.
40. Velders GJM*, AR Ravishankara, et al.* (2012) Preserving Montreal Protocol Climate Benefits by Limiting HFCs. *Science* 335(6071):922-923.
41. Talukdar RK, Burkholder JB, Roberts JM, Portmann RW, and Ravishankara AR (2012) Heterogeneous Interaction of N2O5 with HCl Doped H2SO4 under Stratospheric Conditions: CINO2 and Cl-2 Yields. *J. Phys. Chem. A* 116(24):6003-6014.
42. Ravishankara AR, Dawson JP, and Winner DA (2012) New Directions: Adapting air quality management to climate change: A must for planning. *Atmospheric Environment* 50:387-389.
43. Ravishankara AR (2012) Water Vapor in the Lower Stratosphere. *Science* 337(6096):809-810.
44. Portmann RW, Daniel JS, and Ravishankara AR (2012) Stratospheric ozone depletion due to nitrous oxide: influences of other gases. *Philosophical Transactions of the Royal Society B-Biological Sciences* 367(1593): 1256-1264.
45. Middlebrook AM*, et al.* (2012) Air quality implications of the Deepwater Horizon oil spill. *Proc. Natl Acad Scie USA* 109(50):20280-20285.
46. Brown SS*, et al.* (2012) Effects of NOx control and plume mixing on nighttime chemical processing of plumes from coal-fired power plants. *Journal of Geophysical Research-Atmospheres* 117.
47. Ryerson TB*, et al.* (2011) Atmospheric emissions from the Deepwater Horizon spill constrain air-water partitioning, hydrocarbon fate, and leak rate. *Geophysical Research Letters* 38.
48. Ravishankara AR, Velders GJM, Miller MK, and Molina MJ (2011) HFCs: A Critical Link in Protecting Climate and the Ozone Layer. (United Nations Environment Programme (UNEP)), p 36.

49. de Gouw JA, *et al.* (2011) Organic Aerosol Formation Downwind from the Deepwater Horizon Oil Spill. *Science* 331(6022):1295-1299.
50. Brown SS, *et al.* (2011) Budgets for nocturnal VOC oxidation by nitrate radicals aloft during the 2006 Texas Air Quality Study. *Journal of Geophysical Research-Atmospheres* 116.
51. Baasandorj M, Ravishankara AR, and Burkholder JB (2011) Atmospheric Chemistry of (Z)-CF3CH=CHCF3: OH Radical Reaction Rate Coefficient and Global Warming Potential. *J. Phys. Chem. a* 115(38):10539-10549.
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53. Rajakumar B, McCabe DC, Talukdar RK, and Ravishankara AR (2010) Rate Coefficients for the Reactions of OH with n-Propanol and iso-Propanol between 237 and 376 K. *International Journal of Chemical Kinetics* 42(1):10-24.
54. Dunlea EJ, Talukdar RK, and Ravishankara AR (2010) Kinetics and Products of the Reaction O-2((1)Sigma(+)(g)) with N2O. *Zeitschrift Fur Physikalische Chemie-International Journal of Research in Physical Chemistry and Chemical Physics* 224(7-8):989-1007.
55. Daniel JS, *et al.* (2010) Options to accelerate ozone recovery: ozone and climate benefits. *Atmospheric Chemistry and Physics* 10(16):7697-7707.
56. Brioude J, *et al.* (2010) Variations in ozone depletion potentials of very short-lived substances with season and emission region. *Geophysical Research Letters* 37.
57. Baasandorj M, *et al.* (2010) Rate Coefficients for the Gas-Phase Reaction of the Hydroxyl Radical with CH2 = CHF and CH2 = CF2. *J. Phys. Chem. a* 114(13):4619-4633.
58. Sommariva R, *et al.* (2009) Radicals in the marine boundary layer during NEAQS 2004: a model study of day-time and night-time sources and sinks. *Atmospheric Chemistry and Physics* 9(9):3075-3093.
59. Scinocca JF, *et al.* (2009) Impact of sudden Arctic sea-ice loss on stratospheric polar ozone recovery. *Geophysical Research Letters* 36.
60. Roberts JM, *et al.* (2009) Laboratory studies of products of N2O5 uptake on Cl- containing substrates. *Geophysical Research Letters* 36.
61. Ravishankara AR, Daniel JS, and Portmann RW (2009) Nitrous Oxide (N2O): The Dominant Ozone-Depleting Substance Emitted in the 21st Century. *Science* 326(5949):123-125.
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63. Osthoff HD, *et al.* (2009) Regional variation of the dimethyl sulfide oxidation mechanism in the summertime marine boundary layer in the Gulf of Maine. *Journal of Geophysical Research-Atmospheres* 114.
64. Lack DA, *et al.* (2009) Relative humidity dependence of light absorption by mineral dust after long-range atmospheric transport from the Sahara. *Geophysical Research Letters* 36.
65. Lack DA, *et al.* (2009) Particulate emissions from commercial shipping: Chemical, physical, and optical properties. *Journal of Geophysical Research-Atmospheres* 114.
66. Brown SS, *et al.* (2009) Reactive uptake coefficients for N2O5 determined from aircraft measurements during the Second Texas Air Quality Study: Comparison to current model parameterizations. *Journal of Geophysical Research-Atmospheres* 114.

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71. Ravishankara AR (2008) Trends in Emissions of Ozone-Depleting Substances, Ozone Layer Recovery, and Implications for Ultraviolet Radiation Exposure. eds Ravishankara AR, Kurylo MJ, and Ennis CA (A Report by the U.S. Climate Change Science Program and the Subcommittee on Global Change Research, Asheville, North Carolina), p 240.
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73. Papadimitriou VC, Talukdar RK, Portmann RW, Ravishankara AR, and Burkholder JB (2008) CF3CF=CH2 and (Z)-CF3CF=CHF: temperature dependent OH rate coefficients and global warming potentials. *Physical Chemistry Chemical Physics* 10(6):808-820.
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