PERSONAL:
Born: May 26, 1947, Bethesda, Maryland

EDUCATION:
University of California, Berkeley, A.B., Physics 1969
Cornell University, Ph.D., Physics, 1975. Thesis title "Climatic Change on Mars and Earth"

POSITIONS HELD:
Research Assistant, University of California, Berkeley, 1969.
Physicist, Environmental Research Division, Naval Coastal Systems Center, Panama City, Florida, 1969-1970.
Teaching Assistant, Physics Department, Cornell University, 1970-1972.
Research Assistant, Astronomy Department, Cornell University, 1972-1975.
Visiting Scientist, NASA, Ames Research Center, 1973.
National Academy of Sciences Resident Research Associate, NASA, Ames Research Associate, 1975 to 1977.
Research Associate, Cornell University, 1977-1978.
Visiting Scientist, NASA, Ames Research Center, 1977-1978.
Research Scientist, NASA, Ames Research Center, 1978-1989.
Group Leader for Theoretical Atmospheric Sciences, NASA Ames Research Center, 1984 to 1989.
Associate Fellow, NASA, Ames Research Center, 1987-1989.
Senior Scientific and Technical Staff, NASA Ames, 1989-1997.
Professor, Program in Atmospheric and Oceanic Sciences and Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder Aug. 1997-present.
Professor, Environmental Studies Program, University of Colorado, Boulder, 1999-2005.
Director, Program in Atmospheric and Oceanic Science, University of Colorado, Boulder, Oct 2000-Dec 2005.
Chair (founding), Department of Atmospheric and Oceanic Sciences, University of Colorado, Dec 2005-present.

FIELD PROJECT MANAGEMENT POSITIONS:

Deputy Project Scientist, NASA, Airborne Antarctic Ozone Expedition, 1986-1988.

DC-8 Flight Scientist, NASA, Airborne Arctic Stratospheric Expedition, 1988-1989.

DC-8 Flight Scientist, NASA, Airborne Arctic Stratospheric Expedition II, 1991-1992.

Co-Project Scientist, NASA, Vortex Ozone Transport Experiment /Tropical Ozone Transport Experiment, 1994-1996.

Project Scientist, NASA, Subsonic Aircraft Contrail and Cloud Effects Special Study 1994-1998.

Co-Project Scientist, NASA, SAGE III ozone loss and validation experiment, 1998-2002.

Co-Project Scientist, NASA Crystal field project to understand the role of deep convection in Earth's climate. 2001-2003.

HONORS AND AWARDS:

1979 NASA Special Achievement Award

1981 NASA Group Achievement Award-Shuttle Environmental Effects Team

1983 NASA Certificate of Appreciation-For important scientific and managerial contributions to NASA-sponsored studies of the climatic effects of the massive El Chichon volcanic cloud.

1983 H. Julian Allen Award - Given for the outstanding scientific or engineering paper of 1983 at Ames Research Center. "Evolution of an Impact Generated Dust Cloud and its Effects on the Atmosphere" O.B. Toon et al.

1983 NASA Medal for Exceptional Scientific Achievement - "In recognition of his outstanding contributions to the understanding of the causes of climate variations on the Earth and the relations between atmospheric processes on the Earth and those on other planetary bodies".

1984 Co-recipient International Peace Garden Award from University of N. Dakota - For work on Nuclear Winter.

1985 37th Annual Arthur Flemming Award from Washington D.C. JCees - "For outstanding individual performance in the Federal Government".

1986 NASA Sustained Superior Performance Award

1986 Co-recipient Leo Szilard Award for Physics in the Public Interest from the American Physical Society - "For the investigation of the effects on the global atmosphere and climate from smoke and dust resulting from a nuclear war".

1987 Distinguished Lectureship - Phi Beta Kappa Society of University of Louisville.

1987 Associate Fellow at NASA Ames Research Center - "For sustained innovative and creative contributions to research".

1988 H Julien Allen Award-Given for the outstanding scientific or engineering paper of 1988 at Ames Research Center. "Condensation of HNO3 and HCl in the Winter Polar Stratospheres". O.B. Toon et al.

1988 Elected Fellow of the California Academy of Sciences.

1989 NASA Medal for Exceptional Scientific Achievement-"in recognition of exceptional scientific achievement in identifying the condensation of acid vapors as critical in the chemistry responsible for the formation of the Antarctic Ozone Hole and in recognition of outstanding scientific leadership in the

international missions to investigate the depletion of polar ozone".
1989 Group Achievement Award to Airborne Antarctic Ozone Experiment Team
1991 Elected Fellow of the American Meteorological Society.
1991 Group Achievement Award to Airborne Arctic Ozone Expedition Team
1991 Editor's Citation for Excellence in Refereeing, Geophysical Research Letters.
1992 Elected Fellow of the American Geophysical Union "for important discoveries about the atmospheres of Earth and other planets, including the role of stratospheric clouds in polar ozone depletion, the effects of volcanic and nuclear-war clouds on climate, and the extinction of the dinosaurs by meteor-generated dust clouds".
1995 Doctorate of Science Honoris Causa-University of Southern Utah
2001 NASA Group Achievement Award for SAGE-3 Ozone Loss and Validation Experiment Science Team
2002 Highly Cited Researchers Award, ISI Thomson Scientific for being "one of the most highly cited, influential researchers in Geosciences."
2003 NASA Group Achievement Award, for "outstanding accomplishments and contributions to the extremely successful Cirrus Regional Study of Tropical Anvils and Cirrus Layers-Florida Area Cirrus Experiment".
2005 NASA Group Achievement Award "in recognition of your significant contribution to the design, development and launch of the Aura satellite, which is producing astounding data for the atmospheric science community".

MEMBERSHIP ON COMMITTEES AND EDITORIAL ACTIVITIES:
Science Advisory Committee for NASA's climate research plan-drafted NASA's long-range climate research plan (1977).
Proposal Peer Review Panel Member for NASA's weather and climate program (1978).
Science Steering Group for NASA's program of aircraft measurements of the Earth's atmosphere (1977-1980).
Proposal Peer Review Panel Member for NASA's Mars Data Analysis Program (1983).

NASA Management Operations Working Group for Planetary Atmospheres (1980-1983).
National Academy of Sciences Committee on the Atmospheric Effects of Nuclear Explosions (1983).
Committee on Evolution of Complex and Higher Organisms - NASA (1983)
Panel on Polar Stratospheric Clouds, NASA (1983).
AGU Guest Editor of Geophys Res. Lett. special issue on the El Chichon Volcanic Eruption (with J. Pollack), 1983
Presidential Science Advisor's Committee on National Program to study nuclear winter (1984).
Chairman, Atmospheric Sciences Peer Review Panel for the Mars Orbiter Mission, (1985).
Defense Nuclear Agency Advisory Committee on Field Program for the Global Effects Program (1985 to 1989).
Executive Committee for NASA's ozone-hole projects (1986 to 1992).
Aerosol subpanel of NASA's ozone trends review panel (1987).
Earth Observing System Interdisciplinary Proposal Review Panel member (1988).
AGU Guest Editor of J. Geophys. Res. special issue on the Airborne Antarctic Ozone Experiment (with B. Watson, and A. Tuck), 1989.
NASA Upper Atmosphere Research Program Field Experiments Steering Committee (1990).
DOE Atmospheric Radiation Experiment Science Advisory Group (1990).
NASA High Speed Research Program Stratospheric Field Measurements Advisory Group (1991).
NASA High Speed Research Program Models and Measurements Committee (1991).
DOE Committee on the Use of Aircraft in the ARM program (1990-1992).
AGU 1992 Chapman Conference on Volcanoes and Climate Steering Committee (1991-1992).
NASA Venus Atmospheric Probe Discovery Mission- workshop participant (1991-1992).
AGU 1992-1995. Atmospheric Sciences Section Committee on Honors and Awards, member.
DOE 1992 Atmospheric Radiation Measurements Program Interim Science Team for Unmanned Aerospace Vehicles, member.

AGU- Guest Editor of Geophysical Research Letters for Airborne Arctic Stratospheric Expedition II (with J. Anderson).
Co-chairperson 1993 Gordon conference on volcanoes and climate (with L. Walter).
Organizer, 1994 Workshop on Effects of Subsonic Aircraft on Clouds and Climate, NASA Ames.
Environmental Research Aircraft and Sensor Technology Leadership Team member, NASA, 1994-present.
Co-Chairperson, 1994 Fall AGU meeting session Earth and Planetary Sciences Unified: In memory of James B. Pollack, 1994.
NASA FIRE peer review panel member, Jan.1995.
NASA Committee to draft a Science Policy Guide for NASA, 1995.
Vice President Gore's Space Science Symposium Member, 1996.
Associate Editor, Journal of Geophysical Research (Atmospheric Chemistry) 1996-2001.
Associate Editor, Journal of Geophysical Research (Planets) 1997-9.
Guest Editor, Geophysical Research Letters, Special Issues on SUCCESS, 1998.
Lead Author, 1998 Intergovernmental Panel on Climate Change Special Report on Aviation and the Global Atmosphere.
Member, NASA's Astrobiology Roadmap Committee, 1998.
Member, DOE's Atmospheric Sciences Program Reconfiguration Panel, 2003
Member, DOE's Committee of Visitors review panel, 2004

MEMBERSHIP IN PROFESSIONAL SOCIETIES:
American Meteorological Society (Fellow, 1991)
American Geophysical Union (Fellow 1992)
Division of Planetary Sciences of American Astronomical Society, Affiliate.
Planetary Society

STUDENTS SUPERVISED[1] :

MASTER -

Gail Fondahl - U.C. Berkeley, Dept. of Geography (1984) "The demise of the Norse Greenland colonies". (0. Granger, Committee Chair).
Tim Haddix - San Jose State University, Dept. of Meteorology. Thesis on mesoscale simulations of cirrus clouds (1996).
Annette Walker - San Jose State University, Dept. of Meteorology. Thesis on developing parameterizations of cirrus cloud radiative properties for use in large scale models (1996).
Chris Kuhn- University of Colorado, Atmospheric and Oceanic Sciences Department.
Ana Lia Quijano- University of Colorado, Atmospheric and Oceanic Sciences Department.
Vidal Salazar-University of Colorado, Atmospheric and Oceanic Sciences Department.
Olga Kalashnikova- University of Colorado, Atmospheric and Oceanic Sciences Department, Now at JPL.
Matt Trebella- University of Colorado, Atmospheric and Oceanic Sciences Department
Kari Klein- University of Colorado, Atmospheric and Oceanic Sciences Department.
Elinor Newman- University of Colorado, Astronomy and Planetary Sciences Department.

DOCTORATE -

Douglas Westphal - Pennsylvania State University, Department of Meteorology (1986) - "A numerical investigation of the dynamics of Saharan dust storms" - (Toby Carlson, Committee Chair).
Eric Jensen - University of Colorado, Department of Astrophysical, Planetary and Atmospheric Sciences (1989) - "A numerical model of polar mesospheric cloud formation and evolution"- (Gary Thomas, Committee Chair).
James Murphy - University of Washington, Department of Atmospheric Science (1991) - "A dimensional hierarchy of

[1] Supervision varies from providing numerical models for thesis research to supervision of thesis work

numerical simulations of Martian global dust storms"- (Conway Leovy, Committee Chair).

Jingxia Zhao - UCLA, Atmospheric Sciences Dept. (1993) - "Numerical studies of the stratospheric aerosol layer under background and perturbed conditions" - (Richard Turco, Committee Chair).

Andrew Ackerman- University of Washington, Department of Atmospheric Science (1994) - "A numerical study of the effects of variations in aerosol concentrations on stratiform clouds in the marine boundary layer" - (Peter Hobbs, Committee Chair).

William Hutzell - Georgia Tech, School of Earth and Atmospheric Sciences (1994) - "Variations in the Geometric Albedo of Titan"- (William Chameides, Committee Chair).

Mark Jacobsen - UCLA, Atmospheric Sciences Dept. (1994) - "Developing, coupling, and applying a gas, aerosol, transport, and radiation model to study urban and regional air pollution - (Richard Turco, Committee Chair).

Kelly Snook - Stanford University, Department of Aerospace Engineering - The optical constants of Martian dust. (1997).

Anthony Colaprete- University of Colorado, Astronomy and Planetary Sciences Department (2000). Climate change on Mars-now at NASA Ames Research Center

Peter Colarco-University of Colorado, Program in Atmospheric and Oceanic Sciences Terrestrial dust storms, Now at Goddard Space Flight Center.

Jennifer Heldmann-University of Colorado, Geology Department,(2003) Water on Mars-Now at NASA Ames Research Center

Erica Barth- University of Colorado, Astronomy and Planetary Sciences Department (2004) Clouds on Titan, now at SWRI.

Teresa Segura- (2005)University of Colorado, Program in Atmospheric and Oceanic Sciences. Climate changes due to impacts on Mars.

Tian Feng (2005)- University of Colorado, Astronomy and Planetary Sciences Department. Escape from planetary Atmospheres.

Brandy Gamblin (2005)-University of Colorado, Chemistry Department. Nitric Acid Condensation on Ice Clouds.

Kevin McGouldrick- University of Colorado, Astronomy and Planetary Sciences Department.

Kaj Williams- University of Colorado, Program in Atmospheric and Oceanic Sciences
Attila Elteto- University of Colorado, Astronomy and Planetary Sciences Department.
Lansing Madry- University of Colorado, Program in Atmospheric and Oceanic Sciences
Rebecca Matichuk, University of Colorado, Program in Atmospheric and Oceanic Sciences
Charles Bardeen, University of Colorado, Program in Atmospheric and Oceanic Sciences
Tianyi Fan, University of Colorado, Department of Atmospheric and Oceanic Sciences
Lin Su, University of Colorado, Department of Atmospheric and Oceanic Sciences
Jason English, University of Colorado, Department of Atmospheric and Oceanic Sciences.
Richard Urata, University of Colorado, Astronomy and Planetary Sciences Department.

POST DOCTORAL

Douglas Westphal- from Penn. State University-studied Saharan dust storms 1986-1988, now at Naval Research Laboratory, Monterey.
Bernhard Lindner- from Colorado State University-studied Martian ice clouds.
Joseph Pinto- from New York University-studied volcanic clouds 1988, now at EPA.
Stefan Kinne-from University of Utah-studied radiative transfer in ice clouds 1987-1990, now at University of Hamburg.
Diane Michaelangeli- from California Institute of Technology - studied microphysics of Martian ice clouds 1990-1991, now at York University.
Eric Jensen- from University of Colorado- studied microphysics of cirrus clouds 1990-1993, now at NASA Ames Research Center.
Andy Ackerman- from University of Washington- studying microphysics of marine stratus, now at NASA GISS Research Center.
Azadeh Tabazadeh- from UCLA- studying microphysics of polar stratospheric clouds, 1994-1997. Recipient of NASA Presidential

Young Investigator Award, 1999, AGU McElwayne Award, AMS Houghton Award. Now Associate Professor Stanford University

Irina Sokolik- from Russian Academy of Sciences -studying radiative transfer in the Earth's atmosphere, 1995-1997. Now Professor Georgia Tech.

Michael Mills-from University of Colorado-studying volcanic clouds in the Earth's atmosphere, 1997-present.

Mark Bullock-from University of Colorado-studying the clouds of Venus, 1998-1999. Now at SWRI inc. Boulder Co.

Jamison Smith-University of Colorado-studying cumulus on Earth.

Alex Pavlov-Pennsylvania State-studying atmosphere of early Earth. Now Assistant Professor, University of Arizona.

STUDENT AWARDS

Peter Colarco-Outstanding Student Paper in Atmospheric Science-Fall 1998 AGU meeting-Modeling dust emission and transport from the Western Sahara"

Peter Colarco-NASA Graduate Student Researcher Program-1998-2001.

Olga Kalashnikova-Best student paper-CEDAR_99 (Coupling Energetics and Dynamics of Atmospheric Regions) Fourteenth Summer NSF Workshop, June 13-18, Boulder, CO.

Kari Klein- NASA Graduate Student Researcher Program-2000-2001.

Brandy Gamblin- NASA Graduate Student Researcher Program-2001-2002.

Jennifer Heldmann- NASA Graduate Student Researcher Program-2002-2004.

Teresa Segura-- NASA Graduate Student Researcher Program-2003-2005.

Kaj Williams- NASA Graduate Student Researcher Program-2004-2007.

Attila Elteto NASA Graduate Student Researcher Program-2004-2007.

Rebecca Matichuk-NASA Graduate Student Researcher Program-2005-2008.

Chuck Bardeen- NASA Graduate Student Researcher Program-2005-2008.

BIBLIOGRAPHY:

1. "Optical Properties of some Terrestrial Rocks and Glasses'' (J. B. Pollack, O.B. Toon, and B.N. Khare), Icarus, 19, 372 (1973).
2. "Physical Properties of the Stratospheric Aerosols" (O.B. Toon, J.B. Pollack), J. Geophys. Res., 78, 7051 (1973).
3. ''Man's Impact on the Climate and Inadvertent Climate Modification Book Review,'' (O.B. Toon), Icarus, 19, 609 (1973).
4. "Atmospheric Pressure Variation and the Climate of Mars" (P.J. Gierasch, O.B. Toon), J. Atmos. Sci., 30, 1502 (1973).
5. "Climatic Change on Mars" (C. Sagan, O.B. Toon, and P.J. Gierasch), Science, 181, 1045 (1973).
6. ''Conference Summary--Symposium on Possible Relationships Between Solar Activity and Meteorological Phenomena," (with J. Levine et al.), Bull. Am. Meteor. Soc., 55, 133 (1974); and EOS, 55, 525 (1974).
7. ''A Study of the Effect of Stratospheric Aerosols Produced by SST Emissions on the Albedo and Climate of the Earth" (J. B. Pollack, O.B. Toon), in Proceeding International Conference on Structure, Composition and General Circulation of the Upper and Lower Atmospheres and Possible Anthropogenic Perturbations. Melbourne, Australia, Jan. 1974, pp. 1150, and in Proceedings Third Conference on the Climatic Impact Assessment Program, Feb. 1974, ed. A. Broderick and T. Hard, DOT-TSC-OST-74-15, (1974).
8. "Solar Luminosity Variations and the Climate of Mars" (O.B. Toon, C. Sagan, P.J. Gierasch), in Possible Relationships Between Solar Activity and Meteorological Phenomena, ed. W. Bandeen and S. Maran, NASA SP-366, pp. 179, (1975).
9. "Climatic Change on Mars and Earth" (O.B. Toon, C. Sagan, P. Gierasch, J. Pollack), in Proceedings WM0/IAMAP Symposium on Long Term Climatic Fluctuations, WMO pub. 421, pp. 495, (1975).
10. "Volcanic Explosions and Climatic Change" (J.B. Pollack, O.B. Toon), in Proceedings WMO/IAMAP Symposium on Long Climatic Fluctuations, WMO pub. 421, pp. 495, (1975).
11. Climatic Change on Mars and Earth, (O.B. Toon), Thesis, Cornell University, (1975).

12. ''Volcanic Explosions and Climatic Change: A Theoretical Assessment'' (J.B. Pollack, O.B. Toon, C. Sagan, A. Summers, B. Baldwin, W. Van Camp), J. Geophys. Res., 81, 1071 (1976).
13. ''A Global Average Model of Atmospheric Aerosols for Radiative Transfer Calculations'' (O.B. Toon, J.B. Pollack), J. Appl. Meteor., 15, 225 (1976).
14. "Estimates of the Climatic Impact of Aerosols Produced by Space Shuttles, SST's and Other High-Flying Aircraft" (J.B. Pollack, O.B. Toon, A. Summers, W. Van Camp, and B. Baldwin), J. Appl. Meteor., 15, 247 (1976).
15. "Stratospheric Aerosols and Climatic Change'' (J.B. Pollack, O.B. Toon, C. Sagan, B. Baldwin, A. Summers, W. Van Camp), Nature, 236, 551 (1976).
16. ''The Optical Constants of Several Atmospheric Aerosol Species: Ammonium Sulfate, Aluminum Oxide and Sodium Chloride," (O.B. Toon, J.B. Pollack, B.N. Khare), J. Geophys. Res. 81, 5733 (1976).
17. "A Model of the Stratospheric Sulfate Aerosol'' (R. Turco, O.B. Toon, P. Hamill, R. Whitten), in Atmospheric Aerosols: Their Optical Properties and effects. NASA CP-2004, 1976.
18. "Stratospheric Aerosols and Climatic Change'' (O.B. Toon, J.B. Pollack), in Atmospheric Aerosols: Their Optical Properties and effects . NASA CP-2004, 1976.
19. "Volcanoes and The Weather'' (O.B. Toon, J.B. Pollack), Natural History, 86, 8 (1977).
20. "Physical Properties of the Particles Composing the Martian Dust Storm of 1971-2'' (O.B. Toon, J.B. Pollack, C. Sagan), Icarus, 30, 663 (1977).
21. ''Physical Mechanisms Affecting the Stratospheric Aerosol Particles'' (P. Hamill, O.B. Toon, C.S. Kiang), J. Atmos. Sci., 34, 1104 (1977).
22. ''Past Obliquity Oscillations of Mars: The Role of the Tharsis Uplift'' (W. Ward, J. Burns, O.B. Toon), J. Geophys. Res., 84, 243 (1979).
23. "A One-Dimensional Model Describing Aerosol Formation and Evolution in the Stratosphere. I. Physical Processes and Numerical Analogs" (R. Turco, P. Hamill, O.B. Toon, R. Whitten, C. S. Kiang), J. Atmos. Sci., 36, 699 (1979).
24. ''A One-Dimensional Model Describing Aerosol Formation and Evolution in the Stratosphere. II. Sensitivity Studies and

Comparison with Observations" (O.B. Toon, R. Turco, P. Hamill, R. Whitten, and C. S. Kiang), J. Atmos.,36, 718 (1979).
25. "The NASA-Ames Research Center Stratospheric Aerosol Model. Part I. Physical Processes and Numerical Analogs (R.P. Turco, O.B. Toon, P. Hamill, C.S. Kiang, and R.C. Whitten), NASA Tech. Report 1362, 94 pp., (1979).
26. "The NASA-Ames Research Center Stratospheric Aerosol Model. Part II, Sensitivity Studies and Comparisons with Observations" (O.B. Toon, R.P. Turco, P. Hamill, C.S. Kiang, and R.C. Whitten), NASA Tech Report 1363, 67 pp., (1979).
27. "Lidar Return from Stratospheric Aerosols as Calculated from a One-Dimensional Aerosol Model'' (P. Hamill, T.J. Swissler, R. P. Turco, O.B. Toon), Nature, 278, 149 (1979).
28. ''Anthropogenic Albedo Changes and the Earth's Climate." (C. Sagan, O.B. Toon, J.B. Pollack), Science, 206, 1363 (1979).
29. "Solar Spectral Variations: A Drive for Climatic Change?" (J.B. Pollack, W.J. Borucki, O.B. Toon) Nature, 282, 600 (1979).
30. "Stratospheric Aerosol Modification by Supersonic Transport and Space Shuttle Operations with Climate Implications" (R. Turco, O.B. Toon, J.B. Pollack, R.C. Whitten, I.G. Poppoff, P. Hamill), J. Appl. Meteor, 19, 78 (1980).
31. "OCS, Stratospheric Aerosols and Climate" (R. Turco, R.C. Whitten, O.B. Toon, J.B. Pollack, P. Hamill), Nature, 283, 283 (1980).
32. "Carbonyl Sulfide, Stratospheric Aerosols and Terrestrial Climate" (R.P. Turco, R.C. Whitten, O.B. Toon, J.B. Pollack and P. Hamill), in Environmental and Climatic Impact of Coal Utilization, A. Deepak and J. Singh, Eds., Academic Press, pp. 331-356 (1980).
33. "Stratospheric Aerosol Modification by Supersonic Transport Operations with Climate Implications" (O.B. Toon, R. P. Turco J.B. Pollack, R.C. Whitten, I.G. Poppoff, P. Hamill), NASA Ref. Pub. 1058, 17 pp (1980).
34. "The Stratospheric Sulfate Aerosol Layer: Processes, Models, Observations, and Simulations" (R. Whitten, O.B. Toon, R.P. Turco), Pure and Appl. Geophys., 118, 86 (1980).
35. "Smoke and Dust Particles of Meteoric Origin in the Mesosphere and Stratosphere" (D. Hunten, R. Turco, O.B. Toon), J. Atmos. Sci., 37, 1342 (1980).
36. "Atmospheric Aerosols and Climate" (O.B. Toon, J.B. Pollack), Amer. Scientist, 68, 268 (1980).

37. "Greenhouse Models of Venus' High Surface Temperature, as Constrained by Pioneer Venus Measurements" (J.B. Pollack, O.B. Toon, R. Boese), J. Geophys. Res., 85, 8233 (1980).
38. "Distribution and Source of the U.V. Absorption in Venus' Atmosphere" (J.B. Pollack, O.B. Toon, et al.), J. Geophys. Res., 85, 8141 (1980).
39. "The Astronomical Theory of Climate Change on Mars" (O.B. Toon, J.B. Pollack, W. Ward, J. Burns, K. Bilski), Icarus, 44, 552 (1980).
40. "A Physical Model of Titan's Clouds" (O.B. Toon, R.P. Turco, J.B. Pollack), Icarus, 43, 260 (1980).
41. "On the Possible Relationship Between Secular Brightness Changes on Titan and Solar Variability" (J.B. Pollack, K. Rages, O.B. Toon, Y.L. Yung), Geophys. Res. Lett., 7, 829 (1980).
42. "A Brief Review of the Evidence for Solar Variability on the Planets" (OB. Toon, J.B. Pollack, K. Rages), The Ancient Sun ed. Pepin R., Eddy, J. and Merrill, R.P. Pergammon Press, p. 523 (1980).
43. "The Influence of Solar U.V. Variations on Climate" (W. Borucki, J. Pollack, O.B. Toon, H.T. Woodward, and D.R. Wiedman), The Ancient Sun, ed. Pepin, R. Eddy J. and Merrill, R.P. Pergammon Press, 513 (1980).
44. "Effect of Meteoric Debris on Stratospheric Aerosols and Gases" (R.P. Turco, O.B. Toon, P. Hamill, R.C. Whitten), J. Geophys. Res., 86, 1113 (1981).
45. "Aircraft NOx Emissions and Stratospheric Ozone Reductions: Another Look" (R.P. Turco, O.B. Toon, R.C. Whitten, J.B. Pollack and P Hamill), AIAA Paper 81-0240, 6pp, (1981).
46. "Large Ozone Perturbations Caused by the 1908 Tunguska Meteor Fall: Were There Related Weather Effects?" (R.P. Turco, O.B. Toon, C. Park, R.C. Whitten, and P. Noerdlinger), Proc. Quadrennial Int. Ozone Symposium, S. Rutenberg, Ed. Vol II, pp 1067-1073 (1981).
47. "Reduced Stratospheric OH Concentrations Suggested by Sulfur Gas and Particle Measurements, and Revised Ozone Perturbations Due to Man's Activities" (R.P. Turco, O.B. Toon, E.C.Y. Inn and P. Hamill), Proc. Quadrennial Int. Ozone Symposium, S. Rutenberg, Ed. Vol II, pp . 968-975 (1981).

48. "Implications of Stratospheric Aerosol Measurements for Models of Aerosol Formation and Evolution" (O.B. Toon, R.P. Turco, R. Whitten, P. Hamill), Geophys. Res. Lett., 8, 23 (1981).
49. "Radiative Properties of the Background Stratospheric Aerosols and Implications for Perturbed Conditions" (J.B. Pollack, O.B. Toon, D. Wiedman), Geophys. Res. Lett., 8, 26 (1981).
50. "Particles Above the Tropopause: Measurements and Models of Stratospheric Aerosols, Meteoric Debris, Nacreous Clouds, and Noctilucent Clouds" (O.B. Toon, N. Farlow), Ann. Rev. Earth. Planet. Sci., 9, 19 (1981).
51. "Tunguska Meteor Fall of 1908: Effects on Stratospheric Ozone" (R.P. Turco, O.B. Toon, C. Park, R.C. Whitten, J.B. Pollack, P. Noerdlinger), Science, 214, 19 (1981).
52. "Algorithms for the Calculation of Scattering by Stratified Spheres" (O.B. Toon, T.P. Ackerman), Appl. Optics, 20, 3657 (1981).
53. "Absorption of Visible Radiation in Atmospheres Containing Mixtures of Absorbing and Nonabsorbing Particles" (T.P. Ackerman, O.B. Toon), Appl. Optics, 20, 3661 (1981).
54. "Stratospheric Hydroxyl Radical Concentration: New Limitations Suggested by Observations of Gaseous and Particular Sulfur" (R.P. Turco, R.C. Whitten, O.B. Toon, E.C.Y. Inn, P. Hamill), J. Geophys. Res., 86, 1129 (1981).
55. "Quasi-Periodic Climate Changes on Mars and Earth" (J.A. Cutts, J.B. Pollack, A.D. Howard and O.B. Toon), EOS, 66, 755-759 (1981).
56. "The Ultraviolet Absorber on Venus: Amorphous Sulfur" (O.B. Toon, R.P. Turco, and J.B. Pollack), Icarus, 51, 358-373 (1982).
57. "Climatic Change", (O.B. Toon), McGraw-Hill Yearbook of Science and Technology, 160-163 (1982).
58. "The Meteoric Component of the Stratospheric Aerosols" (R.P. Turco, O.B. Toon, R.C. Whitten, and P. Hamill), in Atmospheric Aerosols: Their Formation Optical Properties and Effects, A. Deepak, Ed., Spectrum Press, Hampton, Va. pp. 1239-165 (1982).
59. "Volcanoes and Climate", Atmospheric Effects and Potential Impact of the 1980 Eruption of Mount St. Helens. (O.B. Toon), ed. Ardash Deepak, NASA CP 2240, 15-36 (1982).
60. "Stratospheric Aerosols and Climate" (O.B. Toon and J.B. Pollack) in The Stratospheric Aerosol Layer ed. by R.C. Whitten, 121-147 Springer-Verlag, (1982).

61. "Stratospheric Aerosols: Observation and Theory" (R.P. Turco, R.C. Whitten, and O.B. Toon), Revs. Geophys. and Space Physics, 20, 233 (1982).
62. "An Analysis of the Physical, Chemical, Optical and Historical Impacts of the 1980 Tunguska Meteor Fall", (R.P. Turco, O.B. Toon, C. Park, R.C. Whitten, J.B. Pollack and P. Noerdlinger), Icarus, 50, 1-52 (1982).
63. "A Study of Mesospheric Rocket Contrails and Clouds Produced by Liquid-Fueled Rockets". (R.P. Turco, O.B. Toon, R.C. Whitten, R.G. Keesee, and D. Hollenbach), Space Solar Power Review, 3, 223-234, (1982).
64. "Quasi-Periodic Climate Changes in Mars: A Review" (J.B. Pollack, and O.B. Toon), Icarus, 50, 259-287 (1982).
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AREAS OF ACTIVE RESEARCH:

I am currently teaching courses in two departments. I developed "Planetary Atmospheres", which is a core graduate level course in the Astrophysical and Planetary Sciences Department, and is also an elective course in the Department of Atmospheric and Oceanic Sciences (ATOC). I also developed "Physics and Chemistry of Clouds and Aerosols", which is a core graduate level course in ATOC.

My research group consists of approximately 14 people. Ten are graduate students at the University of Colorado. Presently research is active in the following areas.

Theoretical Studies of Stratospheric Aerosols: This work has two facets - investigations of stratospheric aerosols and studies of polar stratospheric clouds.

We have constructed a numerical model of stratospheric volcanic aerosols over the past two decades. The model was initially one-dimensional, approximating Earth as a vertical column of air. As computational tools have improved we expanded to a two dimensional framework, and now are moving to a fully three-dimensional global model. Currently we are working to combine our microphysical model with the NCAR WACCM dynamical models so that detailed predictions can be made. This work will be done by Dr. Michael Mills, a LASP Research Associate. These calculations should aid in the analysis of remote sensing information, as well as being useful to studies of stratospheric ozone loss and to studies of climate change. We are currently on the HIRDLS team, an instrument that was launched in 2004 as part of NASA's Earth Observing System. My role is to understand aerosol observations from this instrument.

Investigations of polar stratospheric clouds are based upon analyses of data collected during various field programs and on satellite data. The goal is to determine the physical and chemical properties of the clouds so that they can be better represented in models that assess the role of polar clouds in stratospheric ozone loss. This work is supported by several NASA programs. During 1999-2000 NASA's SOLVE program, for which I was a co-project scientist, we collected a vast array of new data on PSCs. We are currently working with the data set to better understand how large denitrifying particles form, and to determine the composition of

these clouds. An ATOC graduate student is working on HIRDLS data on PSCs and to build a PSC model in conjunction with the NCAR WACCM chemical/dynamical model.

Theoretical Studies of Tropospheric Clouds, Aerosols and Radiative Transfer: Numerical simulations of the interactions between tropospheric aerosols and clouds are being conducted. One goal is to determine if the indirect effects of aerosols on clouds is a significant feature of Earth's climate system. Another goal is to simulate the life cycle of tropospheric aerosols and clouds in detail. During the last few years we developed a three-dimensional large eddy simulation model including detailed microphysics. The eventual goal is to be able to model tropospheric aerosols, marine boundary layer clouds and cirrus clouds including three-dimensional dynamics, atmospheric chemistry, and detailed microphysics. Dr. Peter Colarco recently graduated after studying the three-dimensional distribution of Saharan desert dust aerosols in the earth's troposphere and is now at NASA Goddard. We are using these simulations in conjunction with NASA's TOMS satellite instrument to constrain the optical properties of the dust and to better understand its transport. Mr. Lansing Madry of ATOC is conducting similar studies of sea salt. Ms. Rebecca Matichuk of ATOC is investigating smoke clouds from biomass burning. Ms. Dr. Brandy Gamblin, a recent graduate student from the CU Chemistry Department developed a model of nitric acid condensation on cirrus ice crystals. SOLVE data, and new lab data will help to constrain this problem, which is potentially important for the nitrogen budget of the upper troposphere. Mr. Charles Bardeen, an ATOC student is currently working on a model for subvisible cirrus clouds in conjunction with WACCM. Ms. Tianyi Fan, Ms. Lin Su and Mr. Jason English of ATOC are working on tropospheric aerosol modeling in conjunction with WACCM.

Experimental Investigations of Stratospheric and Tropospheric Phenomena: For many years I have been involved in using NASA aircraft to address various issues in stratospheric and tropospheric science. In the past these studies have dealt with volcanic clouds, stratospheric ozone loss, stratospheric transport processes, searching for evidence of heterogeneous chemistry in the troposphere, as well as investigating the formation and radiative

properties of cirrus clouds and the sensitivity of cirrus clouds to emissions from aircraft. The Subsonic Aircraft Contrail and Cloud Effects Special Study took place during April and May of 1996. This mission, for which I was the project scientist, involved the NASA DC-8, 757, ER-2 and T-39 aircraft. It cut across two project offices within NASA and interacted with Department of Energy studies using remotely piloted aircraft in the same area. The aircraft carried a large variety of instruments designed to investigate the radiative and microphysical properties of clouds, the chemistry of aircraft exhaust and heterogeneous chemistry in the upper troposphere. I edited a special issue of Geophys. Res. Lett. on this mission. More recently, I was a co-Project scientist for SOLVE (SAGE III ozone loss and validation experiment). This multi-aircraft project attempted to better understand polar ozone loss during the winter of 1999-2000. Multiple CU graduate students participated in this project. I was the Co-project scientist for CRYSTAL/FACE in 2002. This project was aimed at understanding the role of deep convection in forming high altitude cirrus, and their role in influencing the energy budget of Earth. The first field mission occurred the summer of 2002. Six research aircraft made numerous flights from Key West, Fla. Data on this mission are currently being reduced and analyzed. Currently I am heading a committee to design two large field programs to occur in the tropics in the next few years to help validate Aura and the A-Train satellites, and to learn more about tropical clouds and stratosphere-troposphere exchange.

Theoretical Investigations of Planetary Atmospheres and work under the Astrobiology Program: The focus of this work is to understand the clouds and climates of the terrestrial planets including Venus, and Mars, and to better understand the habitability of planets. An APS graduate student, Mr. Kevin McGouldrick, is studying the lower clouds of Venus to explain the clearings in the clouds that occasionally occur at near infrared wavelengths as observed, for example, by Galileo spacecraft instruments. During the past I have also investigated the environmental perturbations that would occur on Earth if it were struck by asteroids or comets of various sizes. I found that distinctly different phenomena occur in various size ranges. This study is designed to help guide astronomical searches for dangerous objects, and to shed further light on past impacts such as the one at the K-T boundary. Dr. Tony Colaprete, now a

researcher at NASA Ames, has completed studies of the formation of carbon dioxide clouds in the atmosphere of Mars. These studies show that snow storms occur in Martian wave clouds, and that ancient CO2 clouds were not efficient at warming the surface. He has also developed a model of water-ice clouds on Mars and applied it to Pathfinder, and Mars Global Surveyor data. Dr. Jen Heldmann, a student in the Geology Department, and now at NASA Ames, worked on studies of small rivers that have been observed on steep slopes on Mars and may be of recent origin. She also studied similar springs in the Arctic as an analog. Dr. Tian Feng of Astrophysical and Planetary Sciences studied the ancient atmosphere of Earth. Of interest in this case is the degree to which reducing gases may have been present. Dr. Erica Barth studied the hydrocarbon clouds on Titan to support Cassini observations and is now moving to SWRI. Her work was augmented by relevant laboratory studies in the chemistry department. Similar lab studies are being initiated on Mars methane, and on hydrocarbon clouds in the early atmosphere of Earth. Mr. Kaj Williams of ATOC is working on the stability of ice sheets on Mars. Mr. Attila Elteto is working on Martian dust storms and assimilating spacecraft data on aerosols into numerical models of Martian dust storms.

Management experience

I have held a variety of management positions.

Currently I am the Chair of the Department of Atmospheric and Oceanic Sciences at the University of Colorado. The Program has 14 faculty, about 49 graduate students, and three staff members. The faculty members bring about $6 million dollars to the University each year. As Chair I interface with several research institutes at CU, including LASP, CIRES and INSTAAR, as well as the educational programs at the University, which are centered in the School of Arts and Sciences.

I also have managed, or co-managed, a variety of large NASA field missions over the past 20 years. These field missions have typically involved multiple aircraft and ground stations. They have also involved not only NASA scientists and aircrews, but also scientists from other government agencies and from universities. These projects have required years of advocacy to initiate and organize before the field mission begins. In the field they require coordination of significant numbers of people operating in stressful and dangerous environments where the scientific goals must be met on a daily basis. Following the mission further work is needed to organize meetings, and facilitate discussion so that the data are archived and the science return is maximized.