ESRL/GMD Staff

RESUME:

Dr. Russell C Schnell

Born 1944, Castor, Canada

Physical Science Administrator

National Oceanic and Atmospheric Administration

NOAA ESRL Global Monitoring Division (GMD)

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Deputy-Director. GMD management, baseline observatory operations, budget and global network operations, oil and gas field emissions, winter ozone, biological ice nuclei.

EDUCATION:

University of Alberta, Edmonton, Canada, B.S. in Chemistry, 1966 (with Distinction).

Memorial University of Newfoundland, St. Johns, Canada, B.S. in Biology, 1968, First Class.

University of Hawaii, Honolulu, Climatology, 1968.

University of Wales, Swansea, Agricultural Climatology, 1969-70.

University of Wyoming, Atmospheric Science, M.S., 1971. **Thesis:** "Ice Nuclei from Decomposing Tree Leaves," supervised by Dr. G. Vali.

University of Wyoming, Atmospheric Science, Ph.D., 1974. **Dissertation:** "Biogenic Sources of Atmospheric Ice Nuclei," supervised by Dr. G. Vali.

WORK RESEARCH AND EXPERIENCE:

1960-1963: Castor Advance, Castor, Alberta, Printer's Apprentice

1966-1968: Research Technician, Alberta Research Council, Alberta Hail Studies:

Develop, install and maintain a precipitation and hail collection network over 10,000 square miles of Alberta farmland.

1969-1971: Research Assistant, Department of Atmospheric Science, University of Wyoming, Laramie: National Hail Research Experiment, Elk Mountain Orographic Cloud Studies, and Project METROMEX. Discovered biological ice nuclei, living and inanimate.

1971-1974: Scientist I, Department of Atmospheric Sciences, University of Wyoming, Laramie. Laboratory research into biogenic atmospheric ice nuclei with $133,000/yr. research grant from the National Science Foundation (NSF).

1974-1975: National Center for Atmospheric Research (NCAR), Boulder, CO, Advanced Study Program Fellow. Original research into naturally occurring ice nucleants, conducted a two-month drought research and ice nuclei research project in the Sahel of Africa. Invited member of the 1975 US Navy HAYES Atlantic Fog Research Cruise. On-board aircraft scientist for NCAR Project DUSTSTORM.

1975-1976: National Research Council, Research Associate, NOAA/APCL, Boulder CO. Research into the structure and form of naturally occurring biological ice nucleants, aerosol composition studies, power plant plume studies. Development of techniques for the control of bacterial ice nucleants (i.e. frost damage) in crops, aerosol and ice nucleus research. Research on ski hill snowmaking with biological ice nuclei. This later was developed into SNOWMAX ski hill snowmaking additive by Kodak Inc.

1976-1978: Director, Mount Kenya Baseline Station Feasibility Study, Nairobi, Kenya. Directed a United Nations project studying the feasibility of building an atmospheric baseline monitoring station on Mount Kenya (15,000ft). Overall responsibility for the planning, field research, data analysis, personnel, accounting and reporting. Conducted surface and airborne research. Responsible for a staff growing from 3 up to 45 personnel when in the field. Project successful. Mt. Kenya Atmospheric Baseline Observatory constructed and put into operation at a later date.

1979: Scientist, WMO Project PEP, Valladolid, Spain. Airborne cloud physics research scientist studying the potential for seeding clouds for rain above central Spain.

1979-1991: Research Scientist, Cooperative Institute for Research in Environmental Science (CIRES), University of Colorado, Boulder, CO. Conducting research into the sources, nature, and control of biological ice nucleants in frost protection on plants, Arctic aerosols and Arctic climate and ice projects. Director, Special Operations Group conducting research projects for the US Government in remotes foreign locations.

1983-1984: Guest Editor, Geophysical Research Letters, Arctic Haze Special Issue.

1982-1996: Director, Arctic Gas and Aerosol Sampling Program (AGASP). Conceived, organized, arranged funding for, and directed the multi-$ million, multi-national AGASP

program. At its peak activity in March-April 1986 there were 5 aircraft and 185 personnel representing 8 government agencies and 13 Universities from 6 countries conducting coordinated Arctic Haze, ice and energy budget related measurements around the Arctic Ocean including off Svalbard, the USSR Arctic, Canadian Arctic Archipelago and off Alaska. Co-editor, Atmos. Environ., Special Issue, DGASP/AGASP, 1992-93.

1991-1998: Director, Mauna Loa Observatory (MLO), Hilo, Hawaii. Responsible for overall operations, staff, budget, data collection and data quality for MLO. Instrumental in the successful acquisition of a new main MLO building completed in 1997, five additional research buildings funded from outside NOAA, and a new 18 mile paved road to MLO with funds arranged through then Senator D. Inouye.

1998-2005: Director, Observatory and Global Network Operations, NOAA/GMD, Boulder, CO. Overall responsibility for the operations, budgets, and personnel at the five GMD Global Atmospheric Monitoring Stations (Barrow, AK; Mauna Loa, Hawaii; Samoa; Trinidad, Head, CA; and South Pole, Antarctica).

2005-date: Deputy Director, NOAA Earth System Research Laboratory, Global Monitoring Division (GMD), Boulder, CO. GMD monitors the Earth's atmospheric composition related to climate forcing, ozone, and surface radiation with 100+ personnel, 130 global sampling sites, and an annual $20 M budget.

HONORS, AWARDS AND CERTIFICATIONS:

1962: Royal Canadian Air Cadet Flight Training Scholarship (Pilot License).

1963: Royal Canadian Air Cadet Exchange Scholarship to Israel, Guest of the Israeli Defense Forces (Air), summer 1963.

1964: Royal Lifesaving Society, Gold Medallion

1965-1966: Canadian Union of Student Exchange Scholarship to Memorial University, Newfoundland.

1968-1969: Rotary International Fellow, University of Wales, Swansea.

1969: British Union of Students Exchange with Russia- one month in Russia.

1971: Canadian Student Representative, Williamsburg International Assembly Williamsburg, Virginia, guest of the Rockefeller Foundation.

1972: Sigma Tau (Engineering Honorary)

1976-1979: Member, National Academy of Sciences Committee on Aerobiology

1981-89: US Representative on US-USSR Working Group 8; many trips to Russia.

1981: Certified Consulting Meteorologist Accreditation (American Meteorological Society Certification)

1983: Invited guest to China (one month, China supported) as a visitor and lecturer on atmospheric measurements that led to many programs with China.

1985: Elected Fellow of CIRES, University of Colorado

1995: Selected, Marquis Who's Who in the World

2002: NOAA Administrator's Award for revitalizing Mauna Loa Observatory facilities and operations.

2007: Member of the IPCC that was awarded the 2007 Nobel Peace Prize along with Al Gore.

2008: United States Department of Commerce Silver Medal.

2010: NOAA Distinguished Career Award.

2011: NOAA OAR Outstanding Science Communicator Award (1 awarded per year).

2014: Colorado Governor's Award for High-Impact Research -Atmospheric Impacts of Rapidly Expanding Oil & Gas Development across the West.

2015: Honorary Doctor of Science, University of Alberta, Canada

1980-Present: Invited speaker and lecturer by various governments and agencies in numerous countries including Russia, China, India, Azerbaijan, Nepal, Mexico, Ecuador, Iceland, Norway, Denmark, Germany, France, Taiwan, South Africa, Kenya, Switzerland, UK, Japan, Mongolia, Canada, Korea, Iran, Italy and Austria.

CONSULTANCIES or Large Project Proposal Award Panels:

1978-1981: United Nations, World Meteorological Organization, Geneva.

1978-1979: Shell Development Company, Modesto, California.

1981: Universal High Technologies, Yonkers, New York.

1982-1983: University Patents Incorporated, Norwalk, Connecticut.

1983-1984: Frost Technology Corporation, Norwalk, Connecticut.

1988: Eastman Kodak, Rochester, New York

1989: Global Marine Drilling Co., Houston

1990-1991: Holm, Roberts and Owens, Law Practice, Denver, CO

1991: Battelle Northwest Labs, Richland, WA

2012: Swedish Research Council, Stockholm

2013- 2016: National Research Council of Canada

2016-18: Member, Alberta Environment and Parks, EMSD, Scientific Advisory Panel

2019- Collaboratory to Advance Methane Science, Scientific Advisory Board

INTERNATIONAL MEETINGS ORGANIZED:

First International Biological Ice Nucleus Conference, Laramie, WY, May 1975 (9th held in 2010); Session on Biological Ice Nuclei, AGU Fall Meeting, San Francisco, CA, 1975; AGU Fall Meeting, Session on AGASP/DGASP, 1990; Co-convener, Symposium on the Tropospheric Chemistry of the Antarctic Region, Boulder, CO, 1991; Mauna Loa 40th Anniversary Symposium, AGU, San Francisco, CA 1997; Organizing Committee, Mount Waliguan, 10th Anniversary Symposium, Xining, China, August 2005; Organizing Committee Mount Waliguan, 20th Anniversary Symposium, Xining, China, September 2015; Organizing Committee,7th International Carbon Dioxide Conference, Boulder, CO, September 2005; Organizer and Chairperson, NOAA Global Monitoring Annual Conferences, 1998 through 2018.

Major Committees: National Academy of Sciences, Committee on Aerobiology, 1976-79; Environmental Protection Agency Panel drafting the EPA document "The Potential Atmospheric Impact of Chemicals Released to the Environment, 1979; NOAA Aircraft Instrumentation Upgrade Committee, 1987-89; Convener, IGAC Coordinating Committee, Polar Atmospheric Chemistry, 1990-92; NOAA Polar Committee, 2001 to date; NOAA Pacific Regional Board, 2007 to date.; NOAA Polar Board, 1999-date Numerous NOAA level committees.

PATENTS:

Reducing the Effect, in Plants, of Ice-Promoting Nuclei Originating from Certain Bacteria - U.S. Patent No. 4,311,517. Protecting of Plants Against Frost Injury Using Ice Nucleation-Inhibiting Species -- Specific Bacteriophages - U.S. Patent No. 4,375,734, Canadian Patent No. 1,270,255.

PROFESSIONAL SOCIETIES:

American Meteorological Society, American Geophysical Union, International Association of Aerobiology, Sigma Tau, Sigma XI.

OTHER INTERESTS:

Travel (92 countries to date), income real estate investing, public speaking, woodworking.

POSTDOCTORAL STUDENTS:

Name, Year, Publications, Proceedings, **Books,** Total

Wolfgang Raatz 1983-8412 12 6 18

Howard Bridgman 1986-87 7 5 **2** 12

Pat Sheridan 1987-1989 10 9 19

Jon Kahl 1987-1989 10 9 19

Bill Sturges 1989-1991 7 4 **1** 12

Ira Sokolik 1991-1992 6 6 12

MAJOR FIELD PROGRAMS:

Among the more noteworthy field projects are the Alberta Hail Studies (1964-69);National Hail Research Experiment, Colorado (1973); METROMEX, St. Louis, Missouri (1971-72); Global Ice Nuclei, Europe, USSR, Japan, Burma, Thailand, India and Iran (1971-72); Elk Mountain Observatory Studies, Wyoming (1969-73); Director, Sahel Ice Nuclei Studies, Niger, Dahomey, and Kenya (1974); Project DUSTORM (1975), Texas; USS Hayes Fog Cruise, Grand Banks, (1975); Four Corners Power plant Plume Studies, New Mexico (1975-76); Director, Mount Kenya Baseline Station Project, Kenya (1976-78); WMO Project PEP, Spain, 1979; Johnstown and Homer City Power plant Plume Studies, Pennsylvania (1980); HAMEC, Hawaii (1980); Director, Arctic Gas and Aerosol Sampling Project, Arctic Basin, Greenland ,Norway and USSR (AGASP - I, 1983); Director, WP-3D Component of WATOX, Western Atlantic (1986);

Director, AGASP - II, Western Arctic (1986); PRECP VI, Illinois (1988); Director, Mt. Kenya Ice Nuclei, Kenya (1988); MISERS GOLD nuclear blast simulation, New Mexico (1989); Army Lidar Validation Program, White Sands Missile Range, NM (1989-90); Director, AGASP - III, Eastern Arctic, and Norway (1989); Director, NOAA WP-3D Component, SJVAQS, Northern California (1990), Kuwait Oil Fire Study (NCAR Electra,) Persian Gulf (May 1991); AGASP-IV/LEADEX, Alaska (April, 1992); Bennett Island Project, Siberia, Russia (March-April, 1992); Russian Arctic Research Aircraft Study, Cherskii, Siberia, April 1993; Mongolia Airborne Carbon Cycle Profile program, 2004-2008; Uintah Basin Winter Ozone Study, Winter 2012 and 2013; Front Range Air Pollution Study, Colorado, 2014; TOPDOWN Gas and Oil Filed Emissions Study, New Mexico, 2014; US Mid-Continent Methane Measurement Reconciliation Study, Arkansas, 2015; Alberta Oil Sands Effluent Study, 2017-18; North Park Colorado Winter Ozone Production Study, Initiated January 2019.

Papers: Schnell has ~ 200 publications, 9 of which are in ***Nature*** in four different scientific fields. The first papers in the open literature on biogenic ice nuclei were by Schnell and Vali in 1972 and 1973.

Below are presented papers for the past 3 years followed by papers arranged in five different scientific fields that have been cited 10 times or greater.

2019

Yalda Vasebi, Marco E. Mechan Llontop1, Regina Hanlon1, David G. Schmale III, **Russell Schnell,** Boris A. Vinatzer (2019), Comprehensive characterization of an Aspen (*Populus tremuloides*) leaf litter sample that maintained ice nucleation activity for 48 years. *Biogeosciences Discuss.*, https://doi.org/10.5194/bg-2018-496 (In final copy edit phase).

Gabrielle Petron, Benjamin Miller, Bruce Vaughn, Stefan Schwietzke, Steven Conley, Jeff Peischl, Ed Dlugokencky, Jonathan Kofler, Eryka Thorley, Ingrid Mielke-Maday, Owen Sherwood, Brad Hall, Patricia Lang, Eric Moglia, Colm Sweeney, Jeff Peischl, Pieter Tans, Tim Newberger, Sonja Wolter, Clark King, Tim Coleman, Allen White, Michael Rhodes, Brian

Vanderwende and **Russ Schnell** (Drilling down on satellite captured US Four Corners methane hotspot (In manuscript form, to be submitted early in 2019).

Mielke-Maday, I., Schwietzke, S., Thorley, E., Yacovitch, T., Herndon, S.,M., Conley, S., Kofler, J., Handley, P., Miller, B., Hall, B., Dlugokencky, E., Lang, P., Wolter, S., Moglia,. E., Crotwell, M., Crotwell, A., Kitzis, D., Vaughn, T., Bell, C., Zimmerle, D., **Schnell, R.C**., Petron, G. (2018), Methane Source Attribution in a U.S. Dry Gas Basin Using Spatial Patterns of Ground and Airborne Ethane and Methane Measurements, *Elem Sci Anth*, (In final stage of review).

Oltmans, S., Cheadle, L C., Johnson, B. J., **Schnell, R.C.**, Helmig, D., Thompson, A.M., Cullis, P., Hall, E., Jordan, A., Sterling, C., McClure-Begley, A.M., Sullivan, J.T., McGee T.P., Wolfe, D. (2019), Boundary Layer Ozone in the Northern Colorado Front Range in July-August 2014 during FRAPPE and DISCOVER-AQ from Vertical Profile Measurements, *Elem Sci Anth, 7*: 6. DOI: https://doi.org/10.1525/elementa.345.

2018

Vaughn, T.L., Bell, C. S., Pickering, C. K., Schwietzke, S., Heath, G.A., Pétron, G., . Zimmerle, D.J., **Schnell, R.C**., and Nummedal, D., (2018), Temporal variability largely explains top-down/bottom-up difference in methane emission estimates from a natural gas production region. *Proceeding National Academy of Sciences,* November 13, 2018 115 (46) 11712-11717.

Schwietzke, S., Harrison, M., Lauderdale, T., Branson, K., Conley,S., George, F. C., Jordan, D., Jersey,G., Zhang, C., Mairs, H., Pétron G., &. **Schnell, R.C.** (2018), Aerially guided leak detection and repair: A pilot field study for evaluating the potential of methane emission detection and cost-effectiveness, *JAWMA*, do:10.1080/10962247.2018.1515123.

Creamean, J. M., Kirpes, R. M., Pratt, K. A., Spada, N. J., Maahn, M., de Boer, G., **Schnell, R. C.**, and China, S. (2018), Marine and terrestrial influences on ice nucleating particles during continuous springtime measurements in an Arctic oilfield location, *Atmos. Chem. Phys. Discussions*, doi.org/10.5194/acp-2018-545.

Creamean, Jessie M., Katherine M. Primm, Margaret A. Tolbert**,** Emrys G. Hall**,** Jim Wendell**,** Allen Jordan**,** Patrick J. Sheridan**,** Jedediah Smith and **Russell C. Schnell**, (2018), HOVERCAT: A novel aerial system for evaluation of aerosol-cloud interactions, *Atmospheric Measurement Techniques Discussions*, 1-28, 10.5194/amt-2018-47.

Bian, Lingen, Lei Ye, Minghu Ding, Zhiqiu Gao, Xiangdong Zheng and **Russell C. Schnell**, (2018), Surface Ozone Monitoring and Background Concentration at Zhongshan Station, Antarctica, *Atmospheric and Climate Sciences*, 08, 01, 1-14, 10.4236/acs.2018.81001 .

2017

Smith, Mackenzie L., Alexander Gvakharia, Eric A. Kort**,** Colm Sweeney**,** Stephen A. Conley, Ian Faloona**,** Tim Newberger**, Russell Schnell**, Stefan Schwietzke and Sonja Wolter, (2017), Airborne Quantification of Methane Emissions over the Four Corners Region, *Environmental Science & Technology*, 51, 10, 5832-5837, 10.1021/acs.est.6b06107

Schwietzke, Stefan, Gabrielle Pétron, Stephen Conley, Cody Pickering, Ingrid Mielke-Maday, Edward J. Dlugokencky, Pieter P. Tans, Tim Vaughn, Clay Bell, Daniel Zimmerle, Sonja Wolter, Clark W. King, Allen B. White, Timothy Coleman, Laura Bianco and **Russell C. Schnell**, (2017), Improved Mechanistic Understanding of Natural Gas Methane Emissions from Spatially Resolved Aircraft Measurements, *Environmental Science & Technology*, 51, 12, 7286-7294, 10.1021/acs.est.7b01810 .

Huang, Guanyu, Xiong Liu, Kelly Chance, Kai Yang, Pawan K. Bhartia, Zhaonan Cai, Marc Allaart, Gérard Ancellet, Bertrand Calpini, Gerrie J. R. Coetzee, Emilio Cuevas-Agulló, Manuel Cupeiro, Hugo De Backer, Manvendra K. Dubey, Henry E. Fuelberg, Masatomo Fujiwara, Sophie Godin-Beekmann, Tristan J. Hall, Bryan Johnson**,** Everette Joseph, Rigel Kivi, Bogumil Kois, Ninong Komala, Gert König-Langlo, Giovanni Laneve, Thierry Leblanc, Marion Marchand, Kenneth R. Minschwaner, Gary Morris, Michael J. Newchurch, Shin-Ya Ogino, Nozomu Ohkawara, Ankie J. M. Piters, Françoise Posny, Richard Querel, Rinus Scheele, Frank J. Schmidlin, **Russell C. Schnell**, Otto Schrems, Henry Selkirk, Masato Shiotani, Pavla Skrivánková, René Stübi, Ghassan Taha, David W. Tarasick, Anne M. Thompson, Valérie Thouret, Matthew B. Tully, Roeland Van Malderen, Holger Vömel, Peter von der Gathen, Jacquelyn C. Witte and Margarita Yela, (2017), Validation of 10-year SAO OMI Ozone Profile (PROFOZ) product using ozonesonde observations, *Atmospheric Measurement Techniques*, 10, 7, 2455-2475, 10.5194/amt-10-2455-2017.

Cullis, Patrick**,** Chance Sterling**,** Emrys Hall**,** Allen Jordan**,** Bryan Johnson and **Russell Schnell**, (2017), Pop Goes the Balloon!: What Happens when a Weather Balloon Reaches 30,000 m asl?, *Bulletin of the American Meteorological Society*, 98, 2, 216-217, 10.1175/BAMS-D-16-0094.1.

Conley, Stephen, Ian Faloona, Shobhit Mehrotra, Maxime Suard, Donald H. Lenschow, Colm Sweeney**,** Scott Herndon, Stefan Schwietzke**,** Gabrielle Pétron, Justin Pifer, Eric A. Kort and **Russell Schnell**, (2017), Application of Gauss's theorem to quantify localized surface emissions from airborne measurements of wind and trace gases, *Atmospheric Measurement Techniques*, 10, 9, 3345-3358, 10.5194/amt-10-3345-2017.

Cheadle, L. C., S. J. Oltmans**,** G. Petron**, R. C. Schnell**, E. J. Mattson, S. C. Herndon, A. M. Thompson, D. R. Blake and A. McClure-Begley**,** (2017), Surface ozone in the Colorado northern Front Range and the influence of oil and gas development during FRAPPE/DISCOVER-AQ in summer 2014, *Elem Sci Anth*, 5, 61, 10.1525/elementa.254

2016.

Schnell, Russell C.**,** Bryan J. Johnson**,** Samuel J. Oltmans**,** Patrick Cullis**,** Chance Sterling**,** Emrys Hall**,** Allen Jordan**,** Detlev Helmig, Gabrielle Petron**,** Ravan Ahmadov, James Wendell**,** Robert Albee, Patrick Boylan, Chelsea R. Thompson, Jason Evans, Jacques Hueber, Abigale J. Curtis and Jeong-Hoo Park, (2016), Quantifying wintertime boundary layer ozone production from frequent profile measurements in the Uinta Basin, UT, oil and gas region, *Journal of Geophysical Research: Atmospheres*, 10.1002/2016JD025130.

Oltmans, S. J.**,** A. Karion**, R. C. Schnell**, G. Pétron**,** D. Helmig, S. A. Montzka**,** S. Wolter**,** D. Neff**,** B. R. Miller, J. Hueber, S. Conley**,** B. J. Johnson **and** C. Sweeney**,** (2016), O3, CH4, CO2, CO, NO2 and NMHC aircraft measurements in the Uinta Basin oil and gas region under low and high ozone conditions in winter 2012 and 2013, *Elementa: Science of the Anthropocene*, 4, 000132, 10.12952/journal.elementa.000132.

Bian, Lingen, Zhiqiu Gao, Yulong Sun, Minghu Ding, Jie Tang and **Russell C. Schnell**, (2016), CH4 Monitoring and Background Concentration at Zhongshan Station, Antarctica, *Atmospheric and Climate Sciences*, 06, 01, 135-144, 10.4236/acs.2016.61012

PRIOR PUBLICATIONS:

Arranged by Field/Themes along with Citations.

Papers with less than 10 Science Citations are not categorized and are listed after the

Climate Forcing, Climate and Related Topics theme categorization.

Citations are from Google Scholar in summer 2018.

<u>1.Biogenic Ice Nuclei.</u> Russ Schnell discovered three very different classes of biogenic ice nuclei, one produced by a few species of live bacteria on land, a second from decayed plant litter and a third produced by marine phytoplankton. Schnell's first 2 papers on biogenic ice nuclei, as a M.Sc. student, were both in *Nature*. These discoveries in established a new field that continues to grow rapidly. Mendeley/Elsevier now lists 2583 refereed papers that mention studies on biogenic ice nuclei.

Biological ice nuclei have been shown to be the best and most widespread atmospheric nuclei that initiate the ice phase (i.e. precipitation) in clouds. In the absence of active ice nuclei clouds can supercool to temperature colder than -25ºC without precipitating. Active, living biogenic ice nuclei have even been observed in the Antarctic atmosphere as well as around the Arctic Ocean.

The few species of living bacteria that produce the most active natural ice nuclei also initiate frost damage in plants. By controlling the presence of these bacteria some commercial crops can be protected from frost to temperatures down to -4°C.

A current focus on biogenic ice nuclei is their role in Arctic clouds in an effort to understand why climate and radiation balance models in the Arctic do not agree with observations. This discrepancy may be related to the presence of ice crystals forming in the lower portions of Arctic stratus clouds at low supercooling temperatures. As very active biogenic ice nuclei have been measured in areas of high primary productivity in the Arctic, these biogenic ice nuclei may be a key to the anomalous ice formation.

There are two large scale commercial applications stemming from biologic ice nuclei: SNOWMAX used in ski hill snowmaking around the world, and a variety of products to prevent frost damage in commercial food crops by turning off the ice gene in ice forming bacteria living on plants.

Biogenic ice nuclei are also used to help preserve human transplant organs during storage by inducing gentle ice formation in the organs at temperatures just below freezing.

Papers covering the discovery of stable biogenic ice nuclei in decayed plant litters (leaf derived nuclei, LDN), in some species of living bacteria (bacteria derived nuclei, BDN) and from marine phytoplankton (ocean derived nuclei, ODN) .

Schnell, R.C. and G. Vali, Ice nuclei from decomposing vegetation. *Nature*, 236, 163-164, 1972. Science Citations = 233

Nature, News and Views, "Cloud seeding developments," Editorial comments on the above paper. *Nature*, 236, 139-140, 1972.

Schnell, R.C. and G. Vali, World-wide source of leaf derived freezing nuclei. *Nature*, 236, 212-213, 1973. Science Citations = 100

Schnell, R.C. and G. Vali, Biogenic ice nuclei, Part I: Terrestrial and marine sources. *J. Atmos. Sci.*, 33, 1554-1564, 1976. Science Citations = 242

Vali, G., M. Christensen, R.W. Fresh, E.L. Galyan, L.R. Maki, and **R.C. Schnell,** Biogenic ice nuclei Part II, Bacterial sources. *J. Atmos. Sci., 33*, 1565-1570, 1976. Science Citations = 219

"Microbial antifreeze: Gene Splicing Takes to the Field", Science News of the Week, Editorial using some material from the above paper, *Science News, 120*, 132, 1983.

Schnell, R.C., Ice nuclei in seawater, fog water and marine air off the coast of Nova Scotia: Summer, 1975, J. *Atmos. Sci., 34*, 1299-1305, 1977. Science Citations = 52

Schnell, R.C. and S.N. Tan-Schnell, Kenyan Tea Litter: A source of ice nuclei, *Tellus, 34,* 92-95, 1982. Science Citations = 33

Schnell, R.C., Bacteria acting as natural ice nucleants at temperatures approaching -1°C. *Bull. Amer. Met. Soc., 57,* 11, 1356-1357, 1976. Science Citations = 26

Fall, R.R. and **R.C. Schnell**, Association of an ice-nucleating Pseudomonad with cultures of the marine dinoflagellate, Heterocapsa niei, *J. Marine Res., 43,* 257-265, 1985. Science Citations = 34

Schnell, R.C. and G. Vali, Freezing nuclei in marine waters. *Tellus, 27, 321*, 1975. Science Citations = 39

Schnell, R.C., Ice nuclei produced by laboratory cultured marine phytoplankton

Geophysical Research Letters, 2, 11, 500-502, 1975. Science Citations = 22

Protection of plants against frost injury using ice nucleation-inhibiting species-specific bacteriophages, L.M. Kozloff, R.C. Schnell - US Patent 4,375,734, 1983. Science Citations = 23

2. Ozone Chemistry and Oil and Gas Field Effluents. Schnell is an author on 3 pivotal ozone papers in *Nature*: a highly cited paper showing photochemical ozone destruction in the Arctic; the first scientific publication showing decreasing ozone at the surface in Antarctica; and the first paper showing and explaining wintertime, cold temperature, fast photochemical ozone production in a rural natural gas field.

Barrie, L.A., J.W. Bottenheim, **R.C. Schnell,** P.J. Crutzen and R.A. Rasmussen, Ozone destruction and photochemical reactions at Polar sunrise in the lower Arctic atmosphere, *Nature*, 334, 1, 138-140, 1988. Science Citations = 1047

Schnell, R.C., S. Liu, S. Oltmans, R. Stone, D. Hofmann, E. Dutton, W. Sturges, T. Deschler, J. Harder, S. Sewell, M. Trainer, and J. Harris, Decrease of summer tropospheric ozone concentrations in Antarctica, *Nature*, 351, 726-729, 1991. *Science* Citations = 91

"New ozone hole phenomenon," *Nature* editorial comments, *Nature*, 352, 282-283, 1991

Schnell, R.C., S.J. Oltmans, R.R. Neely, M.S. Endres, J.V. Molenar and A.B. White, Rapid Photochemical production of Ozone at High Concentrations in a Rural Site during Winter, *Nature Geoscience*, 2, 120-122, 2009. Science Citations = 144

"Wyoming Winter Smog", *Nature Geoscience*, News and Views, Editorial comments on above paper, *Nature Geoscience*, 2, 88-90, 2009.

Nature Geoscience, Back Page, "Cold Case", Story on above paper, 2, 152, 2009.

Nature Geoscience, Cover Photo of an natural gas drilling operations relating to the publication, 2, 79, 2009.

Oltmans, S.J., **R.C. Schnell,** P.J. Sheridan R.E. Peterson S.-M. Li J.W. Winchester, P.P. Tans W.T. Sturges J.D. Kahl L.A. Barrie, Seasonal surface ozone and filterable bromine relationship in the high Arctic *Atmospheric Environment*, 23, 11, Pages 2431-2441, 1067, 1989. Science Citations = 127

Sturges, W.T., C.W. Sullivan, **R.C. Schnell**, L.E. Heidt, and W.H. Pollock, Bromoalkane production by Antarctic ice algae, *Tellus*, 45B, 120-126, 1993. Science Citations = 79

Karion, Anna, Colm Sweeney, Gabrielle Pétron, Gregory Frost, R. Michael Hardesty, Jonathan Kofler, Ben R. Miller, Tim Newberger, Sonja Wolter, Robert Banta, Alan Brewer, Ed Dlugokencky, Patricia Lang, Stephen A. Montzka, **Russell Schnell**, Pieter Tans, Michael Trainer, Robert Zamora and Stephen Conley, (2013), Methane emissions estimate from airborne measurements over a western United States natural gas field, *Geophysical Research Letters*, 40, 16, 4393-4397, 10.1002/grl.50811. Science Citations=295

Petron, Gabrielle; Karion, Anna; Sweeney, Colm; … **Schnell, Russell** …et al., A new look at methane and non-methane hydrocarbon emissions from oil and natural gas operations in the Colorado Denver-Julesburg Basin, *J.G.R, Atmos.*, 119, 11, 6836-6852 June 16, 2014. Science Citations = 147

Ahmadov, R; McKeen, S; Trainer, M, …**Schnell, R** et al., Understanding high wintertime ozone pollution events in an oil- and natural gas-producing region of the western US, *Atmos. Chem. and Phys.*,15,1,411-429, 2014, DOI: 10.5194/acp-15-411-2015. Science Citations = 58.

McPeters, R.D., D.J.Hofmann, M Clark, L. Flynn, L. Froidevaux, M. Gross, B. Johnson, G. Koenig, X. Liu, S. McDermid, T. McGee,F. Murcray, M. J. Newchurch, S. Oltmans, A. Parrish, **R. Schnell,** U. Singh, J. J. Tsou, T. Walsh and J. M. Zawodny, Results from the 1995 Stratospheric Ozone Profile Intercomparison at Mauna Loa (MLO3*), J.G.R. (Atmospheres),104*, D23, 30,505-30,514,1999. Citations =36.

Bodhaine, B.A., D.J. Hofmann, E.G. Dutton, **R.C. Schnell,** J.E. Barnes, S.C. Ryan, R.L. McKenzie, P.V. Johnson, and M. Kotcamp, New Ultraviolet spectroradiometer measurements at Mauna Loa Observatory, *Geophys. Res. Lett., 23*, pp 2121-2124, 1996. Science Citations = 23

Hofmann, D.J. S.J. Oltmans, G.L. Koenig, B.A. Bodhaine, J.M. Harris, J.A. Lathrop, **R.C. Schnell,** J. Barnes, J. Chin, D. Kuniyuki, S. Ryan, R. Uchida, A. Yoshinaga, P.J. Neale, D.R. Hayes, Jr., V.R. Goodrich, W.D. Komhyr, R.D. Evans, B.J. Johnson, D.M. Quincy, and M. Clark, Record Low Ozone and Elevated UV Radiation over the Hawaiian Islands During the Winter of 1994-95, *Geophys. Res. Lett*., 23,1533-1536, 1996. Science Citations = 27

Sturges, W.T., **R.C. Schnell,** G.S. Dutton, S.R. Garcia, and J.A. Lind, Spring Measurements of tropospheric bromine at Barrow, Alaska, *GRL*, 20, pp 201-224, 1993. Science Citations = 22

Sheridan, P.J., **R.C. Schnell**, W.H. Zoller, N.D. Carlson, R.A. Rasmussen, J.M. Harris, and H. Sievering, Composition of Br- containing aerosols and gases related to boundary layer ozone destruction in the Arctic, *Atmos. Environ.*, 27A, 2839-2849, 1993. Science Citations = 16

Sturges, W.T., **R.C. Schnell,** S. Landsberger, and J.M. Harris, Chemical and meteorological influences on surface ozone destruction at Barrow, Alaska during spring 1989, *Atmos. Environ.*, 27A, 2851-2863, 1993. Science Citations =35

Sturges, W.T., **R.C. Schnell**, G.S. Dutton, S.R. Garcia, and J.A. Lind, Spring Measurements of tropospheric bromine at Barrow, Alaska, *GRL*, *20*, pp 201-224, 1993. Science Citations = 21

Li, S.M. J.W. Winchester, J.D. Kahl, S.J. Oltmans, **R.C. Schnell** and P.J. Sheridan, Arctic boundary layer ozone variations associated with nitrate, bromine, and meteorology: A case study. *J.G.R.*, *95*, 433 - 40, 1990. Science Citations = 16

Oltmans, S., **Schnell, R.,** Johnson, B., Pétron, G., Mefford, T, Neely III, R. 2014 Anatomy of wintertime ozone production associated with oil and gas extraction activity in Wyoming and Utah, *Elementa*, 2, doi:10.12952/Elementa.000024. (Science Citations=38.

3. Arctic Haze. In 1982 Russ Schnell conceived, arranged funding for and directed the Arctic Gas and Aerosol Sampling Program (AGASP) up until 1992 showing that Arctic Haze was air pollution from Eurasia. In the spring 1986 program there were 6 major aircraft and as many ground based programs in the Arctic studying the phenomenon.

Schnell, R.C., Arctic Haze and the Arctic gas and aerosol sampling program (AGASP), *Geophys. Res. Lett.*, 11, 361-364, 1984. Science Citations = 127

"Implications of Arctic air pollution", Nature editorial on the above paper, *Nature*, 311, 299, 1984.

Bennett Island Plume, Soviet Arctic Ocean.

"U.S.-Russian Team Solves Arctic Mystery", Editorial on a discovery that was not widely publicized for political sensitivity reasons, *Science*, 257, 35, 1992.

"Mountain gives rise to perplexing plumes", *Science News*, 141, 422, 1992.

Schnell, R.C., R.G. Barry, M.W. Miles, E.L. Andreas, L.F. Radhe, C.A. Brock, M.P. McCormick and J.L. Moore, LIDAR detection of leads in Arctic sea ice. *Nature,* 239, pp. 530-532, 1989. Science Citations = 87

"Through the ice." *Nature This Week*, Editorial comments on the above paper, *Nature*, 239, 516, 1989.

Schnell, R.C. and W.E. Raatz, Vertical and horizontal characteristics of Arctic haze during AGASP: Alaskan Arctic, *Geophys. Res. Lett.*, 11, 369-372, 1984. Science Citations = 67

Raatz, W.E. and **R.C. Schnell,** Aerosol distributions and an Arctic aerosol front during AGASP: Norwegian Arctic, *Geophys, Res. Lett.*, 11, 373-376, 1984. Science Citations = 32

Shapiro MA, **Schnell RC**, Parungo FP, Oltmans SJ, Bodhaine BA, El Chichon Volcanic Debris in an Arctic Tropopause Fold, *Geophys. Res. Lett.*, 11, 5, 421-424,1984.

Science Citations = 49

Bodhaine, B.A., N.C. Ahlquist, and **R.C. Schnell,** Three-wavelength nephelometer suitable for aircraft measurement of background aerosol scattering extinction coefficient, *Atmos. Environ.* 25A, 2267-2276, 1991. Science Citations = 82

Bridgman, H.A**., R.C. Schnell**, B.A. Bodhaine and S.J. Oltmans, Aerosol and ozone distributions over the western North Atlantic during WATOX-86, WATOX Special Issue, *Global Biogeochem. Cycles,* 2, 23-39, 1988. Science Citations = 18

Stone, RS; Herber…**Schnell, RC** et al. A three dimensional characterization of Arctic aerosols for airborne sun photometer observations, 2010 *J.G.R-Atmos.*,115 ,D13203 DOI: 10.1029/2009JD013605. Science Citations= 48

Raatz, W.E., **R.C. Schnell**, B.A. Bodhaine, S.J. Oltmans and R.H. Gammon, Air mass characteristics in the vicinity of Barrow, Alaska 9-19 March, 1983. *Atmos. Environ.,* 19, 2127-2134, 1985. Science Citations = 27

Raatz. W.E., **R.C. Schnell,** M.A. Shapiro, S.J. Oltmans and B.A. Bodhaine, Intrusions of stratospheric air into Alaska's troposphere, March 1983. *Atmos. Environ.,* 19, 2153-2158, 1985. Science Citations =29

Sturges, W.T., J.F Hopper, L.A Barrie**, R.C Schnell**, Stable lead isotope ratios in Alaskan arctic aerosols, *Atmospheric Environment*, 27, Issues 17-18, Pages 2865-2871,1993. Science Citations = 50.

Herbert, G.A., **R.C. Schnell,** H.A. Bridgman, B.A. Bodhaine, S.J. Oltmans and G.E. Shaw, Meteorology and haze structure during AGASP-II. Part I: Alaskan Arctic flights 2-10 April, 1986, *J. Atmos. Chem.,* 9, 17-18. Arctic Haze Issue, 1989. Science Citations = 42.

Schnell, R.C., T.B. Watson and B.A. Bodhaine, NOAA WP-3D instrumentation and flight operations on AGASP-II, J. *Atmos. Chem.,* 9, 3-16 Arctic Haze Issue, 1989. Science Citations = 29

Raatz, W.E., **R.C. Schnell**, B.A. Bodhaine and S.J. Oltmans, Observations of Arctic Haze during transpolar flights from Alaska to Norway. *Atmos. Environ.,* 19, 2143-2152, 1985. Science Citations = 23

Raatz, W.E., **R.C. Schnell** and B.A. Bodhaine, The distribution and transport of pollution aerosols over the Norwegian Arctic, 31 March and 4 April 1983. *Atmos. Environ.,* 19, 2135-2142, 1985. Science Citations = 23

Parungo, F., C. Nagamoto, P.J. Sheridan and **R.C. Schnell,** Aerosol Characteristics of Arctic Haze sampled during AGASP-II. *Atmos. Environment*, 24A, 937-949, 1990. Science Citations =29

Stone, R.S., A Herber, V Vitale, M Mazzola, A Lupi, RC Schnell, EG Dutton, ... *A three-dimensional characterization of Arctic aerosols from airborne Sun photometer observations: PAM-ARCMIP, Journal of Geophysical Research: Atmospheres 115* (D13)

April 2009, 2010. Science Citations = 50

Kahl, Jonathan D.W., N.A. Zaitseva, A. Timerev, V. Khattatov, A. Nagurnyi, R.C. Schnell, D.M. Bacon, V. Radionov, and M.C. Serreze, An Archive of Radiosonde Observations from the Former-Soviet North Pole Series of Drifting Ice Stations, 1954-1990, *Bull. of the Amer. Meteor. Soc.,* 80, pp.2019-2026. 1999. Science Citations = 17

Hansen, A.B.A., A.V. Polissar, and R.C. Schnell, Airborne Aerosol and Black Carbon Measurements over the East Siberian Sea, Spring 1992, *Atmospheric Research*, 44, 153-165, 1997. Science Citations = 13

Bridgman, H.A., **R.C. Schnell**, G.A. Herbert, B.A. Bodhaine and S.J. Oltmans, Meteorology and haze structure during AGASP-II. Part 2: Canadian Arctic flights, 13-16 April 1986, *J. Atmos. Chem.,* 9, 49-70. Arctic Haze Issue, 1989. Science Citations = 18

Bridgman, H.A., **R.C. Schnell,** J.D. Kahl, G.A. Herbert and E. Joranger, A major haze event near Point Barrow, Alaska: Analysis of probable source regions and transport pathways. *Atmos. Environment*, 23, 2537-2550. Arctic Haze Issue, 1989. Science Citations =46

Radke, L.F., C.A. Brock, J.H. Lyons, P.V. Hobbs and **R.C. Schnell**, Aerosol and lidar measurements of hazes in midlatitude and polar airmasses, *Atmos. Environ.*, 23, 2417-2430, 1989. Science Citations =30

Winchester J.W., S.M. Li, S.M. Fan, **R.C. Schnell,** B.A. Bodhaine and S.S. Naegele, Coarse particle soil dust in Arctic aerosols, spring 1983, *Geophys. Res. Lett.*, 11, 995-998, 1984. Science Citations = 21

Winchester, J.W., **R.C. Schnell**, S. Fan, S. Li, B.A. Bodhaine, P.S. Naegele, A.D.A. Hansen and H. Rosen, Particulate sulphur and chlorine in Arctic aerosol, spring 1983. *Atmos. Environ.*, 19, 2167-2194, 1985. Science Citations = 21

Li, S.M. J.W. Winchester, J.D. Kahl, S.J. Oltmans, **R.C. Schnell** and P.J. Sheridan, Arctic boundary layer ozone variations associated with nitrate, bromine, and meteorology: A case study. *J.G.R.*, 95, 433 - 40, 1990. Science Citations = 16

Raatz, WE, **Schnell RC**, Bodhaine BA, Oltmans SJ, Gammon RH, Air-mass characteristics in the vicinity of Barrow, Alaska, 9-19 MARCH 1983, *Atmos. Envir.*, 19, 12, 2127-2134, 1985. Science Citations =27

Davidson, C.I. and **R.C. Schnell**, Introduction: the special issue of *Atmospheric Environment*, 27A, No. 17 & 18, pp 2695-2699, 1993. Science Citations = 17.

Schnell RC, Watson TB, Bodhaine BA, NOAA WP-3D Instrumentation and Flight Operations on AGASP-II, *J. A C.*, 9, 1-3, 3-16, 1989, Science Citations = 23

Schnell, R.C., Arctic Haze: Editorial, *Geophys. Res. Lett.*, 11, 359, 1984. Science Citations =114

Schnell, R.C., E Joranger, B. Ottar and W.E. Raatz, 11,5, Issue No. 5

Geophys. Res. Lett, 359, 1984. Science Citations = 10

Boatman, J.F., Wellman, D.L., R.C. Schnell, K.M. Busness, M. Luria and C.V. Valin, In-flight intercomparisons of some aircraft meteorological and chemical measurement techniques, WATOX Special Issue, *Global Biogeochem. Cycles*, *2*, 1-11, 1988. Science Citations = 22

Barry, R.G., M.W. Miles, R.C. Ciaflones, G. Scharfen and R.C. Schnell, Characteristics of arctic sea ice from remote sensing data and their relationship to atmospheric processes, *Annals Glaciology*, 12, 9-15, 1989. Science Citations = 32

Andreas, E.L., M.W. Miles, R.C. Schnell and R.G. Barry, Lidar-derived particle concentration in plumes from Arctic leads. *Annals. Glaciology*, 14, 9-12, 1990. Science Citations = 18

Parungo, F. C. Nagamoto, G. Herbert, J. Harris, R. Schnell, P. Sheridan, ... Individual particle analyses of arctic aerosol samples collected during AGASP-III,

Atmospheric Environment. Part A. General Topics 27 (17-18), 2825-2837, 1993.

4. Aerosols, Black Carbon, Kuwait Oil Fires and Long Range Aerosol Transport

Hansen, A.D., B.A. Bodhaine, E.G. Dutton, and **R.C. Schnell**, Aerosol black carbon measurements at the South Pole: Initial results, 1986-1987. *G.R.L.*, 15, pp. 1193-1196, 1988. Science Citations = 131

Perry, K.D., T.A. Cahill, **R.C. Schnell**, and J.M. Harris, Long-range Transport of Anthropogenic Aerosols to the NOAA Baseline Station at Mauna Loa Observatory, Hawaii, *J.G.R. (Atmospheres)*,104, D15, 18,521-18,533, 1999. Science Citations =141

Parungo, F., B. Kopelwicz, C. Nagamoto, **R.C. Schnell**, P. Sheridan, C. Zhu, J. Harris, B.B. Hicks, and J.M. Miller, Aerosol Particles in the Kuwait Oil-Fire Plumes: Their Morphology, Size Distribution, Chemical Composition, Transport, and Potential Effect on Climate, *J. Geophys. Res.*, 97, pp 15,867-882, 1992. Science Citations = 64

Bodhaine, B.A., N.C. Ahlquist, and **R.C. Schnell**, Three-wavelength nephelometer suitable for aircraft measurement of background aerosol scattering extinction coefficient, *Atmos. Environ*. 25A, 2267-2276, 1991. Science Citation = 82

Sheridan, P.J., **R.C. Schnell,** D.J. Hofmann, and T. Deshler, Electron microscope studies of Mt. Pinatubo aerosol layers over Laramie, Wyoming during summer 1991, *GRL*, 19, 203-206, 1992. Science Citations = 73

Sturges, W.T., J.F. Hooper, L.A. Barrie, and **R.C. Schnell**, Stable lead isotope ratios in Alaskan Arctic aerosols. *Atmos. Environ.*, 27A, 2865-2837, 1993. Science Citations = 49

Cahill, T.A., K. Wilkinson, and **R.C. Schnell**, Compositional analyses of size-resolved aerosol samples taken from aircraft downwind of Kuwait, Spring 1991, *GRL*, 97, pp 14,513-520, 1992. Science Citations = 36.

Sheridan, P.J., **R.C. Schnell**, D.J. Hofmann, J.M. Harris, and T. Deshler, Electron microscope studies of aerosol layers with likely Kuwaiti origins over Laramie, Wyoming during spring 1991, *GRL*, 14, 389-392, 1992. Science Citations = 22

Schnell, R.C. and A.C. Delaney, Airborne ice nuclei near an active volcano. *Nature*, 246, 535-536, 1976. Science Citations =20

Schnell, R.C., R.F. Pueschel and D.L. Wellman, Ice nucleus characteristics of Mount St. Helens effluents, *JGR*, 87, C13, 11109-11112, 1982. Science Citations =14

Rosen, J., B.A. Bodhaine, J.F. Boatman, J.J. DeLuisi, Y. Kim, **R.C. Schnell**, M.J. Post, P.J. Sheridan, and D. Garvey, Measured and calculated optical property profiles in the mixed layer and free troposphere, *J. Geophys. Res.*, 97, 12,837-849, 1992. Science Citations = 20

Schnell, R.C., C.C. Van Valen and R.F. Pueschel, Atmospheric ice nuclei: No detectable effect from a coal-fired power plant plume. *Geophys. Res. Lett.*, 3, 657-660, 1976. Science Citations = 13

Sheridan, P.J., **R.C. Schnell,** J.D. Kahl, J.F. Boatman, and D.M. Garvey, Microanalysis of the aerosol collected over south-central New Mexico during the ALIVE field experiment, May-December, 1989, *Atmos. Environ.*, 27A, pp 1169-1183, 1993. Science Citations = 41

Sheridan, P.J., **R.C. Schnell**, J.D. Kahl, J.F. Boatman, and D.W. Garvey, Analytical electron microscope analysis of aerosol sampled over White Sands Missile Range, N.M., 1989, *Atmos. Environ.*, 27A, pp 1169-1183, 1993. Science Citations = 23

Gunter, R.L., A.D.A. Hansen, **R.C. Schnell**, J.F. Boatman, B.A. Bodhaine, and D.M. Garvey, Airborne measurements of aerosol optical properties over south-central New Mexico, *Atmos. Environ.*, 27A, pp 1363-1368, 1993. Science Citations =17

Kahl, J.D., P.J. Sheridan, **R.C. Schnell**, B.P. Zak, H.M. Church, A. Mason, J.L. Heffter, and J.M. Harris, Forecasting atmospheric debris transport in real-time using a trajectory model. *Atmos. Environ.*, 25A, 1705- 1713, 1991. Science citations = 10

5. Climate Forcing, Climate and Related Topics

Kahl, J.D., D.J. Charlevoix, N.A. Zaitseva, **R.C. Schnell**, and M.C. Serreze, Absence of evidence for greenhouse warming over the Arctic Ocean in the past 40 years, *Nature, 361*, 335-337, 1993. Science Citations = 181

“The elusive Arctic warming,” *Nature editorial comments,* News and Views on the above paper, *Nature*, *361*, 300-301, 1993.

“Arctic shows no signs of greenhouse warmth,” Science News, Editorial comments on the above paper, *Science News*, *143*, 70, 1993.

Bell, G.D., M.S. Halpert, **R.C. Schnell**, R.W. Higgins,J. Lawrimore, V.E. Kousky, R.Tinker, W. Thiaw, M. Chelliah and A. Artusa, Climate assessment for 1997, *Bull. Amer. Met Soc.*, *79*,5, 1014, 1998. Science Citations =573

Serreze, M.C., J.D. Kahl and **R.C. Schnell**, Low-level temperature inversions of the Eurasian Arctic and comparisons with Soviet drifting station data, *J. of Climate*, 5, 615-629, 1992. Science Citations =180

Kahl, J.D., M.C. Serreze, and **R.C. Schnell**, Tropospheric low-level temperature inversions in the Canadian Arctic, *Atmospheric-Ocean*, 30, 511-529, 1992. Science Citations = 68

Kahl, J.D., M.C. Serreze, S. Shiotani, S.M. Skony, and **R.C. Schnell,** In-situ meteorological sounding archives for Arctic Studies, *Bull. Amer. Met. Soc.*, 73, 1824-1830, 1992. Science Citations = 59

Bell, G.D., M.S. Halpert, C.F. Ropelewski, V.E. Kousky, A.V. Douglas**, R.C. Schnell**, and M.E. Gelman, Climate Assessment for 1998, *Bull. of the Amer. Meteor.* Soc., 80, 5, S1-S48, May 1999. Science Citations = 51

Gerald D Bell,G. D., Michael S Halpert, Russell C Schnell, R Wayne Higgins, Jay Lawrimore, Vernon E Kousky, Richard Tinker, Wasila Thiaw, Muthuvel Chelliah, Anthony Artusa, Climate Assessment for 1999, *BAMS*, 81,6, s1-50, 2000. Science Citations = 601

Bodhaine, B. A., R. L. McKenzie, P. V. Johnston, D. J. Hofmann, E. G. Dutton**, R. C. Schnell,** J. E. Barnes, S. C. Ryan, and M. Kotkamp (1996), New Ultraviolet Spectroradiometer measurements at Mauna Loa Observatory, *Geophys. Res. Lett.*, 23(16), 2121–2124, doi:10.1029/96GL01954. Science Citations =22

Kahl, J.D., M.C. Serreze, R.S. Stone, S. Shiotani, M. Kisley and **R.C. Schnell,** Tropospheric temperature trends in the Arctic: 1958-1986, *JGR*, 98, 12,825-838, 1993. Science Citations = 47

Serreze M.C., J.A. Maslanik, M.C. Rehder, **R.C. Schnell**, J.D. Kahl, and E.L. Andreas. Theoretical heights of Buoyant convection above open leads in the winter arctic pack ice cover, *J. Geophys. Res.*, 97, pp 9411-9422, 1992. Science Citations =45

Waple, A.M., J.H. Lawrimore, M.S. Halpert, G.D. Bell, W Higgins, B. Lyon, M.J. Menne, K.L. Gleason, **R.C. Schnell**, J.R. Christy, W. Thiaw, W.J. Wright, M.J. Salinger, L. Alexander, R.S. Stone and S.J. Camargo, Climate Assessment for 2001, *Bull. Amer. Met. Soc.*, 83, 6, June 2002, S1-S62. Science Citations

Waple, A.M. and J.H. Lawrimore (Eds.), State of the Climate in 2002, *Bull. Amer. Met. Soc.*, 84, 2003, pp 68, (**R.C. Schnell**, Chapter: Trends In Trace Gases). Science Citations = 33

Larimore, J., M.S. Halpert, G.D. Bell, M.J. Menne, B.Lyon, **R.C. Schnell**, K.L. Gleason, D.R. Easterling, W.Thiaw, W.J. Wright, R.R. Heim, D.A. Robinson and L. Alexander, Climate Assessment for 2000, *Bull. Amer. Met. Soc.*, 82, 6, S1-S55, June 2001. Science Citations = 42

Schnell, R.C., C.C. Van Valen and R.F. Pueschel, Atmospheric ice nuclei: No detectable effect from a coal-fired power plant plume. *Geophys. Res. Lett.*, 3, 657-660, 1976. Science Citations =10

Schnell, R.C., S.A. Odh and L.N. Njau, Carbon dioxide measurements in tropical East Africa biomes. *J. Geophys. Res.*, 86, pp. 5362-5372, 1981. Science Citations = 14

Ou-Yang, CF ; Yen, MC; Lin, TH Wang, JL; **Schnell, RC**; Lang, PM ; Chantara, S ; Lin, NH, Impact of equatorial and continental airflow on primary greenhouse gases in the northern South China Sea, *E.R.L*, 10,6, 2015, DOI: 10.1088/1748-9326/10/6/065005 Science citations =11

Sun, Yulong; Bian, Lingen; Tang, Jie; … **Schnell, R. C.** et al., CO2 Monitoring and Background Mole Fraction at Zhongshan Station, Antarctica, *Atmosphere*, 5,3,686-698, DOI: 10.3390/atmos5030686, 2014. Science citations =13

Bian, L.G., Gao, Z.Q., Sun, Y.L., Ding, M.H., Tang, J. and Schnell, R.C. (2016) CH4 Monitoring and Background Concentration at Zhongshan Station, Antarctica. *Atmospheric and Climate Sciences*, **6**, 135-144 http://dx.doi.org/10.4236/acs.2016.61012

Ou-Yang, Chang-Feng; Lin, Neng-Huei; Lin, Chia-Ching; .. **Schnell, RC**…et al. Characteristics of atmospheric carbon monoxide at a high-mountain background station in East Asia , Atmospheric Environment,89, 613-622 , doi:10.1016/j.atmosenv.2014.02.060 , Science citations =18

Lin, Neng-Huei; Tsay, Si-Chee; Maring, Hal B.; **Schnell, RC**… et al., An overview of regional experiments on biomass burning aerosols and related pollutants in Southeast Asia: From BASE-ASIA and the Dongsha Experiment to 7-SEAS, *Atmospheric Environment,78*, SI, 1-19, DOI: 10.1016/j.atmosenv.2013.04.066 , 2013. Science Citations = 102

Hansen, A.D.A., **R.C. Schnell,** The Aethalometer, Magee Scientific Company, Berkeley, California, USA, 1-209, 2005. Science Citations = 89

Hofmann, D. J., J.H. Butler, T.J. Conway, E.J. Dlugokencky, J.W. Elkins, K. Masarie, S.A. Montzka, **R.C. Schnell,** and P.P. Tans, Tracking Climate Forcing: The Annual Greenhouse Gas Index, *EOS*, 87, 509-511, 14 Nov, 2006. Science Citations = 16

6. Papers and Conference Proceedings Receiving Less Than 10 Science Citations

Creamean, J. J Ceniceros, …**R.Schnell** (2018) From the ocean to the air: Biological processes as a source of warm temperature ice nucleating particles in the Arctic, AGU Fall Meeting Abstracts, 2018.

Vaughn T.L., C Bell, S Schwietzke…**R.Schnell** (2018), Comparing Top-down and Bottom-up Methane Emission Estimates in a Natural Gas Production Region, AGU Fall Meeting Abstracts, 2018.

Andrews, E. PJ Sheridan, JA Ogren, **RC Schnell (2018)** Overview and selected results from the NOAA Federated Aerosol Network, AGU Fall Meeting Abstracts, 2018.

RC Schnell, BJ Johnson, P Cullis, G Mcconville (2018) Balloon-borne Ozonesonde Profile Measurements at South Pole Station Show an Upward Trend, AGU Fall Meeting Abstracts, 2018

Johnson,B. **RC Schnell,** P Cullis, CW Sterling (2018), Data Homogenization Results from Three NOAA Long-term ECC Ozonesonde Records, AGU Fall Meeting Abstracts, 2018.

Understanding the sources of Arctic biological ice nucleating particles (2018)

J Creamean, A Solomon, R Hanlon… **R.C. Schnell,** EGU General Assembly Conference Abstracts, 2018.

Petron, G., BR Miller, I Mielke-Maday, J Kofler…**R.C.Schnell** (2017), Multi-scale atmospheric measurements to study air toxics emissions and ambient levels, AGU Fall Meeting Abstracts, 2017.

Petron, G. BR Miller, BH Vaughn, J Kofler…**R.C. Schnell,** (2017**)** Top-down constraints on methane and non-methane hydrocarbon emissions in the US Four Corners, AGU Fall Meeting Abstracts, 2017.

G Pétron, BR Miller, SA Montzka, EJ Dlugokencky, **R.C. Schnell (**2013**),** What measurements tell us about air composition and emissions in three US oil and gas fields, AGU Fall Meeting Abstracts, 2013.

Sweeney,C. TB Ryerson, A Karion, J Peischl, G Petron, **R.C. Schnell (**2013**),** Emissions of CH4 from natural gas production in the United States using aircraft-based observations, AGU Fall Meeting Abstracts, 2013.

Schnell, R.C., SJ Oltmans, BJ Johnson, RR Neely III (2012), The Anatomy of Wintertime Photochemical Ozone Production Events in the Upper Green River, WY and Uintah, UT Natural Gas Fields, AGU Fall Meeting Abstracts, 2012.

G Pétron, JD Kofler, GJ Frost, BR Miller, PM Edwards…**R.C.Schnell** (2012), Emissions from oil and natural gas operations in northeastern Utah, AGU Fall Meeting Abstracts, 2012.

Schnell, R.C. and G. Vali, Contribution of natural freezing nuclei to precipitation development. Proceedings of the Cloud Physics Conference, Fort Collins, Colorado, 41-43, August 1970.

Schnell, R.C., Freezing nuclei from decomposing tree leaves. M.S. Thesis, Department of Atmospheric Resources, University of Wyoming, 71 pp, 1971.

Vali, G. and R.C. Schnell, A relation between raindrop sizes and freezing nuclei in the rain. *J. Res. Atmos., 2*, 87-92, 1971.

Schnell, R.C., Freezing nuclei from decomposing tree leaves. Report AR102, Department of Atmospheric Resources, University of Wyoming, Laramie, 17 pp, 1972.

Vali, G., R.C. Schnell, and J. Howatson, Development of leaf-derived ice nuclei for weather modification. Report to National Science Foundation, Washington, D.C., Grant GI-32555X, pp. 33, 1973.

Schnell, R.C., R. Fresh, and G. Vali, Ice nuclei from decaying vegetation. Abstract in Proceedings, Colorado-Wyoming Academy of Science, Golden, Colorado, pp. 18, April 1973.

Schnell, R.C., R. Fresh, and G. Vali, Freezing nuclei from decaying vegetation. Proceedings, VIII Nucleation Conference, Leningrad, USSR, *Gidrometeorizdat*, Moscow, pp. 224-228, 1973.

Schnell, R.C. and G. Vali, Climatic distribution of vegetatively produced ice nuclei. Abstract in Proceedings, AAAS, Southwest and Rocky Mountain Div., Laramie, Wyoming, pp. 19, April 1974.

Schnell, R.C., Atmospheric ice nuclei from the oceans? Abstract in Proceedings, AAAS, Southwest and Rocky Mountain Div., Laramie, Wyoming, pp. 5, April 1974.

Schnell, R.C., Biogenic sources of atmospheric ice nuclei. Ph.D. Dissertation, Department of Atmospheric Resources, University of Wyoming, Laramie, Wyoming, 122 pp, May 1974.

Schnell, R.C., Biogenic sources of atmospheric ice nuclei, Report AR111, Department of Atmospheric Resources, University of Wyoming, Laramie, WY, 33 pp, 1974.

Schnell, R.C., Biogenic sources of atmospheric ice nuclei. Proceedings, Cloud Physics Conference, Tucson, Arizona, Amer. Met. Soc., Boston, Mass., pp. 28-33, October 1974.

Schnell, R.C., M. Reischel, and G. Vali, Sensitivities of ice nuclei to chemical interactions. Proceedings, Cloud Physics Conference, Tucson, Arizona, Amer. Met. Soc., Boston, Mass., pp. 52-56, October 1974.

Schnell, R.C., Biogenic and inorganic ice nuclei sources in the drought-stricken areas of the Sahel-1974. Report to the Rockefeller Foundation, New York, NY, pp. 20, November 1974.

Schnell, R.C., Biogenic ice nuclei related to precipitation efficiencies of Sahelian cumulus clouds. Invited paper, AGU Fall Meeting, San Francisco, California, December 12-17, 1974.

Schnell, R.C. and G. Vali, Heterogeneous ice nucleation in the presence of aliphatic amines and ammonia. Report AR113, Department of Atmospheric Science, University of Wyoming, Laramie, pp. 28, December 1974.

Schnell, R.C., Overgrazing and biogenic ice nuclei: A physical link in the Sahelian drought? Preprint, Proceedings, 12th Conference on Agricultural and Forest Meteorology, Tucson, Arizona, Amer. Met. Soc., Boston, Mass., pp. 29-30, April 1975.

Schnell, R.C., R. Fresh, and L. Maki, Highly active ice nuclei produced during tree litter decay. Preprint, Proceedings, 12th Conference on Agricultural and Forest Meteorology, Tucson, Arizona, Amer. Met. Soc., Boston, Mass., pp. 9-10, April 1975.

Parton, B. and R.C. Schnell, Use of an ecosystem model to study potential interactions between the atmosphere and the biosphere. Preprints, Proceedings, 1975 Summer Computer Simulation Conference, San Francisco, July, 1975.

Schnell, R.C., Ice nuclei associated with cultured and naturally occurring marine phytoplankton. *Geophys. Res. Lett., 2*, 500-502, 1975.

Schnell, R.C. and G. Vali, Biogenic sources of atmospheric ice nuclei -- A review. EOS, 56, 994, 1975.

Schnell, R.C., J. Carney and C. Carty, Active ice nuclei associated with viable bacteria in Nova Scotia marine fogs. Abstract in EOS, 56, 994, 1975.

Schnell, R.C., The biogenic component of Sahelian Eolian dust: A possible drought factor. Abstract in EOS, 56, 994, 1975.

Schnell, R.C. Biogenic ice nuclei removal by overgrazing: A factor in the Sahelian drought? Final Report to the Rockefeller Foundation, New York, NY, pp. 12, 1975.

Schnell, R.C., J. Carney and C. Carty, Ocean derived ice nuclei. Proceedings, Conference on the Interaction of the Sea and Atmosphere, Seattle, Washington, April 1976.

Schnell, R.C., Naturally occurring biological ice nucleants: A review. Proceedings International Cloud Physics Conference, Boulder, CO, Amer. Met. Soc., Boston, Mass., pp. 57-60, July 1976.

Schnell, R.C., Biogenic ice nuclei removal by overgrazing: A factor in the Sahelian drought? Proceedings, IUGG Conference on Desertification, July 20-26, Ashkhabad, USSR, 1976.

Schnell, R.C., Ice nuclei in seawater, fog water and marine air during the USNS HAYES 1975 fog cruise. Marine Fog Cruise, USNS HAYES, 1975, Naval Research Laboratory, Washington, D.C., pp. 595-609, 1976.

Schnell, R.C., C.C. Van Valin and R.F. Pueschel, Atmospheric ice nuclei: No detectable effect from a coal-fired power plant plume, Abstract in EOS, 57, pp. 925, 1976.

Schnell, R.C. and Suan Tan-Schnell, Hail and glaciers on the Equator - The Mount Kenya Baseline Station Feasibility Study: WMO Bulletin, XXVI, 2, 123-125, 1977.

Schnell, R.C., Surface and airborne CO2 measurements around equatorial Mount Kenya. Preprints, IAGA/IAMAP Joint Assembly, Seattle, Washington, pp. 166, Aug-Sept 1977.

Schnell, R.C., A.C. Delaney, and D.A. Gillette, Ice nucleus measurements during wind erosion episodes. Proceedings, IX Nucleation Conference, Galway, Ireland, September 1977.

Schnell, R.C., Kaolin and biogenic ice nucleant: Some nucleation and identification studies. Proceedings, IX Nucleation Conference, Galway, Ireland, pp. 353-380, September 1977.

Schnell, R.C. and Suan N. Tan-Schnell, Tea litter: A prolific source of ice (hail?) nuclei. TEA, pp. 8-12, December 1978.

Schnell, R.C. and S.A. Odh, Carbon dioxide cycles in tropical East Africa. Abstract in EOS, 59, pp. 1077, 1978.

Schnell, R.C. and R.F. Pueschel, CN concentration and aerosol composition measurements on and around Mount Kenya, East Africa. Abstract in EOS, 59, pp. 1086, 1978.

Schnell, R.C. and Suan N. Tan-Schnell, Tea Litter: A prolific source of ice (hail?) nuclei. EOS, 59, pp. 1086, 1978.

Schnell, R.C., Some size and composition characteristics of aerosols at Mount Kenya, East Africa. Preprints, Fourth Conference on Biometeorology, Amer. Met. Soc., Boston, Mass. Minneapolis, MN, pp 255-258, April 3-5, 1979.

Schnell, R.C., S.A. Odh and L.N. Njau, Carbon dioxide cycles in various tropical East Africa biomes. Preprints, Fourth International Conference, Commission on Atmospheric Chemistry and Global Pollution, Boulder, CO, August 12-18, 1979.

Schnell, R.C., The Mount Kenya Baseline Station Feasibility Study: Research and Results. Special Environmental Report No. 14. Paper presented at IWMO Technical Conference on Regional and Global Observation of Atmospheric Pollution Relative to Climate. Boulder, CO, August 20-24, WMO, Geneva, Switzerland, pp. 218-225, 1979.

Schnell, R.C., A new technique for measuring atmospheric ice nuclei active at temperatures from -20oC to 0oC, with results. Preprints, Seventh Conference on Inadvertent and Planned Weather Modification, Banff, Alberta, Amer. Met. Soc., Boston, Mass., October 9-12, pp. 110-111, 1979.

Schnell, R.C., R.F. Pueschel, H.K. Weickmann and D.L. Wellman, Aerosol and ice nuclei measurements in the plume of the Homer City, PA. power plant. *Geophys. Res. Lett., 6*, 371-374, 1979.

Schnell, R.C., R.F. Pueschel, H.K. Weickmann, and D.L. Wellman, Aerosol and ice nuclei measurements in the plume of the Homer City, PA Power Plant. Abstract in EOS, 60, pp. 262, 1979.

Schnell, R.C. and Bernd Wrobel, Variations in atmospheric ice nucleus activity at Boulder, Colorado, Summer, Abstract in EOS, 60, pp. 842, 1979.

Schnell, R.C., R.F. Pueschel, H.K. Weickmann, and D.L. Wellman, Ice nuclei and aerosol measurements in the plume of the Johnstown, PA. Steel Mill, Abstract in EOS, 60, pp. 842, 1979.

Schnell, R.C. and R.F. Pueschel, Airborne aerosol and ice nucleus measurements in support of Project Phoenix, Abstract in EOS, 60, pp. 832, 1979.

Schnell, R.C., R.F. Pueschel, H.K. Weickmann and D.L. Wellman, Ice nuclei and aerosol measurements in the plume of the Johnstown, PA. Steel Mill, Geophys. Res. Lett., 7, 397-400, 1980.

Schnell, R.C., S.W. Miller and B. Wrobel, Seasonal changes and terrestrial sources of atmospheric ice nuclei at Boulder, CO. Preprints, IAMAP-ICCP VII Conference on Cloud Physics, Clermont-Ferrand, pp. 53-56, July 1980.

Schnell, R.C. and S.W. Miller, Aerosol concentrations and related ice nucleation activity: Tent studies. Abstract in EOS, 61, pp. 243, 1980.

Schnell, R.C. and S.W. Miller, Water quality and ice nucleus studies. Abstract in EOS, 61, pp. 243, 1980.

Schnell, R.C. and S.W. Miller, Ice nucleus content with Mount Saint Helens plume ash. Abstract in EOS, 61, pp. 970, 1980.

Schnell, R.C., S.W. Miller and P.A. Allee, Ice nucleation studies on a bacterial aerosol. Preprints, Fifth Conference on Biometeorology, Anaheim, California, March 30-April 3, 1981, AMS Boston, pp. 22-24, 1981.

Schnell, R.C., Biogenic ice nuclei: Intercomparison measurements using a thermal diffusion chamber, an NCAR counter, and a filter drop freezer technique. Preprints IAMAP, 3rd International Assembly, Hamburg, Germany, August 1981.

Schnell, R.C., Atmospheric ice nucleus measurements around the Hawaiian Islands during the HAMEC Project - 1980. Preprints IAMAP, 3rd International Assembly, Hamburg, Germany, August 1981.

Schnell, R.C., Ice nucleus and cloud condensation nucleus characteristics of Mount Saint Helens effluents and their relationships to ash elemental composition. IAMAP, 3rd International Assembly, Hamburg, Germany, August 1981.

Parungo, F.P., C. Nagamoto, I. Nolt, E. Nickerson, W. Caldwell and R.C. Schnell, Hawaii Mesoscale Energy and Climate Project: III, Atmospheric aerosol and cloud microphysics measurements. Project Report, Office of Weather Research and Modification, NOAA, ERL, Boulder, CO, pp. 75, 1981.

Schnell, R.C. and J.M. Harris, A possible drought induced signal in the global atmospheric CO2 record. Preprints WMO Scientific Conference on Analysis and Interpretation of Atmospheric CO2 Data, Bern, Switzerland, Analysis and Interpretation of Atmospheric CO2 Data, Bern, Switzerland, 14-18 September 1981, pp. 113-120, 1981.

Schnell, R.C., Airborne ice nucleus measurements around the Hawaiian Islands, *J. Geophys. Res., 87*, 8886-8890, 1982.

Schnell, R.C., R.F. Pueschel and D.L. Wellman, Ice nucleus characteristics of Mount Saint Helens effluents, J. Geophys. Res., 87, 11, 109-112, 1982.

Schnell R.C., P.A. Allee, S.W. Miller and B. Wrobel, Ice nucleus measurement intercomparisons using three systems and three natural ice nucleants. Preprints Conference on Cloud Physics, Chicago, November, 119-122, 1982.

Schnell, R.C., The Mount Kenya Baseline Station Feasibility Study, Environmental Pollution Monitoring Programme Series, World Meteorological Organization, Geneva, Switzerland, Volume 12, pp. 171, 1982.

Schnell, R.C., Increased production and reduced energy costs in snowmaking: some recent research results, Ski Area Management, 21, 78-80, 1982.

Schnell, R.C., Arctic haze and the arctic gas and aerosol sampling program (AGASP), Proc. American Institute of Aeronautics and Astronautics, 21st Aerospace Science Meeting, Reno, Jan., pp. 6, 1983.

Schnell, R.C., W.E. Raatz and J.T. Peterson, Arctic gas and aerosol sampling program (AGASP), Proc. WMO Tech. Conf. on Observations and Measurement of Atmospheric Contaminants (TECOMAC), Oct., Vienna, pp. 10, 1983.

Shapiro, M.A., R.C. Schnell, F.P. Parungo, S.J. Oltmans, El Chichon Volcanic Debris in an Arctic Tropopause Fold, Arctic Haze Symposium, Toronto, Canada, May. 1984.

Schnell, R.C. and R.R. Fall, Bacterial ice nuclei of marine origin: some recent observations. Preprints, Int. Conf. on Atmos. Aerosols, Condensation, and Ice Nuclei, Budapest, Hungary, 3-8 September 1984.

Schnell, R.C., Condensation nuclei and aerosol size distribution measurements in Arctic haze. Preprints, 11 Int. Conf. on Atmos. Aerosols, Condensation, and Ice Nuclei, Budapest, Hungary, 3-8 September, 1984.

Schnell, R.C., Bacterial ice nuclei and their role in the atmosphere, Preprints, 2nd American Conference on Ice Nucleating Bacteria, Flagstaff, AZ, 6-9 June, 1984.

Schnell, R.C., and R.R. Fall, Isolation of ice-nucleation active bacteria from marine sources. Preprints, 2nd American Conference on Ice Nucleating Bacteria, Flagstaff, AZ, 6-9 June, 1984.

Schnell, R.C., W.E. Raatz and J.T. Peterson, Arctic Gas and Aerosol Sampling Program. Lectures presented at the WMO Technical Conference on Observation of Atmospheric Contaminants, TECOMAC, Vienna, Austria, 17-21 Oct 1983, WMO 64, Spec. Environ. Rept. No. 16, World Meteorological Organization,

Geneva, Switzerland, 324-333, 1985.

Raatz, W.E., R.C. Schnell and B.A. Bodhaine, Atmospheric cross sections for the Arctic Gas and Aerosol Sampling Program, March-April 1983. NOAA Technical Memorandum ERL ARL-134, January pp. 50, 1985.

Schnell, R.C., The International Arctic Gas and Aerosol Sampling Program, Invited Presentation, Arctic Haze Policy and Research Planning Meeting, Cambridge, UK, September (Abstract), 1985.

Schnell, R.C., Rapid long-range transport of air pollutants across the Arctic: The March 1983 Arctic haze episode. IAMAP/IAPSO Joint Assembly, Honolulu, Hawaii, August (Abstract), 1985.

Schnell, R.C., Arctic Gas and Aerosol Sampling Program, Inter-Agency Workshop on Sensing from Aircraft, NCAR, Boulder, CO, August 19-22, (Abstract), 1985.

Schnell, R.C., W.E. Raatz and J.T. Peterson, Arctic Gas and Aerosol Sampling Program (AGASP). 15th Annual Arctic Workshop, University of Colorado, Boulder, April 24-26, (Abstract), 1986.

Schnell, R.C. and M.A. Shapiro, Lower stratosphere in-situ airborne gas and aerosol measurements in the Arctic: Spring 1983. Upper Atmosphere Theory and Data Analysis Program Meeting, Seattle, Washington, June 23-27, (Abstract), 1986.

Schnell, R.C. and R.M. Rosen, Geophysical Monitoring For Climatic Change, Summary Report, #14, Editor, pp. 165, 1986.

Schnell, R.C. and P.T. Sheridan, Lower stratosphere in-situ airborne gas and aerosol measurements in the Arctic: Spring 1986. Upper Atmosphere Theory and Data Analysis Program Meeting, Seattle, Washington, June 23-27, (Abstract), 1986.

Schnell, R.C., The international Arctic gas and aerosol sampling program. In Arctic Air Pollution, B. Stonehouse, Ed., Cambridge University Press, pp. 328, 1986.

Herbert, G.A., J.M. Harris, R.C. Schnell and B.A. Bodhaine, Meteorological Conditions and Air Mass Transport During AGASP-II, EOS, pp. 902, AGU Fall Meeting Abstracts, 1986.

Bridgman, H. and R.C. Schnell, Vertical Cross Sections of Condensation Nuclei over the Western Atlantic During WATOX, January 4-10, 1986. EOS, AGU Fall Meeting Abstracts, 1986.

Schnell, R.C. and T.B. Watson, Airborne gas and aerosol measurements during WATOX, January 1986. EOS, pp. 902, AGU Fall Meeting Abstracts, 1986.

Schnell, R.C., Use of a NOAA WP-3D with multi-sensor gas and aerosol sampling systems: WATOX and AGASP-II, 1986, Proceedings, Second Airborne Science Workshop, University of Miami, Miami, FL, Feb. 3-6, 1987, pp. 151, 1987.

Schnell, R.C., Arctic Haze. DOD Symposium and Workshop on Arctic & Arctic-Related Environmental Sciences, Washington, D.C., January 27-30, 1987, pp. 4, 1987.

Schnell, R.C., H.A. Bridgman, P.S. Naegele and T. Watson, The NOAA WP-3D meteorological, aerosol, and gas systems and flight operations on WATOX-86. WATOX Special Issue, Global Biogeochem. Cycles, 1, 297-307, 1987.

Schnell, R.C., Long range transport of anthropogenic pollutants into the Arctic. 6th Symposium of CACGP, Peterborough, Canada, 23-29 August, 1987. (Poster)

Bridgman, H.A., C.A. Herbert and R.C. Schnell, A major haze event near Point Barrow, Alaska during AGASP-II, flights 201-203. Preprints, 4th Symposium on Arctic Air Chemistry, Hurdal, Norway, Sept. 29-Oct. 2, 1987.

Herbert, G.A., H.A. Bridgman, R.C. Schnell, J.M. Harris and B.A. Bodhaine, Meteorology and atmospheric transport during AGASP-II. Preprints, 4th Symposium on Arctic Air Chemistry, Hurdal, Norway, Sept. 29-Oct. 2, 1987.

Schnell, R.C., Gas and aerosol distribution in the Arctic during AGASP-II. Preprints, 4th Symposium on Arctic Air Chemistry, Hurdal, Norway, Sept. 29-Oct. 2, 1987.

Sheridan, P.J. and R.C. Schnell, Cascade impactor studies of aerosol collected during AGASP-II, flights 201-203. Preprints, 4th Symposium on Arctic Air Chemistry, Hurdal, Norway, Sept. 29-Oct. 2, 1987.

Bridgman H., B. Stunder, R. Artz, G. Roth, R.C. Schnell, B.A. Bodhaine and S. Oltmans, Meteorological and aerosol measurements from the NOAA WP-3D aircraft during WATOX-86, January 4-9, 1986. NOAA Tech Memo, 65 pp, July 1987.

Herbert, G.A., H.A. Bridgman, R.C. Schnell, B.A. Bodhaine and S.J. Oltmans, The analysis of meteorological conditions and haze distribution for the second Arctic Gas and Aerosol Sampling Program (AGASP-II), NOAA Tech. Memo ARL-158, pp. 67, November 1987.

Schnell, R.C. and R.M. Rosen, Geophysical Monitoring for Climatic Change, Summary Report #15, (Ed.), pp. 155, December 1987.

Ruhnke, L.H. and R.C. Schnell, Arctic Haze, In Arctic and Arctic Related Environmental Science, E. Harrison and G. Gomez (eds), A. Deepak Publishing, pp 285-288, 1987.

Schnell, R.C., J.D. Kahl, H.A. Bridgman and G.A. Herbert, A major haze event near Point Barrow, Alaska during AGASP-II, April 2-3, 1986. Preprints, Second Conference on Polar Meteorology and Oceanography, AMS, Madison, Wisconsin, March 29-31, 1988.

Schnell, R.C., G.A. Herbert, J.M. Harris and B.A. Bodhaine, A summary of atmospheric transport to Barrow, Alaska during the Arctic Gas and Aerosol Sampling Program (March 1983 and April 1986). Preprints, Second Conference on Polar Meteorology and Oceanography, AMS, Madison, Wisconsin, March 29-31, 1988.

Oltmans, S.J., R.C. Schnell, P.J. Sheridan and W.D. Kohmyr, Seasonal surface ozone behavior in the high Arctic, Preprints, Quadriennial Ozone Symposium, Gottingen, FRG, August 8-13, 1988.

Schnell, R.C., Bacteria produced atmospheric condensation and ice nuclei, Preprints, AGU, Chapman Conference on the Gaia Hypotheses, March 7-11, San Diego, CA., 1988.

Schnell, R.C., J.D. Kahl, H.A. Bridgman, G.A. Herbert, B.A. Bodhaine and S.J. Oltmans, Aerosol formation and distribution in the Arctic during AGASP-II, Atmospheric Aerosols and Nucleation, P.E. Wagner and Gabor Vali, (Eds), Springer-Verlag, 1988, pp. 32-35, 1988.

Schnell, R.C., R.G. Barry, R.E. Cianflone, W. Miles and M.C. Serreze, Surface characteristics of Arctic sea ice from remote sensing data. Preprints, I.G.S. Symposium on Ice Dynamics, Hobart, Tasmania, Feb. 1988.

Schnell, R.C., Springtime surface ozone fluctuations at high Arctic latitudes and their possible relationship to atmospheric bromine, Polar Ozone Workshop, Snowmass, CO, May 9-13, 1988.

Schnell, R.C., P.J. Sheridan, R.E. Peterson and S.J. Oltmans, Airborne measurements of tropospheric ozone destruction and particulate bromide formation in the Arctic, Polar Ozone Workshop, Snowmass, CO, May 9-13, 1988.

Schnell, R.C., Arctic air chemistry, *Arctic Research, 2*, pp. 39-41, 1988.

Schnell, R.C., Arctic Haze: Long Range Pollution of the Polar Atmosphere, Global Effects of Atmospheric Contaminants Meeting, University of New Mexico, Albuquerque, NM, October 25, 1988.

Sievering, H., P.J. Sheridan, and R.C. Schnell, Size distribution and source identification of large aerosol particles over the Alaskan Arctic during AGASP-II, *Atmos. Environment, 23*, 2495-2499. Arctic Haze Issue, 1989.

Andreas, E.L., M.W. Miles, R.C. Schnell, and R.G. Barry, Massive Plumes from Arctic Leads, Abstract, IGS Annual Meeting, Seattle, WA., August 1989.

Johnson, G.L., V. Alexander, and Schnell, R.C., International marine/atmosphere Arctic science, past-present-future, *Arctic Research, 3,* 3-17, 1989.

Schnell, R.C., AGASP: Clues to transport and chemistry in the Arctic troposphere. Abstract, 5th IAMAP Assembly, Reading, UK, July 31-August 12, 1989.

Schnell, R.C. and J. Kahl, Arctic haze: Long range pollution of the polar atmosphere. Conference on Aerosols and Background Pollution, Galway, Ireland, 13-15 June, 1989.

Schnell, R.C., Highly absorbing and scattering anthropogenic aerosols in the Arctic troposphere, Proceedings, Smoke Obscurants Symposium XIII, OPM Tech. Report, AMCPM - SMK - CT - 011 - 89, Vol. II, 503-516.

Schnell, R.C., J.D. Kahl, A.D.A. Hansen, A methodology for estimating regional emissions of black carbon aerosol in the Arctic. Conference on Aerosols and Background Pollution, Galway, Ireland, 13-15 June 1989.

Schnell, R.C., NOAA Eastern Arctic Aircraft Expedition - A component of the coordinated Eastern Arctic Experiment, March-April, 1989; Reprints, 3rd Interagency Airborne Geosciences Workshop, U. of California, San Diego, CA. Feb 21-24, 1989.

Schnell, R.C., R.G. Barry, M.W. Miles, E.L. Andreas, L.F. Radke, C.A. Brock, M.P. McCormick and J.L. Moore, Lidar detection of leads in Arctic sea ice, Proceedings, ILS-O Meeting APS, Stanford, CA, Aug 27-31, 1989.

Schnell, R.C., Anthropogenic hazes in the Arctic, Proceedings, AWMA/EPA Visibility and Fine Particles Meeting, Estes Park, October 15-19, 1989, pp. 34, 1989.

Schnell, R.C., J.F. Boatman and D.L. Wellman, Measurement of atmospheric aerosols with a research aircraft. Preprints, Smoke Obscurants Symposium XIII, John Hopkins University, 25-27 April, 1989.

Schnell, R.C. and B.A. Bodhaine, The Arctic basin atmospheric chemistry retort, Abstracts, AAAR Proceedings, Oct. 9-13, 1989 Reno, pp. 41, 1989.

Parungo, F., C. Nagamoto, P.J. Sheridan and R.C. Schnell, Aerosol Characteristics of Arctic Haze sampled during AGASP-II. *Atmos. Environment, 24A*, 937-949, 1990.

Schnell, R.C., P.J. Sheridan and J.D. Kahl, AGASP-III, Polar Lows and CEAREX Norwegian Arctic Flight Program, Spring 1989, Proceedings, Role of the Polar Regions in Global Changes, U. of Alaska, Fairbanks, AK, 11-15 June 1990.

Sheridan, P., R.C. Schnell, and J.D. Kahl, Individual particle analysis of the springtime Arctic aerosol, 1983-1989, Role of the Polar Regions in the Global Change, U. of Alaska, Fairbanks, AK, 11-15 June 1990.

Parungo, F.P., C.N. Nagamoto, R.C. Schnell and P.J. Sheridan, Analyses of aerosol samples collected during AGASP, March-April 1989, *Atmos. Environ., 27A*, 2825-2837, 1993.

Hansen, A.D.A., R.C. Schnell, J.D. Kahl, B.A. Bodhaine, and V.N. Kapustin, Comparison of measurements of aerosol black carbon at Barrow, AK and Wrangel Island, USSR, Role of Polar Regions in Global Change, U. of Alaska, Fairbanks, AK, 11-15 June 1990.

Schnell, R.C., P. Sheridan and J.D. Kahl, A comprehensive collection of Arctic meteorological soundings for use in climate studies, Role of the Polar Regions in Global Change, U. of Alaska, Fairbanks, AK, 11-15 June 1990.

Schnell, R.C., The Arctic Ocean Pathway for Eurasian air pollution, Abstracts, 70th Annual Meeting of the AMS, Anaheim, CA, Feb. 4-9, 1990.

Schnell, R.C., R.G. Barry, M.W. Miles, E.L. Andreas, L.F. Radhe, C.A. Brock, M.P. McCormick and J.L. Moore, Lidar detection of leads in Arctic sea ice, Sea Ice Properties and Processes, CRREL Monograph 90-1, S. Ackley and W.F. Weeks, Eds. pp 294, Feb. 1990.

Schnell, R.C., Arctic Haze: Long range transport of European Air Pollution, European Aerosol Conference, Zurich, Switzerland, 1-5 October, 1990.

Schnell, R.C., S.D. Sewell, W.T. Sturges and S.J. Oltmans, Annual photolytic ozone destruction cycle in the Antarctic troposphere, CACGP 7th Int. Symposium, Chamrousse, France, 5-11 September 1990.

Schnell, R.C., Role of polar regions in changing atmospheric composition, CACGP 7th Int. Symposium, Chamrousse, France, 5-11 September 1990.

Sturges, W.T., S. Landsberger and R.C. Schnell, Chemical and meteorological influences on surface ozone destruction at Barrow, Alaska during spring 1989, Abstracts, AGU Fall Meeting, Dec. 1990.

Herbert, G.A., R.C. Schnell, B.J.B. Stunder, B.A. Bodhaine, S.J. Oltmans and M.Z. Bieniulis, Meteorological conditions during the AGASP-III flights, March 1989, Abstracts, AGU Fall Meeting, Dec. 1990.

Bodhaine, B.A., R.C. Schnell and P.J. Sheridan, Aerosol instrumentation on the NOAA WP-30 during the third Arctic Gas and Aerosol Sampling Program, Abstracts, AGU Fall Meeting, Dec. 1990.

Parungo, F., C. Nagamoto, P.J. Sheridan and R.C. Schnell, Individual particle analyses of aerosol samples collected during AGASP-III, abstracts, AGU Fall Meeting, San Francisco, CA, Dec. 1990.

Sheridan, P.J., W. Zoller, J. Freman, R.A. Rasmussen and R.C. Schnell, Composition of Br - containing aerosols and gases related to boundary layer ozone destruction in the Arctic AGU Fall Meeting, San Francisco, Dec. 1990.

Kahl, J.D., P.J. Sheridan, R.C. Schnell, B.P. Zak, H.M. Church, A. Mason, J.L. Heffter, and J.M. Harris, Forecasting atmospheric debris transport in real-time using a trajectory model. Atmos. Environ., 25A, 1705- 1713, 1991.

Schnell, R.C., S. Liu, S. Oltmans, R. Stone, D. Hofmann, S. Sewell, W. Sturges, T. Deschler, E. Dutton, J. Harder, M. Trainer and J. Harris, Seasonal and secular variations of tropospheric ozone in Antarctica, Proc. IUGG Assembly, Vienna, Austria, August 11-24, 1991.

Schnell, R.C., Seasonal and secular variations of tropospheric ozone in Antarctica, Proc. Antarctic Tropospheric Chemistry Meeting, Boulder, CO, June 1991.

Parungo, F., R.C. Schnell, C. Nagamoto, and P. Sheridan, Analyses of aerosol samples collected during AGASP. IUGG Assembly, Vienna, August 11-24, 1991.

Schnell, R.C. and S. Shiotoni, Soot emission from commercial aviation in a heavily traveled air corridor. Proc. 4th International Soot Carbon Conference, Vienna, Austria, April 3-5, 1991.

Schnell, R.C., A.D.A. Hansen and B.A. Bodhaine, Continuous aerosol black carbon measurements inside and outside a large office building. Proc. 4th International Soot Carbon Conference, Vienna, Austria, April 3-5, 1991.

Schnell, R.C., A.D.A. Hansen and B.A. Bodhaine, High-resolution measurements of aerosol black carbon from an instrumented light Aircraft, Proc. 4th International Soot Carbon Conference, Vienna, Austria, April 3-5, 1991.

Schnell, R.C., Bulk aerosol and individual particle black carbon measurements over the Southwestern United States, Proc. 4th International Soot Carbon Conference, Vienna, Austria, April 3-5, 1991.

Sturges, W.T., R.C. Schnell and S. Landsberger, Bromine and surface ozone atmospheric chemistry at Barrow, Alaska during spring 1989, Proc. Int. Conf., Role of Polar Regions in Global Change, June 11-15, U of Alaska, Fairbanks, AK, 1991.

Schnell, R.C., R. Fall, M. Nemecek-Marshall, K. Sweeting, and R. La Duca, A new INA bacterium from high altitude equatorial vegetation, Proc. 5th Int. Conf. on Biological Ice Nuclei Madison, Wisc., 4-7 August, 1991.

DeLuisi, J., R. Haas, E. Dutton, D. Nelson, P. Reddy, R.C Schnell, D. Longenecker and T. McNice, Aerosol and radiation characteristics of smoke from the Yellowstone fire of 1988, Proc. XX General Assembly, IUGG, Vienna, 11-24 August 1991.

Bodhaine, B.A., R.C. Schnell, et al., The second front range lidar, aircraft and balloon experiment, NOAA Data Report ERL, CMDL-8, June 1991, pp. 142, 1991

Schnell, R.C., J.F. Boatman, and T.A. Hansen, Building ventilation measured with a passive continuous soot carbon (Aethalometer) technique, Proc. 10th Annual Meeting, AAAR, Traverse City, MI, October 1991.

Sheridan, P., R.C. Schnell, D. Hofmann, T. Deshler and B. Johnson, Individual particle electron microscope analyses of Mt. Pinatubo stratospheric aerosols collected by balloon-borne impactors, Abs. AGU Fall Meeting, San Francisco, CA, Dec. 1991.

Sheridan, P.J., R.C. Schnell, D.J. Hofmann, T. Deshler, and B. Johnson, Electron microscope studies of Kuwait oil smoke aerosols collected by aircraft-based and balloon-borne impactors, May-July 1991, Abs. AGU Fall Meeting, San Francisco, CA, Dec. 1991.

Cahill, T., J. Schweitzer, K. Wilkinson, R.C. Schnell, J. Reid, R. Eldred, and R. Flocchini, Comparison of the physical and chemical characteristics of Kuwaiti smoke and smoke from Kuwaiti oils, EOS, Abs. AGU Fall Meeting, San Francisco, CA, 72, 44, pp. 81. Dec. 1991.

Yamato, M., Y. Iwasaki, R.C. Schnell, P. Sheridan, M. Nishikawa, and T. Mizoguchi, Aerosols emitted into the atmosphere from Kuwait fires, Proc. Japan Met. Soc., Tokyo, 23-25 Oct., 1991.

Parungo, A., C. Nagamoto, R.C. Schnell, P. Sheridan, and C. Zhu, Aerosol particles in Kuwait oil-fire plumes: their morphology, size distribution and chemical composition, Abstracts, AGU Fall Meeting, San Francisco, CA, Dec. 1991.

Schnell, R.C., Arctic Gas and Aerosol Sampling Program: *Highlights, Arctic Research, 5*, pp 14-16, 1991.

Kahl, J., P. Sheridan and R.C. Schnell, Real-time forecasting of atmospheric debris transport. Proc. NATO/CCMS, Int. Tech. Mtg. on Air Poll. Mod. and Applic., Athens, Greece, Sept. 1991.

Bodhaine, B.A., L.A. Barrie, and R.C. Schnell, Antarctic Tropospheric Chemistry Research, Report of the Int. Symp. on the Trop. Chem. of the Antarctic Region, 3-6 June 1991, Boulder, CO, NOAA Meetings Report, Boulder, CO, pp 20, Nov. 1991.

Sturges, W.T., R.C. Schnell and S. Landsberger, Bromine and surface ozone atmospheric chemistry at Barrow, Alaska during spring, 1989, Role of the Polar Regions in Global Change, U. of Alaska, Fairbanks, AK, 11-15, June 1990, 751-756, 1991.

Barrie, L.A., B.A. Bodhaine, R.C. Schnell, G.A. Shaw, and J.K. McKie, Symposium on the Tropospheric Chemistry of the Antarctic Region, *Tellus, 44B*, 250-251, 1992.

Hansen, A.D.A., R.C. Schnell, A.V. Polissar, and G.S. Golitsyn, Aerosol measurements over the East Siberian Sea, Abstracts, 5th Symposium on Arctic Air Chemistry, Copenhagen, Denmark, Sept. 8-10, 1992.

Kahl, J.D., D.J. Charlevoix, N.A. Zaitseva, and R.C. Schnell, Lower tropospheric temperature trends over the Arctic Ocean: 1950-1990, Proceedings, 3rd Conference Polar Meteorology and Oceanography, AMS, Portland, OR, 29 Sept - 2 Oct, 1992.

Parungo, F., B. Kopelwicz, C. Nagamoto, R.C. Schnell, P. Sheridan, C. Zhu, J. Harris, B.B. Hicks, and J.M. Miller, Aerosol Particles in the Kuwait Oil-Fire Plumes: Their Morphology, Size Distribution, Chemical Composition, Transport, and Potential Effect on Climate, NOAA Tech Memo, ARL, 1992.

Parungo, F., B. Kopelwicz, C. Nagamoto, R.C. Schnell, P. Sheridan, C. Zhu, J. Harris, B.B. Hicks, and J.M. Miller, Aerosol Particles in the Kuwait Oil-Fire Plumes: Their Morphology, Size Distribution, Chemical Composition, Transport, and Potential Effect on Climate, *J. Geophys. Res., 97*, pp 15,867-882, 1992.

Schnell, R.C., G.A. Allen, J.F. Boatman, and A.D.A. Hansen, Black carbon aerosol output from a photocopier, Proc. 85 Annual Meeting, AWMA, June 21-26, Kansas City, 10 pp, 1992.

Schnell, R.C., E. Dlugokencky, T.J. Conway, A.V. Polissar, and G.S. Golitsyn, Airborne investigation of the Bennett Island plume, Abstracts, 5th Symposium on Arctic Air Chemistry, Copenhagen, Denmark, Sept. 8-10, 1992.

Sheridan, P.J., R.C. Schnell, H. Seivering, and R. Ferek, Aerosol chemistry measurements over the Beaufort Sea during AGASP-IV/LEADEX, April, 1992, Abstracts, 5th Symposium on Arctic Air Chemistry, Copenhagen, Denmark, Sept. 8-10, 1992.

Sturges, W.T., R.C. Schnell, S. Landsberger, and J.M. Harris, Chemical and meteorological influences on surface ozone destruction at Barrow, Alaska during spring 1989, *Atmos. Environ., 27A*, 2851-2863, 1993.

Herbert, G.A., P.S. Sheridan, R.C. Schnell, M.Z. Bieniulis, B.A. Bodhaine, Analysis of meteorological conditions during AGASP-IV, March 30-April 23, 1992, NOAA Tech Memo, ERL, CMDL-5, pp 118, April 1993.

Schnell, R.C., Are biological ice nuclei important in drought processes, past thoughts, present perspectives, Abstract, Proceedings, Sixth Int. Conf. on Biological Ice Nuclei, Laramie, Wyoming, August 4-16, 1993.

Schnell, R.C., P.J. Sheridan, B.A. Bodhaine, E.G. Dutton, and J.D. Kahl, Arctic gas and aerosol data sets from AGASP and the Barrow Baseline Station, Proc. Int. Symposium, Ecological Effects of Arctic Airborne Contaminants, Reykjavik, Iceland, Oct. 4-8, 1993, pp 25, USA CRREL Special Report 92-93.

Khalsa, S.J., J.R. Key, R.C. Schnell, J.D. Kahl, M.C. Serreze, and J. Bates, Final Report, Development and trend analyses of an Arctic TOVS temperature sounding record, Report to NASA, Contract NA26GP0186, pp 28 (available from CIRES, U. of Colorado, Boulder),1993.

Sheridan, P.J., C.E. Quincy, and R.C. Schnell, Optical properties of aerosols in the Kuwait oil fire smoke plume, May-June 1991, NOAA Data Report, ERL, CMDL-10, NOAA, Boulder, CO, pp 154, 1993

.

Fett, R.W. (Compiler), with contributions from R.C. Schnell, et al., Leadex Data Report, Part 3: Leadex aircraft data and flight summaries, March 30-April 23, 1992, Naval Research Laboratory/PU/7540-93-0015, pp 302, December 1993.

Davidson, C.I. and R.C. Schnell, Introduction: the special issue of *Atmospheric Environment, 27A*, No. 17 & 18, pp 2695-2699, 1993.

Schnell, R.C., D.T. Kuniyuki, B.A. Bodhaine, and A.D.A. Hansen, The dust component of aerosol light absorption measured at Mauna Loa Observatory, Abstract, Proceedings, 5th Int. Conf. on Carbonaceous Particles in the Atmosphere, LBL/DOE, Berkeley, CA, 23-26 August, 1994.

Clarke, A. and R.C. Schnell, Black Carbon Variability in the Pacific free troposphere and marine boundary layer, Abstract, Proceedings, 5th Int. Conf. on Carbonaceous Particles in the Atmosphere, LBL/DOE, Berkeley, CA, 23-26 August, 1994.

Schnell, R.C., Carbon Cycle Species and Asian Dust at Mauna Loa Observatory in Relation to Air Mass Origins, Proceedings of The Tsukuba Global Carbon Cycle Workshop-Global Environment Tsukuba '95, Tsukuba, Japan, February 1995, pp. 54-61.

Parungo, Farn, Y. Kim, C-J Zhu, J. Harris, R. C. Schnell, X-S Li, D-Z Yang, X-M Fang, P. Yan, X. Yu, M-Y Zhou, Z. Chen, F-L Qian, K. Park, Asian Duststorms and their Effects on Radiation and Climate, Part I, Science and Technology Corporation Tech. Report 2906, July 1995.

Schnell, R.C., Recent Chinese Dust Storms Observed at Mauna Loa Observatory, Hawaii, Proceedings, WMO-IGAC Conference on the Measurement and Assessment of Atmospheric Composition Change, Beijing, China, October 1995, pp. 218-219.

Schnell, R.C., D. Kuniyuki, J. Barnes, B.A. Bodhaine, J.M. Harris, and F.P. Parungo, Recent Chinese Dust Storms Observed at Mauna Loa Observatory, Hawaii, AGU 1995 Fall Meeting, San Francisco, December 1995, EOS, November 7, 1995, pp F76.

Bodhaine, B.A., D.J. Hofmann, E.G. Dutton, R.C. Schnell, J.E. Barnes, S.C. Ryan, R.L. McKenzie, P.V. Johnson, and M. Kotcamp, New Ultraviolet Spectrometer Measurements At Mauna Loa Observatory, Hawaii, AGU Fall Meeting, San Francisco, December 1995, EOS, November 7, 1995, pp F97.

Parungo, Farn, Y. Kim, C.-J. Zhu, J. Harris, R. C. Schnell, X.-S. Li, D.-Z. Yang, X.-M. Fang, P. Yan, X. Yu, M.-Y. Zhou, Z. Chen, F.-L. Qian, K. Park, Asian Duststorms and their Effects on Radiation and Climate, Part II, Science and Technology Corporation Tech. Report 2959, March 1996.

Schnell, R.C., Airflow over the island of Hawaii, *Hawaii Medical Journal*, 55, pp 44-45, March 1996.

Bodhaine, B.A., D.J. Hofmann, E.G. Dutton, R.C. Schnell, J.E. Barnes, S.C. Ryan, R.L. McKenzie, P.V. Johnston, and M. Kotcamp, Ultraviolet Spectroradiometer Measurements at Mauna Loa Observatory, Abstract, International Radiation Symposium (IRS), Fairbanks, AK, August 19-24, 1996.

McKenzie, R. L., P.V Johnston, G.E. Bodeker, M. Kotcamp, B.A. Bodhaine, D.J. Hofmann, E.G. Dutton, R.C. Schnell, J.E. Barnes, and S. Ryan, UV Spectral Irradiance Comparison and Contrast between Mauna Loa Observatory, Hawaii, and Lauder, New Zealand, Presented at Quadrennial Ozone Symposium, Aquila, Italy, 12-21 Sept. 1996, 10 pp.

Schnell, R.C. and D.J. Hofmann, The Network for the Detection of Stratospheric Change (NDSC) Station at Mauna Loa Observatory, Presented at Western Pacific Geophysics Meeting, Brisbane, Australia, EOS, Transactions, 77, 22, 1996, pp W8.

Parungo, Farn, R. C. Schnell, A. Yoshinaga, L. Pajo, Y. Kim, C-J. Zhu, J. Harris, B. Bodhaine, M-Y Zhou, Z. Chen, F-L. Qian, X-S. Li, D-Z. Yang, X-M. Fang, P. Yan, X. Yu, K. Park, Asian Duststorms and Their Effects on Radiation and Climate, Science & Technology Corporation, Part III, Prepared for NOAA under Contract No. 50-EANR-4-00037, Tech. Rep. 3111, October 1996, 95 pp.

Bodhaine, B.A., D.J. Hofmann, E.G. Dutton, R.C. Schnell, J.E. Barnes, S.C. Ryan, R.L. McKenzie, P.V. Johnston, and M. Kotcamp, Ultraviolet Spectroradiometer Measurements at Mauna Loa Observatory, EOS, A32C-01, AGU Fall Meeting, 1996.

Parungo, Farn, R. C. Schnell, A. Yoshinaga, L. Pajo, Y. Kim, C-J. Zhu, J. Harris, B. Bodhaine, X-S. Li, D-Z. Yang, X-M. Fang, P. Yan, X. Yu, M-Y Zhou, Z. Chen, F-L. Qian, K. Park, J-C. Nam, Y-N. Iwasaka, S. Kwon, Asian Duststorms and Their Effects on Radiation and Climate, Part IV, Science & Technology Corporation, Prepared for NOAA under Contract No. 50-EANR-4-00037, Tech. Rep. 3134, March 1997, 124 pp.

Bodhaine, B.A., Hofmann, D.J., Dutton, E.G., Mckenzie, R.L., H Johnston, P.V., Kotkamp, M., Schnell. R.C., Barnes, J.E. and Ryan, S.C., Ultraviolet spectroradiatiometer measurements at Mauna Loa Observatory, IRS'96:Current Problems In Atmospheric Radiation (Hampton, VA:A.Deepak), 1997, 841-44

Schnell, R.C., Mauna Loa Observatory: A Historical View of the First 40 Years of Operations, EOS, 78, 46, F71, 1997.

Schnell, R.C., Photolytic Destruction of Ozone Beneath the Arctic Ice Cap Surface Inversion: A New Look at the AGASP Data Sets, EOS, 79, 45, F82, Dec. 1998.

Kuniyuki, D.T., R.C. Schnell, S.C. Ryan, and J.M. Harris, Transport of Biomass Burning from Central America To Mauna Loa Observatory, Hawaii, July 1998, EOS, 79, 45, F101, Dec.1998.

Schnell, R.C., Global Atmospheric Monitoring: The Mauna Loa Experience, Proceedings, International Symposium on Global Environmental Monitoring, Kwangju Institute of Science and Technology, Kwangju, Korea, Sept.10-13, 1998.

Schnell, R.C., Monitoring global atmospheric constituents capable of forcing climate change, SPIE-International Society for Optical Engineering Conference on Environmental Monitoring and Remediation Technologies II, Boston, MA, SPIE Vol. 3853, 2-14, 1999.

Schnell, R.C., Global Atmospheric Environment Change Monitoring in the 21st Century, Proceedings, Conference on Direction for Atmospheric Environmental Research Toward 21st Century, NEIS, Seoul, Korea, pp 85-95, June 2000.

Schnell, R.C., D.B. King, and R.M. Rosson (Eds.), Climate Monitoring and Diagnostics Laboratory Summary Report No. 25 1998-1999, National Oceanic and Atmospheric Research, Boulder, CO, 154 pp., 2001.

Oh, S-N. , Y-H. Youn, K-J. Park2, H-K Min and R. C. Schnell, Surface Measurements of Global Warming Causing Atmospheric Constituents in Korea, Environmental Monitoring and Assessment, Springer Netherlands, pp 21-34, 70, 1-2 / July, 2001.

Nagurnyi, A.P., N.A. Zaitseva, G.V. Alekseev, E.Yu Medvedchenko, A. Shumbera, J.D. Kahl and R.C. Schnell, Archive of Radiosonde Data Obtained at the Ice Drifting Station North Pole, Meteorology and Hydrology, 6, 55-62, 2001 (Text in Russian).

Schnell, R.C., Arctic Air Pollution Measurements From the Barrow, Alaska, Baseline Station: 1973-2002, Proceedings, Second AMAP International Symposium on Environmental Pollution of the Arctic, Rovaniemi, Finland, October 1-4, 2002.

Schnell, R.C., Long Range Transport of Air Pollutants Across the Pacific, Proceedings, Trends and Intercontinental Transport of Photo-oxidants, Particle and their Precursors Across the Northern Hemisphere, Proceedings, Hemispheric Air Pollution, Bad Breisig, Germany, BMU/UBA, October 7-11, 2002

King, D.B., R.C. Schnell and R.M. Rosson (Eds.), Climate Monitoring and Diagnostics Laboratory Summary Report 26, 2000-2001, National Oceanic and Atmospheric Research, Boulder, CO, 184 pp., 2002.

Schnell, R.C., A-M. Buggle, R.M. Rosson (Eds.) Climate Monitoring and Diagnostics Laboratory Summary Report 27, 2002-2003, National Oceanic and Atmospheric Research, Boulder, CO, 1174 pp., 2004.

Schnell, R.C., Asian Aerosol and Gas Transport to Atmospheric Baseline Stations in Hawaii, California and Alaska, Proceedings, Western Pacific Geophysics Meeting, Honolulu, Hawaii, August 17-20, 2004.

Schnell, R.C., Transport of Gases and Aerosols from Asia to North America, proceedings, Joint AOGS and APHW Conference, Singapore, 5-9 July, 2004, pp 446.

Levinson, D.H. and A.M. Waple (Eds), State of the Climate in 2003, *Bull. Amer. Met. Soc., 85*, 2004 (R.C. Schnell, Chapter: Trends in Trace Gases).

Schnell, R.C. and D.J. Hofmann, , From the Poles to the Top of an Active Volcano: The National Oceanic and Atmospheric Administration Baseline Atmospheric Observatories, X Journades de Meteorologia, Eduard Fontsere, ACAM, Barcelona, Spain, November 2004, pp 117-124.

Levinson, D.H. (Ed), State of the Climate in 2004, *Bull. Amer. Met. Soc , 86*, 2005 (R.C. Schnell, Chapter: Trends in Trace Gases).

Schnell, R.C. and D.J. Hofmann, The Barrow Atmospheric Baseline Observatory, *Arctic Research, Vol.19*, Spring /Summer 2005, pp 34-40.

Schnell, R.C. , Recent Trends in Global Atmospheric Radiative Forcing Trace Gas Concentrations, Proceedings AOGS Annual Meeting, Singapore, 20-24 June, 2005, pp 47.

Schnell, R.C., Recent Trends in Global Atmospheric Radiative Forcing Trace Gas Concentrations, proceedings GAW international Symposium, Chinese Meteorological Agency and World Meteorological organization, Xining, China, August 18-19, 2005.

Shein, K.A. (Ed.), State of the Climate in 2005, *Bull. Amer. Met. Soc., 87*, 2006 (R.C. Schnell, Chapter: Trends in Trace Gases).

Schnell, R.C., Mauna Loa Observatory, Hilo, Hawaii: 50 Years of Atmospheric Monitoring, Proceedings Mt. Fuji Weather Station International Symposium, Gakushikaikan, Tokyo, Japan, March 4-5, 2006.

Schnell, R.C., The Air We Breathe, It Is Not What It Used To Be, Proceedings, International Meeting on Regional Atmospheric Environment Monitoring and Long Range Transport, National Central University, Taipei, Taiwan, April 1, 2006.

Arguez, A. (Ed.), State of the Climate in 2006, *Bulletin of the AMS, 88, 6*, S1-S135, (R.C. Schnell, Chapter on Trace Gases and Aerosols), 2007.

Schnell, R.W. and R.C. Schnell, Supercooling In Over-wintering Pine Beetle Larvae, Proc.IUGG 2007 Perugia - XXIV IUGG General Assembly, Perugia, Italy, July 2-13, 2007.

Schnell, R.C., The discovery of biological ice nuclei: early successes, missteps and some remaining questions, Proc. IUGG 2007 Perugia - XXIV IUGG General Assembly, Perugia, Italy, July 2-13, 2007.

Schnell, R.C., Updates in the Trends in Atmospheric Trace Gases from the NOAA ESRL Global Network, Proc. IGAC Conference 2008, Annecy, France, 7-12 September, 2008.

Schnell, R.C., The Air We Breathe: It is Rapidly Changing, Invited Annual Lecture, U3A Wales, Brecon, Wales, UK, September 18, 2008.

Levinson, D.H. and J.H. Lawrimore (Ed.), State of the Climate in 200, *Bulletin of the AMS, 89,* 7, S1-S179, (R.C. Schnell, Chapter on Trace Gases and Aerosols), 2008.

Schnell, R.C., S. J. Oltmans1, R. R. Neely, M. S. Endres, J. V. Molenar and A. B. White, Rapid High Concentration Rural Wintertime Photochemical Ozone Production, CMOS-2008 CONGRESS, 26-29 May, Kelowna, BC, Canada, May 26-29, 2008.

Schnell, R.C., The Growing Network of Arctic Atmospheric Observatories now Allows for Better Monitoring of Arctic Air Pollution, Eos Trans. AGU, 89 (53), Fall Meet. Suppl., Abstract, Dec15-19, 2008.

Kramer, L. J. , Honrath, R. E., Dziobak, M .P., Helmig, D., Hueber, J., Goodwin, S., Oltmans, S. J., Schnell, R.C., Burkhart, J. F., Stohl, A., Biomass-burning and Anthropogenic Impacts On Arctic Tropospheric Chemistry Assessed Using Measurements At Summit, Greenland , Eos Trans. AGU, 89 (53), Fall Meet. Suppl., Abstract, Dec15-19, 2008.

Schnell, R.C. “The Air We Breathe – It Ain’t What it Used to Be”, I-CARES Distinguished Speaker Series, Washington University, St. Louis, MO, Jan 20, 2009.

Schnell, R.C., The Changing Atmosphere, Invited Keynote Lecture, CETAS Conference-2009, Hisar, India, Feb 9-11, 2009.

Neely, R.R., R. C. Schnell, S. J. Oltmans, J. V. Molenar, A. B. White, and M. S. Endres, Cold Temperature Ozone Production in a Mountain Basin, Proceedings, 89th American Meteorological Society Annual Meeting, Phoenix, AZ, January 10-16, 2009.

Schnell, R.C., Updates on Radiatively Important Atmospheric Trace Gas Concentrations and Trends in other Parameters from the NOAA ESRL Global Network, Proceedings, 89th American Meteorological Society Annual Meeting, Phoenix, AZ, January 10-16, 2009.

Past Competitive Research Support

1983-1991 ($10 M grant from ONR to Schnell, University of Colorado and Dartmouth University for Arctic Research Topics)

Additional Grants

1985-86 (FY 86) $1,680,800

1986-87 (FY 87) $597,000

1987-88 (FY 88) $566,000

1988-89 (FY 89) $1,243,000

1989-90 (FY 90) $1,695,000

1990-91 (FY 91) $895,000

1991-92 (FY 92) $911,000

1992-Date: In 1992, Schnell joined NOAA as Director of the Mauna Loa Observatory, Hawaii and in 1998 moved to Boulder, Colorado as Director of NOAA Observatory Operations. In 2005 he became Deputy Director, NOAA/ GMD, with an operational budget in the region of $20 M/year

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