Petr Chylek

CV - May 2005

Space and Remote Sensing Sciences
Los Alamos National Laboratory

Professional Affiliation:
Optical Society of America: Fellow
American Geophysical Union: Member
American Meteorological Society: Member

Education
1966, Diploma in Theoretical Physics Charles University, Prague, Czech Republic
1970, Ph. D., Physics University of California, Riverside, California

Professional Experience
2001-present: Technical Staff Member, Space and Remote Sensing Sciences, LANL
2001-present: Adjunct professor of Physics and Atmospheric Science, Dalhousie University, Halifax, Canada
1990-present: Adjunct Professor of Physics, New Mexico State University, Las Cruces, NM
1990-2001: Professor of Physics and Atmospheric Science; Senior Chair in Climate Research; Founder and Coordinator of Atmospheric Science Program, Dalhousie University, Halifax, Nova Scotia, Canada
1986-1990: Professor, School of Meteorology, University of Oklahoma, Norman, OK
1978-1986: Research Professor, Department of Atmospheric Science, SUNY, Albany, NY
1975-1978: Associate Professor, Dept. of Geosciences, Purdue University, West Lafayette, IN
1973-1975: Assistant Professor, Department of Atmospheric Science, SUNY, Albany, NY
1972-1973: Postdoctoral Fellow, Advanced Study Program, National Center for Atmospheric Research, Boulder, CO
1970-1972: Research Associate, Department of Physics, Indiana University, Bloomington, IN

Visiting Positions
1966: March – May, Visiting Scientist, Instituto di Fisica de la Atmosfera, Frascati, Italy
2000-2001: Visiting Scientist, Air Resources Laboratory, NOAA, Boulder, CO

Research Experience and Interests: Remote Sensing, Atmospheric Radiation, Climate Change, Cloud and Aerosol Physics, Applied Laser Physics, Ice Core Analysis.

Honors
- University of California Graduate Fellowship, 1968-1970
- National Center for Atmospheric Research, Advanced Study Program Postdoctoral Fellowship, 1972-1973
- Honorary Fellow, Center for Earth and Planetary Physics, Harvard University, 1976-1978
- National Research Council Senior Fellowship, White Sand Missile Range, 1984-1985
- Paper by P. Chylek, J. Kiehl, and M. Ko "Optical levitation and partial wave resonances" (Phys. Rev. A, 18, 2229-2233, 1978) reprinted in the SPIE Milestone Series as one of the milestone papers in the field of Light Scattering, 1988
- Natural Sciences and Engineering Research Council of Canada, Senior Research Chair in Climate Research, 1990-2000

- Elected a Fellow of the Optical Society of America, 1991
- Naval Research Laboratory, Distinguished Faculty Summer Fellowship, April-June 1992
- Invited paper at the Spring AGU Meeting, 1995.
- Paper by P. Chylek and V. Srivastava, "Dielectric constant of a composite inhomogeneous medium" (Phys. Rev. B, 27, 5098-5106, 1983) reprinted in the SPIE Milestone Series as one of the milestone papers in the field of Linear Optical Composite Materials, 1996.
- Invited presentation at the Spring AGU Meeting, Baltimore, 1997.
- Invited presentation at the Gordon Research Conference on Solar Radiation and Climate, 1998.
- Invited presentation at the 5th International Conference on Light Scattering by Nonspherical Particles, Halifax, 2000.
- Paper by P. Chylek and C. Borel, "Mixed Phase Clouds Water/Ice Structure From High Spatial Resolution Satellite Data", (*Geophys. Res. Lett.*, 31, L14104, doi:10.1029/2004GL020428, 2004) selected by American Geophysical Union Editors as a Journal Highlight in August 2004.
- An invitation to present an invited talk at the International Radiation Symposium, Busan, Korea.
- Los Alamos National Laboratory Award for Scientific and Technical Leadership, 2004.
- Chairman, Scientific Program Committee, The Second International Conference on Global Warming and the Next Ice Age, Santa Fe, NM, 2006.

Recent Invited Seminars

1. Seminar, "Multi-spectral Remote Sensing: Water Vapor, Aerosols and Clouds", College of Oceanography and Atmospheric Sciences, Oregon State University, Corvallis, 2004
2. Colloquium, "Mixed Phase Clouds", Department of Atmospheric Sciences, University of Washington, Seattle, 2004
3. Colloquium, "Global Warming and Greenland Ice Sheet", Department of Geosciences, University of Nebraska, Lincoln, 2003
4. Seminar, "Temperature Changes at Greenland Coastal Stations and at the Summit of the Ice Sheet", Department of Atmospheric Sciences, South Dakota School of Mines and Technology, Rapid City, 2003

Recent International Committee Assignments

Co-Chair: Organizing Committee, 5th International Conference on Light Scattering by Nonspherical Particles, Halifax, 2000.

Co-Chair, Scientific Program Committee, The First International Conference on Global Warming and the Next Ice Age, 2001, Halifax.

Member: Program Committee, 6th International Conference on Light Scattering, Gainsville, Florida, 2002.

Member: Scientific Program Committee: 7th International Conference on Light Scattering, Brehmen, Germany, 2003.

Member , Committee on Nucleation and Atmospheric Aerosols, International Association of Meteorology and Atmospheric Physics, 1998-2006.

Publications

Over 100 publications in peer reviewed scientific journals

Peer Reviewed Publications (2003-2005)

- P. Chylek, B. Henderson, and Glen Lesins, Aerosol Optical Depth Retrieval Over the NASA Stennis Space Center: MTI, MODIS and AERONET. *IEEE Transactions on Geoscences and Remote Sensing*, 2005, in print.
- B. Henderson and P. Chylek, The Effect of Resolution on Satellite Aerosols Optical Depth Retrieval, *IEEE Trans. Geosci. and Remote Sens*., 2005, in print.
- R. Gupta, D. Vaidya, S. Dobbie, and P. Chylek, Scattering Properties and Composition of Cometary Dust, *Astrophysics and Space Science*, 2005, in print.
- P. Chylek, J. Box, and G. Lesins, Global Warming and the Greenland Ice Sheet, *Climatic Change*, 63, 201-221, 2004.
- P. Chylek, C. Borel, A. Davis, S. Bender, J. Augustine, and G. Hodges, Effect of Broken Clouds on Satellite Based Columnar Water Vapor Retrieval, *IEEE Geosci. and Remote Sens. Lett*, 1, 175-179, 2004.
- P. Chylek, and C. Borel, Mixed Phase Clouds Water/Ice Structure From High Spatial Resolution Satellite Data, *Geophys. Res. Lett*., 31, L14104, doi:10.1029/2004GL020428, 2004.
- P. Chylek, W. B. Clodius, S. C. Bender, W. H. Atkins, and L. K. Balick, Sensitivity of near infrared total water vapor estimate to calibration errors, *Int. J. Rem. Sens.*, 25, 4457-4470, 2004.
- P. Chylek, B. Henderson, and M. Mishchenko, Satellite based retrieval of aerosol optical thickness: The effect of sun and satellite geometry, *Geophys. Res. Lett*., 30, 1553, doi:10.1029/2003GL016917, 2003.
- S. L. Gong, L. Barrie, J. Blanchet, K. von Salzen, U. Lohmann, G., Lesins, L. Spacek, L. Zhang, E. Girard, H. Lin, and P. Chylek, Canadian Aerosol Module: A size-segragated simulation of atmospheric aerosol processes for climate and air quality models, *J. Geophys. Res*., 108, D1, p. 4007, 2003.
- P. Chylek, S. G. Jennings, and R. Pinnick, "Soot" in *Encyclopedia of Atmospheric Sciences*, ed. J.R Holton, Academic Press, New York, pp. 2093-2099, 2003.
- S. Dobbie, J. Li, R. Harvey, and P. Chylek, Sea-salt optical properties and GCM forcing at solar wavelengths, *Atmos. Res*., 65, 211-233, 2003.
- P. Chylek, B. Henderson and M. Mishchenko, Aerosol Radiative Forcing and the Accuracy of the Satellite Aerosol Optical Depth Retrieval, *J. Geophys. Res*.. 108 (D24), 4764, 10.1029/2003JD004044, 2003.
- P. Chylek, and C. Borel, Columnar Water Vapor Retrieval Using Multi-Spectral Satellite Data, in *Recent Res. Develop. Atmos. Sci.,* 2, pp. 105-118, 2003.
- P. Chylek, C. Borel, W. Clodius, P. Pope, and A. Rodger, Satellite Based Columnar Water Vapor Retrieval with the Multi-Spectral Thermal Imager (MTI), *IEEE Trans. Geosci. and Remote Sens*., 2767-2770, 2003.
- B. Henderson, and P. Chylek, Comparison of a Single-View and a Double-View Aerosol Optical Depth Retrieval Algorithm, *Proc. SPIE* 5157, 116-123, 2003.

MAJOR ACHIEVEMENTS

A. Research Highlights at LANL (since October 2001)

A-1. Aerosol Optical Depth: One of my tasks, after joining the Space and Remote Sensing Group at the LANL, was to develop science applications using the Multispectral Thermal Imager (MTI). The aerosol optical depth (AOD) characterizes the amount and optical activities of natural and anthropogenic atmospheric aerosols. AOD is an important parameter needed for assessment of mankind induced global change (aerosols counteract the heating effects of greenhouse gases) and for atmospheric correction of satellite imagery. By combination of theoretical work and the MTI image analysis we were able to develop a method of satellite based AOD retrieval that reduces the error of retrieval by about a factor of three compared to the error of current NASA and NOAA satellite instruments. We were able to show that by adapting our method for a suitable sub-set of NASA MODIS (Moderate Resolution Imaging Spectroradiometer) images, the error of the AOD retrieval was reduced from 0.12 to 0.04. Our work on AOD satellite retrieval helped to establish LANL as a recognized center of atmospheric remote sensing. In recognition of my work I have received the Los Alamos National Laboratory Award for Scientific and Technical Leadership in 2004. The major publications include: (1) P. Chylek, B. Henderson and M. Mishchenko, Aerosol Radiative Forcing and the Accuracy of the Satellite Aerosol Optical Depth Retrieval, *J. Geophys. Res.*. 108 (D24), 4764, doi: 10.1029/2003JD004044, 2003; (2) P. Chylek, B. Henderson, and Glen Lesins, Aerosol Optical Depth retrieval Over the NASA Stennis Space Center: MTI, MODIS and AERONET. *IEEE Transactions on Geosciences and Remote Sensing*, 2005, in print; (3) B. Henderson and P. Chylek, The Effect of Resolution on Satellite Aerosols Optical Depth Retrieval, *IEEE Trans. Geosci. Remote Sens*., 2005, in print.

A-2. Water, Ice and Mixed Phase Clouds: Based on our earlier laboratory measurements we have developed a satellite based method for remote sensing of the thermodynamic phase (water, ice or mixture of water and ice) of clouds. To be able to determine the cloud phase is essential for assessing the climate change, for atmospheric corrections in remote sensing and for flying through the clouds (aircraft icing occurs usually only in mixed phase clouds). Using the MTI high spatial resolution imagery we have shown that the Arctic stratus clouds often contain pockets of pure water and pockets of pure ice in addition to mixed phase region. Published paper by P. Chylek, and C. Borel, Mixed Phase Clouds Water/Ice Structure From High Spatial Resolution Satellite Data, *Geophys. Res. Lett*., 31, doi:10.1029/2004GL020428, 2004, has been recognized by the Board of AGU Editors as Journal Highlight in August 2004. The IGPP funded project, developed in collaboration with Prof. Q. Fu from the Department of Atmospheric Sciences, University of Washington, supports a graduate student who will continue the research and its remote sensing and climate change applications.

A-3. Special MTI Related Section of the IEEE Transactions on Geosciences and Remote Sensing: To recognize the success of an open science applications of the LANL MTI project I have organized a special MTI related section of the *IEEE Transactions on Geosciences and Remote Sensing*. The goal is to enhance the LANL reputation as a world-class center of remote sensing. A total of seven manuscripts have been submitted for publication by members of the former MTI team. By now six of the submitted papers have been accepted; one manuscript is still in the reviewing process. The special section is expected to be published in late 2005 or early 2006.

A-4. Aerosols-Climate and Hydrological Cycle: I have helped to develop the LDRD-DR funded project "Resolving the Aerosol-Climate-Water Puzzle (20050014DR – M. Dubey -PI)", where I am now leader of the observational part of the proposed research. Within the past few months, we have made a major discovery concerning the effect of aerosols on the size distribution of ice crystals of cirrus clouds. It is reasonably well documented that the man made pollution modifies the size distribution of water droplets in clouds toward smaller sizes which leads to higher cloud reflectivity and cooling of the climate (a partial compensation of the warming produced by greenhouse gases). Till now it has been assumed that man made pollution will have a similar effect on ice clouds. Our satellite based observations suggest, however, that aerosols may have an opposite effect on ice clouds. The

paper describing our results is currently in preparation in collaboration with the foremost climate experts (V. Ramanathan – Scripps; U. Lohmann – ETH Zurich; Y. Kaufman –NASA GSFC).

B. Research Highlights From Before 2001

B-1. Aerosols and Climate: When atmospheric aerosols were not considered a major player in climate change, we (in collaboration with J. Coakley) presented one of the first studies to assess the effect of aerosol on the earth-atmosphere energy budget. Today, aerosols and their effect on atmospheric radiation (direct and indirect through modification of clouds life cycle) are considered to be one of the most important anthropogenic modifiers of global climate. As a byproduct of our research we have developed an approximation to the radiative transfer equation suitable for optically thin aerosols layers. The essential publications include: (1) P. Chylek and J. Coakley, "Aerosols and climate", *Science*, 183, 75-77, 1974; (2) J. Coakley and P. Chylek, "The two stream approximation in radiative transfer: Including the angle of the incident radiation"*, J. Atmos. Sci*., 32, 409-418, 1975 (together cited 203 times).

B-2. Mie Scattering Resonances: When Arthur Ashkin from Bell Labs published the first results of light scattering by a single optically levitated droplets (Phys. Rev. Lett., 1977), the observed rich structure was a mystery. At the same time we were studying (with M. Ko – a postdoctoral research associate, and J Kiehl – a graduate student) the effect of resonances on electromagnetic scattering by small particles (Mie scattering). It became apparent that there was a connection between the experimentally observed structure and our resonance approach. We were the first one to connect the two. Today, our explanation of the resonance structure is a part of many textbooks and monographs on light scattering by small particles. My work on scattering resonances lead to my election as a Fellow of the Optical Society of America. One of our publications (Phys. Rev. 1978) was later re-printed in the SPIE Milestone Series (1988). The essential publications include: (1) P. Chylek, "Partial wave resonances and the ripple structure in the Mie normalized extinction cross section", *J. Opt. Soc. Am*., 66, 285-287, 1976; (2) P. Chylek, J. Kiehl, and M. Ko", Optical levitation and partial wave resonances", *Phys. Rev*., A18, 2229-2233, 1978; (3) P. Chylek, J. Kiehl ,and M. Ko, "Resonant structure of the Mie scattering", *Appl. Opt*., 17, 3019-3021, 1978 (together cited 305 times).

B-3. Optical Constants: Many atmospheric aerosols are a mixture of material like, sulfates, nitrates, black carbon and dust. The effective refractive index of such a mixture as defined by classical mean field approximations is a function only of volume fractions of individual materials and their topological arrangement. However, if the grains of individual materials are not much smaller than the wavelength of considered radiation, the effective refractive index depends also on the size of individual grains. We have developed an extension of classical mean field theories to include the effect of the grain size. Our original paper (Phys. Rev. 1983) describing our work was later re-printed in the SPIE Milestone Series (1996). The most accurate up to date laboratory measurements of imaginary parts of refractive indices of water, super-cooled water and ice have been included in the HIGHTRAN database. As such our results are used by hundreds of HIGHTRAN and MODTRAN users every year. The essential publications in this area of research include: (1) P. Chylek and V. Srivastava, "Dielectric constant of a composite inhomogeneous medium", Phys. Rev. B, 27, 5098-5106, 1983;(2) P. Chylek, V. Ramaswamy, A. Ashkin, and J. Dziedzic, "Simultaneous determination of refractive index and size of spherical dielectric particle from light scattering data", *Appl. Opt*., 22, 2302-2307, 1983; (3) L. Kou, D. Labrie, and P. Chylek, "Refractive index of water and ice in the 0.65 to 2.5 micron spectral range", *Appl. Opt*. , 32, 3531-3540, 1993 (total cited 268 times).

B-4. Black Carbon (soot): Black carbon due to its high absorption of solar radiation is an important part of atmospheric aerosols. My theoretical work as well as field measurements contributed

significantly to the knowledge of black carbon concentrations, its radiative properties and effect on climate. The recognition of my work includes the presentation of an invited talk at the AGU meetings in 1995 and 1997. The essential publications include: (1) P. Chylek, and V. Ramaswamy, Optical properties and mass concentration of carbonaceous smokes, *Appl. Opt*., 20, 2980, 1981, (2) P. Chylek, V. Ramaswamy, and R. Cheng, Effect of graphitic carbon on the albedo of clouds, *J. Atmos. Sci*., 41, 3076, 1984, (3) P. Chylek, G. Videen, D. Ngo, R. Pinnick, and J. Klett, Effect of black carbon on the optical properties and climate forcing of sulfate aerosols, *J. Geophys. Res*., 100, 16325-16332, 1995 (total cited 194 times).

C. Educational Activities

C-1. Students and Postdocs: I have supervised the research of ten postdoctoral research associates and over 20 M.S. and Ph. D. graduate students. Some of my former Ph. D. students are among today's world-class scientists (J. Kiehl – National Center for Atmospheric Research, Boulder; V. Ramaswamy – Geophysical Fluid Dynamics Laboratory, Princeton University; J. Li – Canadian Centre for Climate Modeling and Analysis, Victoria). I am currently hiring two postdoctoral associates (offers have been accepted) and will mentor two graduate students during their summer stay at the LANL.

C-2. Atmospheric Science Program at Dalhousie University: In 1990 I accepted a tenured full professor position at Dalhousie University in Halifax, Canada with the task to build an Atmospheric Science Graduate Program (M.S. and Ph. D. degrees). In addition to my position three junior faculty positions were allocated to establish the program. I was able to recruit several of the highly talented young scientists (all postdoctoral fellows at that time) and within a few years we had an excellent program consisting of Ian Folkins (currently Associate Professor at Dalhousie University), Qiang Fu (currently Associate Professor at the University of Washington) and Ulrike Lohmann (currently a Full Professor at the ETH, Zurich), several postdoctoral fellows and over 20 students. To recognize the achievements of the Atmospheric Science Program, the Department of Physics was renamed to the Department of Physics and Atmospheric Science, in the year 2000.