Christopher R. Williams, PhD

Research Professor
Ann and H.J. Smead Department of Aerospace Engineering Sciences
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Research Interest

My research vision is to advance our understanding of precipitation microphysical processes and cloud dynamics with the ultimate aim of improving parameterizations in numerical models. I pursue this vision by analyzing ground-, air-, and space-based radar observations to retrieve raindrop number and size estimates that lead to improved global rainfall estimates and improved understanding of precipitation processes and dynamics.

Education

Ph.D.	1994	University of Colorado Boulder, CO (Electrical Engineering) Thesis: Deep convective clouds and their association with nonmigrating atmospheric diurnal tides in the tropical troposphere (Prof. Susan Avery)
M.S.	1986	Purdue University, West Layette, IN (Electrical Engineering)
B.S.	1985	California Polytechnic State University, San Luis Obispo, CA (Electronic Engineering)

Professional Experience

2018-Present	**Research Professor**, Ann and H.J. Smead Department of Aerospace Engineering Sciences, University of Colorado Boulder
2015-2017	**Senior Scientist**, Cooperative Institute for Research in Environmental Sciences (CIRES) / University of Colorado Boulder (CU), in partnership with National Oceanic and Atmospheric Administration (NOAA) / Earth System Research Laboratory (ESRL)
1994-2015	**Research Scientist**, CIRES / CU & NOAA
1991-1994	**Graduate Research Assistant**, CIRES / CU & NOAA Aeronomy Lab
1988-1991	**Development Engineer**, Next Generation Perfusion Team, COBE Laboratories, Arvada, Colorado
1987-1988	**Design Engineer**, CO_2 Laser Tube Development Group, HGM Medical Laser Systems, Salt Lake City, Utah

Academic Appointments

2017-Present	Affiliate Member, Earth Science and Observation Center (ESOC), CIRES, University of Colorado Boulder (non-paid)
2007-2008	Adjunct Faculty, Department of Aerospace Engineering Sciences, University of Colorado Boulder (co-taught ASEN 5245: Radar and Remote Sensing)

2005-2007 Adjunct Faculty, Department of Atmospheric Science, Colorado State University, Fort Collins (non-paid)

2004-2007 Adjunct Faculty, Department of Atmospheric Science, University of Alabama at Huntsville (non-paid)

Patents

7,920,959 5 April 2011: Method and apparatus for estimating the velocity vector of multiple vehicles on non-level and curved roads using a single camera. Inventor: Christopher R. Williams

Peer-Reviewed Publications

All Peer-Reviewed Publications are listed on www.ResearcherID.com with ID#: A-2723-2015
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- *82 published peer-reviewed publications*
- *Collaborated with over 120 different co-authors*
- *Publications cited over 2700 times in other peer-reviewed articles*
- *Publications cited over 200 times in 2020*
- *h-index = 32 (32 papers have at least 32 citations), as of August 2021*

Publication number. (Citation count) Publication detail

85. (N/A) Kramer, A. K. Harlow, C. Heckman, and **C.R. Williams**, 2021: ColoRadar: The direct 3D millimeter wave radar dataset. *Intern. J. Robotics Research*, accepted, in revision.
84. (N/A) Johnston, P. E., **C. R. Williams**, A. B. White, 2021: Preliminary Drop Size Distributions measured with NOAA's Snow-Level Radar. *J. Atmos. Oceanic Technol.*, accepted, in revision.
83. (N/A) Montopoli, M., E. Adirosi, L. Baldini, and **C. R. Williams**, 2020: Estimation of the vertical wind component from vertically pointing K-band radar measurements in convective regimes and implications on retrieved drop size distribution. *IEEE Trans. Geosci. Remote. Sens.*, submitted.
82. (0) Gatlin, P., M. Thurai, **C.R. Williams**, and E. Adirosi, 2021: Measurement and modeling of the precipitation particle size distribution. *Atmosphere*, doi: 10.3390/atmos12070819.
81. (0) **Williams, C.R.**, K.L. Johnson, S. E. Giangrande, J. C. Hardin, R. Oktem, and D. M. Romps, 2021: Identifying insects, clouds, and precipitation using vertically pointing polarimetric radar Doppler velocity spectra. *J. Atmos. Meas. Techn.*, doi: 10.5194/amt-14-4425-2021.
80. (7) Narsey, S., C. Jakob, M.S. Singh, M. Bergemann, V. Louf, A. Protat, and C.R. Williams, 2019: Convective precipitation efficiency observed in the Tropics. Geophys. Res. Let., 270 Nov-2019, doi: 10.1029/2019GL085031.
79. (2) Wohltmann, I., R. Lehmann, G.A. Gottwald, K. Peters, A. Protat, V. Louf, C.R. Williams, W. Fen, and M. Rex, 2019: A Lagrangian convective transport scheme including a simulation of the time air parcels spend in updrafts. *Geoscientific Model Development*, doi: 10.5194/gmd-2019-5.
78. (2) Tian, J., X. Dong, B. Xi, **C.R. Williams**, and P. Wu, 2019: Estimation of liquid water path in stratiform precipitation systems using radar measurements. *J. Atmos. Meas. Tech.*, **12**, 3759-3759, doi: 10.5194/amt-12-3743-2019.
77. (17) Han, B., J. Fan, A. Varble, H. Morrison, **C.R. Williams**, B. Chen, X. Dong, S.E.

Giangrande, A. Khain, E. Mansell, J.A. Milbrandt, J. Shpund, and G. Thompson, 2019: Cloud-resolving model intercomparison of an MC3E squall line case: Part II – Stratiform precipitation properties. *Journal of Geophysical Research*, doi: 10.1029/2018JD029596.

76. (4) Ovchinnikov, M., S. Giangrande, V.E. Larson, A. Protat, and **C.R. Williams**, 2019: Dependence of vertical alignment of cloud and precipitation properties on their effective fall speeds. *J. Geophys. Res. Atmos.*, **124**, doi: 10.1029/2018JD029346.
75. (0) Ghate, V., P. Kollias, S. Crewell, A. Fridlind, T. Heus, U. Löehnert, M. Maahn, G. McFarquhar, D. Moisseev, M. Oue, M. Wendisch, and **C. Williams**, 2019: The second ARM training and science application Event: Training the next generation of atmospheric scientists. *Bull. Amer. Meteor. Soc*., doi: 10.1175/BAMS-D-18-0242.1.
74. (7) **Williams, C.R.**, M. Maahn, J.C. Hardin, and G. de Boer, 2018: Clutter mitigation, multiple peaks, and high-order spectral moments in 35-GHz vertically pointing radar velocity spectra. *J. Atmos. Meas. Tech.*, 11, 4963-4980, doi: 10.5194/amt-11-4963-2018.
73. (20) de Boer, G., and 24 co-authors, 2018: A bird's eye view: Development of an operational ARM Unmanned aerial capability for atmospheric research in Arctic Alaska. *Bull. Amer. Meteor. Soc.*, doi: 10.1175/BAMS-D-17-0156.1.
72. (3) Fairall, C.W., S.Y. Matrosov, **C.R. Williams**, and E.J. Walsh, 2018: Estimation of rain rate from airborne Doppler W-band radar in CalWater-2. *J. Atmos. Oceanic Technol.*, **35**, 593-608, doi: 10.1175/JTECH-D-17-0025.1.
71. (32) Giangrande, S.E., T. Toto, M. P. Jensen, M.J. Bartholomew, Z. Feng, A. Protat, **C.R. Williams**, C. Schumacher, and L. Machado, 2016: Convective cloud vertical velocity and mass-flux characteristics from radar wind profiler observations during GoAmazon2014 /15. *J. Geophys. Res. Atmos.*, **121**, 12 891-12 913, doi: 10.1002/2016JD025303.
70. (7) **Williams, C.R.**, R.M. Beauchamp, and V. Chandrasekar, 2016: Vertical air motions and raindrop size distributions estimated using mean Doppler velocity different from 3- and 35-GHz vertically pointing radars. *IEEE Trans. Geosci. Remote Sens.*, **54**, 6048-6060, doi: 10.1109/TGRS.2016.2580526.
69. (94) Jensen, M.P., W.A. Petersen, A. Bansemer, N. Bharadwaj, L.D. Carey, D.J. Cecil, S.M. Collis, A.D. Del Genio, B. Dolan, J. Gerlach, S.E. Giangrande, A. Heymsfield, G. Heymsfield, P. Kollias, T.J. Lang, S.W. Nesbitt, A. Neumann, M. Poellot, S.A. Rutledge, M. Schwaller, A. Tokay, **C.R. Williams**, D.B. Wolff, S. Xie, and E.J. Zipser, 2016: The Midlatitude continental convective clouds experiment (MC3E), *Bull. Amer. Meteor. Soc.*, doi: 10.1175/BAMS-D-14-00228.1.
68. (7) Kumar, V.V., A. Protat, C. Jakob, **C.R. Williams**., S. Rauniyar, G.L. Stephens and P.T. May, 2016: The estimation of convective mass flux from radar reflectivities. *J. App. Meteorol. and Climatol.*, **55**, 1239-1257, doi: 10.1175/JAMC-D-15-0193.1.
67. (21) **Williams, C.R.**, 2016: Reflectivity and liquid water content vertical decomposition diagrams to diagnose vertical evolution of raindrop size distributions. *J. Atmos. Oceanic Technol.*, **33**, 579-595, doi: 10.1175/JTECH-D-15-0208.1.
66. (1) **Williams, C.R.**, V.N. Bringi, L. Carey, V. Chandrasekar, P. Gatlin, Z.S. Haddad, R. Meneghini, S.J. Munchak, S.W. Nesbitt, W.A. Petersen, S. Tanelli, A. Tokay, A. Wilson and D. Wolff, 2015: Reply to "Comments on 'Describing the shape of raindrop size distributions using uncorrelated raindrop mass spectrum parameters'". *J. Appl. Meteorol. and Climatol.,* **54**, 1977-1982, doi: 10.1175/JAMC-D-15-0058.1.
65. (17) Fridlind, A.M., A.S. Ackerman, A. Grandin, F. Dezitter, M. Weber, J.W. Strapp, A.V. Korolev, and **C.R. Williams**, 2015: High ice water content at low radar reflectivity near deep convection – Part 1: Consistency of in situ and remote-sensing observations with stratiform rain column simulations. *Atmos. Chem. Phys. Discuss.* **15**, 16505-16550. Doi:

10.5194/acpd-15-16505-2015.

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63. (36) Kumar, V.V., C. Jakob, A. Protat, **C.R. Williams**, and P.T. May, 2015: Mass-flux characteristics of tropical cumulus clouds from wind profiler observations at Darwin, Australia. *J. Atmos. Sci.*, **72**, 1837-1855, doi: 10.1175/JAS-D-14-0259.1.
62. (0) **Williams, C.R.**, V.N. Bringi, L. Carey, V. Chandrasekar, P. Gatlin, Z.S. Haddad, R. Meneghini, S.J. Munchak, S.W. Nesbitt, W.A. Petersen, S. Tanelli, A. Tokay, A. Wilson and D. Wolff, 2015: Corrigendum 'Describing the shape of raindrop size distributions using uncorrelated raindrop mass spectrum parameters'. *J. Appl. Meteorol. and Climatol.,* **54**, 932, doi: 10.1175/JAMC-D-15-0055.1.
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60. (70) Varble, A., E.J. Zipser, A.M. Fridlind, P. Zhu, A.S. Ackerman, J.-P. Chaboureau, J. Fan, A. Hill, B. Shipway, and **C.R. Williams**, 2014: Evaluation of cloud-resolving and limited area model intercomparison simulations using TWP-ICE observations. Part 2: Rain microphysics. *J. Geophys. Res.*, doi/10.1002/2013JD021372.
59. (21) Thurai, M., **C.R. Williams**, and V.N. Bringi, 2014: Examining the correlations between drop size distribution parameters using data from two side-by-side 2D-video disdrometers. *Atmospheric Res.*, dx.doi.org/10.1016/j.atmosres.2014.01.002.
58. (58) **Williams, C.R.**, V.N. Bringi, L. Carey, V. Chandrasekar, P. Gatlin, Z.S. Haddad, R. Meneghini, S.J. Munchak, S.W. Nesbitt, W.A. Petersen, S. Tanelli, A. Tokay, A. Wilson and D. Wolff, 2014: Describing the shape of raindrop size distributions using uncorrelated raindrop mass spectrum parameters. *J. Appl. Meteorol. and Climatol.,* **53**, 1282-1296, doi: 10.1175/JAMC-D-13-076.1.
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56. (41) Collis, S., A. Protat, P.T. May, and **C.R. Williams**, 2013: Statistics of storm updraft velocities from TWP-ICE including verification with profiling measurements. *J. Appl. Meteor. and Climatol.*, **52**, 1909-1922, doi: 10.1175/JAMC-D-12-0230.1
55. (20) Tridon, F., A. Battaglia, P. Kollias, E. Luke, and **C.R. Williams**, 2013: Signal Post-processing and Reflectivity Calibration of the Atmospheric Radiation Measurement Program 915 MHz Wind Profilers. *J. Atmos. Oceanic Technol.*, **30**, 1038-1054, doi: 10.1175/JTECH-D-12-00146.1.
54. (38) Han, M., S.A. Braun, T. Matsui, and **C.R. Williams**, 2013: Evaluation of cloud microphysics schemes in simulations of a winter storm using radar and radiometer measurements. *J. Geophys. Res. Atmos.*, **118**, 1401-1419, doi:10.1002/jgrd.50115.
53. (35) **Williams, C.R.**, 2012: Vertical air motion retrieved from dual-frequency profiler observations. *J. Atmos. Oceanic Technol.*, **29**, 1471-1480, doi: http://dx.doi.org/10.1175/JTECH-D-11-00176.1.
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Szoeke, V. Ghate, 2012: A motion-stabilized W-band radar for shipboard observations of marine boundary-layer clouds. *Bound.-Layer Meteor.*, 143, 3-24, doi:10.1007/s10546-011-9674-5.

50. (1) **Williams, C.R.**, 2011: Inexpensive FM-CW radar for boundary-layer precipitation studies. *IEEE Geoscience and Remote Sensing Letters*, **8**, 1031-1035, 10.1109/ LGRS.2011.2150733.
49. (28) Protat, A., and **C.R. Williams**, 2011: The accuracy of radar estimates of ice terminal fall speed from vertically pointing Doppler radar measurements. *J. Appl. Meteor. and Climate*, **50**, 2120-2138, doi:10.1175/JAMC-D-10-05031.1.
48. (76) Ault, A.P., **C.R. Williams**, A.B. White, P.J. Neiman, J.M. Creamean, C.J. Gaston, F.M. Ralph, and K.A. Prather, 2011: Detection of Asian Dust in California Orographic Precipitation. *J. Geophys. Res.*, **116**, D16205, doi:10.1029/2010JD01535.
47. (17) Lerach, D.G., S.A. Rutledge, **C.R. Williams**, and R. Cifelli, 2010: Vertical structure of convective systems during NAME 2004. *Mon. Wea. Rev.*, **138**, 1695-1714.
46. (109) Bringi, V.N., **C.R. Williams**, M. Thurai, and P. May, 2009: Using dual-polarized radar and dual-frequency profiler for DSD characterization: A case study from Darwin, Australia. *J. Atmos. Oceanic Technol.*, **26**, 2107-2122.
45. (13) Kim, D.-K., K.R. Knupp, and **C.R. Williams**, 2009: Airflow and precipitation properties within the stratiform region of Tropical storm Gabrielle during landfall. *Mon. Wea. Rev.*, **137**, 1954-1971.
44. (48) Tokay, A., P. Hartmann, A. Battaglia, K.S. Gage, W.L. Clark, and **C.R. Williams**, 2009: A field study of reflectivity and Z-R relations using vertically pointing radars and disdrometers. *J. Atmos. Oceanic Technol.*, **26**, 1120-1134.
43. (4) Newman, A.J., P.A. Kucera, **C.R. Williams**, and L.F. Bliven, 2009: Snowflake size spectra retrieved from a UHF vertical profiler. *J. Atmos. Oceanic Technol.*, **26**, 180-199.
42. (28) **Williams, C.R.**, and K.S. Gage, 2009: Raindrop size distribution variability estimated using ensemble statistics. *Ann. Geophys.,* **27***, 555-567, 2009, www.ann-geophys.net/27/55/2009/.*
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35. (31) Sassen, K., J.R. Campbell, P. Kollias, M. Shupe, **C.R. Williams**, and J. Zhu, 2005: Lidar and triple-wavelength Doppler radar measurements of the melting layer: A revised model for dark and bright band phenomena. *J. Appl. Meteor.*, **44**, 301-312.

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1. (2) **Williams, C.R.**, L.A. Geddes, J.D. Bourland, and E.S. Furgason, 1987: Analysis of the current-density distribution from a tapered, gelled-pad external cardiac pacing electrode. *Medical Instrumentation*, **21**, 329-334.

Field Campaign Deployments

Involved with instrument deployment and data analysis from these experiments

17. Mid-Latitude Continental Convective Cloud Experiment (MC3E), April-June 2011, Oklahoma
16. CalWater Experiment, November 2009-March 2010, California Sierra Nevada
15. CalWater Early Start Campaign, February-March 2009, California Sierra Nevada
14. Hydrometeorological Testbed 2008-2009 Winter Season (HMT-09), Dec. 2008-March 2009, California Sierra Nevada
13. Hydrometeorological Testbed 2007-2008 Winter Season (HMT-08), Dec. 2008-March 2009, California Sierra Nevada
12. Tropical Warm Pool-International Cloud Experiment (TWP-ICE), January-February 2006, Darwin, Australia.
11. Wallops Island Precipitation Variability Experiment, 2004-2006, Wallops Island, VA.
10 North American Monsoon Experiment (NAME), July-August 2004, Estacion Obispo, Mexico.
11 Front Range Pilot Project (FRPP), May-August 2004, Platteville, CO.
8. Distrometer Evaluation Experiment (DEVEX), April-Sept. 2002, Iowa City, IA.
7. Cirrus Regional Study of Tropical Anvils and Cirrus Layers – Florida Area Cirrus Experiment (CRYSTAL-FACE), July 2002, Miami, FL.
6. 2001 Multi-Frequency Radar IOP, ARM Southern Great Plains (SGP) Site, Lamont, OK.
5. Kwajalein Experiment (KWAJEX), July-Sept. 1999, Kwajalein Island, Republic of the Marshall Islands.
4. Tropical Rainfall Measuring Mission-Land-Biosphere-Amazonia (TRMM-LBA), January-February 1999, Ji Parana, Brazil.
3. Texas-Florida Underflight Experiment – Florida Phase (TEFLUN-B), August-Sept. 1998, Melbourne, FL.
2. Texas-Florida Underflight Experiment – Texas Phase (TEFLUN-A), April-June 1998, Houston, TX.
1. Tropical Eastern Pacific Precipitation Study (TEPPS), July-Sept. 1997, on the NOAA *R/V Ronald H. Brown*, 1500 nmi west of Panama City, Panama.

Honors and Awards

2015 NASA Goddard Space Flight Center Robert H. Goddard Award (Ground Validation Team) for the category of *Exceptional Achievement in Science in 2014*.

2015 - NASA Group Achievement Award, Global Precipitation Measurement (GPM) Post-Launch Team, "For exceeding all expectations for GPM operations, data processing, algorithm performance, science impact, and education and public outreach within one year after launch".

2014 American Meteorological Society Editor's Award from *Journal of Atmospheric and Oceanic Technology*

2006 CIRES/University of Colorado Outstanding Scientist of the Year

Professional Service and Contribution

NASA Precipitation Measurement Mission (PMM)

Coordinated and hosted the *NASA Cal/Val and Algorithm Symposium*, March 2020
NASA PMM Science Team, Member, 2000 – Present
NASA PMM Raindrop Size Distribution Working Group, Chair, 2007 – Present
NASA PMM Ground Validation Working Group, Member, 2007 – Present

Department of Energy (DOE), Atmospheric Science Research (ASR) Program

DOE ASR Science Team, Member, 2011 – Present
DOE ASR Vertical Velocity Focus Group, Member, 2011 – Present
DOE ASR Radar Science Committee, Member, Member, 2011 – Present

American Meteorological Society (AMS) – Leadership Positions

36th AMS Conference on Radar Meteorology, Conference co-chair, 14-20 September 2013, Breckenridge, CO, (over 400 abstracts and over 400 attendees)
AMS Radar Committee, Member, 2013 - Present.

Scientific and Professional Memberships

Project Management International (PMI, certified Project Manager Professional, PMP)
American Geophysical Union (AGU)
American Meteorological Society (AMS)
Institute of Electrical and Electronics Engineers (IEEE, Senior Member)

Teaching Experience

Taught ASEN 5245 "Radar Remote Sensing", Ann and H.J. Smead Department of Aerospace Engineering Sciences, University of Colorado Boulder, Spring Semesters 2017, 2018, 2019, and 2021.

Guest Instructor, "ARM Radars and Radar Data Analysis", 2018 Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) Summer Training and Science Application Workshop, Norman, OK, 14-21 July 2018.

Co-taught ASEN 5245 "Radar Remote Sensing" with Prof. Jeffery Thayer, Department of Aerospace Engineering Sciences, University of Colorado Boulder, Spring Semester 2008.

Guest Lectures on wind profiler radars for Prof. Steven Rutledge, Atmospheric Science Department, Colorado State University, Fort Collins, Spring 2007, Spring 2008, Spring 2009, and Fall 2009.

Professional Presentations / Non-Reviewed Publications

Over 270 professional presentations or non-reviewed publications