

## CORA EINTERZ RANDALL

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### **Education**

B.A. / Chemistry. State University of New York, College at Purchase. 1982.  
M.S. / Chemistry. University of California at Santa Cruz. 1983.  
Ph.D. / Chemistry. University of California at Santa Cruz. 1985.

### **Professional Experience**

2020 – present Distinguished Professor, University of Colorado Boulder (CU) Department of Atmospheric and Oceanic Sciences (ATOC) and Laboratory for Atmospheric and Space Physics (LASP)  
2010 – 2020 Professor, CU ATOC and LASP  
2012 – 2017 Chair, CU ATOC  
2006 – 2010 Associate Professor, CU ATOC and LASP  
1989 – 2005 Research Scientist, CU LASP  
1987 – 1989 Research Scientist, University of California (UC), Santa Cruz  
1986 – 1987 Post-doctoral Research Scientist, Carnegie Mellon University  
1985 – 1986 Post-doctoral Research Scientist, UC Santa Cruz  
1985 (Fall) Lecturer, Physical Chemistry (quantum mechanics/kinetics), UC Santa Cruz

Research at UC Santa Cruz and Carnegie Mellon focused on laser spectroscopy and time resolved measurements of protein folding. Research at CU has focused on satellite remote sensing of the Earth and comets. Primary areas of expertise are in atmospheric effects of energetic particle precipitation, stratospheric ozone depletion, polar mesospheric clouds, and satellite measurement validation. Current or previous member of numerous satellite science teams including:

- NASA Aeronomy of Ice in the Mesosphere (AIM), 2000-Present  
*Principal Investigator: AIM Cloud Imaging and Particle Size instrument, 2009-Present*  
*AIM U. Colorado PI: 2017-Present*
- Atmospheric Chemistry Experiment (ACE, Canada), 2005-2017
- NASA Aura High Resolution Dynamics Limb Sounder (HIRDLS), 2004-2013
- NASA Solar Occultation Satellite Science Team (SOSST), 2004-2006
- Improved Limb Atmospheric Spectrometer (ILAS2, Japan), 2002-2006
- NASA Stratospheric Aerosol and Gas Experiment (SAGE) II, 2000-2003
- DOD Polar Ozone and Aerosol Measurement (POAM), 1993-2005
- Hubble Space Telescope Goddard High Resolution Spectrograph, 1989-1993

### **Honors**

American Geophysical Union Bowie Lecturer: Marcel Nicolet Lecture, 2019  
Natl. Acad. Sci. Space Studies Board; Decadal Survey Recognition, 2019  
CU Boulder Faculty Assembly Excellence in Leadership and Service Award, 2017

Elected Fellow of the American Association for the Advancement of Science, 2015  
Elected Fellow of the American Geophysical Union, 2012  
University of Colorado Excellence in Leadership Program Fellow, 2010-2011  
University of Colorado Provost's Faculty Achievement Award, 2008  
NASA Group Achievement Award, AIM Mission, GSFC / NASA, 2008  
NASA Group Achievement Award, Aura Program, GSFC / NASA, 2005  
NASA Certificate of Recognition, Aura Program, GSFC / NASA, 2005  
NASA Group Achievement Award, SOLVE-II program, NASA, 2004  
Alan Berman Research Publications Award, Department of the Navy; 1996, 2003  
Editors' Citation for Excellence in Refereeing, *Geophysical Research Letters*, 1998  
Certificate of Recognition, Hubble Space Telescope Program, GSFC / NASA, 1991  
Group Achievement Award, HST-GHRS Development Team, GSFC / NASA, 1991  
University of California Regents Fellowship, University of California at Santa Cruz, 1982-1983  
Outstanding Freshman Chemistry Award, American Chemical Society; Westchester, NY, 1979

### **Publications**

Polarized Light in Optics and Spectroscopy. D.S. Kliger, J.W. Lewis and C.E. Randall. Academic Press, San Diego, CA. 1990.

### **ARTICLES UNDER REVIEW OR IN PRESS**

1. Stevens, M. H., C. E. Randall, J. Carstens, D. E. Siskind, J. McCormack, D. Kuhl, M. Dhadly, Northern Mid-Latitude Mesospheric Cloud Frequencies Observed by AIM/CIPS: Interannual Variability Driven by Space Traffic, under review at Earth and Space Science, doi:10.1029/2022EA002217-T, 2022.
2. Bailey, S. M., W. E. McClintock, J. N. Carstens, B. Thurairajah, S. Das, C. E. Randall, V. L. Harvey, D. E. Siskind, M. H. Stevens, and K. Venkataramani, Sounding Rocket Observation of Nitric Oxide in the Polar Night, under review at J. Geophys. Res. Space Physics, doi:10.1029/2021JA030257, 2021.

### **PUBLISHED, REFEREED ARTICLES**

1. Goncharenko, L. P., V. L. Harvey, C. E. Randall, A. J. Coster, S.-R. Zhang, A. Zalizovski, I. Galkin, and M. Spraggs, Observations of pole-to-pole, stratosphere-to-ionosphere connection, *Front. Astron. Space Sci.*, 19, doi:10.3389/fspas.2021.768629, 2022.
2. Tyssøy, H. N., M. Sinnhuber, T. Asikainen, S. Bender, M. A. Clilverd, B. Funke, et al., HEPPA III intercomparison experiment on electron precipitation impacts, part I: Estimated ionization rates during a geomagnetic active period in April 2010, *J. Geophys. Res. Space Physics*, 127, e2021JA029128, doi:10.1029/2021JA029128, 2021.
3. Pettit, J. M., C. E. Randall, E. D. Peck, and V. L. Harvey, A new MEPED-based Precipitating Electron data set, *J. Geophys. Res. Space Physics*, 126, e2021JA029667, doi:10.1002/2021JA029667, 2021.
4. McCormack, J. P., V. L. Harvey, C. E. Randall, N. Pedatella, D. Koshin, K. Sato, L. Coy, S. Watanabe, F. Sassi, and L. A. Holt, Intercomparison of Middle Atmospheric Meteorological Analyses for the Northern Hemisphere Winter 2009-2010, *Atmos. Chem. Phys.*, doi:10.5194/acp-21-17577-2021, 2021.

5. Harvey, V. L., S. Datta-Barua, N. M. Pedatella, N. Wang, C. E. Randall, D. E. Siskind, and W. E. van Caspel, NO transport via Lagrangian Coherent Structures into the top of the polar vortex, *Journal of Geophysical Research: Atmospheres*, v126, e2020JD034523, <https://doi.org/10.1029/2020JD034523>, 2021.
6. Forbes, J. M., Zhang, X., Randall, C. E., France, J., Harvey, V. L., Carstens, J., & Bailey, S. M., Troposphere-mesosphere coupling by convectively forced gravity waves during Southern Hemisphere monsoon season as viewed by AIM/CIPS. *Journal of Geophysical Research: Space Physics*, 126, e2021JA029734. <https://doi.org/10.1029/2021JA029734>, 2021
7. Siskind, D. E., V. L. Harvey, F. Sassi, J. McCormack, C. E. Randall, M. E. Hervig, and S. M. Bailey, 2 and 3-dimensional structure of the descent of mesospheric trace constituents after the 2013 sudden stratospheric warming elevated stratopause, *Atmos. Chem. Phys.*, 21, 14059-14077, doi:10.5194/acp-21-14059-2021, 2021.
8. Rong, P., J. Yue, J. M. Russell, J. D. Lumpe, D. E. Siskind, and C. E. Randall, AIM CIPS PMC tracking wind product retrieval approach and first assessment, *J. Atmos. Sol. Terr. Phys.*, 209, doi:10.1016/j.jastp.2020.105394, 2020.
9. Marshall, R. A., W. Xu, T. Woods C. Cully, A. Jaynes, C. E. Randall, D. N. Baker, M. McCarthy, H. E. Spence, G. Berland, A. Wold, and E. Davis, The AEPEX mission: Imaging energetic particle precipitation in the atmosphere through its Bremsstrahlung x-ray signatures, *Adv. Space Research*, 66, doi:10.1016/j.asr.2020.03.003, 2020.
10. Fritts, D. C., et al. (16 co-authors), PMC Turbo: Studying gravity wave and instability dynamics in the summer mesosphere using polar mesospheric cloud imaging and profiling from a stratospheric balloon, *J. Geophys. Res. Atmospheres*, 124, 6423-6443, doi:10.1029/2019JD030298, 2019.
11. Pettit, J. M., C. E. Randall, D. E. Peck, D. R. Marsh, M. van de Kamp, X. Fang, V. L. Harvey, C. J. Rodger, and B. Funke, Atmospheric effects of >30 keV energetic electron precipitation in the southern hemisphere winter during 2003, *J. Geophys. Res. Space Physics*, 124, doi:10.1029/2019JA026868, 2019.
12. Harvey, V. L., C. E. Randall, E. Becker, A. K. Smith, C. G. Bardeen, J. A. France, and L. P. Goncharenko, Evaluation of the mesospheric polar vortices in WACCM, *J. Geophys. Res. Atmospheres*, doi:10.1029/2019JD030727, 2019.
13. Broman, L., S. Benze, J. Gumbel, O.-M. Christensen, and C. E. Randall, Common volume satellite studies of polar mesospheric clouds with Odin/OSIRIS tomography and AIM/CIPS nadir imaging, *Atmos. Chem. Phys.*, 19, 12455-12475, doi:10.5194/acp-19-12455-2019, 2019.
14. Thomas, G., C. E. Randall, J. D. Lumpe, and C. Bardeen, Albedo-Ice regression method for determining ice water content of Polar Mesospheric Clouds using ultraviolet observations from space, *Atmospheric Measurement Techniques*, 12, 1755-1766, doi:10.5194/amt-12-1755-2019, 2019.
15. Siskind, D. E., Merkel, A. W., Marsh, D. R., Randall, C. E., Hervig, M. E., Mlynczak, M. G., & Russell, J. M. III, Understanding the effects of polar mesospheric clouds on the environment of the upper mesosphere and lower thermosphere. *Journal of Geophysical Research: Atmospheres*, 123. doi:10.1029/2018JD028830, 2018.
16. Harvey, V. L., C. E. Randall, L. Goncharenko, E. Becker, and J. France, On the upward extension of the polar vortices into the mesosphere, *J. Geophys. Res.: Atmospheres*, doi:10.1029/2018JD028815, 2018. **AGU Editors' highlight** (<https://eos.org/editor-highlights>).

17. Pettit, J., C. E. Randall, D. R. Marsh, C. Bardeen, L. Qian, C. H. Jackman, T. N. Woods, A. Coster, and V. L. Harvey, Effects of the September 2005 solar flares and solar proton events on the middle atmosphere in WACCM, *J. Geophys. Res.: Space Physics*, 123, 5747-5763, doi:10.1029/2018JA025294, 2018.
18. France, J. A., C. E. Randall, R. S. Lieberman, V. L. Harvey, S. D. Eckermann, D. E. Siskind, J. D. Lumpe, S. M. Bailey, J. N. Carstens, and J. M. Russell, III, Local and remote planetary wave effects on polar mesospheric clouds in the northern hemisphere in 2014, *J. Geophys. Res.*, doi:10.1029/2017JD028224, 2018.
19. Sassi, F., D. E. Siskind, J. L. Tate, H. Liu, and C. E. Randall, Simulations of the Boreal Winter Upper Mesosphere and Lower Thermosphere with Meteorological Specifications in SD-WACCM-X, *J. Geophys. Res. Atmospheres*, doi:10.1002/2017JD027782, 2018.
20. Rong, P., J. Yue, J. M. Russell, III, D. E. Siskind, and C. E. Randall, Universal power law of the gravity wave manifestation in the AIM CIPS polar mesospheric cloud images, *Atmos. Chem. Phys.*, 18, 883-899, doi:10.5194/acp-18-883-2018, 2018.
21. Benze, S., J. Gumbel, C. E. Randall, B. Karlsson, K. Hultgren, J. D. Lumpe, and G. Baumgarten, Making limb and nadir measurements comparable: a common volume study of PMC brightness observed by Odin OSIRIS and AIM CIPS, *J. Atmos. Sol. Terr. Phys.*, 167, 66-73, doi:10.1016/j.jastp.2017.11.007, 2018.
22. Randall, C. E., J. Carstens, J. A. France, V. L. Harvey, L. Hoffmann, S. M. Bailey, M. J. Alexander, J. D. Lumpe, J. Yue, B. Thurairajah, D. E. Siskind, Y. Zhao, M. J. Taylor, and J. M. Russell, III, New AIM/CIPS global observations of gravity waves near 50–55 km, *Geophys. Res. Lett.*, 44, 7044–7052, doi:10.1002/2017GL073943, 2017.
23. Rusch, D., G. Thomas, A. Merkel, J. Olivero, A. Chandran, J. Lumpe, J. Carstens, C. Randall, S. Bailey, J. Russell, III, Large ice particles associated with small ice water content observed by AIM CIPS imagery of polar mesospheric clouds: Evidence for microphysical coupling with small-scale dynamics, *J. Atmos. Sol. Terr. Phys.* 162, 97-105, doi:10.1016/j.jastp.2016.04.018, 2017.
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25. Funke, B., W. Ball, S. Bender, A. Gardini, V. L. Harvey, A. Lambert, M. López-Puertas, D. R. Marsh, K. Meraner, H. Nieder, S.-M. Päiväranta, K. Pérot, C. E. Randall, T. Reddmann, E. Rozanov, H. Schmidt, A. Seppälä, M. Sinnhuber, T. Sukhodolov, G. P. Stiller, N. D. Tsvetkova, P. T. Verronen, S. Versick, T. von Clarmann, K. A. Walker, and V. Yushkov, HEPPA-II model-measurement intercomparison project: EPP indirect effects during the dynamically perturbed NH winter 2008-2009, *Atmos. Chem. Phys.*, 17, 3573-3604, doi: 10.5194/acp-17-3573-2017, 2017.
26. Sheese, P. E., K. A. Walker, C. D. Boone, C. A. McLinden, P. F. Bernath, A. E. Bourassa, J. P. Burrows, D. A. Degenstein, B. Funke, D. Fussen, G. L. Manney, C. T. McElroy, D. Murtagh, C. E. Randall, P. Raspollini, A. Rozanov, J. M. Russell, III, M. Suzuki, M. Shiotani, J. Urban, T. von Clarmann, and J. M. Zawodny, Validation of ACE-FTS version 3.5 NO<sub>y</sub> species profiles using correlative satellite measurements, *Atmos. Meas. Tech.*, 9, 5781-5810, doi:10.5194/amt-9-5781-2016, 2016.

27. Bardeen, C. G., D. R. Marsh, C. H. Jackman, M. E. Hervig, and C. E. Randall, Impact of the January 2012 solar proton event on polar mesospheric clouds, *J. Geophys. Res. Atmos.*, 121, 9165–9173, doi:10.1002/2016JD024820, 2016.
28. Duderstadt, K. A., J. E. Dibb, C. H. Jackman, C. E. Randall, N. A. Schwadron, S. C. Solomon, and H. E. Spence, Comment on “Atmospheric ionization by high-fluence, hard spectrum solar proton events and their probable appearance in the ice core archive” by A. L. Melott et al., *J. Geophys. Res. Atmos.*, 121, doi:10.1002/2016JD025220, 2016.
29. Duderstadt, K. A., J. E. Dibb, N. A. Schwadron, H. E. Spence, S. C. Solomon, V. A. Yudin, C. H. Jackman, and C. E. Randall, Nitrate ion spikes in ice cores not suitable as proxies for solar proton events, *J. Geophys. Res. Atmos.*, 121, 2994–3016, doi:10.1002/2015JD023805, 2016.
30. Siskind, D. E., G.E. Nedoluha, F. Sassi, P.P. Rong, S.M. Bailey, M.E. Hervig, and C.E. Randall, Persistence of upper stratospheric winter time tracer variability into the Arctic spring and summer, *Atmos. Chem. Phys.*, 16, 7957–7967, doi:10.5194/acp-16-7957-2016, 2016.
31. Siskind, D. E., F. Sassi, C. E. Randall, V. L. Harvey, M. E. Hervig, S. M. Bailey, and J. M. Russell, III, Is a high-altitude meteorological analysis necessary to simulate thermosphere-stratosphere coupling?, *Geophys. Res. Lett.*, 42, 8225–8230, doi:10.1002/2015GL065838, 2015.
32. Harvey, V. L., C. E. Randall, and R. L. Collins, Chemical definition of the mesospheric polar vortex, *J. Geophys. Res. Atmos.*, 120, 10,166–10,179, doi:10.1002/2015JD023488, 2015.
33. Siskind, D. E., D. R. Allen, C. E. Randall, V. L. Harvey, M. E. Hervig, J. D. Lumpe, B. Thurairajah, S. M. Bailey, and J. M. Russell, III, Extreme stratospheric springs and their consequences for the onset of Polar Mesospheric Clouds, *J. Atmos. Solar-Terrestrial Physics* 132, 74-81, 2015.
34. Bailey S. M., G. E. Thomas, M. E. Hervig, J.D. Lumpe, C. E. Randall, J. N. Carstens, B. Thurairajah, D. W. Rusch, J. M. Russell, and L.L. Gordley, Comparing nadir and limb viewing observations of polar mesospheric clouds: The effect of the assumed particle size distribution, *J. Atmos. Sol. Terr. Phys.*, 127, 51-65, doi:10.1016/j.jastp.2015.02.007, 2015.
35. Rong, P. P., J. Yue, J. M. Russell, III, J. D. Lumpe, J. Gong, D. L. Wu, and C. E. Randall, Horizontal winds derived from the polar mesospheric cloud images as observed by the CIPS instrument on the AIM satellite. *J. Geophys. Res. Atmos.*, 120, 5564–5584. doi: 10.1002/2014JD022813, 2015.
36. France, J. A., V. L. Harvey, C. E. Randall, R. L. Collins, A. K. Smith, E. D. Peck, and X. Fang, A climatology of planetary wave-driven mesospheric inversion layers in the extratropical winter, *J. Geophys. Res. Atmos.*, 120, 399–413, doi:10.1002/2014JD022244, 2015.
37. Peck, E. D., C. E. Randall, V. L. Harvey, and D. R. Marsh, Simulated solar cycle effects on the middle atmosphere: WACCM3 Versus WACCM4, *J. Adv. Model. Earth Syst.*, 07, doi:10.1002/2014MS000387, 2015. **AGU Research Spotlight**, <https://eos.org/>.
38. Randall, C. E., V. L. Harvey, L. A. Holt, D. R. Marsh, D. Kinnison, B. Funke, and P. F. Bernath, Simulation of energetic particle precipitation effects during the 2003–2004 Arctic winter, *J. Geophys. Res. Space Physics*, 120, doi:10.1002/2015JA021196, 2015.
39. Peck, E. D., C. E. Randall, J. C. Green, J. V. Rodriguez, and C. J. Rodger, POES MEPED differential flux retrievals and electron channel contamination correction, *J. Geophys. Res. Space Physics*, 120, doi: 10.1002/2014JA020817, 2015. **Featured Article**.
40. Brinkhoff, L., C. von Savigny, C. E. Randall, and J. P. Burrows, The fractal perimeter dimension of noctilucent clouds: Sensitivity analysis of the area-perimeter method and results

- on the seasonal and hemispheric dependence of the fractal dimension, *J. Atmos. Solar-Terr. Physics* 127, 66-72, doi:10.1016/j.jastp.2014.06.005, 2015.
41. Zhao, Y., M. J. Taylor, C. E. Randall, J. D. Lumpe, D. E. Siskind, S. M. Bailey, and J. M. Russell, III, Investigating seasonal gravity wave activity in the summer polar mesosphere, *JASTP* 127:8-20, doi:10.1016/j.jastp.2015.03.008, 2015.
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  44. Rong, P. P., J. M. Russell III, C. E. Randall, S. M. Bailey, and A. Lambert, Northern PMC brightness zonal variability and its correlation with temperature and water vapor, *J. Geophys. Res. Atmos.*, 119, 2390–2408, doi:10.1002/2013JD020513, 2014.
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  51. Tweedy, O. V., et al. (10 co-authors), Nighttime secondary ozone layer during major stratospheric sudden warmings in specified-dynamics WACCM, *J. Geophys. Res. Atmos.*, 118, 8346–8358, doi:10.1002/jgrd.50651, 2013.
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