

## CORA EINTERZ RANDALL

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### **Education**

B.A. / Chemistry, with Honors. 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**

2010 – present Professor, University of Colorado Boulder (CU) Department of Atmospheric and Oceanic Sciences (ATOC) and Laboratory for Atmospheric and Space Physics (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 Project Manager and CU Boulder Institutional 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**

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

## 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

1. 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, submitted to Atmospheric Measurement Techniques, 2018.
2. 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, submitted to Atmos. Chem. Phys., 2018.

## PUBLISHED, REFEREED ARTICLES

1. 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.
2. 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>).
3. 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.
4. 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. Research*, doi:10.1029/2017JD028224, 2018.
5. 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.
6. 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.

7. 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.
8. 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.
9. 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.
10. Thurairajah, B., Thomas, G. E., von Savigny, C., Snow, M., Hervig, M. E., Bailey, S. M., Randall, C. E., Solar-Induced 27-day Variations of Polar Mesospheric Clouds from the AIM SOFIE and CIPS Experiments, *J. Atmos. Sol. Terr. Phys.*, 162, 122-135, doi:10.1016/j.jastp.2016.09.008, 2017.
11. 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.
12. 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.
13. 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.
14. 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.
15. 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.
16. 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.
17. 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.
18. 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.
  19. 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.
  20. 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.
  21. 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.
  22. 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.
  23. 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/>.
  24. 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.
  25. Peck, E. D., C. E. Randall, J. C. Green, J. V. Rodriguez, and C. J. Rogder, POES MEPED differential flux retrievals and electron channel contamination correction, *J. Geophys. Res. Space Physics*, 120, doi: 10.1002/2014JA020817, 2015. **Featured Article**.
  26. 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.
  27. 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.
  28. Funke, B., M. López-Puertas, L. Holt, C. E. Randall, G. P. Stiller, and T. von Clarmann, Hemispheric distributions and interannual variability of NO<sub>y</sub> produced by energetic particle precipitation in 2002–2012, *J. Geophys. Res. Atmos.*, 119, 13,565–13,582, doi:10.1002/2014JD022423, 2014.
  29. Bailey, S. M., B. Thurairajah, C. E. Randall, L. A. Holt, D. E. Siskind, V. L. Harvey, K. Venkataramani, M. E. Hervig, P. Rong, and J. M. Russell, III, A multi-tracer analysis of thermosphere to stratosphere descent triggered by the 2013 stratospheric sudden warming, *Geophys. Res. Lett.* 41, 5216-5222, doi:10.1002/2014GL059860, 2014. **AGU Research Spotlight** (Wendel, J. (2014), What causes nitric oxide to infiltrate the ozone layer?, *Eos Trans. AGU*, 95(49), 472, doi:10.1002/2014EO490018).

30. 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.
31. Seppälä, A., K. Matthes, C. E. Randall, and I. Mironova, What is the solar influence on climate? - Overview of activities during CAWSES-II, *Progress in Earth and Planetary Science*, 1:24, doi:10.1186/s40645-014-0024-3, 2014.
32. Duderstadt, K. A., J. E. Dibb, C. H. Jackman, C. E. Randall, S. C. Solomon, M. J. Mills, N. A. Schwadron, and H. E. Spence, Nitrate deposition to surface snow at Summit, Greenland, following the 9 November 2000 solar proton event, *J. Geophys. Res. Atmos.*, 119, 6938–6957, doi:10.1002/2013JD021389, 2014.
33. Yue, J., B. Thurairajah, L. Hoffman, J. Alexander, A. Chandran, M.J. Taylor, J.M. Russell, III, C.E. Randall, and S.M. Bailey, Concentric gravity waves in polar mesospheric clouds from the Cloud Imaging and Particle Size (CIPS) experiment, *J. Geophys. Res.* 119, doi:10.1002/2013JD0213852013, 2014.
34. Jackman, C.H., C. E. Randall, V. L. Harvey, S. Wang, E. L. Fleming, M. Lopez-Puertas, B. Funke, and P. F. Bernath, Middle atmospheric changes caused by the January and March 2012 solar proton events, *Atmos. Chem. Phys.* 14, 1025-1038, doi:10.5194/acp-14-1025-2014, 2014.
35. Stevens, M.H., S. Lossow, D.E. Siskind, R.R. Meier, C.E. Randall, J.M. Russell, III, J. Urban., and D. Murtagh, Space shuttle exhaust plumes in the lower thermosphere: Advective transport and diffusive spreading, *J. Atmos. Solar Terr. Phys.* 108, 50-60, doi:10.1016/j.jastp.2013.12.004, 2014.
36. Smith, A. K., et al. (16 co-authors), Satellite observations of ozone in the upper mesosphere, *J. Geophys. Res. Atmos.*, 118, 5803–5821, doi:10.1002/jgrd.50445, 2013.
37. 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.
38. Holt, L. A., C. E. Randall, E. D. Peck, D. R. Marsh, A. K. Smith, and V. L. Harvey, The influence of major sudden stratospheric warming and elevated stratopause events on the effects of energetic particle precipitation in WACCM, *J. Geophys. Res. Atmos.*, 118, 11,636–11,646, doi:10.1002/2013JD020294, 2013.
39. Carstens, J.N., S.M. Bailey, J.D. Lumpe, and C.E. Randall, Understanding uncertainties in the retrieval of polar mesospheric clouds from the cloud imaging and particle size experiment in the presence of a bright Rayleigh background, *J. Atmos. Solar. Terr. Physics*, 104, 197-212, doi:10.1016/j.jastp.2013.08.006, 2013.
40. Lumpe, J.D., S.M. Bailey, J.N. Carstens, C.E. Randall, D.W. Rusch, G.E. Thomas, K. Nielsen, C. Jeppesen, W.E. McClintock, A.W. Merkel, L. Riesberg, B. Templeman, G. Baumgarten, J.M. Russell, III, Retrieval of polar mesospheric cloud properties from CIPS: algorithm description, error analysis and cloud detection sensitivity, *J. Atmos. Solar. Terr. Physics*, 104, 167-196, doi:10.1016/j.jastp.2013.06.007, 2013.
41. Thurairajah, B., S.M. Bailey, D.E. Siskind, C.E. Randall, M.J. Taylor, J.M. Russell, III, Case study of an ice void structure in polar mesospheric clouds, *J. Atmos. Solar. Terr. Physics*, 104, 224-233, doi:10/1016/j.jastp.2013.02.001, 2013.
42. Brakebusch, M., C. E. Randall, D. E. Kinnison, S. Tilmes, M. L. Santee, and G. L. Manney, Evaluation of Whole Atmosphere Community Climate Model simulations of ozone during

- Arctic winter 2004–2005, *J. Geophys. Res. Atmos.*, 118, 2673–2688, doi:10.1002/jgrd.50226, 2013.
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  44. Thurairajah, B., S.M. Bailey, K. Nielsen, C.E. Randall, J.D. Lumpe, M.J. Taylor, and J.M. Russell, III, Morphology of polar mesospheric clouds as seen from space, *J. Atmos. Solar-Terr. Phys.* doi:10.1016/j.jastp.2012.09.009, 2013.
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  46. Stevens, M. H., et al., Bright polar mesospheric clouds formed by main engine exhaust from the space shuttle’s final launch, *J. Geophys. Res.*, 117, D19206, doi:10.1029/2012JD017638, 2012.
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  51. Peevey, T. R., J. C. Gille, C. E. Randall, and A. Kunz, Investigation of double tropopause spatial and temporal global variability utilizing High Resolution Dynamics Limb Sounder temperature observations, *J. Geophys. Res.*, 117, D01105, doi:10.1029/2011JD016443, 2012.
  52. Karlsson, B., C.E. Randall, et al., On the seasonal onset of polar mesospheric clouds and the breakdown of the stratospheric polar vortex in the southern hemisphere, *J. Geophys. Res.*, 116, D18107, doi:10.1029/2011JD015989, 2011.
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  54. Jackman, C.H., D.R. Marsh, F.M. Vitt, R.G. Roble, C.E. Randall, P.F. Bernath, B. Funke, M. López-Puertas, S. Versick, G.P. Stiller, A.J. Tylka, and E.L. Fleming, Northern hemisphere atmospheric influence of the solar proton events and ground level enhancement in January 2005, *Atmos. Chem. Phys.*, 11, 6153-6166, doi:10.5194/acp-11-6153-2011, 2011.
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