

## **DR. ADAM C. VARBLE**

Earth Scientist  
Pacific Northwest National Laboratory  
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Research Assistant Professor  
University of Utah  
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### **EDUCATION**

- 2013 Ph.D. Atmospheric Sciences University of Utah  
*Title: "Using Tropical Warm Pool-International Cloud Experiment observations to evaluate and improve high resolution simulations of tropical convective precipitation systems"*  
*Committee: Edward Zipser (Chair), Ann Fridlind, Steve Krueger, Gerald Mace, and Zhaoxia Pu*
- 2007 B.S. Atmospheric and Oceanic Sciences University of Wisconsin-Madison

### **EMPLOYMENT**

- 2018-Present Scientist Pacific Northwest National Laboratory  
My research is focused on advancing understanding of cloud kinematic and microphysical processes and translating that improved understanding into improved model physics parameterizations. This involves design of and participation in field experiments, analysis of atmospheric state, cloud, and aerosol in situ and remote sensing measurements, design and implementation of cloud-scale models, evaluation of model output with observations, and testing of new physics parameterization components.
- 2014-Present Research Assistant Professor University of Utah  
I advised three MS students and continue to advise two PhD students. Our research is broadly focused around identifying causes for biased model representation of convective cloud properties and processes using novel modeling, observing, and model-observation comparison techniques for the purpose of improving microphysics parameterizations. Through this process, we utilize new measurements and improved modeling frameworks to advance understanding and prediction of cloud life cycles.
- 2013-2014 Post-Doctoral Research Associate University of Utah
- 2007-2013 Graduate Research Assistant University of Utah

### **RESEARCH INTERESTS**

I am broadly interested in advancing understanding of cloud processes and properties to improve weather and climate prediction. A particular focus is improving representation of convective cloud systems (e.g., thunderstorms) in models using both long term and field experiment in situ (e.g., aircraft) and remote sensing (e.g., radar and satellite) measurements. Additionally, I combine observations with high-resolution modeling in novel ways to better understand complex cloud dynamical and microphysical processes, as well as interactions between convective cloud systems and their surrounding environment. Lastly, I am interested in improving retrieval and

understanding of high societal impact “extreme” precipitation systems around the world. My research has been supported by DOE, NSF, NASA, and Rockwell Collins, Inc.

## **FIELD EXPERIENCE**

Oct 2018 – Apr 2019      Principal Investigator  
*Cloud, Aerosol, and Complex Terrain Interactions (CACTI) Experiment*

Nov 2018 – Jan 2019      Science Team Member  
*Remote sensing of Electrification, Lightning, And Meso-scale/micro-scale Processes with Adaptive Ground Observations (RELAMPAGO) Experiment*

May 2015                      Forecaster/Flight Guidance  
*High Altitude Ice Crystals (HAIC)/High Ice Water Content (HIWC) Experiment*

Jan – Feb 2014              Forecaster/Flight Guidance  
*High Altitude Ice Crystals (HAIC)/High Ice Water Content (HIWC) Experiment*

Apr – May 2011              Forecaster  
*Mid-Latitude Continental Convective Clouds Experiment (MC3E)*

Nov 2010 – Apr 2011      Instrument Maintenance  
*Storm Peak Laboratory Cloud Property Validation Experiment (STORMVEX)*

## **TEACHING EXPERIENCE**

Spring 2014                  Three weeks of University of Utah ATMOS 5230/6230 Radar/Mesoscale Meteorology

## **GRADUATE STUDENTS MENTORED**

### Advisor

McKenna Stanford	M.S.	Fall 2014 – Fall 2016
Crystal Painter	M.S.	Fall 2015 – Fall 2017
McKenna Stanford	Ph.D.	Spring 2017 – Present
Zhixiao Zhang	Ph.D.	Fall 2018 – Present

### Committee Member

Alexandria Gingrey	M.S.	Graduated Spring 2017
Ian Glenn	Ph.D.	Graduated Spring 2018
Andrew Lesage	Ph.D.	Graduated Spring 2018
George Alvey	Ph.D.	Graduated Spring 2019

## **SYNERGISTIC ACTIVITIES**

*Member*                      ARM User Executive Committee  
2019-present

<i>Chair</i>	Convective Processes Working Group, DOE ASR Program 2016-present
<i>Member</i>	DOE ARM/ASR Coordination Team 2016-present
<i>Associate Editor</i>	Monthly Weather Review 2014-present
<i>Organizing Committee Member</i>	14 <sup>th</sup> Conference on Cloud Physics July 2014 RELAMPAGO-CACTI Data Analysis Workshop November 2019 Joint ARM/ASR User Facility and Principal Investigators Meeting March 2017, March 2018, June 2019, June 2020
<i>Participant</i>	Large-Eddy Simulation ARM Symbiotic Simulation and Observation (LASSO) Expansion Workshop May 2019 NASA Aerosols, Clouds, Convection and Precipitation (ACCP) Sub- Orbital Working Group Workshop March 2020 ARM Cloud and Precipitation Measurements and Science Group Workshop March 2020 Tracking Aerosol Convection interactions ExpeRiment (TRACER) Science and Logistics Workshop April 2020
<i>Case Co-lead</i>	International Cloud Modeling Workshop July 2016
<i>Co-lead</i>	Mesoscale Convective Organization Group, DOE ASR Program 2013-2015
<i>Member</i>	American Meteorological Society Cloud Physics Committee 2011-2014
<i>Member</i>	American Meteorological Society, American Geophysical Union
<i>Reviewer</i>	Many academic journals including Nature, Journal of Geophysical Research-Atmospheres, Quarterly Journal of the Royal Meteorological Society, Journal of Atmospheric and Oceanic Technology, Climate Dynamics, Monthly Weather Review, Journal of the Atmospheric Sciences, Atmospheric Chemistry and Physics, Atmosphere, and research programs including NASA, DOE, NSF, and NERC

## **HONORS AND AWARDS**

2012 Atmospheric System Research Student Poster Award

## SUBMITTED/ACCEPTED MANUSCRIPTS

- Hunzinger, A., J. C. Hardin, N. Bharadwaj, **A. Varble**, and A. Matthews (2020), An Extended Radar Relative Calibration Adjustment (eRCA) Technique for Higher Frequency Radars and RHI Scans. *Atmos. Meas. Tech.*, In press.
- Morrison H., J. M. Peters, **A. C. Varble**, W. M. Hannah, and S. E. Giangrande (2020), Thermal Chains and Entrainment in Cumulus Updrafts, Part 1: Theoretical Description. *J. Atmos. Sci.*, Accepted.
- Peters J. M., H. Morrison, **A. C. Varble**, W. M. Hannah, and S. E. Giangrande (2020), Thermal Chains and Entrainment in Cumulus Updrafts, Part 2: Analysis of Idealized Simulations. *J. Atmos. Sci.*, Accepted.
- Stanford M. W., H. Morrison, and **A. Varble** (2020), Impacts of Stochastic Mixing in Idealized Convection-Permitting Simulations of Squall Lines. *Mon. Wea. Rev.*, Accepted.
- Nelson T. C., J. Marquis, **A. Varble**, and K. Friedrich (2020), Radiosonde Observations of Environments Supporting Deep Moist Convection Initiation during RELAMPAGO-CACTI. *Mon. Wea. Rev.*, Submitted.

## PUBLICATIONS

- Varble, A.**, H. Morrison, and E. Zipser (2020), Effects of under-resolved convective dynamics on the evolution of a squall line. *Mon. Wea. Rev.*, 148, 289-311, doi:10.1175/MWR-D-19-0187.1.
- Stanford, M., **A. Varble**, and coauthors (2019), Sensitivity of simulated deep convection to a stochastic ice microphysics framework. *J. Adv. Model. Earth Sys.*, 11, 3362-3389, doi:10.1029/2019MS001730.
- Han, B., J. Fan, **A. Varble**, and coauthors (2019), Cloud-resolving model intercomparison of an MC3E squall line case: Part II – Stratiform precipitation properties. *J. Geophys. Res.*, 124, 1090-1117, doi:10.1029/2018JD029596.
- Varble, A.** (2018), Erroneous attribution of deep convective invigoration to aerosol concentration. *J. Atmos. Sci.*, 75, 1351-1368, doi:10.1175/JAS-D-17-0217.1.
- Gingrey, A., **A. Varble**, and E. Zipser (2018), Relationships between extreme rain rates and convective intensities from the perspective of TRMM and WSR-88D radars. *J. Appl. Meteor. Climatol.*, 57, 1353-1369, doi:10.1175/JAMC-D-17-0240.1.
- Fan, J., B. Han, **A. Varble**, H. Morrison, and coauthors (2017), Cloud-resolving model intercomparison of a MC3E squall line case: Part I – Convective updrafts. *J. Geophys. Res.*, 122, 9351-9378, doi:10.1002/2017JD026622.
- Lebo, Z. J., B. J. Shipway, J. Fan, I. Geresdi, A. Hill, A. Miltenberger, H. Morrison, P. Rosenberg, **A. Varble**, and L. Xue (2017), Challenges for cloud modeling in the context of aerosol-cloud-precipitation interactions. *Bull. Amer. Meteorol. Soc.*, 98, 1749-1755, doi:10.1175/BAMS-D-16-0291.1.
- Stanford, M. W., **A. Varble**, E. Zipser, J. W. Strapp, D. Leroy, A. Schwarzenboeck, and R. Potts (2017), A ubiquitous ice size bias in simulations of tropical deep convection. *Atmos. Chem. Phys.*, 17, 9599-9621, doi:10.5194/acp-17-9599-2017.
- Varble, A.**, E. J. Zipser, A. M. Fridlind, P. Zhu, A. S. Ackerman, J.-P. Chaboureau, S. Collis, J. Fan, A. Hill, and B. Shipway (2014), Evaluation of cloud-resolving and limited area model

- intercomparison simulations using TWP-ICE observations: 1. Deep convective updraft properties. *J. Geophys. Res.*, 119, 13,891-13,918, doi:10.1002/2013JD021371.
- 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: 2. Precipitation microphysics. *J. Geophys. Res.*, 119, 13,919-13,945, doi:10.1002/2013JD021372.
- Fridlind, A. M., A. S. Ackerman, J.-P. Chaboureau, J. Fan, W. W. Grabowski, A. Hill, T. R. Jones, G. Liu, H. Morrison, S. Park, J. C. Petch, J.-P. Pinty, C. Schumacher, **A. C. Varble**, X. Wu, S. Xie, and M. Zhang (2012), A comparison of TWP-ICE observational data with cloud-resolving model results. *J. Geophys. Res.*, 117, D05204, doi:10.1029/2011JD016595.
- Mrowiec, A. A., C. Rio, A. M. Fridlind, A. S. Ackerman, A. D. Del Genio, O. M. Pauluis, **A. C. Varble**, and J. Fan (2012), Analysis of cloud-resolving simulations of a tropical mesoscale convective system observed during TWP-ICE: Vertical fluxes and draft properties in convective and stratiform regions. *J. Geophys. Res.*, 117, D19201, doi:10.1029/2012JD017759.
- Zhu, P., J. Dudhia, P. R. Field, K. Wapler, A. Fridlind, **A. Varble**, M. Chen, J. Petch, Z. Zhu, and E. Zipser (2012), A limited area model (LAM) intercomparison study of a TWP-ICE active monsoon mesoscale convective event. *J. Geophys. Res.*, 117, D11208, doi:10.1029/2011JD016447.
- Varble, A.**, A. M. Fridlind, E. J. Zipser, A. S. Ackerman, J.-P. Chaboureau, J. Fan, A. Hill, S. A. McFarlane, J.-P. Pinty, and B. Shipway (2011), Evaluation of cloud-resolving model intercomparison simulations using TWP-ICE observations: Precipitation and cloud structure. *J. Geophys. Res.*, 116, D12206, doi:10.1029/2010JD015180.

## SELECT RECENT LEAD AUTHOR CONFERENCE PRESENTATIONS

1. "Sensitivity of Deep Convective Upscale Growth to Precipitation Properties and Ambient Environmental Conditions During the CACTI Field Campaign" poster, AGU Fall Meeting, San Francisco, CA, December 9-13, 2019.
2. "Preliminary Results from the Cloud, Aerosol, and Complex Terrain (CACTI) Field Campaign", talk, CACTI/RELAMPAGO Data Analysis Workshop, Buenos Aires, Argentina, November 19-22, 2019.
3. "Datasets and Preliminary Results from the Cloud, Aerosol, and Complex Terrain Interactions (CACTI) Field Campaign", talk, 18<sup>th</sup> Conference on Mesoscale Processes, Savannah, GA, July 29 – August 1, 2019.
4. "The DOE ARM Cloud, Aerosol, and Complex Terrain Interactions (CACTI) field campaign", talk, Joint ARM/ASR User Facility and PI Meeting, Rockville, MD, June 10-13, 2019.
5. "The Cloud, Aerosol, and Complex Terrain Interactions (CACTI) field campaign", talk, Pacific Northwest National Laboratory, Richland, WA, March 13, 2019.
6. "A pseudo-aerosol convective invigoration effect caused by aerosol-thermodynamics correlation", talk, ARM/ASR Joint User Facility and PI Meeting, Vienna, VA, March 19-22, 2018.
7. "Toward improved understanding and prediction of deep convective systems", talk, University of Washington, Seattle, WA, January 19, 2018.
8. "Impacts of initial convective structure on subsequent squall line evolution", poster, AGU Fall Meeting, New Orleans, LA, December 11-15, 2017.

9. “Overlap of extreme convective intensities and extreme rain rates from TRMM and WSR-88D perspectives”, poster, 38<sup>th</sup> Conference on Radar Meteorology, Chicago, IL, August 28 – September 1, 2017.
10. “The Cloud, Aerosol, and Complex Terrain Interactions (CACTI) field campaign”, talk, ARM/ASR Joint User Facility and PI Meeting, Vienna, VA, March 13-16, 2017.
11. “CACTI (+RELAMPAGO) radar science”, talk, 5<sup>th</sup> DOE ARM/ASR Radar Workshop, Richland, WA, November 14-15, 2016.
12. “Impacts of mesoscale circulation amplification on simulated squall line precipitation biases”, talk, 17<sup>th</sup> International Conference on Clouds and Precipitation, Manchester, England, July 25-29, 2016.
13. “A pseudo-aerosol invigoration effect caused by meteorology”, poster, 17<sup>th</sup> International Conference on Clouds and Precipitation, Manchester, England, July 25-29, 2016.
14. “Validating and improving simulated deep convective vertical velocities”, talk, ARM/ASR Joint User Facility and PI Meeting, Vienna, VA, May 2-5, 2016.
15. “Moving from establishing model deep convective biases toward constraining their causes”, poster, ARM/ASR Joint User Facility and PI Meeting, Vienna, VA, May 2-5, 2016.
16. “Disentangling dynamical and microphysical causes of tropical convective precipitation biases in high-resolution simulations”, talk, 32<sup>nd</sup> Conferences on Hurricanes and Tropical Meteorology, San Juan, Puerto Rico, April 17-22, 2016.
17. “Observed and simulated relationships between tropical deep convective updraft dynamics and ice microphysics”, poster, AGU Fall Meeting, San Francisco, CA, Dec. 14-18, 2015.
18. “Constraining microphysics parameterizations in models with HIWC/HAIC-Darwin observations”, talk, HAIC-HIWC Science Team Meeting, Melbourne, Australia, Nov. 9-12, 2015.
19. “Are long-term measurements at the ARM Southern Great Plains site adequate for detecting aerosol invigoration of deep convection?,” poster, ARM/ASR Joint User Facility and PI Meeting, Vienna, VA, Mar. 16-19, 2015.
20. “Using ARM radar facilities to improve representation of deep convective systems in high resolution models”, talk, 3<sup>rd</sup> Annual DOE ARM/ASR Radar Workshop, Miami, FL, Feb. 25-27, 2015.