Kamal Kant Chandrakar

Project Scientist (MMM, NCAR)

Personal Data

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Research interest

Clouds are critical for both short-term weather patterns and long-term climate change since they affect radiative forcing and the hydrological cycle. Of particular importance, clouds and associated microphysical processes significantly impact climate sensitivity. My research interest lies in the interdisciplinary area of aerosol-cloud and cloud-turbulence interactions, focusing on microphysical interactions and their implications for macro-scale cloud properties and processes. Specifically, I am interested in theoretical, cutting edge numerical modeling and experimental/measurement studies of processes that determine climate sensitivity: aerosol-cloud-turbulence interactions, microphysics, precipitation formation, moist convection, and turbulence. My research interest also aims to improve the representation of clouds in models across scales.

Education

2014 - 2019 | **PhD.** in *Atmospheric Sciences*,
Michigan Technological University, Houghton, MI
Major: Atmospheric Sciences
Thesis: *Aerosol-Cloud Interactions in Turbulent Clouds: A Combined Cloud Chamber and Theoretical Study.* | Advisor: Prof. Raymond A. Shaw

2011 - 2013 | **Master of Engineering** in *Mechanical Engineering*,
Indian Institute of Science, Bangalore (INDIA)
First Class | Major: Fluid Dynamics
Thesis: *Unsteady Flow Through Flexible Opening.* | Advisor: Prof. Jaywant H. Arakeri

Research Experience

Sep 2022 | **Project Scientist I** at **MMM, National Center for Atmospheric Research, Boulder**

Sep 2019 - Sep 2022	**ASP Postdoctoral Fellow** at **National Center for Atmospheric Research, Boulder** Collaborators: Dr. Hugh Morrison, Dr. Wojciech W. Grabowski, and Dr. George Bryan
Fall 2014 - Fall 2019	**Graduate Research** at **Michigan Technological University** Π-*Chamber Group* | Advisor : Prof. Raymond A. Shaw
Aug 2013 - Jul 2014	**Research Assistant** at **Indian Institute of Science** *Fluid Mechanics Laboratory* | Advisor : Prof. Jaywant H. Arakeri
Jan 2012 - Jul 2013	**Graduate Research** at **Indian Institute of Science** *Fluid Mechanics Laboratory* | Advisor : Prof. Jaywant H. Arakeri

Teaching Experience

Fall 2022	**Guest Lectures**, **Department of Physics** at **Michigan Technological University** *Atmospheric Physics (taught five lectures on Cloud Physics)*
Fall 2015	**Teaching Assistant**, **Department of Physics** at **Michigan Technological University** *Physics by Inquiry I*
Fall 2014	**Teaching Assistant**, **Department of Physics** at **Michigan Technological University** *Physics by Inquiry I*

Mentoring Experience

2020	Served as a mentor for the ASP peer mentoring program at NCAR-ASP
2022	Co-mentored a graduate student visitor at MMM (Yayun Qiao, The University of Oklahoma)

Awards & Fellowships

2019-22	NCAR Advance Study Program Postdoctoral Fellowship
2019	Dean's Award for Outstanding Scholarship, MTU
2017-19	NASA Earth and Space Science Fellowship
2017	Best Graduate Poster Presentation Award, MTU (Physics)
2011-13	Ministry of Human Resource Development Scholarship by the Government of India *to pursue Master's at IISc after qualifying Graduate Aptitude Test in Engineering (GATE) with all India rank - 8*

Funded Research Grants

2023	Untangling Dynamical and Microphysical Controls of Convective Updraft Vertical Velocity: Insights From a Lagrangian Perspective. | Source of Support: DOE ASR, PI: Y Tian, co-I: **Kamal Kant Chandrakar** | Total Amount- $931,028
2022	Benchmark simulations using a Lagrangian microphysics scheme to study cloud-turbulence interactions: from direct numerical simulations of a laboratory cloud chamber to high-resolution large-eddy simulations of clouds | Source of Support: Accelerated Scientific Discovery CISL / NCAR (computational resources in a new supercomputer – Derecho), PI: H Morrison, co-PI: **Kamal Kant Chandrakar** | Total Allocation: 50M CPU hours
2022	Surface, aerosol, and meteorological controls on Arctic boundary layer clouds: Observations and simulations of MOSAiC and COMBLE clouds. | Source of Support: DOE ASR, PI: A Dzambo, co-I: **Kamal Kant Chandrakar** | Total Amount- $888,000
2022	Building a next-generation microphysics scheme for E3SM: a data-driven, physically constrained, single-category approach | Source of Support: DOE ESMD, PI: H Morrison, co-I: **Kamal Kant Chandrakar** | Total Amount- $890,000
2021	Direct numerical simulations of a laboratory cloud chamber to investigate aerosol-cloud-turbulence interactions. | Source of Support: University Large Request CISL / NCAR (request for computational resources), PI: R A Shaw | Total Allocation: 2M CPU hours
2019-2022	Research Proposal for the NCAR ASP Fellowship Program.
2017	Aerosol indirect effects on optical properties of turbulent clouds. | Source of Support: NASA Earth and Space Science Fellowship Program

Reviewer

AGU Books	Journal of the Atmospheric Sciences
Atmospheric Chemistry and Physics	Journal of Geophysical Research: Atmospheres
Boundary-Layer Meteorology	Physical Review E
Geophysical Research Letters	Quarterly Journal of the Royal Meteorological Society

Services

2023-current	NCAR MMM DEI Committee
2022-current	AMS Committee on Cloud Physics
2022	Session co-Chair in AMS 16th Conference on Cloud Physics
2022	Judge for Student Presentations in AMS 16th Conference on Cloud Physics
2021-2022	ASP Research Review Committee, NCAR
2019-2022	Thompson Lecture Series Committee, NCAR

2019 Poster Judge, ATOC ESSS Poster Conference, CU, Boulder

Selected Workshop and Training

2022 Early Career Leadership Program, NCAR, Boulder, CO

2021 GPU Workshop, CISL (NCAR), Boulder, CO

2019 Leadership Training, NCAR ASP, Boulder, CO

2019 Diversity, Equity, and Inclusion Training, Boulder, CO

2019 NCAR WRF Workshop, Boulder, CO

2014 Teaching Assistant Orientation and Training, Michigan Tech, Houghton, MI

Media Coverage of Research

PHYS.ORG - Cloud in a box: Mixing aerosols and turbulence by Stefanie Sidortsova, MichiganTech

List of Publications

Publication Statistics (Based on Google Scholar on 12/17/23):

Total Citations	h-index	i10-index
555	13	14

2016

1. **K. K. Chandrakar**, W. Cantrell, K. Chang, D. Ciochetto, D. Niedermeier, M. Ovchinnikov, R. A. Shaw, and F. Yang. Aerosol indirect effect from turbulence-induced broadening of cloud-droplet size distributions. **Proceedings of the National Academy of Sciences of the United States of America**, 113:14243–14248, 2016

2. K. Chang, J. Bench, M. Brege, W. Cantrell, **K. K. Chandrakar**, D. Ciochetto, C. Mazzoleni, L. R. Mazzoleni, D. Niedermeier, and R. A. Shaw. A laboratory facility to study gas–aerosol–cloud interactions in a turbulent environment: The π chamber. **Bulletin of the American Meteorological Society**, 97(12):2343–2358, 2016

2017

3. **K. K. Chandrakar**, W. Cantrell, D. Ciochetto, S. Karki, G. Kinney, and R. A. Shaw. Aerosol removal and cloud collapse accelerated by supersaturation fluctuations in turbulence. **Geophysical Research Letters**, 44(9):4359–4367, 2017

2018

4. N. Desai, **K. K. Chandrakar**, K. Chang, W. Cantrell, and R. A. Shaw. Influence of microphysical variability on stochastic condensation in a turbulent laboratory cloud. **Journal of the Atmospheric Sciences**, 75(1):189–201, 2018

5. D. Niedermeier, K. Chang, W. Cantrell, **K. K. Chandrakar**, D. Ciochetto, and R. A. Shaw. Observation of a link between energy dissipation rate and oscillation frequency of the large-scale circulation in dry and moist rayleigh-bénard turbulence. **Physical Review Fluids**, 3(8):083501, 2018

6. **K. K. Chandrakar**, W. Cantrell, and R. A. Shaw. Influence of turbulent fluctuations on cloud droplet size dispersion and aerosol indirect effects. **Journal of the Atmospheric Sciences**, 75(9):3191–3209, 2018

7. **K. K. Chandrakar**, W. Cantrell, A. B. Kostinski, and R. A. Shaw. Dispersion aerosol indirect effect in turbulent clouds: Laboratory measurements of effective radius. **Geophysical Research Letters**, 45(19): 10–738, 2018

2019

8. N. Desai, **K. K. Chandrakar**, G. Kinney, W. Cantrell, and R. A. Shaw. Aerosol mediated glaciation of mixed phase clouds: Steady state laboratory measurements. **Geophysical Research Letters**, 46(15):9154–9162, 2019

9. J. Bhandari, S. China, **K. K. Chandrakar**, G. Kinney, W. Cantrell, R. A. Shaw, L. R. Mazzoleni, G. Girotto, N. Sharma, K. Gorkowski, et al. Extensive soot compaction by cloud processing from laboratory and field observations. **Scientific reports**, 9(1):1–12, 2019

10. **K. K. Chandrakar.** Aerosol-Cloud Interactions in Turbulent Clouds: A Combined Cloud Chamber and Theoretical Study. Open Access Dissertation, **Michigan Technological University**, 2019

2020

11. **K. K. Chandrakar**, I. Saito, F. Yang, W. Cantrell, T. Gotoh, and R. A. Shaw. Droplet size distributions in turbulent clouds: experimental evaluation of theoretical distributions. **Quarterly Journal of the Royal Meteorological Society**, 146(726): 483–504, 2020

12. **K. K. Chandrakar**, W. Cantrell, S. Krueger, R. A. Shaw, and S. Wunsch. Supersaturation fluctuations in moist turbulent Rayleigh-Bénard convection: a two-scalar transport problem. **Journal of Fluid Mechanics**,884, 2020

13. **K. K. Chandrakar** and R. A. Shaw. Chapter-16: In-situ and laboratory measurements of cloud microphysical properties. Fast Physics in Large Scale Atmospheric Models: Parameterization, Evaluation, and Observation (**AGU BOOK (John Wiley & Sons)**), ISBN: 978-1-119-52899-9, 2023

2021

14. **K. K. Chandrakar**, W. Grabowski, H. Morrison, and G. H. Bryan. Entrainment-mixing and evolution of droplet size distribution in a cumulus cloud: an investigation using Lagrangian microphysics with a sub-grid-scale model. **Journal of the Atmospheric Sciences**, 78(9):2983–3005, 2021

15. **K. K. Chandrakar**, H. Morrison, W. Grabowski, G. H. Bryan, and R. A. Shaw. Supersaturation variability from scalar mixing at unresolved scales: sub-grid model and its evaluation using direct numerical simulations of turbulent moist Rayleigh–Bénard convection. **Journal of the Atmospheric Sciences**, 79(4), 1191-1210, 2022

2022

16. H. Morrison, J. Peters, **K. K. Chandrakar**, and S. Sherwood. Influences of environmental relative humidity and horizontal scale of sub-cloud ascent on deep convective initiation. **Journal of the Atmospheric Sciences**, 79(2), 337–359, 2022

17. H. Morrison, P. Lawson, and **K. K. Chandrakar**. Observed and bin model simulated evolution of drop size distributions in high-based cumulus congestus over the United Arab Emirates. **Journal of Geophysical Research: Atmosphere**, 127, e2021JD035711, 2022

18. **K. K. Chandrakar**, H. Morrison, W. Grabowski, and G. H. Bryan. Comparison of Lagrangian super-droplet and Eulerian double-moment spectral microphysics schemes in large-eddy simulations of an isolated cumulus-congestus cloud. **Journal of the Atmospheric Sciences**, 79(7), 1887–1910 , 2022

19. **K. K. Chandrakar**, H. Morrison, and M. Witte. Evolution of droplet size distributions during the transition of an ultraclean stratocumulus cloud system to open cell structure: an LES investigation using Lagrangian microphysics. **Geophysical Research Letters**, 49(17), e2022GL100511, 2022

20. **K. K. Chandrakar**, H. Morrison, and R. A. Shaw. Lagrangian and Eulerian supersaturation statistics in turbulent cloudy Rayleigh–Bénard convection: applications for LES subgrid modeling. **Journal of the Atmospheric Sciences**, 80, 2261-2285, 2023

Manuscripts in Review / Preparation

21. R. A. Shaw, **K. K. Chandrakar**, P. Prabhakaran, H. Siebert, and F. Yang Book Chapter 14: Turbulence and Microphysics in Atmospheric Clouds, Elsevier Book, Environmental Turbulence. **Elsevier Book** (submitted), 2022

22. H. Morrison, **K. K. Chandrakar**, S. Shima, P. Dziekan, and W. Grabowski. Impacts of Stochastic Coalescence Variability on Warm Rain Initiation Using Lagrangian Microphysics in Box and Large-eddy Simulations. **Journal of the Atmospheric Sciences**, (under review), 2023

23. **K. K. Chandrakar**, H. Morrison, and W. Grabowski Are turbulence effects on droplet collision-coalescence a key to understanding observed rain formation in clouds? **The Proceedings of the National Academy of Sciences of the United States of America** (submitted), 2023

24. **K. K. Chandrakar**, H. Morrison, and J. Y. Harrington What Controls Microphysical Variability in Cirrus Clouds? **Geophysical Research Letters**, 2023 (in preparation)

25. **K. K. Chandrakar**, H. Morrison, and W. Grabowski. Impact of aerosol processing in stratocumulus cloud transition from closed to open cellular structure: Comparison of Lagrangian super-droplet and Eulerian double-moment bin microphysics schemes. **Monthly Weather Review** (in preparation), 2023

Selected Presentations

2016

Chandrakar *et al.* Correlation of cloud droplet growth with the scalar fluctuations in a turbulent moist convection. In *APS Meeting Abstracts*, 2016

2017

Chandrakar *et al.* Experimental investigation of cloud formation and growth in turbulent moist convection: turbulence induced droplet activation and growth. In *Summer school and Discussion Meeting on Buoyancy-driven flows*, ICTS, Bangalore, 2017

2018

Chandrakar *et al.* Influence of turbulent fluctuations on cloud droplet size dispersion and aerosol indirect effects. In *AMS: 15th Conference on Cloud Physics*, 2018

Chandrakar *et al.* Aerosol removal and cloud collapse accelerated by supersaturation fluctuations with a positive feedback in a turbulent cloud: a cloud-chamber study. In *International Workshop on Cloud Dynamics, Microphysics, and Small-Scale Simulation,*IITM, Pune, 2018

Chandrakar *et al.* Supersaturation fluctuations from scalar transport in moist Rayleigh-Bénard convection: One-dimensional-turbulence simulation. In *AGU Fall Meeting*, 2018

2019

Chandrakar *et al.* Supersaturation fluctuations in moist turbulent Rayleigh-Bénard convection: a two-scalar transport problem. In *Pi chamber simulation workshop,*MichiganTech, Houghton, 2019

2020

Chandrakar *et al.* Droplet size distributions in turbulent clouds: experimental evaluation of theoretical distributions. In *3rd International Workshop on Cloud Turbulence (Nagoya Institute of Technology)*, 2020

K. K. Chandrakar Cloud turbulence interactions in a laboratory and cumulus clouds: theoretical, experimental, and modeling perspectives. In *Leibniz Institute for Tropospheric Research*, Leipzig (Germany), 2020

2021

K. K. Chandrakar Cloud turbulence interactions from a laboratory scale to cumulus entrainment: theoretical, experimental, and modeling perspectives. In *Brookhaven National Laboratory*, Upton (NY), 2021

K. K. Chandrakar Cloud-turbulence interactions from laboratory scale to cumulus entrainment and their impact on droplet size distributions. In *University of Wyoming*, Laramie (WY), 2021

K. K. Chandrakar Impact of Turbulence on Cloud Droplets in Laboratory and Cumulus Clouds and Comparison of Lagrangian and Eulerian Microphysics Schemes. In *University of Utah*, Salt Lake City (UT), 2021

Chandrakar *et al.* Droplet spectra in ice-free cumulus clouds: Lagrangian particle-based modeling and high-resolution observations. In *Joint ARM/ASR Meeting*, 2021

Chandrakar *et al.* Isolated cumulus congestus based on SCMS campaign: comparison between Eulerian bin and Lagrangian particle-based microphysics. In *The 10th International Cloud Modelling Workshop*, 2021

Chandrakar *et al.* Impact of entrainment-mixing and turbulent fluctuations on droplet size distributions in a cumulus cloud. In *AGU Fall Meeting*, 2021

2022

Chandrakar *et al.* Comparison of Lagrangian super-droplet and Eulerian double-moment spectral microphysics schemes in large-eddy simulations of an isolated cumulus-congestus. In *102nd AMS Annual Meeting (14th Symposium on Aerosol-Cloud-Climate Interactions)*, 2022

Chandrakar *et al.* Supersaturation variability from scalar mixing at unresolved scales: sub-grid model and its evaluation using direct numerical simulations of turbulent moist Rayleigh–Bénard convection. In *4th International Workshop on Cloud Turbulence (Nagoya Institute of Technology)*, 2022

2022

K. K. Chandrakar Impact of aerosols and turbulence on clouds: process level investigations using experiments, theory, and modeling. In *Penn State MAS Colloquia*, University Park (PA), 2022

K. K. Chandrakar Impact of aerosols and turbulence on clouds: process level investigations using experiments, theory, and modeling. In *RAL seminar series*, NCAR, Boulder (CO), 2022

Chandrakar *et al.* Impact of aerosol processing in stratocumulus cloud transition from closed to open cellular structure: Comparison of Lagrangian super-droplet and Eulerian double-moment bin microphysics schemes. In *AMS Collective Madison Meeting (16th Conference on Cloud Physics)*, 2022

Chandrakar *et al.* Supersaturation variability from scalar mixing: evaluation of a new subgrid-scale model using direct numerical simulations of turbulent Rayleigh–Bénard convection. In *AMS Collective Madison Meeting (16th Conference on Cloud Physics)*, 2022

K. K. Chandrakar Impact of aerosols and turbulence on cumulus and stratocumulus clouds: process level investigations using a Lagrangian particle-based scheme in large-eddy simulations. In *Michigan Technological University Physics Colloquium*, Houghton (MI), 2022

Chandrakar *et al.* Comparison of Lagrangian Super-droplet and Eulerian Double-moment Bin Microphysics Schemes in Stratocumulus and Cumulus Clouds. In *Joint ARM/ASR Meeting*, 2022

Chandrakar *et al.* Evolution of Droplet Size Distributions During the Transition of an Ultraclean Stratocumulus Cloud system to Open Cell Structure: an LES Investigation Using Lagrangian Microphysics. In *Warm Boundary Layer Processes Working Group Breakout (Joint ARM/ASR Meeting)*, 2022

Chandrakar *et al.* Lagrangian Supersaturation Statistics in Turbulent Cloudy Rayleigh–Bénard Convection: Applications for LES Subgrid Modeling. In *AGU Fall Meeting*, 2022

Chandrakar *et al.* Evolution of Droplet Size Distributions During the Transition of an Ultraclean Stratocumulus Cloud system to Open Cell Structure: an LES Investigation Using Lagrangian Microphysics. In *AGU Fall Meeting*, 2022

2023

Chandrakar *et al.* Comparison of Lagrangian Super-droplet and Eulerian Double-moment Bin Microphysics Schemes in Stratocumulus and Cumulus Clouds. In *103rd AMS Annual Meeting, January 2023*

Chandrakar *et al.* What Controls Microphysical Variability in Cirrus Clouds? In *Joint ARM/ASR Meeting*, 2023

Chandrakar *et al.* Are turbulence effects on droplet collision-coalescence a key to understanding observed rain formation in clouds? In *Convective Processes Working Group Breakout (Joint ARM/ASR Meeting)*, 2023

Chandrakar *et al.* What Controls Microphysical Variability in Cirrus Clouds? In *AGU Fall Meeting*, 2023

Chandrakar *et al.* Are turbulence effects on droplet collision-coalescence a key to understanding observed rain formation in clouds? In *AGU Fall Meeting*, 2023