Manikandan (Mani) Rajagopal, Ph.D

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Research Statement

My broad research interests are to understand thermodynamic, and microphysical cloud processes in deep convection. Using observations and idealized numerical simulations, I strive to understand the environmental conditions and processes that lead to convection initiation, upscale growth, spatiotemporal precipitation, and the observed cloud properties. My recent research projects focused on

- Characterizing regional variability of Mesoscale Convective Systems properties and their diurnal cycle using satellite observations
- Evaluation of convection in high resolution models through MCS model intercomparison project (MCSMIP)
- Evaluating Emanuel's cumulus parameterization scheme, which has a sophisticated representation of sub-grid scale updrafts and downdrafts, against Large Eddy Simulation of a tropical convection, with resolved updrafts and downdrafts.
- Using one-dimensional models to simulate and investigate microphysical properties of clouds generated in a laboratory cloud chamber.

Education

Ph.D. in Atmospheric Sciences **Aug 2022**
University of Utah, Salt Lake City
Dissertation: Spatiotemporal variability of Mesoscale Convective Systems and their properties in the Tropics
Advisor: Prof. Ed Zipser

Master of Science in Atmospheric and Space Sciences **May 2016**
Savitribai Phule Pune University and Indian Institute of Tropical Meteorology, Pune, India
Thesis: On the applicability of Monin-Obukhov similarity theory in the weakly forced turbulent convection
Advisors: Dr. Shivsai A. Dixit and Mr. Subarthi Chowdhuri

Research Experience

Postdoctoral Research Associate **Sep 2022 – Oct 2024**
Department of Atmospheric Sciences, University of Utah
Advisor: Prof. Steven Krueger, Dr. Peter Veals

- Evaluated Emanuel's cumulus parameterization, with sophisticated updraft and downdraft representation, against the Large Eddy Simulation of tropical convection, with resolved updrafts and downdrafts. Emanuel's parameterization reasonably represents the mass flux profiles, average surface precipitation, and downdraft properties.
- Developed the microphysics module for the One-dimensional Turbulence model that can resolve turbulence and cloud microphysics in a convection cloud chamber. This will be used to investigate the turbulence effects on supersaturation variability and cloud microphysical properties.
- Tracked Mesoscale Convective Systems(MCS) in OLR output of high resolution model simulations from DYAMOND project to evalute the resolved convection in these models against observations for MCS tracking method intercomparisons project (MCSMIP).

Graduate Research Assistant **Aug 2017 – Aug 2022**
Department of Atmospheric Sciences, University of Utah
Advisor: Prof. Ed Zipser

- Identified biases in IMERG satellite precipitation in the absence of passive microwave satellite observations. This led to the improved IMERG precipitation estimation algorithm.
- Contrasted the regional variability of MCSs' properties in the tropics. MCSs over the ocean are typically larger, longer-lived, and have higher precipitation intensity than MCSs over land.
- Investigated the diurnal precipitation cycle over the ocean with an atypical afternoon maximum over certain regions using the tracked MCS dataset. The afternoon precipitation maximum is likely due to propagating disturbances from the coastline rather than propagating storms.

Graduate Research Assistant **Aug 2015 – May 2016**
Indian Institute of Tropical Meteorology, Pune, India
Advisors: Dr. Shivsai A. Dixit and Mr. Shubharthi Chowdhuri

- We compared the surface flux estimates from the Monin-Obukhov similarity theory with micrometeorological tower data during the Indian summer monsoon. The theory underestimated the fluxes calculated from the vertical gradients of mean temperature and wind.

Summer Research Fellow **Jun 2015 – Jul 2015**
Indian Institute of Science, Bangalore, India
Advisor: Prof. GS Bhat

- Characterized rain drop size distribution observed over the Bay of Bengal during the Indian summer monsoon using a ship-borne distrometer data from Continental Tropical Convergence Zone field experiment.

Teaching and Mentorship

Cloud Physics **Fall 2022**
Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio
Two lectures on Mesoscale Convective systems and Cumulus parameterization

Mesoscale Meteorology **Spring 2023**
Department of Atmospheric Sciences, University of Utah
Two lectures on Hail and Floods

Research Mentor for a Master student **Feb 2023 – Sep2023**
Department of Atmospheric Sciences, University of Utah
Research topic: Characteristics of Mesoscale Convective Systems at different life cycle stages

Field and Lab Experiences

Short Visit to Pi cloud chamber **Oct 2023**
NSF facility at Michigan Technological University

- Participated and learned about the ongoing mixed-phased cloud experiment
- Learned about instrumentation for producing and size-selecting aerosols required for experiments
- Exposed to various techniques and instrumentation to measure temperature, water vapor, turbulence, and particle size distribution in the cloud chamber.

Convective Processes Experiment – Aerosols & Winds (CPEX-AW) **Sep 2021**
NASA funded field campaign at St. Croix, the US Virgin Islands
- Planned and strategized the radiosonde launches to investigate boundary layer evolution
- Led the forecast discussion to help plan the aircraft mission

Remote sensing of Electrification, Lightning, And Mesoscale/microscale Processes with Adaptive Ground Observations (RELAMPAGO) / Cloud, Aerosol, and Complex Terrain Interactions (CACTI) **Dec 2018**
NSF/DOE funded field program in Cordoba, Argentina
- Deployed and collected data from mobile mesonet and radiosonde
- Assisted with Doppler-on-wheels X-band radar deployment and data collection

Professional Services

Reviewer for the Journal of Geophysical Research: Atmospheres **2024, 2019**

Reviewer for NASA proposals **Apr 2023**

Reviewer for the Journal of Hydrometeorology **Jan 2023**

Postdoctoral Representative in Diversity Equity and Inclusion Committee **Sep 2022 – Jun 2023**
College of Mines and Earth Sciences, University of Utah

Poster Evaluator for UG conference **Feb 2019 – Aug 2022**
University of Utah

Professional Development Colloquia / Workshops

NSF FARE Workshop **Sep 2023**
NCAR, Boulder

Metpy for satellite, radar, radiosonde, and mesonet data **Jan 2023**
AMS Annual Meeting

Proposal Writing Workshop **Dec 2022**
AGU Fall Meeting

Leadership Skills Seminar Series, Presentation Skills Seminar Series **2021/2022**
College of Mines and Earth Sciences, University of Utah

Weather Research and Forecasting (WRF) Model Users Workshop **Jan 2020**
NCAR, Boulder

Short Course on Eddy Covariance and GHG Flux Estimation **Nov 2016**
Indian Institute of Tropical Meteorology, Pune.

Awards and Scholarships

- Jan 2023 : Travel award to AMS annual meeting, 2023, from Postdoctoral Affairs Office, University of Utah
- Dec 2016: All India First rank in National Eligibility Test (NET) Lectureship Examination
- Jul 2015 : Indian Academy of Sciences Summer Research Fellow
- Aug 2001: Academic Merit Scholarship for undergraduates at Vellore Institute of Technology, India

Technical Skills

Programming Languages:	Python, Matlab, Fortran, HTML, CSS, and Javascript
Numerical Models:	Linear Eddy Model, One Dimensional Turbulence, Single-Column model, and Weather and Research Forecasting model
Research Methods:	Track convective systems using the "Forward in Time" tracking algorithm. Perform case study analysis from field programs using aircraft, satellite, and reanalysis data.

Peer-reviewed Publications

Rajagopal, M., Zipser, E., & Veals, P. (2025). Diurnal cycle of precipitation in coastal tropics. *Journal of Climate,* in-preparation.

Tinoco-Morales, M., Veals, P., **Rajagopal, M**., Russell, J., & Zipser, E (2025) The Vertical, Horizontal, and Temporal Characteristics of Tropical Mesoscale Convective Systems at Different Lifecycle Stages. *Journal of Applied Meteorology and Climatology,* in-preparation

Sakaeda, N., & Co-authors [including **Rajagopal, M.**] (2025) Synoptic Modulation of the West African Coastal Atmosphere and Mesoscale Convective Systems. *Monthly Weather Review*. Submitted.

Feng, Z. & Co-authors [including **Rajagopal, M.**] (2025) Mesoscale Convective Systems tracking Method Intercomparison (MCSMIP): Application to DYAMOND Global km-scale Simulations. *Journal of Geophysical Research: Atmospheres,* Accepted with minor revisions

Russell, J., **Rajagopal, M.,** Veals, P., Skok, G., Zipser, E. & Tinoco-Morales, M. (2024) A dataset of tracked mesoscale precipitation systems in the tropics. *Geoscience Data Journal*, 00, 1–15. Available from: https://doi.org/10.1002/gdj3.275

Nowottnick, E., & Co-authors [including **Rajagopal, M.**] (2024). Dust, Convection, Winds and Waves: The 2022 NASA CPEX-CV Campaign. *Bulletin of the American Meteorological Society,* https://doi.org/10.1175/BAMS-D-23-0201.1

Rajagopal, M., Russell, J., Skok, G., & Zipser, E. (2023). Tracking mesoscale convective systems in IMERG and regional variability of their properties in the tropics. *Journal of Geophysical Research: Atmospheres*, 128, e2023JD038563. https://doi.org/10.1029/2023JD038563

Rajagopal, M. (2022). Spatiotemporal Variability of Mesoscale Convective Systems and Their Properties in the Tropics Using IMERG, *Doctoral dissertation*, The University of Utah. access it on proquest

Rajagopal, M., Zipser, E., Huffman, G., Russell, J., & Tan, J. (2021). Comparisons of IMERG version 06 precipitation at and between passive microwave overpasses in the tropics. *Journal of Hydrometeorology,* 22(8), 2117–2130. https://doi.org/10.1175/jhm-d-20-0226.1.

Tan, J., Huffman, G. J., Bolvin, D. T., Nelkin, E. J., & **Rajagopal, M**. (2021). SHARPEN: A scheme to restore the distribution of averaged precipitation fields. *Journal of Hydrometeorology*, 22(8), 2105–2117. https://doi.org/10.1175/jhm-d-20-0225.1.

Selected Conference Presentations

Rowe, A., Rodenkirch, B. D., Martinez, G., Zipser, E. J., **Rajagopal, M**., Monje, R. R., ... & Tanelli, S. (2024, May). Multi-Frequency Radar Observations of Tropical Oceanic Convection during CPEX-CV. In *36th Conference on Hurricanes and Tropical Meteorology*. AMS

Rajagopal, M., Krueger, S., Chandrakar, K., & Wunch, S. (2023). Using the One-Dimensional Turbulence (ODT) Model to Simulate Cloudy Rayleigh-Benard Convection in a Cloud Chamber, AGU Fall Meeting, (2023, Dec). https://agu.confex.com/agu/fm23/meetingapp.cgi/Paper/1443377

Krueger, S., **Rajagopal, M**., Bois, C., & Thomas, I. (2023). Parameterization of tropical convective downdrafts. AGU Fall Meeting, 2023. https://agu.confex.com/agu/fm23/meetingapp.cgi/Paper/1394723

Rowe, A., Rodenkirch, B., Martinez, G., Zipser, E., **Rajagopal, M.,** Ocasio, K., Monje, R., Rodriguez; Bedka, K., Thornhill II, K. (2023) New insights into tropical Atlantic oceanic convection from NASA's CPEX campaign series. AGU Fall Meeting, 2023. https://agu.confex.com/agu/fm23/meetingapp.cgi/Paper/1410242

Rajagopal, M., Skok, G., Russell, J., and Zipser, E.: A multi-threshold-based identification and tracking of Mesoscale Convective Systems in a multi-satellite precipitation product, EMS Annual Meeting 2023, Bratislava, Slovakia, 4–8 Sep 2023, EMS2023-396, https://doi.org/10.5194/ems2023-396.

Rajagopal, M., & Zipser, E. (2022). Regional Variability of Mesoscale Convective Systems' Properties in the Global Tropics. AGU Fall Meeting 2022. https://agu.confex.com/agu/fm22/meetingapp.cgi/Paper/1124459.

Rajagopal, M., Russell, J. O. H., & Zipser, E. J. (2021a). Mesoscale Convective Systems Over Tropical Oceans: The Spatiotemporal Distribution of Size, Duration, and Rain Volume using IMERG. *34th Conference on Hurricanes and Tropical Meteorology. American Meteorological Society.*

Rajagopal, M., Russell, J., & Zipser, E. J. (2021b). Objective Tracking of Precipitation Systems in IMERG over Tropical Oceans. *101st American Meteorological Society Annual Meeting.*

Rajagpoal, M., & Zipser, E. (2019). IMERG precipitation rate distribution. *NASA PMM Science Meeting: Multi-Satellite Working Group (**invited talk**), Indianapolis, Indiana.*

Rajagopal, M., Russell, J., & Zipser, E.: Using IMERG to define precipitation features and their upscale growth. Subjective vs. objective tracking. *NASA Convective Processes Experiment science team meeting, July 16-17, 2019, Seattle, Washington*

Zipser, E., **Rajagopal, M**., & Huffman, G., 2018: Growth and Decay of Organized Convection during CPEX 2017: Insights from IMERG and DC-8 data. *NASA Precipitation Monitoring Mission (PMM), science team meeting, Phoenix, Arizona.*

Rajagopal, M., Dixit, S. A., & Chowdhuri, S. (2016). Departures of Monin-Obukhov Similarity theory in Monsoon Trough region over India. *Monsoon Workshop, Indian Meteorological Society, Pune, India.*