Research scientist involved in compiling artificial-intelligence-ready data from various sources to aid in more efficient analysis of tropical cyclone satellite and environmental data, and applying mathematical techniques, including machine learning, to understand tropical cyclone structure and processes and develop new forecast applications and products. Co-creator of the Tropical Cyclone Precipitation, Infrared, Microwave, and Environmental Dataset (TC PRIMED)

RESEARCH EXPERIENCE

2023 – present
Research Scientist I
Cooperative Institute for Research in the Atmosphere, Colorado State University
- Utilize mathematical techniques to analyze tropical cyclone convective and precipitation structure
- Develop statistical/machine learning models for forecast applications
- Develop and manage the data stream for real-time tropical cyclone satellite passive microwave observations from low-Earth orbit satellites on the CIRA TCRealtime website
- Update and expand the Tropical Cyclone Precipitation, Infrared, Microwave, and Environmental Dataset (TC PRIMED)
- Develop training materials for machine learning applications of weather data

2021 – 2023
Postdoctoral Fellow
Cooperative Institute for Research in the Atmosphere, Colorado State University
- Continue the development, archiving, and application of the Tropical Cyclone Precipitation, Infrared, Microwave, and Environmental Dataset (TC PRIMED)
- Develop training materials for tropical cyclone analysis and machine learning applications using satellite passive microwave observations and environmental data
- Utilize mathematical techniques to analyze tropical cyclone convective and precipitation structure
- Develop statistical/machine learning models for forecast applications

2016 – 2022
Graduate Research Assistant, Advised by Dr. Michael M. Bell
Colorado State University
- Collaborate with ATS and CIRA scientists to compile an early version of the Tropical Cyclone Precipitation, Infrared, Microwave, and Environmental Dataset (TC PRIMED)
- Develop a machine learning model to classify precipitation types from satellite passive microwave observations and characterize the model's errors
- Process and integrate aircraft in-situ and radar data using the Spline Analysis at Mesoscale Utilizing Radar and Aircraft Instrumentation (SAMURAI) software. Analyze and interpret SAMURAI outputs to improve understanding of processes behind tropical cyclone eyewall replacement cycles

2015 – 2016
Graduate Research Assistant, Advised by Dr. Michael M. Bell
University of Hawai'i at Mānoa
- Process airborne radar observations

September – October 2018
Forecaster, Radar and Radiosonde Operator for the PISTON Field Campaign
Colorado State University
- Interpret and present numerical weather model outputs to guide research cruise operations
- Collect radiosonde and shipborne radar data

May – June 2017
Drone Operator for the C^3LOUD-Ex Field Campaign
Colorado State University
- Operate the drone for the collection of cold pool data
- Assist in the collection environmental and updraft radiosonde data

October – November 2013
Forecaster and Volunteer for the HERO Field Campaign
University of Hawai'i at Mānoa
- Interpret and present numerical weather model outputs to guide operational deployment
- Assist in collecting data in the field

Muhammad Naufal Bin Razin (Naufal)

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naufal@colostate.edu

EDUCATION

2018 – 2022
Ph.D. in Atmospheric Science
Colorado State University

2016 – 2018
M.S. in Atmospheric Science
Colorado State University

2012 – 2015
B.S. in Meteorology
University of Hawai'i at Mānoa

2011 – 2012
American Degree Transfer Program
Sunway University, Malaysia

AWARDS

2021
1st Place Student Poster Presentation
34th AMS Conference on Hurricanes and Tropical Meteorology

2018 – 2021
NASA Earth and Space Science Fellowship

2019
2nd Place Poster Presentation
NOAA/NESDIS CoRP 15th Annual Student Science Symposium

2017
WSCoE Excellence in Research
CSU Graduate Student Showcase

2012 – 2015
International Undergraduate Student Scholarship
University of Hawai'i at Manoa

PROJECTS/PROPOSALS

Principal Investigator

CIRA/NESDIS Research Towards Improving Tropical Cyclone Monitoring by Increasing the Utility and Quality of ATMS Imagery and Products	NOAA/JPSS	August 2024 – July 2025	$154,500
CIRA/NESDIS Research Towards Routine Detection of Structural Changes in Tropical Cyclones Through Artificial Intelligence Ready Data and Learning Journeys	NOAA/NCAI	September 2024 – August 2025	$170,000
CIRA/NESDIS Research Towards NOAA Center for Artificial Intelligence (NCAI) Hazards and Extreme Events Learning Journeys	NOAA/NCAI	August 2024 – July 2027	$189,150
CIRA/NESDIS Research Towards NOAA Center for Artificial Intelligence's (NCAI) Climate Information Partnership Development and Responsible AI Training	NOAA/NCAI	September 2023 – June 2025	$36,000

Co-Principal Investigator

Developing tropical cyclone rapid intensification forecast consensus aids and uncertainty estimates from probabilistic and deterministic guidance	NOAA/WPO	Pending	$363,115

PUBLICATIONS

Dataset

Razin, Muhammad Naufal; Slocum, Christopher J.; Knaff, John A.; Brown, Paula J. 2024. Tropical Cyclone PRecipitation, Infrared, Microwave, and Environmental Dataset (TC PRIMED). v01r01. NOAA National Centers for Environmental Information. https://doi.org/10.25921/dmy1-0595.

Razin, Muhammad Naufal; Slocum, Christopher J.; Knaff, John A.; Brown, Paula J. 2023. Tropical Cyclone PRecipitation, Infrared, Microwave, and Environmental Dataset (TC PRIMED). v01r00. NOAA National Centers for Environmental Information. https://doi.org/10.25921/dmy1-0595.

Code/Packages

TC PRIMED Development Team, 2024: TC PRIMED API, https://pypi.org/project/tcprimedapi/.

Training Materials

Razin, N., K. Haynes, and C. J. Slocum, 2023: NCAI Learning Journey: TC PRIMED. https://github.com/noaa-ncai/learning-journey/tree/main/tcprimed.

Scientific Literature

Cheung, A. A., C. J. Slocum, J. A. Knaff, and **M. N. Razin**, 2024: Documenting the Progressions of Secondary Eyewall Formations. *Wea. Forecasting*, **39**, 19 – 40, 10.1175/WAF-D-23-0047.1.

van den Heever and **Coauthors**, 2024: C^3LOUD-Ex: Raising the Curtain on Convection. *Bull. Amer. Meteor. Soc.,* **103**, 25 – 34, 10.1175/BAMS-D-19-0013.A

Razin, M. N., C. J. Slocum, P. J. Brown, J. A. Knaff, and M. M. Bell 2023: Tropical Cyclone Precipitation, Infrared, Microwave, and Environmental Dataset (TC PRIMED). *Bull. Amer. Meteor. Soc.,* **104**, E1980–2988, 10.1175/BAMS-D-21-0052.1.

Slocum, C. J., **M. N. Razin**, J. A. Knaff, and J. P. Stow, 2022: Does ERA5 mark a new era for resolving the tropical cyclone environment? *J. Climate.*, **35**, 3547 – 3564, 10.1175/JCLI-D-22-0127.1.

Razin, M. N. B., 2022: Satellite-Based Investigation of Convection and Precipitation in Tropical Cyclone Intensity Change. *Ph.D. dissertation*, Department of Atmospheric Science, Colorado State University. 93 pp. *Unpublished manuscript, available upon request.*

Razin, M. N. and M. M. Bell, 2021: The Unconventional Eyewall Replacement Cycle of Hurricane Ophelia (2005). *Mon. Wea. Rev.* **149**, 2151 – 2170, 10.1175/MWR-D-20-0181.1.

van den Heever and **Coauthors**, 2021: The Colorado State University Convective CLoud Outflows and UpDrafts Experiment (C^3LOUD-Ex). *Bull. Amer. Meteor. Soc.*, **102**, E1283 – E1305, 10.1175/BAMS-D-19-0013.1

Razin, M. N. B., 2018: The Unconventional Eyewall Replacement Cycle of Hurricane Ophelia (2005). *M. S. Thesis*, Department of Atmospheric Science, Colorado State University. 48 pp. *Unpublished manuscript, available upon request.*

LEADERSHIP EXPERIENCE

2023 – present
Mentor, CIRA/ATS Mentoring Program (CAMP)
- Periodically meet with other mentors and the mentee to offer support to the mentee in acclimatizing to life as a graduate student

2024
Co-Proposer and Co-Chair, Session on the Applications of Artificial Intelligence on Tropical Cyclones and Tropical Meteorology, AMS 36th Conference on Hurricanes and Tropical Meteorology
- Assisted the conference organizers in organizing the oral and poster presentation abstracts and in soliciting volunteers to chair the oral presentation sessions.

2018 – 2021
Advisor to the Malaysian Student Association
Colorado State University
- Oversee and advise undergraduate student members on association-related activities

2017 – 2018
Department of Atmospheric Science Master's Student Representative
Colorado State University
- Facilitate communications regarding student affairs between faculty and students

2015 – 2016
WxChallenge Local Manager
University of Hawai'i at Mānoa
- Facilitate participant registration
- Assist participants in interpreting numerical weather outputs

TEACHING EXPERIENCE

Fall 2019
Graduate Teaching Assistant, ATS 620: Thermodynamics and Cloud Physics
Colorado State University

RESEARCH PRESENTATIONS

Razin, M. N., C. Slocum, J. Knaff, K. Haynes, and M. McGraw: Updates on the Tropical Cyclone Precipitation, Infrared, Microwave, and Environmental Dataset (TC PRIMED), *Poster Presentation, AMS 36th Conference on Hurricanes and Tropical Meteorology*, Long Beach, CA, May 2024.

Razin, N.: Secondary Eyewall Detection in Passive Microwave Imagery, *Oral Presentation, AMS 36th Conference on Hurricanes and Tropical Meteorology*, Long Beach, CA, May 2024.

Razin, N., and C. Slocum: AI Demonstration: The Tropical Cyclone Precipitation, Infrared, Microwave, and Environmental Dataset (TC PRIMED), *Oral Presentation, 5th NOAA Workshop on Leveraging AI in Environmental Sciences*. Online, September 2023.

Razin, N.: Machine Learning Application of the Tropical Cyclone Precipitation, Infrared, Microwave, and Environmental Dataset (TC PRIMED), *Oral Presentation, NOAA CoRP Symposium*, Madison, WI, July 2023.

Razin, N. C. Slocum, J. A. Knaff, and P. J. Brown: Tropical Cyclone Precipitation, Infrared, Microwave, and Environmental Dataset (TC PRIMED), *Oral Presentation, CIRA Mid-Term Science Review*, Fort Collins, CO, May 2023.

Razin, M. N., K. Haynes, and C. Slocum: Towards Enhancing Participation in Science and AI: The Tropical Cyclone Precipitation, Infrared, Microwave, and Environmental Dataset (TC PRIMED), *Oral Presentation, AMS 22nd Conference on Artificial Intelligence for Environmental Science*, Denver, CO, January 2023.

Razin, N.: TC PRIMED and Precipitation Type Classification Using Random Forest. *Oral Presentation, NOAA ESRL AI Working Group Meeting*. Online, October 2022.

Razin, N.: TC PRIMED and Precipitation Type Classification Using Random Forest. *Oral Presentation, CIRA ML Core Meeting*. Online, August 2022.

Razin, N.: Tropical Cyclone Precipitation, Infrared, Microwave, and Environmental Dataset (TC PRIMED). *Oral Presentation, Office of Naval Research (ONR) GeoIPS/OVERCAST Program Review*. Fort Collins, CO, August 2022.

Razin, M. N., C. J. Slocum, and K. Haynes: AI-Readiness of the Tropical Cyclone Precipitation, Infrared, Microwave, and Environmental Dataset (TC PRIMED). *Poster Presentation, ESIP July Meeting 2022*. Pittsburgh, PA, July 2022.

Razin, M. N., C. J. Slocum, J. A. Knaff, and M. M. Bell: Climatology of Convective and Stratiform Precipitation in Tropical Cyclones. *Oral Presentation, 35th Conference on Hurricanes and Tropical Meteorology*. New Orleans, LA, May 2022.

Razin, N.: Tropical Cyclone Precipitation, Infrared, Microwave, and Environmental Dataset (TC PRIMED). *Oral Presentation, U.S. Indo-Pacific Command (INDOPACOM) Tropical Cyclone Conference 2022 (TCC-22)*. Online, April 2022.

RESEARCH PRESENTATIONS (CONTINUED)

Razin, M. N., C. J. Slocum, P. J. Brown, J. A. Knaff, and M. M. Bell: Tropical Cyclone Precipitation, Infrared, Microwave, and Environmental Dataset (TC PRIMED). *Poster Presentation, 34th Conference on Hurricanes and Tropical Meteorology*. Online, May 2021.

Razin, M. N., P. J. Brown, J. A. Knaff, K. D. Musgrave, and M. M. Bell: Tropical Cyclone Precipitation, Infrared, Microwave, and Environmental Dataset (TC PRIMED). *Poster Presentation, NOAA/NESDIS CoRP 15th Annual Student Science Symposium,* College Park, MD, August 2019.

Razin, M. N., and M. M. Bell: The Unconventional Eyewall Replacement Cycle (ERC) of Hurricane Ophelia (2005). *Oral Presentation, 33rd Conference on Hurricanes and Tropical Meteorology*, Ponte Vedra, FL, April 2018.

Razin, N., and M. M. Bell: Airborne Radar Observations of Rainband Structure in Hurricane Ophelia (2005). *Poster Presentation, Colorado State University Graduate Student Showcase*, Fort Collins, CO, November 2017.

Razin, N., and M. M. Bell: Airborne Radar Observations of Rainband Structure in Hurricane Ophelia (2005). *Poster Presentation, AMS 38th Conference on Radar Meteorology*, Chicago, IL, August 2017.

SKILLS

Operating Systems	Proficient in navigating UNIX and Windows
Programming	Proficient in Julia and Python
Geophysical Datasets	Experienced in creating and manipulating convention-compliant low-Earth and geostationary satellite dataset files in HDF5 and netCDF file format, as well as McIDAS AREA files

RELEVANT COURSES

ATS651 Data Assimilation
Colorado State University

ATS652 Atmospheric Remote Sensing
Colorado State University

ATS655 Objective Analysis
Colorado State University

NOAA/NASA Satellite Meteorology Summer Workshop 2019
Cooperative Institute for Research in the Atmosphere