

Dr. Robert G. Nystrom

Assistant Professor
Department of Earth, Atmosphere, and Climate
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EDUCATION:

Ph.D. in Meteorology and Atmospheric Science, 2020

The Pennsylvania State University, University Park, PA

Thesis: *The Dynamics and Predictability of Major Hurricanes: Influences of Initial Condition Uncertainty and Model Error Explored Using Ensemble Data Assimilation*

Advisors: Dr. Fuqing Zhang, Distinguished Professor of Meteorology and Professor of Statistics & Dr. Steven Greybush, Associate Professor of Meteorology

B.S. in Atmospheric Sciences with highest distinction, 2015

University of Illinois at Urbana-Champaign, Urbana, IL

RESEARCH INTERESTS:

Atmospheric Predictability, Earth System Modeling, Data Assimilation, Tropical Cyclones and Tropical Meteorology, Air-Sea Interactions, Mesoscale Meteorology, and Atmospheric Dynamics

PROFESSIONAL APPOINTMENTS:

Iowa State University of Science and Technology, Ames, IA

Assistant Professor, Department of Earth, Atmosphere, and Climate, 2024 – present

The National Science Foundation National Center for Atmospheric Research, Boulder, CO

Project Scientist I, 2023 – 2024

The National Center for Atmospheric Research, Boulder, CO

Advance Study Program Postdoctoral Fellow, 2020 – 2023

The Pennsylvania State University, University Park, PA

Graduate Research Assistant, 2015 – 2020

PEER-REVIEWED PUBLICATIONS:

Nystrom, R. G., C. Snyder, and M. Gharamti, 2023: An Ensemble Kalman Smoother Approach Toward Estimating the Tropical Cyclone Surface-Exchange Coefficients. *Mon. Wea. Rev.*, **151**, 625–642, <https://doi.org/10.1175/MWR-D-22-0147.1>.

D. Tao, **R. G. Nystrom**, and M. Bell, 2023: The Quasi-Linear Absolute Angular Momentum Slope of Tropical Cyclones Under Rapid Intensification. *Geophys. Res. Lett.*, **50**, e2023GL104583. <https://doi.org/10.1029/2023GL104583>.

Nystrom, R. G. and F. Judt, 2022: The consequences of surface-exchange coefficient uncertainty on an otherwise highly predictable major hurricane. *Mon. Wea. Rev.*, **150**, 2073–2089, <https://doi.org/10.1175/MWR-D-21-0320.1>.

Zhao, Q., N. L. Baker, Y. Jin, and **R. Nystrom**, 2021: Scale Analysis of Infrared Water Vapor Brightness Temperatures for Tropical Cyclone All-Sky Radiance Assimilation. *Geophys. Res. Lett.*, **48**, e2021GL095458, <https://doi.org/10.1029/2021GL095458>.

Zhang, Y., S. B. Sieron, Y. Liu, X. C. Chen, **R. G. Nystrom**, M. Minamide, M.-Y. Chan, C. Hartman, Z. Yao, J. H. Ruppert, A. Okazaki, S. J. Greybush, E. E. Clothiaux, and F. Zhang, 2021: Ensemble-Based Assimilation of Satellite All-Sky Microwave Radiances Improves Intensity and Rainfall Predictions for Hurricane Harvey (2017). *Geophys. Res. Lett.*, **48**, e2021GL096419, <https://doi.org/10.1029/2021GL096410>.

Nystrom, R. G., S. J. Greybush, X. Chen, and F. Zhang, 2021: Potential for new constraints on tropical cyclone surface-exchange coefficients through simultaneous ensemble-based state and parameter estimation. *Mon. Wea. Rev.*, **149**, 2213–2230, <https://doi.org/10.1175/MWR-D-20-0259.1>.

Chen, X., **R. G. Nystrom**, C. A. Davis, C. Zarzycki, 2021: Dynamical Structures of Cross-Domain Forecast Error Covariance of a Simulated Tropical Cyclone Using a Convection-Permitting Coupled Atmosphere-Ocean Ensemble. *Mon. Wea. Rev.*, **149**, 41–63, <https://doi.org/10.1175/MWR-D-20-0116.1>.

Yu, C.-L., A. C. Didlake Jr., F. Zhang, and **R. G. Nystrom**, 2021: Asymmetric Rainband Processes Leading to Secondary Eyewall Formation in a Model Simulation of Hurricane Matthew (2016). *J. Atmos. Sci.*, **78**, 29–49, <https://doi.org/10.1175/JAS-D-20-0061.1>.

Nystrom, R. G., R. Rotunno, C. A. Davis, and F. Zhang, 2020: Consistent impacts of surface enthalpy and drag coefficient uncertainty between an analytical model and simulated tropical cyclone maximum intensity and storm structure. *J. Atmos. Sci.*, **77**, 3059–3080, <https://doi.org/10.1175/JAS-D-19-0357.1>.

Nystrom, R. G., X. Chen, F. Zhang, and C. A. Davis, 2020: Nonlinear Impacts of Surface Exchange Coefficient Uncertainty on Tropical Cyclone Air-Sea Interactions and Intensification. *Geophys. Res. Lett.*, **47**, e2019GL085783, <https://doi.org/10.1029/2019GL085783>.

Nystrom, R. G. and F. Zhang, 2019: Practical Uncertainties and Underlying Dynamics in the Limited Predictability of the Record-Breaking Intensification of Hurricane Patricia (2015). *Mon. Wea. Rev.*, **147**, 3535–3556, <https://doi.org/10.1175/MWR-D-18-0450.1>.

Zhang F., M. Minamide, **R. G. Nystrom**, X. Chen, S.-J. Lin, and L. M. Harris, 2019: Improving Harvey forecasts with next-generation weather satellites. *Bull. Amer. Meteor. Soc.*, **100**, 1217–1222, <https://doi.org/10.1175/BAMS-D-18-0149.1>.

Tao. D., K. A. Emanuel, F. Zhang, R. Rotunno, M. M. Bell, and **R. G. Nystrom**, 2019: Evaluation of the assumptions in the steady-state tropical cyclone self-stratified outflow using three-dimensional convection-allowing simulations. *J. Atmos. Sci.*, **76**, 2995–3009, <https://doi.org/10.1175/JAS-D-19-0033.1>.

Nystrom, R. G., F. Zhang, E. B. Munsell, S. A. Braun, J. A. Sippel, Y. Weng, and K. A. Emanuel, 2018: Predictability and dynamics of Hurricane Joaquin (2015) explored through convection-permitting ensemble sensitivity experiments. *J. Atmos. Sci.*, **75**, 401–424, <https://doi.org/10.1175/JAS-D-17-0137.1>.

FUNDED PROPOSALS:

Nystrom, R. G. (PI), 2020, A hierarchical modeling and data assimilation approach toward improved understanding of tropical cyclone predictability, risk and air-sea interactions. *NSF Atmospheric and Geospace Sciences Physical and Dynamical Meteorology Postdoctoral Research Fellowship (Declined)*.

Nystrom, R. G. (Co-PI), 2017-2020: Improving the Predictability and Understanding of Tropical Cyclones: Ensemble Assimilation of All-Sky Satellite Observations. *NASA Earth and Space Science Graduate Fellowship Program Grant 17-EARTH17F-184*.

INVITED TALKS:

Earth System Predictability: Bridging Temporal and Spatial Scales, Tufts University Department of Earth and Climate Sciences, 2024

Earth System Predictability: Bridging Temporal and Spatial Scales, Iowa State University Department of Geological and Atmospheric Sciences, 2023

Tropical Cyclone Predictability: opportunity at the air-sea interface, University of Nevada Reno Department of Physics and Atmospheric Science, 2023

Tropical Cyclone Predictability: opportunity at the air-sea interface, University of Michigan Department of Climate and Space Sciences and Engineering, 2023

Tropical Cyclone Predictability: opportunity at the air-sea interface, Cornell University Department of Earth and Atmospheric Science, 2022

Tropical Cyclone Predictability: opportunity at the air-sea interface, National Center for Atmospheric Research Mesoscale and Microscale Meteorology Laboratory, 2022

Predictability of Tropical Cyclones: challenges and opportunities, United States Naval Academy Department of Oceanography, 2022

Opportunities and challenges in using ensemble-based parameter estimation to constrain tropical cyclone surface-exchange coefficients, University of Reading Data Assimilation Research Centre Seminar, 2021

Predictability, Uncertainties and Underlying Dynamics in the Limited Predictability of the Record-Breaking Intensification of Hurricane Patricia, 3rd International Workshop of the Severe Weather International Consortium, Peking University Department of Atmospheric and Oceanic Sciences, 2019

The Predictability and Dynamics of Major Hurricanes: explored through ensemble data assimilation, Nanjing University School of Atmospheric Science, 2019

SELECTED CONFERENCE PRESENTATIONS:

The predictability of atmospheric conditions relevant for tropical cyclone activity on subseasonal timescales, Talk, 36th AMS Conference on Hurricanes and Tropical Meteorology, 2024

A Four-Dimensional Ensemble Variational (4DEnVar) data assimilation system for the Model for Prediction Across Scales (MPAS), Talk, 2024 AMS Annual Meeting, 2024

The predictability of atmospheric conditions relevant for tropical cyclone activity on subseasonal timescales, Poster, 2024 AMS Annual Meeting, 2024

Predictions of North Atlantic TC activity out to 4 weeks with global MPAS simulations, Talk, 2023 EGU Annual Meeting, 2023

Predictions of North Atlantic TC activity out to 4 weeks with global MPAS simulations, Talk, 2023 AMS Annual Meeting, 2023

A One-Step-Ahead Ensemble Kalman Smoothing Approach Toward Estimating the TC Surface-Exchange Coefficients, Talk, 2022 AGU Fall Meeting, 2022

An ensemble Kalman smoother approach toward estimating the tropical cyclone surface-exchange coefficients, Talk, International Symposium on Data Assimilation, 2022

An ensemble Kalman smoother approach toward estimating the tropical cyclone surface-exchange coefficients, Talk, 35th AMS Conference on Hurricanes and Tropical Meteorology, 2022

The consequences of surface-exchange coefficient uncertainty on an otherwise highly predictable major hurricane, Poster, 35th AMS Conference on Hurricanes and Tropical Meteorology, 2022

An ensemble Kalman smoother approach toward estimating the tropical cyclone surface-exchange coefficients, Talk, 2022 AMS Annual meeting, 2022

Parameter Estimation of Tropical Cyclone Air-Sea Enthalpy and Momentum Exchange Coefficients by Ensemble Data Assimilation, Talk, 34th AMS Conference on Hurricanes and Tropical Meteorology, 2021

Consistent Impacts of Surface Enthalpy and Drag Coefficient Uncertainty between an Analytical Model and Simulated Tropical Cyclone Maximum Intensity and Storm Structure, Poster, 34th AMS Conference on Hurricanes and Tropical Meteorology, 2021

Potential for new constraints on tropical cyclone surface-exchange coefficients through simultaneous ensemble-based state and parameter estimation, Talk, 2021 AMS Annual Meeting, 2021

Potential for new constraints on tropical cyclone surface-exchange coefficients through simultaneous ensemble-based state and parameter estimation, Talk, 2020 AGU Fall Meeting, 2020

The influence of TC air-sea enthalpy and momentum exchange coefficients and the potential for parameter estimation, Talk, 2020 AMS Annual Meeting, 2020

Consistent impacts of surface enthalpy and drag coefficient uncertainty between an analytical model and simulated TC maximum intensity and structure, Poster, 2020 AMS Annual Meeting, 2020

The Importance of Air-Sea Momentum and Enthalpy Fluxes and their Physical Uncertainties in the Development, Structure and intensification of Hurricane Patricia (2015), Talk, 18th AMS Conference on Mesoscale Processes, 2019

Practical Uncertainties and Underlying Dynamics in the Limited Predictability of the Record-Breaking Intensification of Hurricane Patricia (2015), Talk, 2019 AMS Annual Meeting, 2019

Predictability and Dynamics of the Record-Breaking Intensification of Hurricane Patricia (2015), Poster, 2019 AMS Annual Meeting, 2019

An Energetics Perspective of Hurricane Patricia (2015) as a Heat Engine through Isentropic Analysis, Poster, 2019 AMS Annual Meeting, 2019

Predictability and Dynamics of the Record-Breaking Intensification of Hurricane Patricia (2015), Talk, 2018 AGU Fall Meeting, 2018

“Historic rapid intensification of Hurricane Patricia (2015): Cloud-resolving analysis and prediction through ensemble assimilation of dropsonde, radar, and satellite observations”, Talk, The 8th EnKF Data Assimilation Workshop, 2018

Historic rapid intensification of Hurricane Patricia (2015): Cloud-resolving analysis and prediction through ensemble assimilation of dropsonde, radar, and satellite observations, Talk, 33rd Conference on Hurricanes and Tropical Meteorology, 2018

Predictability and Dynamics of Hurricane Joaquin (2015), Explored through Convection-Permitting Ensemble Sensitivity Experiments, Talk, 33rd AMS Conference on Hurricanes and Tropical Meteorology, 2018

Dynamics and Predictability of Hurricane Joaquin (2015): An Ensemble Sensitivity Prospective, Talk, 8th Northeast Tropical Meteorology Workshop, 2017

Improving the Vortex Initialization of Hurricane Karl (2010) Through the Assimilation of Tropical Cyclone Vitals Quadrant Wind Radii Estimates, Talk, 7th EnKF Data Assimilation Workshop, 2016

A Statistical Take on the Hurricane’s Structure and its Spatial Extent, Poster, 2015 American Meteorological Society Student Conference, 2015

Intraseasonal Variability of Tropical Cyclogenesis over the East Atlantic, Poster, University of Illinois School of Earth, Society, and the Environment Research Review, 2015

A Statistical Take on the Hurricane's Structure and its Spatial Extent, Talk, NOAA Hurricane Research Division Monthly Science Meeting, 2014

A Statistical Take on the Hurricane's Structure and its Spatial Extent, Talk, NOAA Science and Education Symposium, 2014

Impacts of ENSO on the Formation of Cape Verde Storms, Poster, American Meteorological Society Student Conference, 2014

TEACHING & MENTORING:

Research Mentor, NCAR Significant Opportunities in Atmospheric Research and Science (SOARS) program, 2021, 2022, & 2024

Research Mentor, Metropolitan State University Department of Meteorology, undergraduate independent research, 2023

Instructor, MPAS-JEDI Tutorial, National Center for Atmospheric Research, 2023

Lecturer, The International Multiscale Convection Summer School (Undergraduate/Graduate level), *Tropical Cyclone Data Assimilation: challenges, current practices, and future frontiers*, Peking University Department of Atmospheric and Oceanic Sciences, Beijing, China, 2019

Guest Lecturer, Data Assimilation (Graduate level), Penn State University Department of Meteorology and Atmospheric Science, University Park, PA, 2019

Instructor, Severe and Unusual Weather (Undergraduate level), Penn State University Department of Meteorology and Atmospheric Science, University Park, PA, 2018

Teaching Assistant, Radiation and Climate (Undergraduate level), Penn State University Department of Meteorology and Atmospheric Science, University Park, PA, 2016

FIELD WORK:

Flight Scientist, NOAA Field Program Mission Flights into Hurricane Arthur, 2014

ACADEMIC SERVICE:

Associate Editor, AMS Journal of the Atmospheric Sciences, 2021 – present

Member, AMS committee on Tropical Meteorology and Tropical Cyclones, 2018 – 2024

Program Chair, 104th American Meteorological Society Annual Meeting, 6th special symposium on Tropical Meteorology and Tropical Cyclones (Baltimore, MD), 2024

Member, AMS Joanne Simpson Tropical Meteorology Research Award committee, 2019 – 2023

Member, AMS Banner I. Miller award committee, 2019, 2021, & 2023

Member, AMS Max A. Eaton and outstanding student presentation award selection committees, 2022

Session Organizer, *Special Symposium: Honoring Professor Fuqing Zhang's contributions to the Tropical Meteorology Community*, 35th American Meteorological Society Conference on Hurricanes and Tropical Meteorology (New Orleans, LA), 2022

Session Chair, *Data Assimilation Methodology Advancement for Numerical Weather Prediction*, 102nd American Meteorological Society Annual Meeting (virtual), 2022

Session Chair, *Tropical Cyclone Theory and Intensity*: 34th American Meteorological Society Conference on Hurricanes and Tropical Meteorology (virtual), 2021

Session Chair, *Tropical Cyclone Research and Forecasting: Multiscale Processes and Model Development II*, 2021 American Meteorological Society Annual Meeting (virtual), 2021

Session Chair, *Tropical Cyclone Research and Forecasting III: Climate and Theory*, 2020 American Meteorological Society Annual Meeting (Boston, MA), 2020

Invited Participant, *NCAR Advanced Study Program Colloquium, Quantifying and Communicating Uncertainty in High-Impact Weather Prediction*, 2019

Session Chair, *Tropical Cyclones: Observations, Data Assimilation, and Forecasting III*, 2019 American Meteorological Society Annual Meeting (Phoenix, AZ), 2019

Session Chair, *Field Experiments: Observations and Assimilation Results—Part I*, 2019 American Meteorological Society Annual Meeting (Phoenix, AZ), 2019

Member, Next Generation Global Prediction System (NGGPS) Ensemble Working Group, 2017

Member, Penn State Department of Meteorology Graduate Academic Planning Committee, 2016 – 2017

Reviewer of Articles for the Following Professional Journals

Journal of Applied Meteorology and Climatology, Journal of the Atmospheric Sciences, Journal of Advances in Modeling Earth Systems, Atmosphere, Atmospheric Chemistry and Physics, Journal of Geophysical Research: Atmospheres, Journal of Climate, Communications in Computational Physics, Geophysical Research Letters, Monthly Weather Review, Nature Communications, Nature Communications Earth and Environment, Quarterly Journal of the Royal Meteorological Society, Tellus A: Dynamic Meteorology and Oceanography, Weather and Forecasting

Reviewer of Proposals for the Following Organizations

National Science Foundation-Physical & Dynamical Meteorology

EDUCATION & OUTREACH:

Panelist, Metropolitan State University, Graduate School Panel, 2023

Member, NCAR Earth System Science Internship (NESSI) Selection Committee, 2023

Judge, EGU Annual Meeting Outstanding Student Presentation Award, 2023

Judge, AMS Annual Meeting Outstanding Student Presentation Award, 2023
Judge, AGU Fall Meeting Outstanding Student Presentation Award, 2022
Invited Scientist, Metropolitan State University Severe and Hazardous Weather Class, 2022
Judge, Globe International Virtual Science Symposium, 2022
Forecaster, NOAA Hurricane Research Division Hurricane Field Program map discussions, 2014, 2020, 2022, 2023
Judge, Colorado Science and Engineering Fair, 2021
Quoted Scientist, [Quartz article](#) highlighting the recent advances in data assimilation for improved hurricane prediction, 2019
Invited Scientist, Centre County, Pennsylvania, Weather Where I Am, 2017
Invited Scientist, Rock 'N Weather Camp at Discovery Space Science Center, 2016

HONORS AND AWARDS:

NCAR Early Career Leadership Program graduate, 2022
Alumni Association Dissertation Award/Distinguished Doctoral Scholar Medal nominee, The Pennsylvania State University, 2020
Al and Betty Blackadar Graduate Scholarship for superior academic record and promise of outstanding academic success, The Pennsylvania State University Department of Meteorology and Atmospheric Science, 2019
NASA Earth and Space Science Fellowship (NESSF) program recipient, 2017 – 2020
Hans Neuberger Award for excellent teaching of meteorology, The Pennsylvania State University Department of Meteorology and Atmospheric Science, 2017
National Science Foundation Graduate Research Fellowship honorable mention, 2015
Ogura Outstanding Senior in Atmospheric Sciences, University of Illinois at Urbana-Champaign Department of Atmospheric Sciences, 2015
Ogura Undergraduate Research Award, University of Illinois at Urbana-Champaign Department of Atmospheric Sciences, 2015
NOAA Ernest F. Hollings Scholarship, 2013 – 2015

PROFESSIONAL AFFILIATIONS:

American Meteorological Society (AMS)
American Geophysical Union (AGU)
European Geophysical Union (EGU)