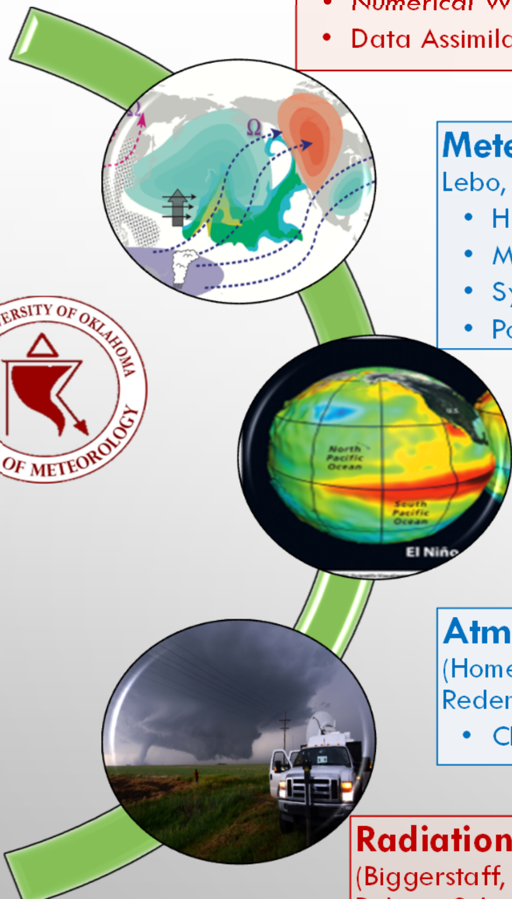
Current and Future Strengths of the School of Meteorology at OU

Weather & Climate Prediction
(Droegemeier, McGovern, X. Wang, Xue)

- Numerical Weather Prediction
- Data Assimilation
- Machine Learning/Artificial Intelligence (AI)
- Ensemble Forecasting
- Physical Process Parameterization

Meteorology
(Bluestein, Cavallo, Klein, Lebo, Parsons, Ruppert, Salesky, C. Wang)

- High-Impact & Severe Weather
- Mesoscale
- Synoptic Scale
- Polar
- Boundary Layer, Urban Meteorology and Turbulence
- Cloud and Precipitation Properties and Processes
- Hydrometeorology
- Cloud Electrification



Climate
(Basara, Furtado, Martin, Pegion, Sakaeda)

- Tropical
- Aerosol-Cloud Interactions
- Variability and Change
- Subseasonal-to-Seasonal (S2S)
- Droughts & Floods, Precipitation Extremes & Variability

Atmospheric Composition
(Homeyer, Loria-Salazar, McFarquhar, Redemann)

- Chemical Transport
- Air Quality/Pollution
- Fire Weather
- Cloud and Precipitation Microphysics
- Aerosols

Radiation and Remote Sensing
(Biggerstaff, Bodine, Kirstetter, Moore, Palmer, Schvartzman, Xu, Zhang)

- Radar Observations
- Surface Active (e.g., lidar) and Passive (e.g., VIS/IR, microwave) Remote Sensing
- Light Scattering & Radiative Transfer Theory
- Satellite and Airborne Observations and Retrievals

Recent Expansions in High-Impact and Severe Weather

- Radar Meteorology
- NWP
- Boundary Layer - Theory, Modeling and Observations
- Sub-seasonal to Seasonal Forecasting
- Urban Systems Modeling

Future Additions in S2S & Earth Systems Modeling

- Data Analytics (ongoing)
- Weather to Climate, Regional to Earth System Modeling
- Large-Scale Dynamics
- Data Analytics
- Carbon Cycle & Global Biogeochemical Modeling
- Aerosol, Cloud, Convection & Precipitation Processes
- Data Science & Algorithm Development for GeoCarb and ACCP Mission
- Earth System Modeling of Past, Present, and Future Climates

THE UNIVERSITY OF OKLAHOMA SCHOOL OF METEOROLOGY

COLLEGE OF ATMOSPHERIC AND GEOGRAPHIC SCIENCES
The UNIVERSITY of OKLAHOMA

Weather & Climate Prediction

Numerical Weather Prediction (NWP)
Droegemeier, Lebo, McGovern, Parsons, Ruppert, X. Wang, Xue

Data Assimilation
Cavallo, Droegemeier, Loria-Salazar, Xue, X. Wang

Machine Learning/Artificial Intelligence (AI)
Kirstetter, McGovern, Pegion, X. Wang

Ensemble Forecasting
Droegemeier, Parsons, Pegion, X. Wang, Xue

Physical Process Parameterization
Klein, McFarquhar, Parsons, Salesky, C. Wang, Xue, Zhang

Meteorology

High Impact & Severe Weather
Biggerstaff, Bodine, Bluestein, Cavallo, Droegemeier, Furtado, Homeyer, Kirstetter, Martin, McGovern, Palmer, Parsons, Ruppert, Schvartzman, Xue, X. Wang

Mesoscale
Biggerstaff, Bodine, Bluestein, Cavallo, Droegemeier, Lebo, McGovern, Parsons, Ruppert, X. Wang, Xue

Synoptic Scale
Bluestein, Cavallo, X. Wang

Polar
Cavallo, Furtado, McFarquhar, Salesky, X. Wang

Boundary Layer, Urban Meteorology & Turbulence
Bodine, Klein, Loria-Salazar, Palmer, Salesky, C. Wang

Cloud and Precipitation Properties & Processes
Biggerstaff, Homeyer, Kirstetter, McFarquhar, Lebo, Redemann, Ruppert, Sakaeda, Salesky, X. Wang, Xue, Zhang

Hydrometeorology
Kirstetter, C. Wang, Zhang

Cloud Electrification
Biggerstaff, Schvartzman

Climate

Tropical
Furtado, Martin, Pegion, Sakaeda, Xue, Homeyer

Aerosol-Cloud Interactions
Homeyer, Lebo, McFarquhar, Redemann, Xu

Variability and Change
Cavallo, Furtado, Lebo, Martin, Pegion, Sakaeda, C. Wang, Xue

Subseasonal-to-Seasonal (S2S)
Furtado, Martin, Pegion, Sakaeda

Droughts & Floods, Precipitation Extremes & Variability
Basara, Kirstetter, Martin, Pegion, Xue

Atmospheric Composition

Chemical Transport
Homeyer, Klein, Loria-Salazar, Redemann, Salesky

Air Quality/Pollution
Klein, Salesky, Homeyer, Loria-Salazar, C. Wang

Fire Weather
McGovern, Loria-Salazar

Cloud & Precipitation Microphysics
Biggerstaff, Kirstetter, Schvartzman, Xue, Zhang

Aerosols
Loria-Salazar, Redemann, Xu

Radiation & Remote Sensing

Radar Observations
Biggerstaff, Bodine, Bluestein, Droegemeier, Homeyer, Kirstetter, Palmer, Parsons, Schvartzman, Zhang

Surface Active
Bluestein, Klein, Kirstetter, Palmer, Parsons, Zhang

Light Scattering & Radiative Transfer Theory
Redemann, Xu, Zhang

Satellite & Airborne Observations & Retrievals
Homeyer, Kirstetter, Loria-Salazar, McFarquhar, Redemann, Schvartzman, Xu

OU - School of Meteorology

CHEWe group – Climate, Hydrology, Ecosystems, Weather

Group Lead: Jeffrey Basara (jbasara@ou.edu)

Group members: J. Christian, R. Wakefield, N. Brauer, D. Woods, S. Edris, T. Grace, B. Puxley, A. Woodward, D. Mesheske, B. Illston, E. West

Key research themes

1. Drought – Intensification, Evolution, and Persistence
2. Excessive Precipitation – Flash Flood, Pluvial Dynamics, Landfalling and Post-Landfall Tropical Cyclones
3. Land-Atmosphere Exchange and Coupling

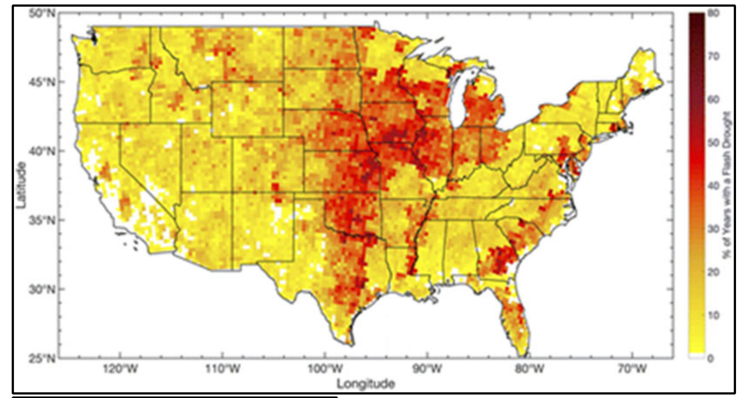
Key references

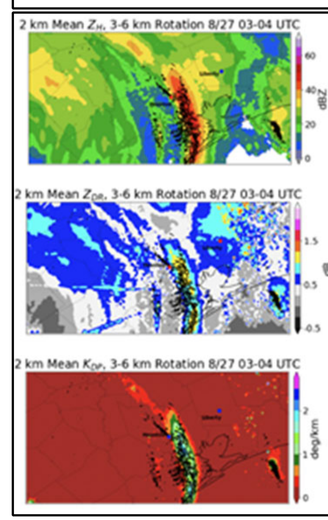
1.Christian, J., Basara, J. B., Otkin, J., Hunt, E., Wakefield, R., Flanagan, P., Xiao, X., 2019: A Methodology for Flash Drought Identification: Application of Flash Drought Frequency Across the United States. *Journal of Hydrometeorology, 20, 833–846.*

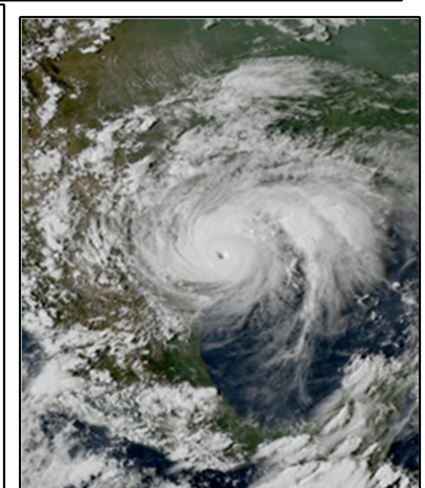
2.Flanagan, P.X., J.B. Basara, J.C. Furtado, E.R. Martin, and X. Xiao, 2019: Role of Sea Surface Temperatures in Forcing Circulation Anomalies Driving United States Great Plains Pluvial Years. *J. Climate*, **32**, 7081–7100.

3.Wakefield, R.A., J.B. Basara, J.C. Furtado, B.G. Illston, C.R. Ferguson, and P.M. Klein, 2019: A Modified Framework for Quantifying Land-Atmosphere Covariability during Hydrometeorological and Soil Wetness Extremes in Oklahoma. *J. Appl. Meteor. Climatol.,* 58, 1465–1483.

4.Brauer, N., Basara, J. B., Homeyer, C. R., McFarquhar, G., Kirstetter, P.-E., 2020: Quantifying Precipitation Efficiency and Drivers of Excessive Precipitation in Post-Landfall Hurricane Harvey. *Journal of Hydrometeorology* ,**21**, 433–452.







OU - School of Meteorology

SMART Radar Storm Dynamics Group

Group Lead: Michael Biggerstaff (drdoppler@ou.edu)

Group members: Gordon Carrie, Addison Alford, Alec Prosser, Emily Blumenauer, Jeffrey Stevenson, Robert Moore, Bobby Standford

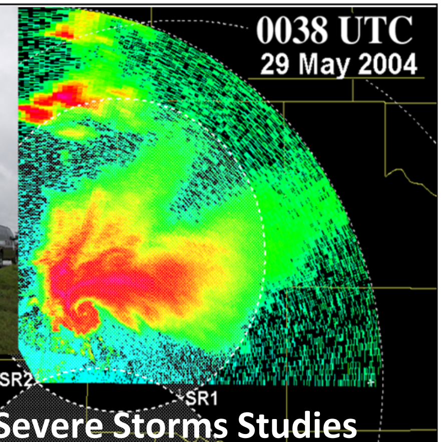
Key research themes

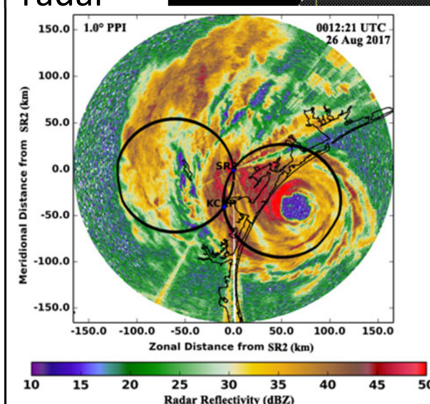
1. Mobile C-band dual-polarimetric radar— Director, SMART radar program
2. Hurricanes— Dynamics and microphysics of landfalling storms
3. Cloud Electrification— Lightning, microphysics, and dynamics relations
4. Severe Storms— Supercell and tornado dynamics; multicell storm dynamics and microphysics

Key references

1. Alford, A. A., M. I. Biggerstaff, G. D. Carrie, J. L. Schroeder, B. D. Hirth, and S. M. Waugh, 2019: Near-surface maximum winds during the landfall of Hurricane Harvey. *Geophys. Res. Lett.*, **46**, 973-982. *doi: 10.1029/2018GL080013.*
2. Betten, D. P., M. I. Biggerstaff, and C. L. Ziegler, 2018: Three-dimensional storm structure and low-level boundaries at different stages of cyclic mesocyclone evolution in a high-precipitation tornadic supercell. *Advances in Meteor.*, 2018, 24 pp. *doi:10.1155/2018/9432670.*
3. Biggerstaff, M. I., Z. Zounes, A. A. Addison, G. D. Carrie, J. T. Pilkey, M. A. Uman, and D. M. Jordan, 2017: Flash propagation and inferred charge structure relative to radar-observed ice alignment signatures in a small Florida Mesoscale Convective System, *Geophys. Res. Lett.*, **44**, 8027-8036, *doi:10.1002/2017GL074610.*

Mobile radar





Hurricane Dynamics & Microphysics

OU - School of Meteorology

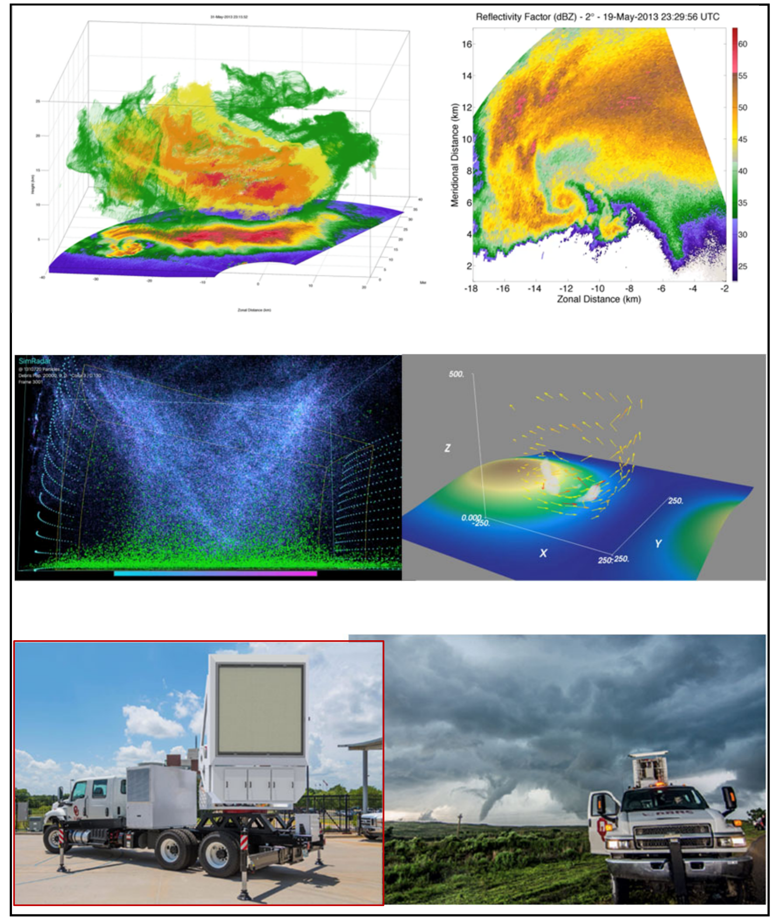
Radar and Severe Weather Research Group

Group Lead: David Bodine (bodine@ou.edu)

Group members: Dominic Candela, Brandon Cohen, Rachael Cross, Sam Emmerson, Nathan Kuhr, Omitusa Oluwafemi, Laura Shedd, Savannah Southward, Min-Duan Tzeng

Key research themes

1. Phased array and polarimetric radar analyses of convective storms
2. Simulations of tornadoes and interactions with buildings and terrain
3. Intercomparisons between radar observations and numerical models
4. Radar simulation studies for future operational radar networks
5. Developing and fielding high-impact radar technologies for weather research



Key references

1. Griffin, C. B., D. J. Bodine, J. M. Kurdzo, A. Mahre, and R. D. Palmer, 2019: High-temporal resolution observations of the 27 May 2015 Canadian, Texas, tornado using the Atmospheric Imaging Radar. *Mon. Wea. Rev.*, **147,** 873 – 891.

2. Palmer, R., D. Bodine, and coauthors, 2022: A primer on phased array radar technology for the atmospheric sciences. Bull. Amer. Meteor. Soc., in press.

3. Satrio, M., D. J. Bodine, A. E. Reinhart, T. Maruyama, and F. T. Lombardo, 2020: Understanding how complex terrain impacts tornado dynamics using a suite of high-resolution numerical simulations. *J. Atmos. Sci.,* **77,** 3277 – 3300.

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Convective Storms and Tornadoes Group

Group Lead: Howard (Howie ”Cb”) Bluestein (hblue@ou.edu)

Group members: Dylan Reif, Trey Greenwood, Boonleng Cheong

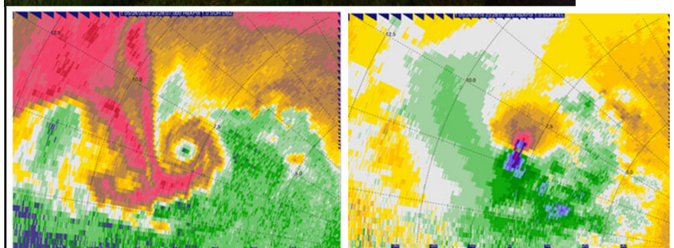
Key research themes

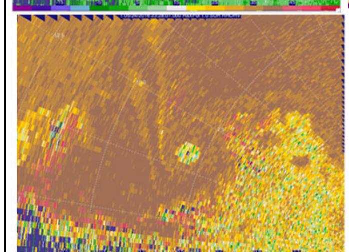
1. Tornadogenesis and the structure of supercell tornadoes
2. Supercell structure and evolution
3. Convective-storm initiation and planetary boundary-layer behavior
4. Nocturnal elevated convection in the central Plains of the U. S.

Key references

1. Bluestein, H. B., K. J. Thiem, J. C. Snyder, and J. B. Houser, 2018: The multiple-vortex structure of the El Reno, Oklahoma tornado on 31 May 2013. *Mon. Wea. Rev.*, **146**, 2483 – 2502.
2. Bluestein, H. B., K. J. Thiem, J. C. Snyder, and J. B. Houser, 2019: Tornadogenesis and early tornado evolution in the El Reno, Oklahoma supercell on 31 May 2013. *Mon. Wea. Rev.*, **147**, 2045 – 2066.
3. Bluestein, H. B., G. S. Romine, R. Rotunno, and D. W. Reif, 2018: On the anomalous counterclockwise turning of the surface wind with time in the Plains of the United States. *Mon. Wea. Rev.*, **146**, 467 – 484.
4. Reif, D. W., and H. B. Bluestein, 2018: Initiation mechanisms of nocturnal convection without nearby surface boundaries over the central and southern Great Plains during the warm season. *Mon. Wea. Rev.*, **146**, 3053 – 3078.
5. Bluestein, H. B., D. T. Lindsey, D. Bikos, D. W. Reif, and Z. B. Wienhoff, 2019: The relationship between overshooting tops in a tornadic supercell and its evolution at mid and low levels. *Mon. Wea. Rev., **147***, 4151 -4176.

RaXPol probing a tornado on 24 May 2016 SW of Dodge City, KS





RaXPol observations of: reflectivity (upper left), Doppler velocity (upper right), and co-polar cross-correlation coefficient (debris signature) in the tornado shown in the photo

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AAARG (Arctic And Antarctic Research Group)

Group Lead: Steven Cavallo (cavallo@ou.edu)

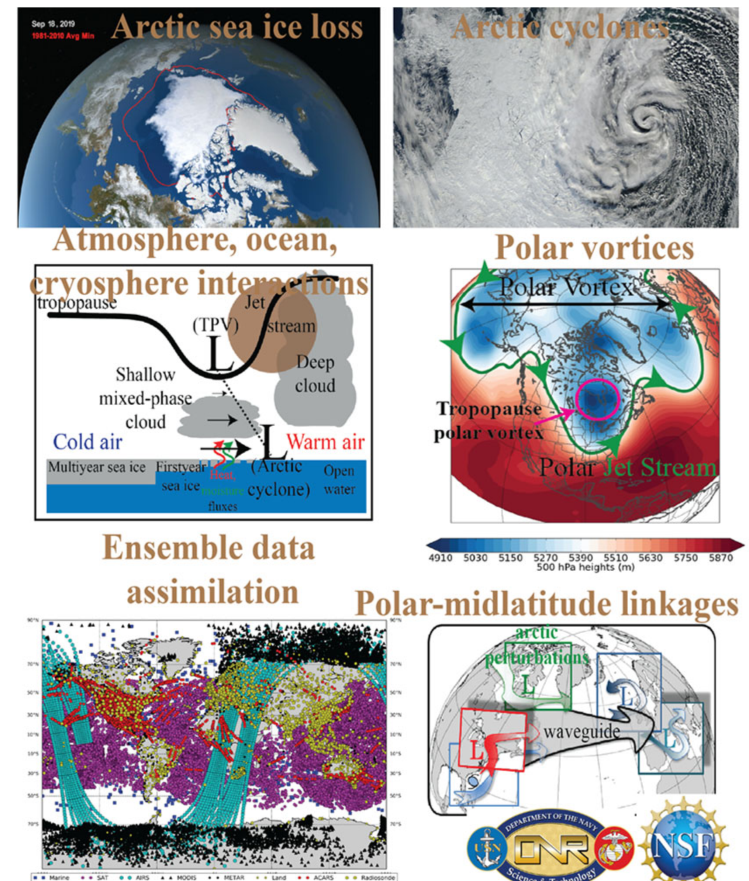
Group members: M. Bray, T. Burg, M. Frank, J. Kyle, S. Lillo, D. Lusk, I. Majhi, R. Pajela, D. Parsons, C. Rattray, C. Riedel, B. Schenkel, A. Woodward

Key research themes:

1. Polar regions weather and climate processes
2. High latitude atmospheric dynamics and cryosphere interactions
3. Linkages between polar and midlatitude processes
4. Global, nonhydrostatic, Earth-system coupled multi-scale modeling of weather and climate phenomena
5. Ensemble data assimilation and upper-troposphere lower-stratosphere observations in polar regions

Key references

1. Cavallo, S.M. and G.J. Hakim, 2013: Physical mechanisms of tropopause polar vortex intensity change, *J. Atmos. Sci.*, **70**, 3359-3373.
2. Cavallo, S.M., J. Berner, and and C. Snyder, 2016: Diagnosing Model Errors from Time-Averaged Tendencies in the Weather Research and Forecasting (WRF) Model, *Mon. Wea. Rev.*, **144 (2)**. 759-779.
3. Cavallo, S. M. and G. J. Hakim, 2010: The composite structure of tropopause polar cyclones from a mesoscale model. *Mon. Wea. Rev.* , **138 (10)** , 3840-3857, doi:10.1175/ 2010MWR3371.1.



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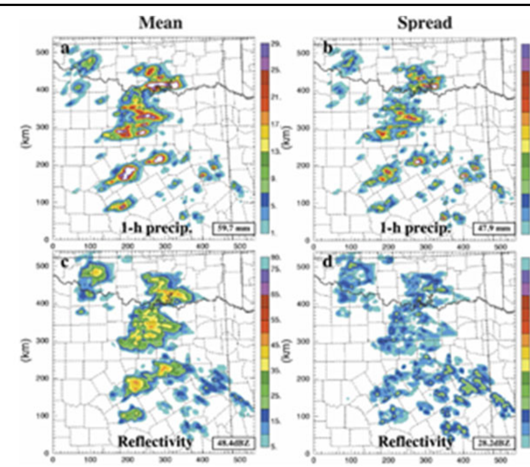
Dr. Kelvin Droegemeier (kkd@ou.edu)

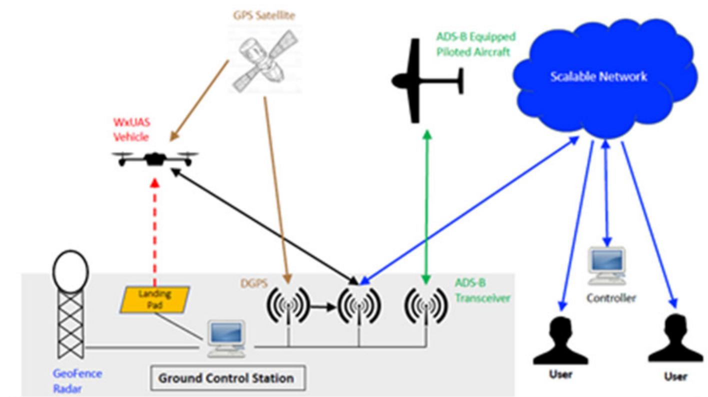
Key research themes:

1. Dynamics and Predictability of Deep Convective Storms
2. Storm-Scale Numerical Prediction and Data Assimilation
3. Computational Fluid Dynamics
4. Aviation Weather
5. The Academic Research Enterprise
6. Science Policy

Key references

1. Dong, J., M. Xue and K.K. Droegemeier 2011: The analysis and impact of simulated high-resolution surface observations in addition to radar data for convective storms with an ensemble Kalman filter. *Meteor. Atmos. Phys*, **112**, 41-61.
2. Droegemeier, K.K. and Co-Authors, 2017: The Roles of Chief Research Officers at American Research Universities: A Current Profile and Challenges for the Future. *J. Res. Admin*., **48**, 26-64.
3. Chilson, P.B. and Co-Authors, 2019: Moving towards a Network of Autonomous UAS Atmospheric Profiling Stations for Observations in the Earth's Lower Atmosphere: The 3D Mesonet Concept. *Sensors*, 19**,** 2720, 23pp. doi:10.3390/s19122720.
4. Droegemeier, K.K. and N.A. Jacobs, 2021: Restructuring of U.S. Federal Coordination to Advance Meteorological Services. In press for *Bull. Amer. Meteor. Soc.*
5. Droegemeier, K.K., 2021: *Demystifying the Academic Research Enterprise*. MIT Press (evaluation in progress).





OU - School of Meteorology

Applied Climate Dynamics (https://ifurtado.org)

Group Lead: Jason C. Furtado (jfurtado@ou.edu)

Group Members: Ty Dickinson, Oliver Millin, and Katie Giannakopoulos

Key research themes

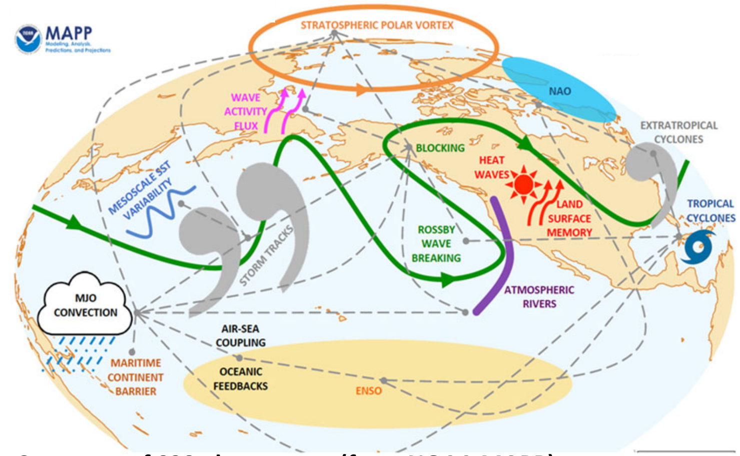
1. Large-scale climate dynamics and interactions of multiple modes
2. Subseasonal-to-seasonal (S2S) forecasting
3. Extratropical stratosphere-troposphere coupling dynamics
4. Pacific climate variability (seasonal to multi-decadal)
5. Climate change

Key references

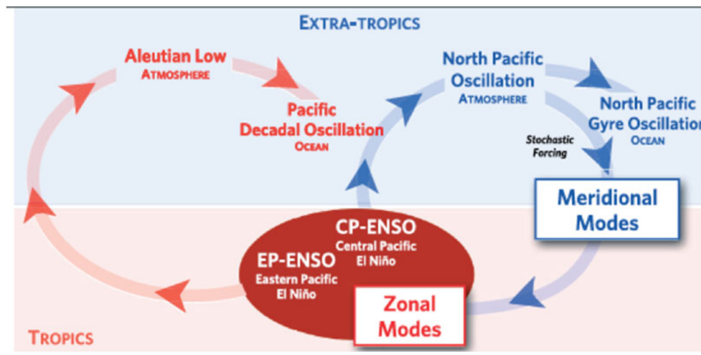
1.Furtado, J. C., J. Cohen, E. J. Becker, and D. C. Collins, 2021: Evaluating the relationship between sudden stratospheric warmings and tropospheric weather regimes in the NMME Phase-2 models. *Climate Dyn.*, https://doi.org/10.1007/s00382-020-05591-x.

2. Dickinson, T. A., M. B. Richman, and J. C. Furtado, 2021: Subseasonal to seasonal extreme precipitation events in the contiguous United States: Generation of a database and climatology. *J. Climate*, **34**, 7571-7586.

3.You, Y. and J. C. Furtado, 2018: The South Pacific Meridional Mode and its role in tropical Pacific climate variability. *J. Climate*, **31**, 10141–10163.



Summary of S2S phenomena (from NOAA MAPP)



Paradigm of Pacific climate variability (*Di Lorenzo et al.*, 2015)

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CCC – Convection, Chemistry, and Climate

Group Lead: Cameron Homeyer (chomeyer@ou.edu)

Group members: Elisa Murillo, Amanda Murphy, Emily Tinney, Andrea Gordon, Amanda Burke, Rachael Auth, and Kiley Allen

Key research themes

1. Overshooting Convection and Stratosphere-Troposphere Exchange (STE)
2. Tropopause Definition, Characteristics, and Change
3. Radar and Satellite Meteorology, with a focus on Severe Storms
4. Airborne Observations of the Upper Troposphere and Lower Stratosphere

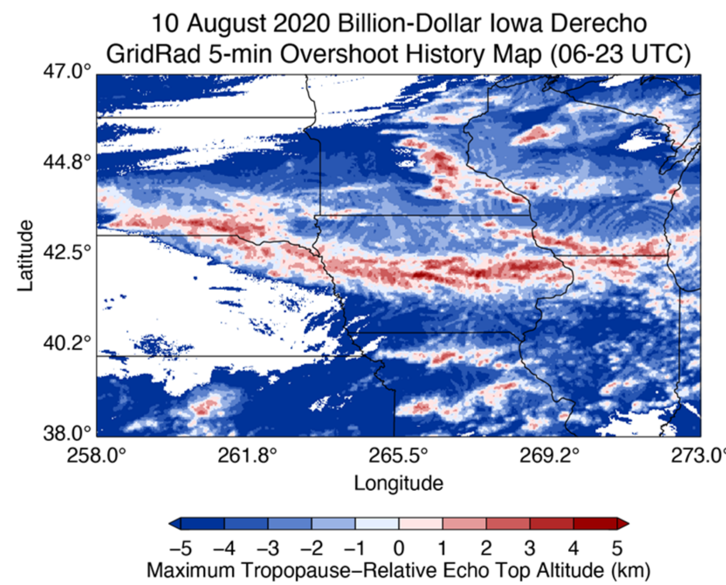
Key references

1. Homeyer, C. R., and K. P. Bowman, 2021: A 22-Year Evaluation of Convection Reaching the Stratosphere over the United States, J. Geophys. Res. Atmos., 126, doi:10.1029/2021JD034808
2. Murillo, E. M., C. R. Homeyer, and J. T. Allen, 2021: A 23-Year Severe Hail Climatology using GridRad MESH Observations, Mon. Wea. Rev., 149, 945–958, doi:10.1175/MWR-D-20-0178.1
3. Tinney, E. N., and C. R. Homeyer, 2021: A 13-year Trajectory-Based Analysis of Convection-Driven Changes in Upper Troposphere Lower Stratosphere Composition over the United States, J. Geophys. Res. Atmos., 126, doi:10.1029/2020JD033657
4. Homeyer, C. R., T. N. Sandmæl, C. K. Potvin, and A. M. Murphy, 2020: Distinguishing Characteristics of Tornadic and Nontornadic Supercell Storms from Composite Mean Analyses of Radar Observations, Mon. Wea. Rev., 148, 5015–5040, doi:10.1175/MWR-D-20-0136.1

DCOTSS

NASA Earth Venture Suborbital 3

Dynamics and Chemistry of the Summer Stratosphere



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Hydrometeorology

Group Lead: Pierre Kirstetter

Group members: S. Upadhyaya, Y. Derin, N. Brauer, D. Woods, A. Potdar, J. Duarte

Key research themes

1. Atmospheric and surface water cycle
2. Ground-based and satellite precipitation observations
3. Water vapor satellite observations
4. Extreme weather events and related hazards
5. Observation platform development: stratospheric radar

Key references

1. Kirstetter, P., et al., 2012: Toward a Framework for Systematic Error Modeling of Spaceborne Precipitation Radar with NOAA/NSSL Ground Radar–Based National Mosaic QPE. J. Hydrometeor., 13, 1285–1300, https://doi.org/10.1175/JHM-D-11-0139.1
2. Skofronick-Jackson, G., W. Petersen, W. Berg, C. Kidd, E. Stocker, D. Kirschbaum, R. Kakar, S. Braun, G. Huffman, T. Iguchi, P.E. Kirstetter, et al., 2017: Global Precipitation Measurement for Science and Society. Bulletin of the American Meteorological Society, 98, 1679-1695. doi: 10.1175/BAMS-D-15-00306.1
3. Kirstetter, P.E., et al., 2015: Probabilistic Precipitation Rate Estimates with Ground-based Radar Networks. Water Resources Research, 51, 1422–1442. doi:10.1002/2014WR015672

Improving the Earth's atmospheric water cycle observations, knowledge, and prediction

OU - School of Meteorology

BLISS Group: Boundary Layer Integrated Sensing and Simulation

Faculty Leads: Petra Klein and Evgeni Fedorovich

Group members: Tyler Bell, Phil Chilson, Josh Gebauer, Jeremy Gibbs, Liz Pillar-Little, Alan Shapiro, Elizabeth Smith

Key research themes

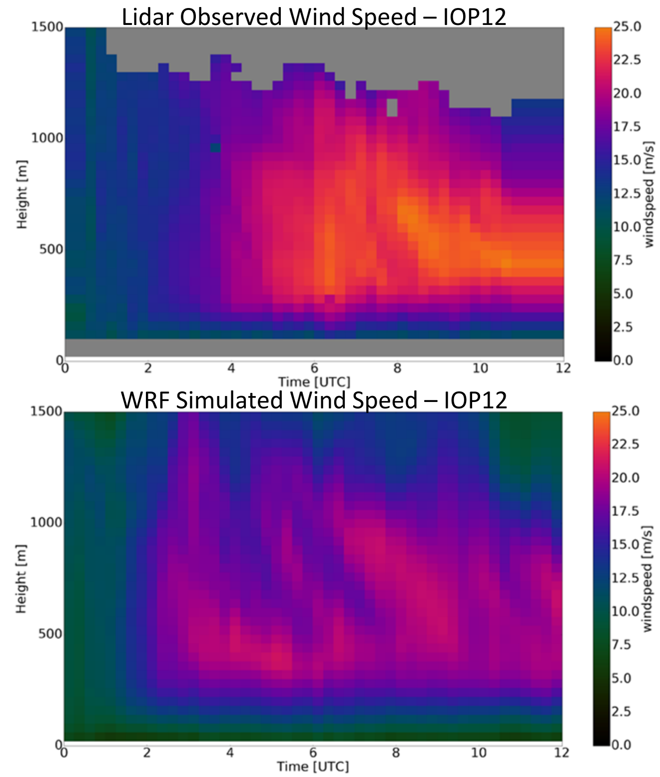
1. Atmospheric boundary-layer profiling using remote techniques (radars, lidars, sodars, radiometers) and unmanned aerial vehicles (UAVs)
2. Numerical and analytical model studies of boundary-layer and related flow phenomena (urban-canopy flows, slope winds, low-level jets)
3. High-resolution numerical simulations of atmospheric turbulence

Key references

Klein P. M., X. M. Hu, A. Shapiro, and M. Xue, 2016: Linkages between boundary-layer structure and the development of nocturnal low-level jets in central Oklahoma. *Bound.-Layer Meteor.,* **158**, 383-408.

Fedorovich, E., J. A. Gibbs, and A. Shapiro, 2017: Numerical study of nocturnal low-level jets over gently sloping terrain. *J. Atmos. Sci.,* **74**, 2813–2834.

Smith, E. N, J. A. Gibbs, E. Fedorovich, P. M. Klein, 2018: WRF model study of the Great Plains low-level jet. *J. Appl. Meteor. Climatol.,* **57**, 2375–2397.



Observed and simulated wind speeds during one of the PECAN low-level jet IOPs

OU - School of Meteorology

Aerosols, Clouds, and Convection Group

Group Lead: Zachary Lebo (zachary.lebo@ou.edu)

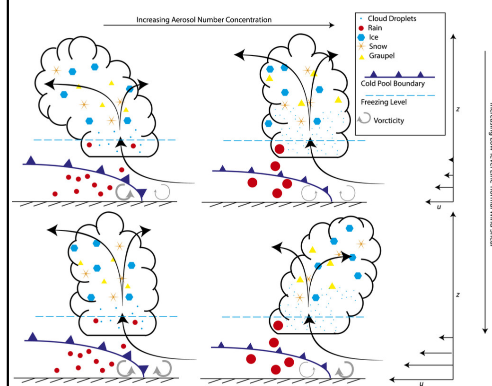
Group members: Yishi Hu (PhD student) and Ali Al Jabri (PhD student)

Key research themes

1. Aerosol-cloud-precipitation interactions in moist deep convection
2. Dynamical downscaling of climate models
3. Relation between environmental factors and convective storm dynamics
4. Parameterization and development and numerical weather prediction

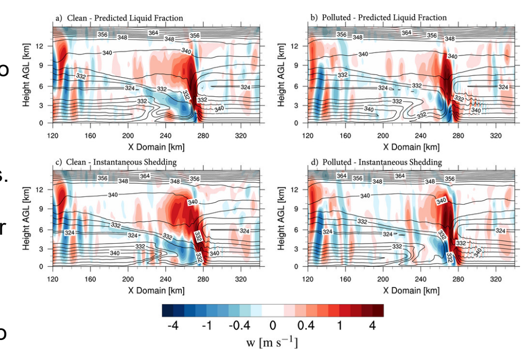
Key references

1. Rahimi, S., W. Krantz, Y.-H. Lin, B. Bass, N. Goldenson, A. Hall, and Z. J. Lebo (2021), Evaluation of a reanalysis-driven configuration of WRF4 over the Western United States from 1980-2020, J. Geophys. Res., 127, e2021JD035699, doi: 10.1029/2021JD035699.
2. Kacan, K. G., and Z. J. Lebo (2019), Microphysical and dynamical effects of mixed-phase hydrometeors in convective storms using a bin microphysics model: Melting, Mon. Wea. Rev., 147, 4437-4460, doi: 10.1175/MWR-D-18-0032.1.
3. Lebo, Z. J. (2018), A numerical investigation on the effects of enhanced latent heat release in deep convective clouds relative to other factors, J. Atmos. Sci., 75, 535-554, doi:10.1175/JAS-D-16-0368.1.



Schematic showing the competing effects of low-level wind shear and aerosol loading in the dynamics of squall lines from Lebo and Morrison (2014, JAS).

Sensitivity of a simulated squall line to the representation of melting graupel and hail in clean and polluted environments. Instantaneous shedding of meltwater leads to colder cold pools and more tilted and weaker updrafts. From Kacan and Lebo (2019, JAS).



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Atmospheric Aerosol and Air Quality Laboratory (AAAQ Lab)

Group Lead: S. Marcela Loría-Salazar (mloria@ou.edu)

Group members: Jeffree Lee and Hayden Webb

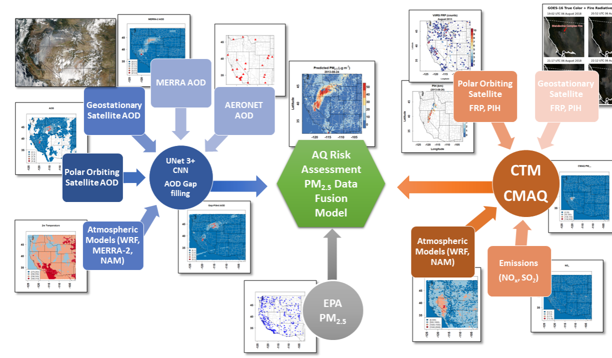
Key research themes

1. Satellite remote sensing evaluation and applications, 2. AQ data assimilation using numerical weather prediction models and satellite retrievals, 3. Field experiments, 4. Aerosol transport and relationships with atmospheric physical phenomena, 5. Big data, 6.Atmospheric inversion

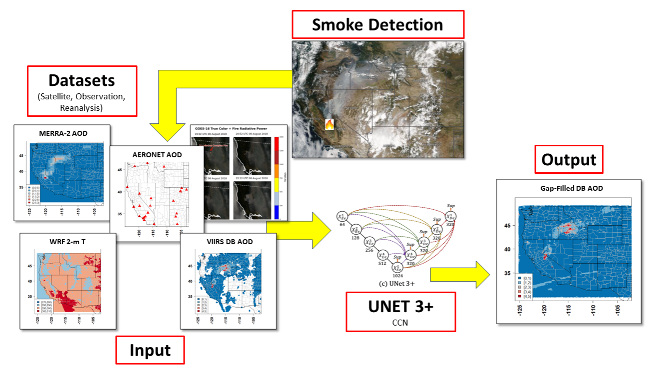
Key references

- Shuman, J. K., Loría-Salazar, S. M., et al. Reimagine fire science for the anthropocene. PNAS Nexus 1, pgac115 (2022).
- Loría-Salazar, S. M., Sayer, A. M., Barnes, J., Huang, J., Flynn, C., Lareau, N., et al. (2021). Evaluation of Novel NASA Moderate Resolution Imaging Spectroradiometer and Visible Infrared Imaging Radiometer Suite Aerosol Products and Assessment of Smoke Height Boundary Layer Ratio During Extreme Smoke Events in the Western USA. Journal of Geophysical Research: Atmospheres, 126(11), e2020JD034180. https://doi.org/10.1029/2020JD034180
- Loría-Salazar, S.M., Panorska, A., Arnott, W.P., Barnard, J.C., Boehmler, J.M., Holmes, H.A., 2017. Toward understanding atmospheric physics impacting the relationship between columnar aerosol optical depth and near-surface PM2.5 mass concentrations in Nevada and California, U.S.A., during 2013. Atmos. Environ. 171, 289–300. http://dx.doi.org/10.1016/j.atmosenv.2017.10.023

Satellite-Derived Data Fusion Model



Satellite AOD gap-filling with ML



OU - School of Meteorology

Climate Variability and Change Group

Group Lead: Elinor Martin (elinor.martin@ou.edu)

Group members: Gabe Bromley, Adrienne Wootten, Melanie Schroers, Margaret Hollis, Bryony Puxley, Audrey Brandon, Devin McAfee

Key research themes

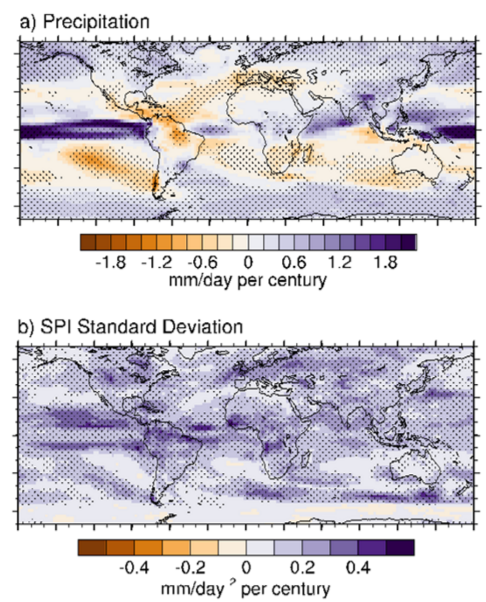
1. Precipitation variability from sub-seasonal to centennial
2. Precipitation extremes including pluvials and droughts
3. Tropical weather-climate interactions, climate variability, and change
4. Applied climate change science in the South Central United States

Key references

1. Martin, E. R. (2018). Future Projections of Global Pluvial and Drought Event Characteristics. *Geophys. Res. Lett*.. https://doi.org/10.1029/2018GL079807.
2. Brannan, A. L., Martin, E. R. (2019). Future Characteristics of African Easterly Wave Tracks. *Climate Dynamics.* 52, 5567-5584, https://doi.org/10.1007/s00382-018-4465-z.
3. Danco, J., and Martin, E. R. (2017) "Understanding the influence of ENSO on the Great Plains low-level jet in CMIP5 models." *Climate Dynamics*, doi: https://doi.org/10.1007/s00382-017-3970-9.

PRES^{2}iP

Prediction of Rainfall Extremes at Sub-seasonal to Seasonal Periods



Future trends in precipitation and precipitation variability

OU - School of Meteorology

Cloud Physics Group

Group Lead: Greg M. McFarquhar (mcfarq@ou.edu)

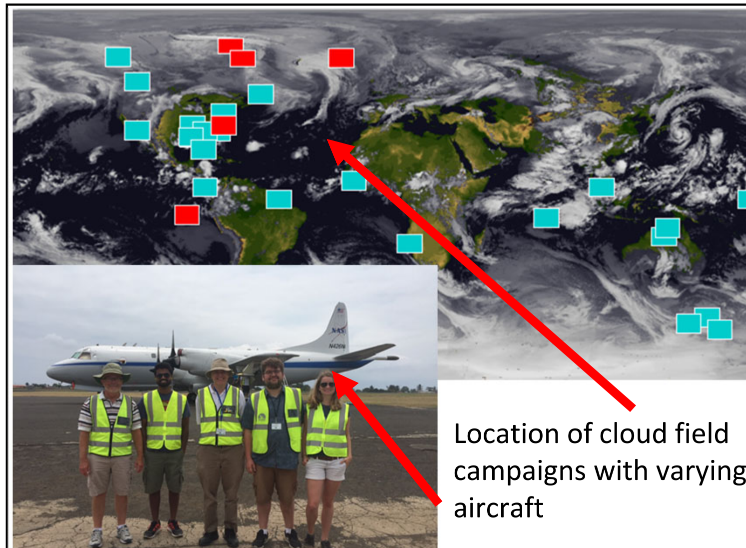
Group members: Peter Brechner (G), John D'Alessandro (G), Andrew Dzambo (P), Siddhant Gupta (G), Christian Hall (G), Yachao Hu (V), Qing Niu (G), Saurabh Patil (G), Jonah Pehl (G), Yayun Qiao (G), Logan Roy (G), Ethan Schaefer (UG), Julian Schima (UG), Wei Wu (RS), Hazel Xia (G)

Key research themes

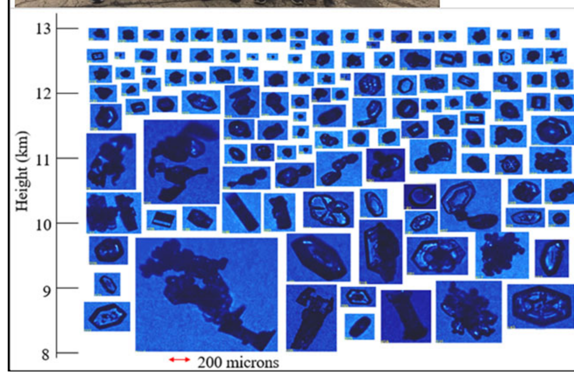
1. Observations of cloud microphysical properties using aircraft
2. Impact of cloud-aerosol Interactions on water and energy cycles
3. Cloud-radiative Interactions
4. Winter storms, tropical convection, Arctic and Southern Ocean clouds
5. Representation of cloud processes in models

Key references

1. McFarquhar, G.M., et al., 2021: Unique observations of clouds, aerosols and precipitation over the Southern Ocean: An overview of CAPRICORN, MARCUS, MICRE and SOCRATES. *Bull. Amer. Meteor. Soc.*, Early Online Release, doi.org/10.1175/BAMS-D-20-0132.1.
2. McFarquhar, G.M., 2021: Rainfall microphysics. In Morbidelli R, editor: Rainfall. Modeling, Measurement and Applications, Amsterdam, 2021, Elsevier, In press.
3. Hu, Y., G.M. McFarquhar, et al., 2021: Dependence of ice microphysical properties on environmental parameters: Results from HAIC-HIWC Cayenne field campaign, *J. Atmos. Sci.*, In press.
4. Gupta, S., G.M. McFarquhar, et al., 2021: Impact of the variability in vertical separation between biomass-burning aerosols and marine stratocumulus on cloud microphysical properties over the Southeast Atlantic. *Atmos. Chem. Phys.*, **21**, 4615-4633, https://doi.org/10.5194/acp-21-4615-2021.



Location of cloud field campaigns with varying aircraft



E.g., of cloud particles measured during field campaigns

OU - School of Meteorology

NSFAI Institute for Research on Trustworthy AI in Weather, Climate, and Coastal Oceanography (AI2ES)

Group Lead: Amy McGovern (amcgovern@ou.edu)

Group members: David Harrison, Amanda Burke, Bethany Earnest, Grant Eckstein, Kendall Junker, Andrew Justin

Key research themes

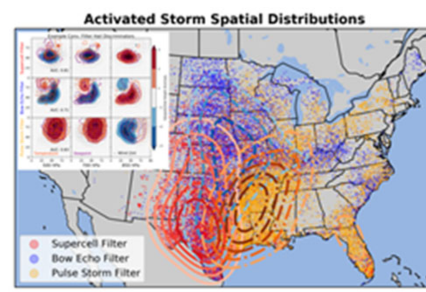
1. Trustworthy AI
2. Use-inspired research in Convective weather, Winter weather, S2S, Tropical Cyclones, Oceanography
3. Risk Communication

Key references

1.McGovern, Amy; Bostrom, Ann; Ebert-Uphoff, Imme; He, Ruoying; Thorncroft, Chris; Tissot, Philippe; Boukabara, Sid; Demuth, Julie; Gagne II, David John; Hickey, Jason; Williams, John K. (2020) Weathering Environmental Change Through Advances in AI. EOS, Volume 101, https://doi.org/10.1029/2020EO147065

2.McGovern, A., D.J. Gagne II, R. Lagerquist, K. Elmore, and G.E. Jergensen (2019) Making the black box more transparent: Understanding the physical implications of machine learning. Bulletin of the American Meteorological Society, Volume 100, Number 11, Pages 2175-2199. https://doi.org/10.1175/BAMS-D-18-0195.1

3.McGovern, Amy; Elmore, Kim; Gagne II, David John; Haupt, Sue Ellen; Karstens, Chris; Lagerquist, Ryan; Smith, Travis and J. K. Williams. Using Artificial Intelligence to Improve Real-time Decision Making for High-Impact weather. (2017) Bulletin of the American Meteorological Society. Volume 98, Issue 10, pages 2073-2090. https://doi.org/10.1175/BAMS-D-16-0123.1



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ARRC - Advanced Radar Research Center

Group Lead: Robert Palmer, ARRC Executive Director

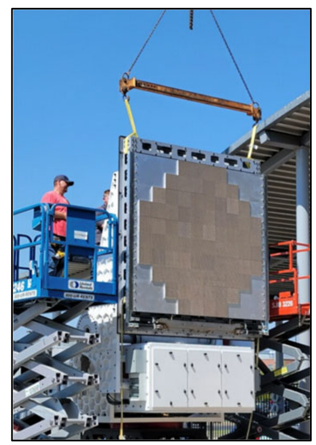
The ARRC (http://arrc.ou.edu) is an interdisciplinary research center focused on innovations in radar. Currently, the ARRC has 20 faculty members from engineering and meteorology, 80 graduate students and 24 technical support staff.

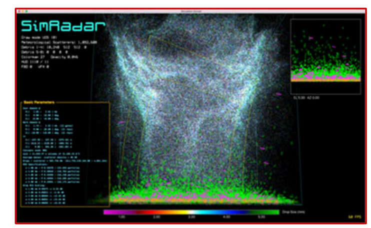
Key research themes

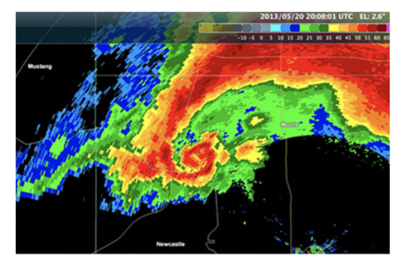
- Development of Novel Radar Solutions – Including Phased Array Radars
- Application of Array/Signal Processing to Weather Radar Problems
- Profiling Radar Techniques for Observations of the Optically Clear Atmosphere
- Waveform Design for Severe Weather Observations
- Passive Radar

Radar Innovations Laboratory (RIL)

The ARRC is located in the state-of-the-art RIL, which includes a large microwave lab, a high-bay garage for mobile radar platforms, prototype fabrication facilities, two precision anechoic chambers, an experimental observation deck, and a unique "Ideas Room" for fostering collaboration and innovation.







OU - School of Meteorology

Multi-scale Atmospheric Dynamics Research Group

Group Lead: David Parsons

Group members: A. Shapiro, S. Lillo*, C. Rattray*, M. Gomes*, J. Chiappa*

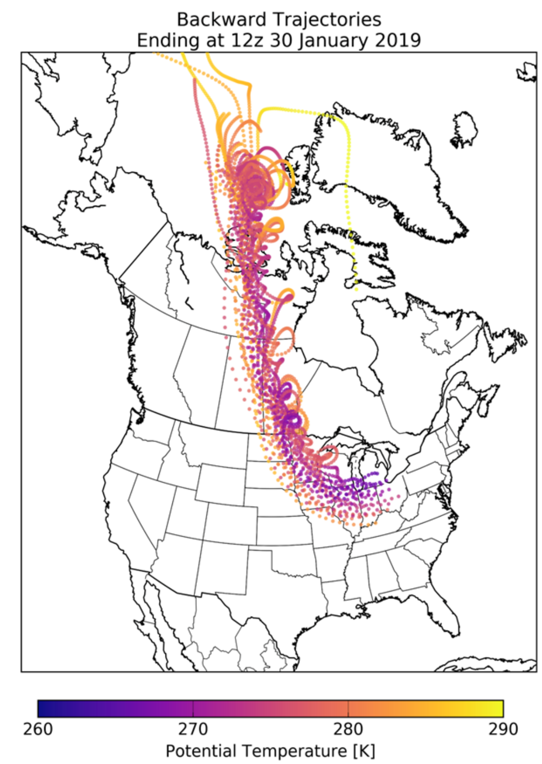
Key collaborators: P. Bechtold (ECMWF), S. Cavallo, J. Burzdak*, G. Zhang, and J. Ho* (SoM), S. Zhang (Nanjing Joint Institute), J. Methven, H. Croad*, S. Gray, and R. Plant (U Reading), and N. Roberts (Met Office) [*= current graduate student]

Research themes

1. Low-level jet, bores, and nocturnal convective systems
2. Extreme events in our changing climate
3. Dynamics and predictability of polar and middle latitude weather systems

Key references

1. Parsons, D.B., Haghi, K.R., Halbert, K.T., Elmer, B. and Wang, J., 2019. The potential role of atmospheric bores and gravity waves in the initiation and maintenance of nocturnal convection over the Southern Great Plains. *J. Atmos. Sci.*, *76*(1), pp.43-68.
2. Shapiro, A., Fedorovich, E. and Rahimi, S., 2016. A unified theory for the Great Plains nocturnal low-level jet. *Journal of Atmospheric Sciences*, *73*(8), pp.3037-3057.
3. Lillo, S. P. S. M. Cavallo, D.B. Parsons, C. Riedel, 2021: The role of a Tropopause Polar Vortex in the generation of the 2019 Extreme Arctic Outbreak J. Atmos. Sci, 78(9), 2801-2821.



Trajectories of air parcels associated with the Tropopause Polar Vortex that caused the 2019 extreme cold air outbreak

OU - School of Meteorology

Earth System Prediction Lab

Group Lead: Kathy Pegion (kpegion@ou.edu)

Group members: Guanoh Jheong (OU), Kai Huang (Mason)

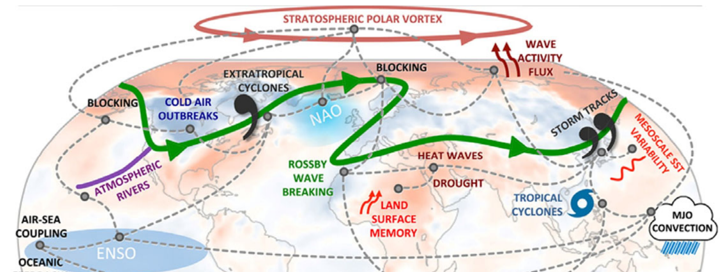
Key research themes

1. Subseasonal to Seasonal (S2S) Predictability & Prediction
2. Global Coupled Ocean-Atmosphere-Land models for understanding, simulating, and predicting S2S variability & predictability
3. Interpretable AI for understanding S2S predictability
4. Applications of Subseasonal to Seasonal Predictions

Key references

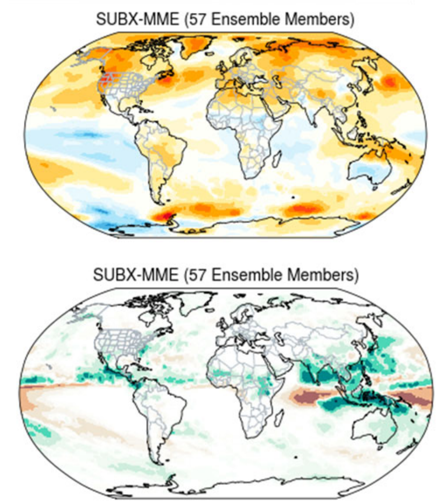
1. Pegion, K, E. J. Becker, B.P Kirtman, Understanding Predictability of Daily Southeast US Precipitation using Explainable Machine Learning, Under Revision in AI for Earth Systems.
2. Huang, K., & Pegion, K. (2022). The Roles of Westward-Propagating Waves and the QBO in Limiting MJO Propagation, *Journal of Climate* (published online ahead of print 2022)
3. Kim, H. M. A. Janiga, and K. Pegion, 2019: MJO Propagation Processes and Mean Biases in the SubX and S2S Reforecasts, Journal of Geophysical Research:Atmospheres, 124.https://doi.org/10.1029/2019JD031139
4. Pegion, K. and Co-authors, 2019: The Subseasonal Experiment (SubX): A multi-model subseasonal prediction experiment, BAMS, https://doi.org/10.1175/BAMS-D-18-0270.1

Better Forecasts. Better Decisions



S2S Sources of Predictability from Lang, Pegion, Barnes, 2020

Multi-model Forecasts from the Subseasonal Experiment (SubX)



OU - School of Meteorology

CL²EAR group - CLouds, CLimatE, Aerosols & Radiation

Group Lead: Jens Redemann (jredemann@ou.edu)

Group members: I. Chang, L. Gao, C. Flynn, E. Lenhardt, M. Logan, A. Fakoya, B. Lamkin

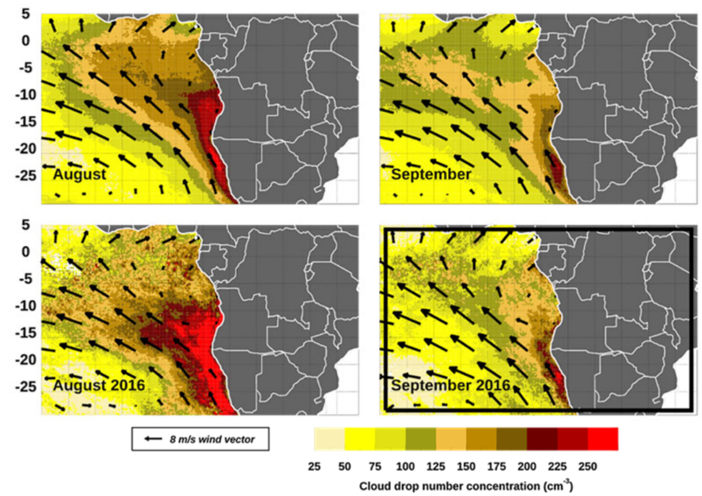
Key research themes

1. Global and regional scale aerosol-radiation-cloud interactions
2. Multi-satellite and airborne observations of aerosols and clouds
3. Airborne and ground-based radiation instrument development
4. Multi-scale climate and chemical transport model verification
5. Leadership - satellite (AOS) and aircraft observations (Earth-Venture)

Key references

1. Redemann, J., et al.: An overview of the ORACLES (ObseRvations of Aerosols above CLouds and their intEractionS) project: aerosol–cloud–radiation interactions in the southeast Atlantic basin, Atmos. Chem. Phys., 21, 1507–1563, https://doi.org/10.5194/acp-21-1507-2021, 2021
2. Pistone, et al.: Intercomparison of biomass burning aerosol optical properties from in-situ and remote-sensing instruments in ORACLES-2016, Atmos. Chem. Phys., https://doi.org/10.5194/acp-2019-142, 2019
3. Zuidema, P., et al., 2016: Smoke and Clouds above the Southeast Atlantic: Upcoming Field Campaigns Probe Absorbing Aerosol's Impact on Climate. Bull. Amer. Meteor. Soc., doi: 10.1175/BAMS-D-15-00082.1., 2016

NASA EVS-2 Mission logo: ORACLES (ObseRvations of Aerosols Above Clouds and Their IntEractionS)



Stratocumulus (Sc) cloud droplet number concentration in the SE Atlantic

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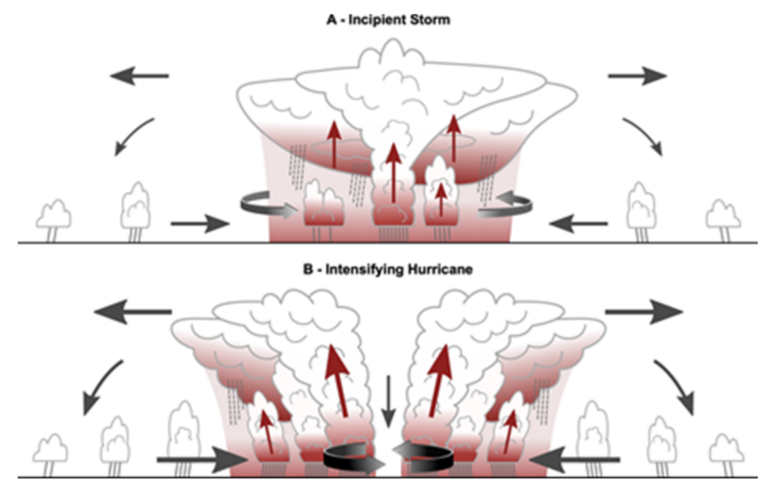
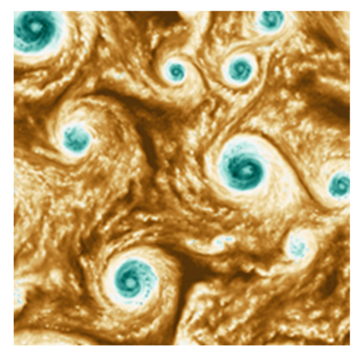
Convection Storm Dynamics Lab

Group Lead: James Ruppert (jruppert@ou.edu)

Group members: Theresa Lincheck, Emily Luschen





Key research themes

1. Convective storms and large-scale interaction
2. Tropical cyclones (hurricanes)
3. Weather–climate links
4. The Madden–Julian Oscillation
5. Cloud–radiation feedback

Key references

1. Ruppert, J. H., Jr., A. A. Wing, X. Tang, and E. L. Duran, 2020: The critical role of cloud–infrared radiation feedback in tropical cyclone development, *Proc. Natl. Acad. Sci.,* **117,** 27884–27892.
2. Ruppert, J. H., Jr., 2016: Diurnal timescale feedbacks in the tropical cumulus regime. *J. Adv. Model. Earth Syst.,* **8,** 1483–1500.
3. Ruppert, J. H., Jr., and R. H. Johnson, 2015: Diurnally modulated cumulus moistening in the pre-onset stage of the Madden–Julian oscillation during DYNAMO. *J. Atmos. Sci.,* **72,** 1622–1647.

OU - School of Meteorology

Sakaeda Research Group: Tropical Convective Variability and Its Links to Global Weather and Climate

Group Lead: Naoko Sakaeda

Group members: Hrag Najarian (PhD), Sadiksha Rai (PhD), Tatiana Esteva-Ingram (MS), Shun-Nan Wu (Postdoc), Grant Talkington (Undergrad)

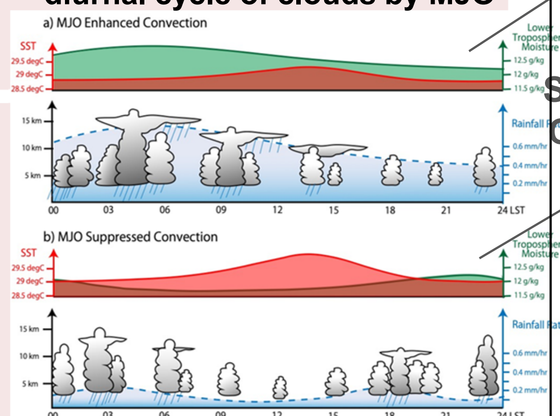
Key research themes

1. Dynamics of large-scale tropical convective variability
2. Interactions between tropical cloud organization and large-scale atmospheric variability
3. Sub-seasonal to seasonal variability
4. Tropical-extratropical interactions
5. Weather-climate interactions

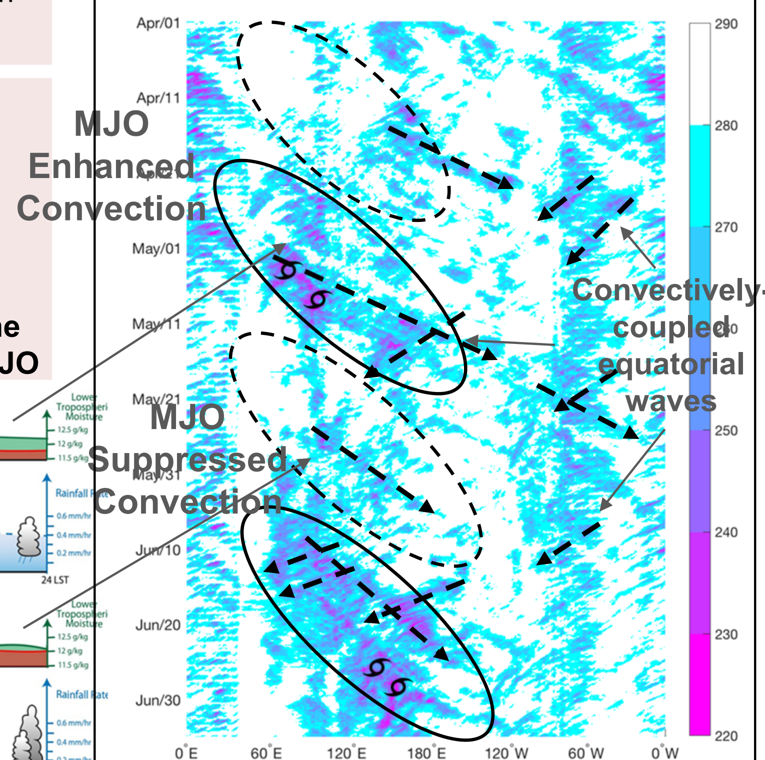
Key references

1. **Sakaeda, N.**, J. Dias, and G. Kiladis, 2020: The unique characteristics and potential mechanisms of the MJO-QBO relationship. *J. Geophys. Res. Atmos.*, 125, 17, e2020JD033196.
2. **Sakaeda, N.**, G. Kiladis, and J. Dias, 2020: The diurnal cycle of rainfall and the convectively coupled equatorial waves over the Maritime Continent. *J. Climate*, 33, 3307-3331.
3. **Sakaeda, N.**, Powell, S., Kiladis, G., and Dias, J., 2018: The diurnal variability of precipitating cloud populations during DYNAMO. *J. Atmos. Sci.*, **75**, 1307–1326.

Schematic of changes in the diurnal cycle of clouds by MJO



2002 April-July Brightness temperature averaged from 5°S to 15°N



OU - School of Meteorology

ART - Advanced Radar Techniques

Group Lead: David Schvartzman (dschvart@ou.edu)

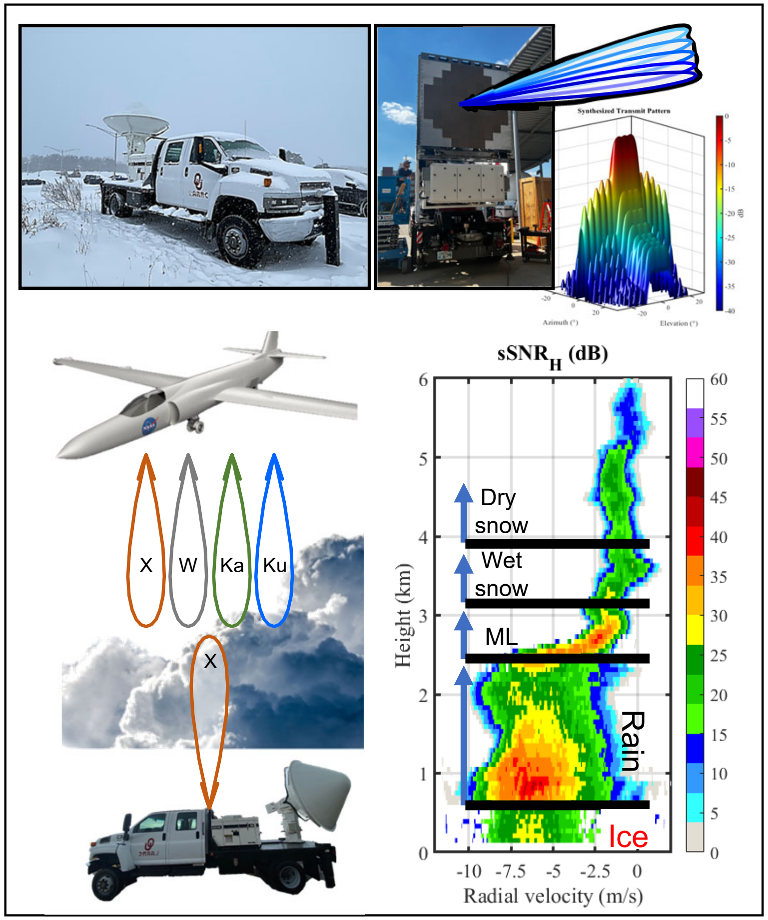
Group members: Yoon Kim (MS), Gwyneth Glanton (UG), Reece Reinke (MS), Gustavo Britto Hupsel de Azevedo (PhD)

Key research themes

- Development of Novel Scanning Concepts using Phased Array Radars
- Polarimetric Radar Observations and Polarimetric Spectral Densities for High-Impact Weather Events (lightning, snowstorms, refreezing microphysics)
- Signal Processing Methods for Phased Array Radar (e.g., waveform/antenna pattern synthesis)
- Multistatic Radar Observations (passive) for 3D wind retrievals

Key references:

1. D. Schvartzman, S. M. Torres and T. -Y. Yu, "Distributed Beams: Concept of Operations for Polarimetric Rotating Phased Array Radar," in IEEE Transactions on Geoscience and Remote Sensing, vol. 59, no. 11, pp. 9173-9191, Nov. 2021, doi: 10.1109/TGRS.2020.3047090.
2. D. Schvartzman, and C. Curtis. "Signal processing and radar characteristics (SPARC) simulator: A flexible dual-polarization weather-radar signal simulation framework based on preexisting radar-variable data." IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing.
3. D. Schvartzman, E. Bruning, T. Y. Yu, V. Chmielewski, D. Bodine, H. Bluestein, "Analysis of polarimetric spectral densities in severe thunderstorms for the identification of lightning-induced signatures", Proc. of Eleventh European Conference on Radar in Meteorology and Hydrology (ERAD 2022).
4. Zrnić, D., & Schvartzman, D. (2021). Phase codes for mitigating ambiguities in range and velocity. *Journal of Atmospheric and Oceanic Technology*, *38*(2), 313-329.



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Sustainable URban Futures (SURF) Lab

Group Lead: Chenghao Wang (chenghao.wang@ou.edu)

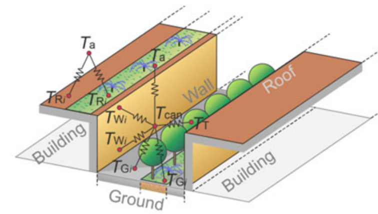
Group members: TBD

Key research themes

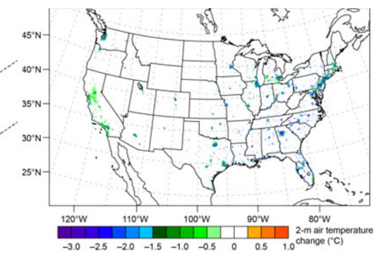
1. Multiscale urban climate modeling
2. Data analytics and complex systems
3. Energy consumption and carbon emissions in response to climate change
4. Impact of urban environment and climate change on public health

Key references

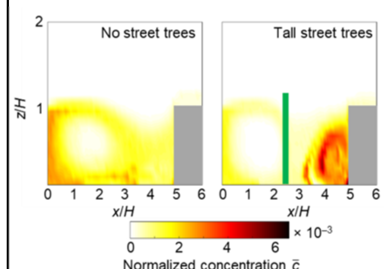
1. Wang, C., Li, Q., & Wang, Z.-H. (2018). Quantifying the impact of urban trees on passive pollutant dispersion using a coupled large-eddy simulation–Lagrangian stochastic model. *Building and Environment*, 145, 33–49.
2. Wang, C., Wang, Z.-H., & Yang, J. (2018). Cooling effect of urban trees on the built environment of contiguous United States. *Earth's Future*, 6(8), 1066–1081.
3. Wang, C., Wang, Z.-H., Wang, C. Y., & Myint, S. W. (2019). Environmental cooling provided by urban trees under extreme heat and cold waves in U.S. cities. *Remote Sensing of Environment*, 227, 28–43.
4. Wang, C., Wang, Z.-H., & Ryu, Y.-H. (2021). A single-layer urban canopy model with transmissive radiation exchange between trees and street canyons. *Building and Environment*, 191, 107593.
5. Wang, C., Sierra Huertas, D., Rowe, J. W., Finkelstein, R., Carstensen, L. L., & Jackson, R. B. (2021). Rethinking the urban physical environment for century-long lives: from age-friendly to longevity-ready cities. *Nature Aging*, 1, 1088–1095.



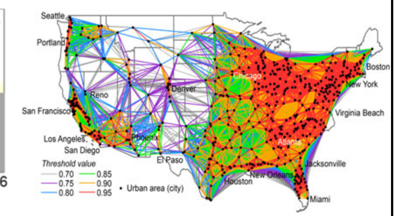
Single-layer urban canopy model



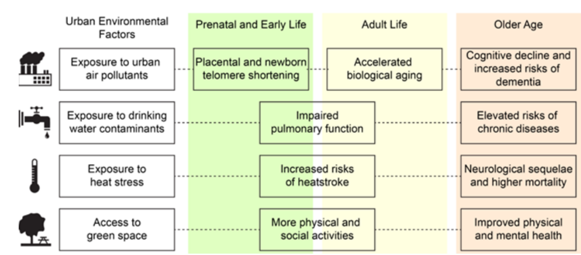
Mitigation of urban heat stress



Pollutant transport and dispersion in urban environments



Networks constructed based on urban climate



Long-term impacts of urban environments on health

OU - School of Meteorology

OU MAP Lab (Multiscale data Assimilation and Predictability)

weather.ou.edu/~map

Lab lead: Xuguang Wang (xuguang.wang@ou.edu)

18 Lab members: Faculty, Research scientists , Postdoc researchers, Graduate students, Undergraduate students

MAP students have won **29** awards!

Key research themes

i) **New method and theory for data assimilation, ensemble prediction, and model verification**

ii) **Data Assimilation, numerical modeling and prediction from global scale to convective scale**

iii) **Predictability and dynamics from global to convective scales**

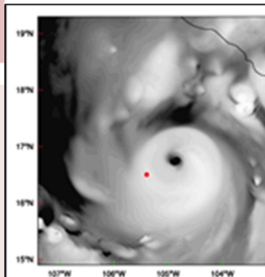
iv) **Interdisciplinary research**: e.g. machine learning and data assimilation

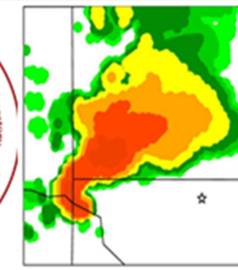
v) **Transitioning research to operations** (**O2R2O**)

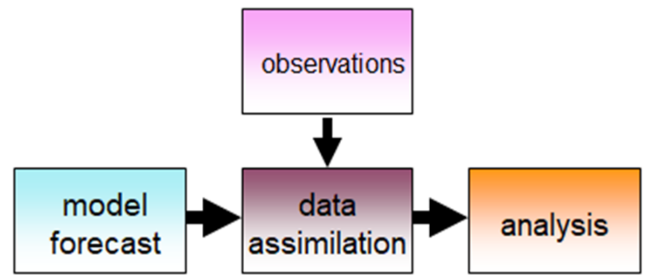
vi) **Scientific leadership** – e.g. co-lead of the observation and data assimilation task team to develop US Congress mandated Priorities for Weather Research (PWR) report (2021)

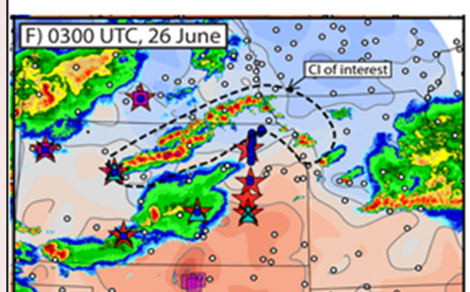
References

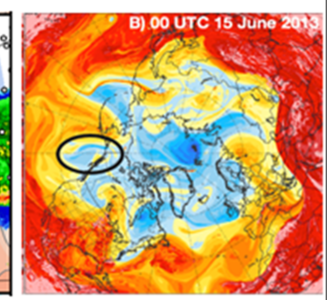
http://weather.ou.edu/~map/js/publication.html











OU - School of Meteorology

Atmospheric Radiation & Remote Sensing Group

Group Lead: Feng Xu (fengxu@ou.edu)

Group members: D. Nowicki, T. Huang, L. Gao, C. Flynn and Z. Zeng

Key research themes

1. Atmospheric inversion
2. Radiative transfer modeling and light scattering by small particles
3. Aerosol, cloud and ocean color remote sensing
4. Miniaturization of remote sensing instruments

Key references

1. F. Xu, et al. A correlated multi-pixel inversion approach for aerosol remote sensing, Remote Sensing, 11, 746, 2019.
2. F. Xu, et al. Coupled retrieval of cloud and aerosol above cloud properties using the Airborne Multiangle SpectroPolarimetric Imager, J. Geophys. Res. Atmos., 123, 3175-3204, 2018
3. F. Xu, et al. Coupled retrieval of aerosol properties and land surface reflection using the Airborne Multiangle SpectroPolarimetric Imager, J. Geophys. Res. Atmos. 122, 7004-7026, 2017.
4. F. Xu, et al. Joint retrieval of aerosol and water-leaving radiance from multi-spectral, multi-angular and polarimetric measurements over ocean, Atmos. Meas. Tech. 9, 2877-2907, 2016.

Our group focuses on developing remote sensing models, algorithms and instruments for accurately quantifying the amount, composition, and microphysical properties of particles from different emission sources – thus assisting the investigation of their impact on air quality, climate and public health.

OU - School of Meteorology

CAPS - Center for Analysis and Prediction of Storms

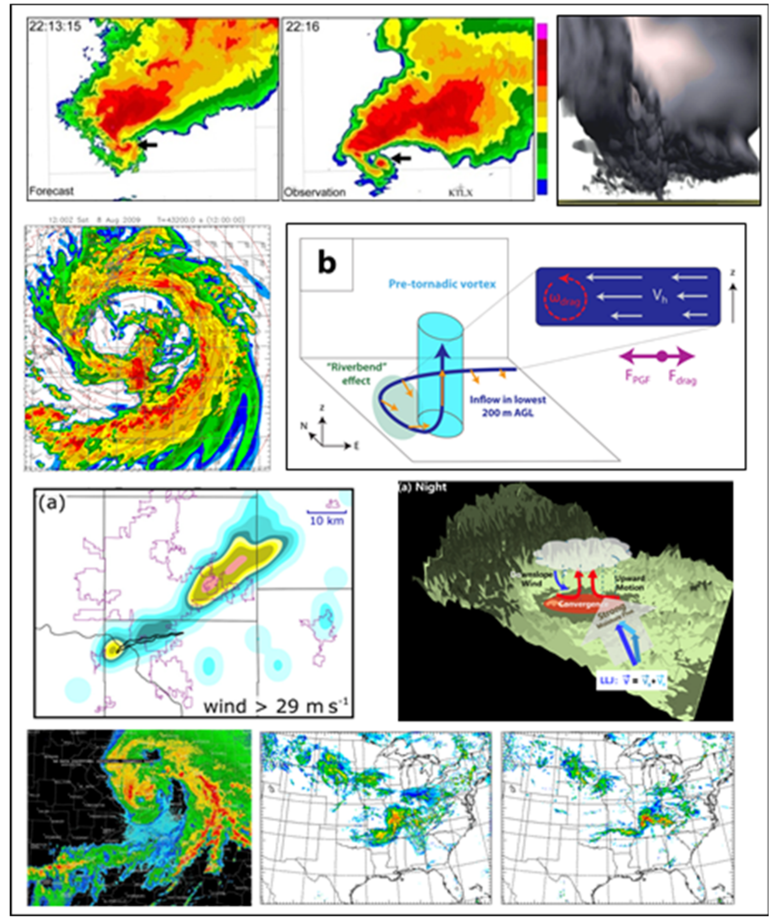
Group Lead: Ming Xue, CAPS Director (mxue@ou.edu)

CAPS (http://caps.ou.edu) is a formal NSF Science and Technology Center. It develops and demonstrates techniques for the numerical analysis and prediction of severe and high-impact (e.g., tornado, hail, heavy rainfall) weather and environmental (e.g., air quality) conditions, with emphasis on the assimilation of observations from remote sensing platforms (e.g., weather radar, satellite), and the development and application of high-resolution prediction models (e.g., ARPS, WRF, FV3).
CAPS also conducts basic and applied research on weather systems ranging from microscales to synoptic scales, weather and environmental forecasting techniques and methods (including AI), regional climate modeling, climate changes and impacts.

Key research themes

- •Severe storm and tornado and dynamics
- •Data assimilation and ensemble forecasting
- •Numerical weather prediction and physics parameterization
- •Simulation, prediction, and predictability of severe and high-impact weather
- •Radar meteorology and precipitation process studies
- •Regional climate, air quality and environmental modeling and climate change impacts

Publications: See complete list at http://twister.ou.edu.



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EMPL: ElectroMagnetics and MicroPhysics Laboratory

Group Lead: Guifu Zhang (guzhang1@ou.edu)

Group members: Lesya Borowska, Junho, Ho, Hadi Saeidi-Manesh, Zhe Li, Nathan Lis, Jiafeng Hu

Key research themes

1. Radar meteorology
2. Radar remote sensing
3. Weather radar polarimetry: principle, technology and applications
4. Cloud/precipitation microphysics and parameterization
5. Wave propagation and scattering in geophysical media

Key references

1. Zhang, G., G. Cao, and M. Du, 2021: Parameterized Forward Operators for Simulation and Assimilation of Polarimetric Radar Data with Numerical Weather Predictions. *Adv. Atmos. Sci.* **38,** 737–754.
2. Li, Z. and G. Zhang, 2021: Similarities and Differences in Clutter Detection Between Electronic Scans and Mechanical Scans with Initial Observations With a Polarimetric Phased Array Radar, *IEEE Transactions on Geoscience and Remote Sensing*, doi: 10.1109/TGRS.2021.3063910
3. Mahale, V. G. Zhang, M. Xue, J. Gao, and H. Reeves, 2019: Variational Retrieval of Rain Microphysics and Related Parameters from Polarimetric Radar Data with a Parameterized Operator, *Journal Of Atmospheric And Oceanic Technology (Accepted),* 36(12), 2483-2500, DOI: 10.1175/JTECH-D-18-0212.1